Buying medicine online: Comparing the convenience, quality, and price of online vs. offline medicine

Mawaddati Rahmi, William Nathanial, Sara Valente de Almeida, Sondang Khairani, Hesty Utami Ramadaniati, Yusi Anggriani, Elizabeth Pisani

Submitted to: Journal of Medical Internet Research
on: May 20, 2024

Table of Contents

Buying medicine online: Comparing the convenience, quality, and price of online vs. offline medicine

Mawaddati Rahmi[1*]; William Nathanial[1*]; Sara Valente de Almeida[2*]; Sondang Khairani[1*]; Hesty Utami Ramadaniati[1*]; Yusi Anggriani[1*]; Elizabeth Pisani[1*]

[1]Faculty of Pharmacy Universitas Pancasila Jakarta ID
[2]Department of Infectious Disease Epidemiology School of Public Health Imperial College London London GB
[*]these authors contributed equally

Corresponding Author:
Mawaddati Rahmi
Faculty of Pharmacy
Universitas Pancasila
Jl.Srengseng sawah, Jagakarasa, Jakarta selatan
Jakarta
ID

Abstract

Background: People buy medicines online for various reasons, such as convenience and cost savings. In Indonesia, the Ministry of Health allows registered platforms to sell medicines online; however, unregistered sellers are still widely circulated. While numerous studies have highlighted the quality of online medicines, comparisons with medicines purchased from licensed physical pharmacies are rare.

Objective: To explore the conveniences of buying medicine online on several online platforms in Indonesia, investigate the quality, and compare the price and quality of medicine bought online to medicine purchased in physical pharmacies.

Methods: The online sellers were categorised by regulatory status, and the conveniences of each were explored. Between February and May 2022, samples were collected from 732 physical pharmacies and 328 online platforms. Quality and price comparisons were conducted across different types of medicine sellers.

Results: Obtaining samples from other online sellers was not always easy. Some platforms have complex registration processes, and we found locating unregulated sellers challenging. Notably, 58.8% of sampled medicines exceeded the median retail price from physical pharmacies for the same dose and form. Branded generic medicines exhibited the widest price variation, ranging from 0.15 to 16.4 times the median offline retail price, while generic medicines ranged from 0.18 to 4.1 times. Regarding quality, the failure rates were 7.9% online and 8.7% offline, showing no significant difference. Among online sellers, unregulated ones had a higher failure rate (11.2%) compared to regulated (3.0%) and semi-regulated (4.5%) sellers. Antibiotics were 2.6 times more likely to fail quality tests than other medicines (13.8% vs. 5.1%).

Conclusions: The conveniences of purchasing medicine online vary among sellers, and prices are not consistently lower than offline sellers. In terms of quality, as long as patients buy medicine online from regulated sellers, they don’t have to worry about the quality of medicines.

(JMIR Preprints 20/05/2024:60723)
DOI: https://doi.org/10.2196/preprints.60723

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**
Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
Only make the preprint title and abstract visible.
No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v
Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http

Original Manuscript

Buying medicine online: Comparing the convenience, quality, and price of online vs. offline medicine.

Mawaddati Rahmi[1*], William Nathanial[1*], Sara Valente de Almeida[2*], Sondang Khairani[1*], Hesty Utami Ramadaniati[1*], Yusi Anggriani[1*] and Elizabeth Pisani[1*] on behalf of STARmeds Study Group
[1]: Faculty of Pharmacy, Universitas Pancasila, Jakarta, Indonesia
[2]: Department of Infectious Disease Epidemiology, School of Public Health, Imperial College London, United Kingdom

Corresponding author:
Mawaddati Rahmi
Faculty of Pharmacy
Universitas Pancasila
Jagakarsa, Jakarta, Indonesia.
Phone: 62 81280729710
Email: mawrahmi@gmail.com

Abstract

Background: People buy medicines online for various reasons, such as convenience and cost savings. In Indonesia, the Ministry of Health allows registered platforms to sell medicines online; however, unregistered sellers are still widely circulated. While numerous studies have highlighted the quality of online medicines, comparisons with medicines purchased from licensed physical pharmacies are rare.
Objective: To explore the conveniences of buying medicine online on several online platforms in Indonesia, investigate the quality, and compare the price and quality of medicine bought online to medicine purchased in physical pharmacies.
Methods: The online sellers were categorised by regulatory status, and the conveniences of each were explored. Between February and May 2022, samples were collected from 732 physical pharmacies and 328 online platforms. Quality and price comparisons were conducted across different types of medicine sellers.
Results: Obtaining samples from other online sellers was not always easy. Some platforms have complex registration processes, and we found locating unregulated sellers challenging. Notably, 58.8% of sampled medicines exceeded the median retail price from physical pharmacies for the same dose and form. Branded generic medicines exhibited the widest price variation, ranging from 0.15 to 16.4 times the median offline retail price, while generic medicines ranged from 0.18 to 4.1 times. Regarding quality, the failure rates were 7.9% online and 8.7% offline, showing no significant difference. Among online sellers, unregulated ones had a higher failure rate (11.2%) compared to regulated (3.0%) and semi-regulated (4.5%) sellers. Antibiotics were 2.6 times more likely to fail quality tests than other medicines (13.8% vs. 5.1%).
Conclusions: The conveniences of purchasing medicine online vary among sellers, and prices are not consistently lower than offline sellers. In terms of quality, as long as patients buy medicine online from regulated sellers, they don’t have to worry about the quality of medicines.
Keywords: internet pharmacy; online medicine; online pharmacies; substandard medicines; poor-quality medicines;

Introduction

Background

Recent research has found that the sale of medicines through websites or mobile phone applications increases patients' access to medicines; people buy medicines online because they perceive it to be cheap and convenient compared to buying the same products online, while simultaneously providing greater choice and autonomy (1–5). Online outlets may also provide an alternative for people who want or need medication, but who have no access to legitimate healthcare channels or prescriptions (5–7).

Researchers also report downsides to online sales of medicines. If patients buy medicines without adequate consultation with a doctor or pharmacist, they may take incorrect medicines or incorrect doses, increasing the risk of adverse reactions, overdose, or therapeutic failure (5,7–11). The quality of medicines bought online has been questioned by many(1,6,12,13), and shown to be poor by some (14–18).

This study explored the online medicine market in Indonesia, the world's fourth most populous country and one of the fastest-growing e-commerce markers. We measured convenience and price and tested for quality, comparing medicine samples bought online to those purchased in physical pharmacies.

Methods

Study context

Indonesia has one of the highest mobile phone ownership rates in the world and is home to the fastest-growing e-commerce sector in Southeast Asia, with a large variety of indigenous marketplace platforms and applications (19,20). In order to sell medicine online, pharmacies or aggregators in Indonesia are required to obtain approval from the Ministry of Health (MoH). At the time of our research (2022), only seven groups had registered. However, the MoH itself encouraged patients to buy online from other, unregistered groups, in order to overcome the difficulties posed by COVID-19-related restrictions on movement (21). This has resulted in some confusion about the regulatory status of different sellers.

For post-market surveillance activities, Indonesia's national drug regulatory agency BPOM does not sample from online sellers or apps, although the investigation division does search online for narcotics and other medicines prone to off-label use(19).

The study of online medicine sales was embedded in a larger study known as STARmeds, in which we collected and tested 1274 samples of allopurinol, amlodipine, amoxicillin, cefixime, and dexamethasone. Detailed methods, including details of the choice of medicines and sampling areas, sampling design, data collection and handling, laboratory testing and ethical considerations are reported elsewhere in accordance with MEDQUARG reporting guidelines (22,23). We summarise key points briefly here.

Sampling Design

We collected medicine samples from all the main outlets from which Indonesians obtain common essential medicines: pharmacies, over-the-counter medicine shops, primary health centres, public and private hospitals, doctors and midwives, as well as online stores. All physical outlets were randomly selected from verified listings in seven sampling areas, chosen purposively to reflect Indonesia's geographic, economic, and demographic diversity: Greater Jakarta and an urban and a rural district in Western, Central and Eastern Indonesia (Medan/Labuhan Batu; Surabaya/Kabupaten Malang; and Kupang/Timor Tengah Selatan respectively).

Mystery shoppers bought 684 medicines samples from physical retail outlets, and we sampled

another 263 samples overtly from health facilities. We also bought 328 samples online.

Online sampling

We mapped online sellers in the Indonesian market. First, we consulted the Ministry of Health website and listed the sellers that were listed as online sources for COVID-19 medicines. Second, we searched for mobile applications from the play-store with "*beli obat*" (buying medicine) as the keyword and added applications to our list. Finally, we added sales platforms/outlets that appeared when we searched Google with the keywords "buy medicine" or "buy [medicine name]."

There are only seven platforms that are regulated sellers, which means they've registered with the Ministry of Health to sell online medicines. Due to the pandemic, some covid-medicine sellers have not registered as approved medicines sellers and the classification is still based on the general regulatory status of online medication sales.

Among the registered seller platforms, three were apps using geo-positioning to arrange instant deliveries from physical pharmacies (similar to food-delivery platforms in many cities worldwide) (24). Two of these, Halodoc and Grab, sourced products from participating independent or chain pharmacies. The third, K24klik, was sourced only from its nationwide chain of franchised K24 pharmacies. The remaining four approved platforms accept orders through websites but do not use geopositioning to source products for instant delivery. Two were
individual pharmacies (Alodokter & Lifepack) while the other two were relatively small chains (Mandjur & Viva). All licensed online sellers must verify that patients have prescriptions before selling prescription-only medicines; four of the seven provided paid consultation services and issued prescriptions in-app.

In practice, medicines are also sold from individual stores within general online marketplaces (similar to Amazon or Alibaba in other countries), as well as from unapproved websites which specialise in medicine sales. Table 1 shows the product type for each platform.

Table 1: Type product per platform

Platform	Source of medicines	Products sold	Offering consultation	Prescription requirement
Halodoc	Participating pharmacies[a]	Medical and health services	√ Paid consultation	√
Grabhealth	Participating pharmacies[a]	Medical and health services	√	√
K24klik	K24 chain pharmacies[b]	Medical	√	√
Alodokter	Unsure[c]	Medical and health services	√ Paid consultation	√
Lifepack	Unsure[c]		X	√
Mandjur	Single pharmacy	Medical	X	√
Viva	Viva chain pharmacies[b]	Medical	X	Depends on medicine
Tokopedia official seller	Multiple individual pharmacies	Medical	X	Depends on seller
Tokopedia, unregulated	Multiple individuals	General marketplace	X	Depends on seller
Shopee	Multiple individuals	General marketplace	X	X
Lazada	Multiple individuals	General	X	X

		marketplace		
Bukalapak	Multiple individuals	General marketplace	X	X
Blibli	Multiple individuals	General marketplace	X	X
Medicastore	Unsure[c]	Medical	X	√
Farmaku	Unsure[c]	Medical	X	√
Instagram	Multiple individuals	Social media	X	X
HDmall	Unsure[c]	Medical and health services	X	Varies

[a]The platform has more than one seller that participates in selling medicine. It is shown in the package we received and the choices of sellers on the platform catalase.
[b]One giant pharmacy with many branches spread everywhere
[c]There is no information about sellers for this platform, and even on the package, there is no name of the store that sent the package to us. The platform may have warehouses.

Tokopedia, Indonesia's largest internet marketplace, was not approved to sell medicine at the time of data collection. However, the platform collaborated with other parties to verify potential sellers' licenses to sell medical products, awarding them a purple tick logo and designating them as verified sellers of medical products. Verified sellers are primarily the online stores of physical pharmacies. We classified this category as semi-regulated, unless they also carried the logo of one of the MoH-approved platforms, indicating they were officially regulated.
We classified the following sellers as unregulated: unverified individual sellers on Tokopedia; anyone selling medicines on other general marketplace platforms; anyone selling medicines through social media apps; and internet sites specializing in medicine sales that are not MoH-approved. Table 2 summarises our classification.

Table 2 Medicine sellers classification on STARmeds study

No	*Sellers classification*	*Platform name*
1	MoH-approved sellers :	
	a. Instant delivery	Halodoc, K24klik, Grab
	b. Non-Instant delivery	Viva, Madjur, Lifepack, Alodokter
2	Semi-regulated	Tokopedia verified sellers
3	Unregulated	
	a. Pharmacy	HdMall, Farmaku, Medicastore
	b. Non-pharmacy	Tokopedia unverified sellers, Shopee, Lazada, Blili, Bukalapak, Instagram.

Sample frame

We included medicines from sellers using geopositioning and instant delivery in the daily sampling plans of sample collectors in all regions where those services were available.
We also attempted to buy from semi-regulated and unregulated online sellers in all regions, distributing target samples by medicine and branded status. We adopted a take-all approach to apps and platforms, attempting to sample from all those listed in our mapping (see Table 1). On Tokopedia, which had both official stores (semi-regulated) and unregulated sellers, we proactively targeted samples from both types of sellers. We could not randomise at the level of the individual store or seller because we could not list all individual sellers on each site.

Searching and purchasing

We collected samples of medicines, both online and physical, from February to May 2022. For online sampling, we provided data collectors with an individualised sample frame listing the target platform (and seller-type; regulated or unregulated, if relevant), as well as the medicine, formulation and dose for each sample. Branded status (branded or unbranded generic) was also included in the sample frame for buyers from geo-positioned apps.

Buyers from other online platforms and seller types were instructed to prioritise a diversity of brands or (for unbranded medicines) producers, and price points. We provided symptom-based scenarios to help in consultations or chatting as necessary, as well as search keywords and images (Tokopedia and Shopee allow for searching based on product images). Search words included the medicine name, spelt both correctly and incorrectly; common informal terms (e.g. amoks, purinol); and locally well-known brands, also in correct and incorrect spellings.

Sample collectors were instructed to use the chat function, if available, to contact the seller and ensure that the target product and volume were in stock. Samples were sent to several addresses for security purposes and to prevent suspicion.

All shoppers were provided with prescriptions matching their sample frame (written with molecule rather than brand names), but were instructed not to use them unless specifically requested by the seller (a procedure we also used on offline sampling).

Record keeping

Data collectors recorded the whole sampling process, both in a spreadsheet and using a smartphone-based data entry form. They recorded the keywords used, medicine and brand ordered, drug form, strength, number of samples ordered, price paid, seller name, location, and delivery cost. Data collectors recorded the time spent shopping (including chatting) and the interval between order and delivery. Orders that did not make a successful purchase (for example, because after chatting, the product proved unavailable, or because the wrong product was sent) were still recorded to help measure convenience. We additionally downloaded all platform-based records of successful and unsuccessful purchase attempts, many of which include time stamps.

The data collection form evolved over time as we gained experience with the challenges of online sampling. For this reason, some information used in measures of the convenience of online shopping was thus not recorded for earlier samples (or aborted purchases).

Data analysis

Convenience

Qualitative and quantitative measures were used to estimate the convenience of purchasing medicine online based on data collector's records during the sampling process. The variables used to estimate convenience are shown in Table 3.

Table 3 Variable list to measure conveniences

	Characteristic of the conveniences	*Variable*
Qualitative	How easy is it to find a sample	Easy/Medium/Hard
	Number of sellers on one platform	Not sure/One/Limited/Many
	Type of products sold	Medical/ Medical & health services/ Various
	Offering consultation	Yes/No
Quantitative	Time searching	The time required to search for the samples, calculated from opening the application/website until the order was

		made
	Average searching time	The weighted average time required to search for the samples by all searching times, in every type of sellers
	Delivery time	Time taken for the sample to be delivered, calculated from the time made an order to package delivered to the designated address.
	Average delivery time	The weighted average time required for the sample to be delivered by all delivery times, in every type of sellers
	Success rate	The number of samples collected compared to the number of attempted to-buy samples
	Accuracy rate	The accuracy of the sample that has been ordered vs. the sample that was received: Yes, if accurate, and no, if there was a difference in number/brand/active ingredient/manufacturers/ nie-holder.
	Success rate	The number of samples collected compared to the number of attempted to-buy samples
	Prescription requirement	The number of sellers asking for prescriptions as a requirement for buying medicine

Price

We calculated the price of online medicine by the price of the sample plus shipping costs, divided by the number of smallest units in the sample (single tablet or capsule, or, for syrups, per 5ml). If there were multiple medicines in one transaction, the shipping cost was divided across the number of units purchased in that transaction.

To allow for comparison between medicines with different base prices, we calculated the ratio of the sample price to the median retail price of all samples of that medicine (by active ingredient, dose and formulation) bought offline. We similarly calculated the average offline price by unique product (active ingredient, dose, formulation and brand), to allow for a comparison of prices for the identical product. Data analysis was conducted using STATA 18(25). The study data, data cleaning and management code were published in the study archive(23).

Quality

Samples were tested for identity, assay (% of labelled active ingredient), dissolution and uniformity of assay in a private ISO/IEC 17025: 2017 certified laboratory in Jakarta, using United State Pharmacopeia (USP) reference standards and USP 43, NF38 monographs(26). Exceptionally, because USP has no monograph for cefixime capsules, we used the Chinese Pharmacopeia for that formulation, in accordance with the suggestion of Indonesian Pharmacopeia VI (27). A sample was considered out of specification if it failed any test to which it was subjected.
We calculated the raw prevalence of failure (number failing any sample divided by the number of samples, x 100) for online and offline samples, examining differences using a Pearson Chi-Squared test.

Authenticity

We contacted all market authorisation holders, provided them with high-definition photos and data from each sample of their products, and asked them to verify that batch and expiry date combinations

printed on the primary packaging of individual samples matched their production records. If companies reported that batch numbers were falsified or expiry dates did not match batch numbers, we considered the sample falsified, regardless of the results of compendial testing. We report separately on falsified samples; they are not included in our definition of substandard medicines.

Ethics

We discussed the study design with the Indonesian medicine regulator BPOM before finalising it. We obtained ethical approval from The University of Indonesia with reference number KET-970/UN2.F1/ETIK/PPM.00.02/2020, September 7th 2020, with the extension letter on September 13th 2021; S-736/UN2.F1/ETIK/PPM.00.02/2021, and from Imperial College Research Ethics Committee (reference number 21IC7265 on November 16th, 2021). The District Health Department in every sampling area provided written approval for the research.

Results

Sample distribution

We managed to collect medicines from 16 platforms, buying from a total of 165 different vendors. Of a total of 327 samples bought online; 91 were unbranded generic medicines, while 237 were branded generics. 72% came from sellers based in Greater Jakarta, as shown in Figure 1. We found no online sellers based in or near our sampling areas in rural North Sumatera (Labuhan Batu district), or the eastern province of East Nusa Tenggara, with the exception of two K24 franchise pharmacies in Kupang which sold through an instant delivery app. We did not buy from them online because they had already been included in our random selection of outlets for offline samples. While sellers on Tokopedia or other general sales platforms based in other areas would deliver to these regions, we found none that could deliver in less than a week.

Quality

There was no significant difference in quality between online and offline medicines, with the percentage of samples failing quality tests being 7.9% online and 8.7% offline (p=0.66, data provided in Table 4). Among online sellers, samples collected from unregulated sellers were significantly more likely to fail the test than those from regulated and semi-regulated sellers (11.2% vs 3.0% vs 4.5%, p=0.03). Antibiotics were more likely to fail the test compared with other medicines both in online and offline as shown in Figure 1.

Table 4. A percentage of samples that failed the quality test results in the STARmeds study, based on seller's classification.

	Online sellers				*Offline sellers*
Sellers Classification:	MoH approved sellers	Semi-regulated sellers	Unregulated sellers	*Total*	
Allopurinol (fail/tested)	0% (0/20)	0% (0/16)	7.0% (3/43)	3.8% (3/79)	7.5% (12/160)
Amlodipine (fail/tested)	0% (0/20)	0% (0/10)	0% (0/10)	0% (0/61)	3.1% (4/129)
Amoxicillin (fail/tested)	9.1% (1/11)	14.3% (1/7)	8,2% (4/49)	9.0% (6/67)	8.9% (14/157)
Cefixime (fail/tested)	5.9% (1/17)	33.3% (1/3)	43.8% (14/32)	30.8% (16/52)	15.8% (18/114)

Dexamethasone (fail/tested)	3.4% (1/29)	0% (0/8)	0% (0/31)	1.5% (1/68)	9.7% (12/124)

Convenience

We report the convenience of buying online by the following parameters: registration on the site; searching for and confirming the product's availability; placing an order and having it accepted; and delivery times.

Registration

All identified sites required buyers to register before completing a transaction, providing, at a minimum, name and phone number or email for verification. Regulated instant delivery sellers asked for a new client’s address via geopositioning before finalising the account registration.

Searching for products

Ease of searching and product confirmation varied greatly by target platform type. All MoH-approved sites could be easily searched using correct medicine names, in either their international or Indonesian spellings (e.g. amoxicillin, amoksisilin), and products were easily found, although the variety was limited and expensive brands were over-represented.

Though the geo-positioned sites did not all use chat functions, they generally confirmed sales rapidly. The K24klik app, however, often aborted sales, apparently after searching branches near the buyer's location and finding no stock of the ordered product. Other government-approved sellers were generally unresponsive; we failed to buy any samples from at least one approved store.

A Google search using the correct medicine name would most often lead either to an "official store" on the Tokopedia platform or to a regulated medicine marketplace. Both offered both branded and unbranded medicines. In the case of medicines sold by unregulated sellers, the name of the medicine is often misspelled. Sometimes, we use Google search to find the right keyword for medicine sold by unregulated sellers.

Searches based on correct medicine names entered directly on the Tokopedia platform generally yielded thousands of offers from different official stores, overwhelmingly based in Java (which accounts for 7% of Indonesia's land mass but is home to 60% of its 280 million people), especially the Greater Jakarta region. It was also exceptionally easy to find specific brands of medicines, as well as unbranded generics from specific manufacturers. Sellers usually responded quite rapidly through the platform's built-in chat function, a behaviour incentivised by the widely used in-platform rating system.

Our experience buying from unregulated medicine marketplaces was mixed. While marketplaces often came up in Google search results, finding specific medicines on the sites was not straightforward, and advertised products were often unavailable. While sellers were responsive on chats, they sometimes provided incorrect information about products,

Finding unregulated sellers on Tokopedia, and identifying sellers of prescription medicines on other general marketplaces, was much more difficult. One strategy involved jumping through pages to the later pages of a search (ordered by the default "Best Match", 60 results per page), starting, for example, on page 75 or 80 of the search results. Once we identified an unregulated seller, we harversted their keywords and images, using those in future searches. We also entered their stores, searching for other study medicines. Unregulated sellers frequently used apparently deliberately misspelled keywords. From the photgraphs they post and our chatting experience, it appears that unregulated sellers do not aspire to sell a full range of products, and may be selling products they have acquired opportunistically, such as over-stock. Unregulated sellers posting individual products

sometimes have similar names, such as "Always_Healthy2" and "Always_Healthy3" (Tetap_Sehat2; Tetap_Sehat3) that sometimes tag one another indicating that the same seller may be selling from multiple "stores" on the same platform. Table 5 shows the different outcomes of searches on Tokopedia using different search terms.

Each platform has advantages and disadvantages (see Table 6). Overall, regarding brand variation and the general process of searching for medicines, we found that semi-regulated sellers were the most convenient for patients.

Table 5. Sampling opportunities for unregulated sellers on Tokopedia

Medicine/ Brand name	*Keyword*	*Total Found*	*Total Page*	*Number of unverified Seller*	*Page Number of the un-official seller found*	*Notes*
Allopurinol	Allopurinol[a]	5098	85	0	0	all is the official store
	Purinol[b]	30	1	10	1	
Zyloric	Zyloric[a]	2619	44	7	43	
	Ziloric[b]	23	1	17	1	
Amlodipine	Amlodipine[a]	11k+	194	0	0	all is the official store
	Amlo[b]	165	3	19	1	
Norvask	Norvask[a]	2261	38	0	0	all is the official store
	Norfas[b]	1	1	1	1	
Amoxicillin	Amoxicillin[a]	3578	60	0	0	all is the official store
	Amoks[b]	3	1	3	1	
Amoxsan	Amoxsan[a]	4380	75	0	0	all is the official store
	Amoksan[b]	6	1	3	1	
Cefixime	Cefixime[a]	3382	57	0	0	all is the official store
	Sefiks[b]	1	1	1	1	
Cefspan	Cefspan[a]	876	15	0	0	all is the official store
	Cesfpan[b]	3	1	3	3	
Dexamethasone	Dexamethasone[a]	2130	36	0	0	all is the official store
	Deksa[b]	263	5	16	1	5 pages containing 263 items for the keyword “deksa”, where 16 items branded medicine for dexamethasone found from the unregulated seller, 71 clothing items, and 176 other medicine produced by a manufacturer named “dexa”

Note: [a] a correct name [b] an incorrect name

Table 6. Pros and cons of the online market platform

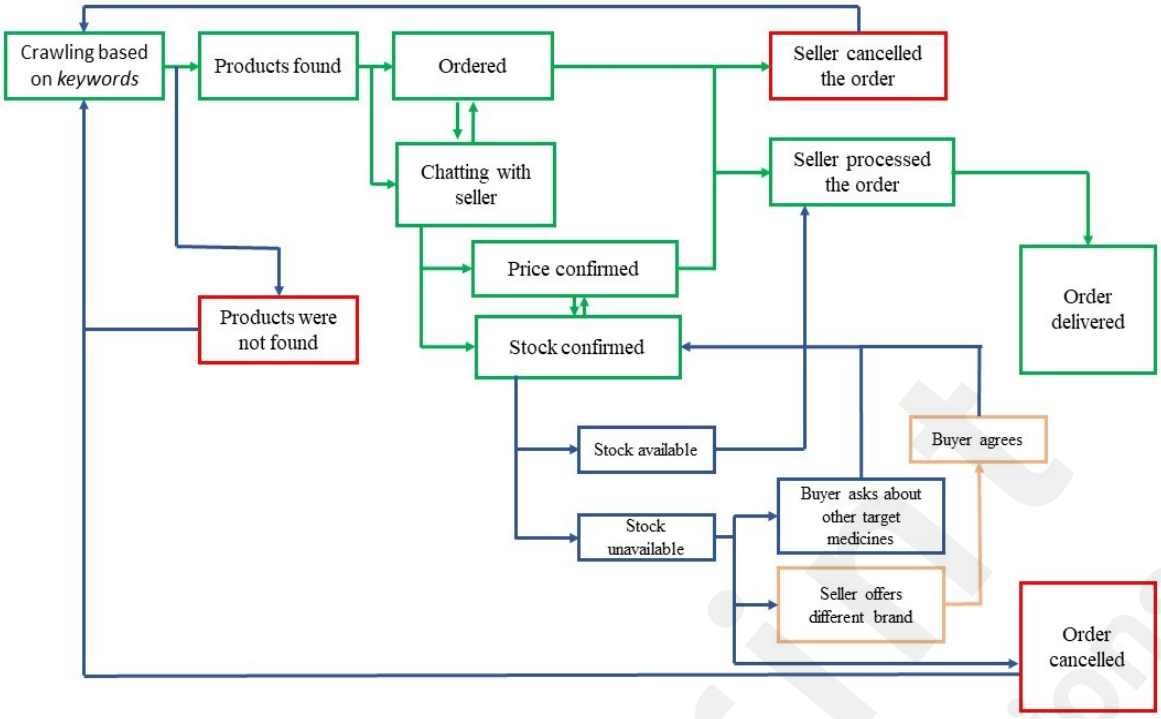
Sellers clasification	Convenient	Less convenient
1a. Regulated instant-delivery	Easy to register	Limited product variation

Sellers clasification	Convenient	Less convenient
	Easy to find medicine Fastest delivery time	Generally expensive Prescription required Frequently requires paid consultation
1.b. Regulated non-instant delivery	Fast delivery time if stocks were confirmed.	Some use complex registration processes Limited product variation Limited stocks Slow response times
2. Semi-regulated	Easy to register Easy to find medicine Wide price variation Many brand variation Many sellers Choice of shipping times, sometimes free Prescription rarely required	Seller response uneven Buying multiple medicines in one transaction depends on the sellers-stock. Product display information is often limited and sometimes inaccurate
3.a. Unregulated medicine-specific platform	Direct contact with sellers so can change the order or buy multiple medicines in one transaction	Some have a complex registration process Hard to find target medicines Stock are limited Prescription requirements are strict sometimes Limited and inaccurate product information
3.b. Unregulated non-pharmacy	Easy to register Direct contact with sellers so can change the order or buy multiple medicines in one transaction	Hard to find target medicines Stock are limited Product display information is often limited and inaccurate

Ordering and delivery

Once a product is identified, the focus on convenience shifts to ease of transaction. Even after a medicine has been found online, there are many points at which the purchase can fail, as illustrated in Figure 1, which shows the flow of buying medicine on online shopping platforms in Indonesia.

Figure 1. Buying medicine on online shopping platforms flowchart



Product availability affects the time taken to search, as sellers can unilaterally cancel orders if stock is not available. Occasionally, the price changed after we ordered the product; the seller contacted us with a proposed higher price, cancelling the sale if we did not agree. This was especially likely among unregulated sellers, both on general market-places and on pharmacy-specific platforms.

In the latter case, the seller generally presented two options: they offered either to search for the stock in their warehouse, which would take additional time or propose an alternative brand of the same medication.

Capturing the time from browsing to final delivery was challenging because of the spread of chat intervals and the samples were sent to multiple addresses for security reasons. We were able to record timing data for 124 successfully-acquired samples fully. Table 7 summarises the convenience of those samples. It excludes the time spent searching for products that were ordered but never delivered (aborted sales), which will be discussed below.

Table 7. Indicators for the conveniences of buying medicine on each type of seller

Convenient variable	Regulated sellers		Semi-regulated sellers	Unregulated sellers	
	Instant-delivery	Non-instant delivery		Pharmacy	Non-pharmacy
Time from initial searching to the transaction was made in average (range of days) (n=124)	2.7 (0-8)	0 (0-1)	0.4 (0-1)	2.8 (1-8)	0.7(0-12)
Time from transaction to delivery in average (range of days) (n=93)	0.5 (0-4)	0.75(0-3)	1.4(0-2)	2,0 (1-3)	2.2(0-5)
The success rate of transaction	56.7%	63.0%	57.0%	66.0%	53.4%
Prescription requirement	53.7%	35.2%	40.0%	22.8%	11.2%

As reported above, one "instant delivery" seller, which also accepted orders through its website rather than the geo-positioned app, was inconsistent in their sourcing of products, sometimes

delivering only days after the order was placed. If we look just at the two purely geo-positioned apps, the delivery time for instant-delivery sellers reduces to an average of 0.6 days.

For other seller types, delivery time depended largely on shipping options available and choices made at check-out. Most semi-regulated sellers in the metropolitan areas of Medan, Greater Jakarta and Surabaya offered instant-delivery and same-day shipping options to buyers in those areas. Delivery from unregulated sellers took the longest (up to 7 days).

We recorded 553 purchased medicine attempts. Among these recorded attempts, 59.3 % were unsuccessful, and 328 samples were collected from 159 transactions. Table 8 gives examples of reasons for the failures recorded by data collectors.

Table 8. Shopping experience during purchasing medicine online in STARmeds study

Seller	Quote from data collector:
Regulated Instant delivery	*I ordered (brand) Anfix; then the seller called to offer Simfix at the same price.*
	First, purchasing 4 medicines at once was possible but was cancelled by the seller. Finally bought one by one.
	Orders can be changed via chat with the admin. Allopurinol is available from only one manufacturer
Semi-regulated	*The pharmacy sells at 2650 per strip, then they called and said we have to add (money) up to 4240 per strip.*
	We can easily order (click) the items we want, but the seller's response is to cancel the order.
Unregulated pharmacy	*I tried to register on PlazaMedi platform and was successful. But unable to shop because I did not receive an email to verify my account. I tried again and still had the same result.*
	I ordered branded dexamethasone from HDmall and paid for it online. The seller telephoned me to say that the requested brand was unavailable. They suggested substituting another brand, Dexteem. I asked if it was as good as the brand I had ordered. They assured me it was the same product and quality and that I would benefit because it was cheaper than the brand I had ordered. When it arrived, it turned out it was a combination medicine, not exactly the same as the target.
	Purchasing 40 tablets of Alluric, arrived 150 tablets of Allofar.
Unregulated non-pharmacy	*Delivery takes too long. Each batch (number) on the strip (which arrived) is different, and there are signs as if it has been thrown and stepped on, and some capsules appear broken in the packaging. The packaging was damaged and almost torn.*
	the search must be specific and sometimes use a unique code.
	I ordered 70 tablets of amlodipine (produced by) Novell, arrived 60 tablets of amlodipine (produced by) Novell + 10 tablets of amlodipine (produced by) Rama
	Order and payments have to move to WhatsApp. if I want to go through the platform, it's much more expensive.

Accuracy of order fulfilment

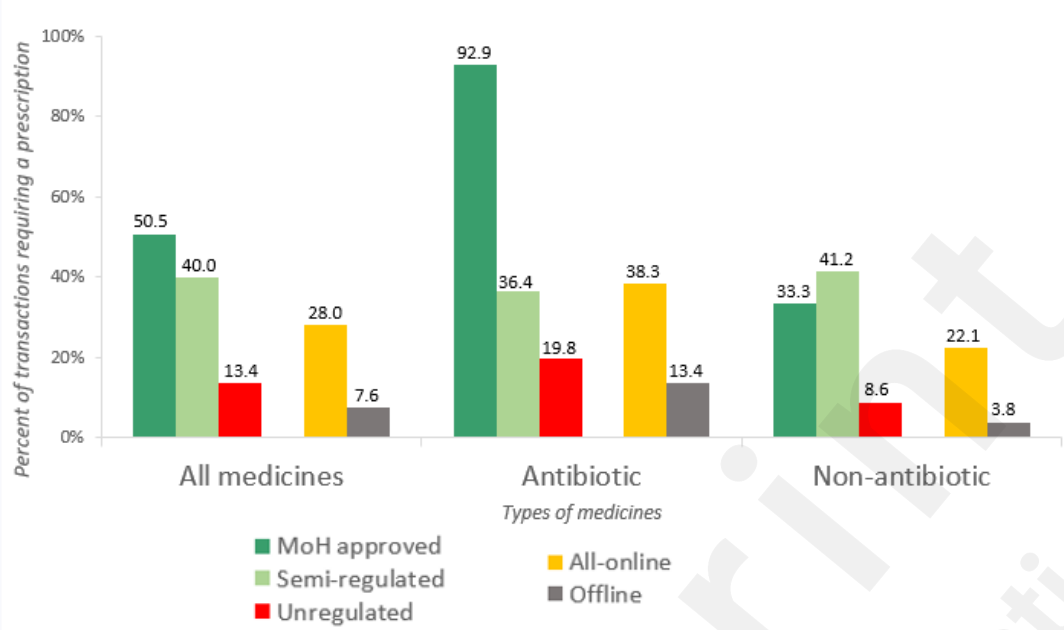
As indicated in Table 8, many deliveries did not match orders. In 14 cases, there was a discrepancy in the volume of medicines (number of pills) received compared to what was ordered or expected. For instance, we ordered (or thought we were ordering) a four strips containing 10 pills each, but instead received four boxes containing 100 (and sometimes 200) pills for the same price. 16 medicines were of brands other than those ordered, and in 7 cases, we medicines (active ingredients) and doses that differed from those originally ordered, posing potential health risks to patients.

Prescription requirements

Indonesian regulations require that all the medicine sampled in this study be sold only against a doctor's prescription. In practice, we were required to upload prescriptions for 28.1% of successful online transactions. In sales of the same medicines in physical pharmacies and medicine shops in the

larger STARmeds study, the proportion requiring prescriptions was 7.6% ($p<0.00$). Further details, including antibiotic status, are provided in Figure 2.

Figure 2. The prescription requirement in the STARmeds study, based on the seller's classification and medicines types.



In general, MoH-approved and unregulated sellers on pharmacy-specific platforms responded to the prescriptions we uploaded, while semi-regulated sellers did not, even when the prescription was not valid (for example, a photograph of a pet).

When valid prescriptions were uploaded, we did not always receive the prescribed volume of medicine. In some cases, this was because of system-imposed limits on antibiotic sales. Other regulated sellers required their own doctors to issue prescriptions, usually for an extra fee. For example:

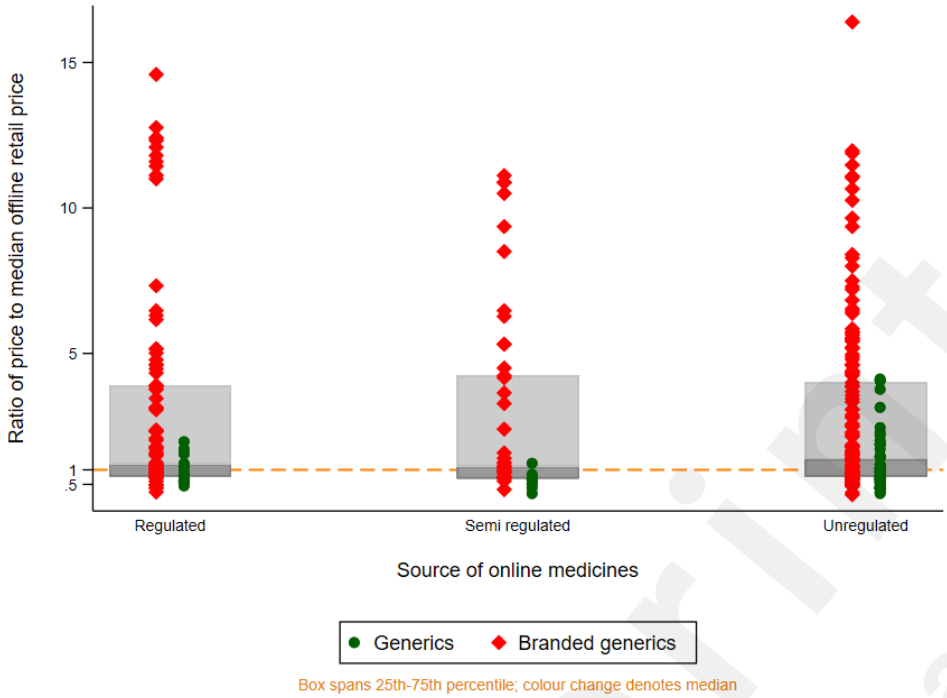
1) Registered site Alodokter obliges users to undergo a paid consultation, even if they have already uploaded a doctor's prescription. The seller asked why we attempted to buy that medicine and for details of the patient and symptoms. At the end of the consultation, they provided a new prescription, occasionally for a different medicine. The platform only allowed purchases according to that prescription.
2) On the registered instant delivery site Grabhealth, the system limits antibiotic purchase to 20 tablets -- less than many common courses of antibiotics. However, we were able to upload the same prescription (for 40 tablets) twice in back-to-back purchases from the same seller.
3) HDmall, at the time of the study an unregulated medicine-specific sales platform, limited customers to purchasing only 10 antibiotics tablets on their website. However, data collectors successfully negotiated with the seller through WhatsApp, placing an order for 50 antibiotic tablets.

Price

We analysed the price within the medicine (same medicine, same dose and same form, but potentially different brands), comparing the prices we paid online with the median retail price paid offline. 58.8% of our online purchases were more expensive than the median offline price, of which 51.1% were unbranded and 74.3% were branded medicines. Among the online sellers, unregulated sellers had the most samples with prices above the median retail price, both in branded and unbranded generic medicine (78.2% & 55.5%). This could be due to the uneven distribution of samples from each seller. Branded generic medicines had the widest price variation, (range: 0.15 to 16.4 times the median offline-retail price). Unbranded generics ranged from 0.18 to 4.1 times the

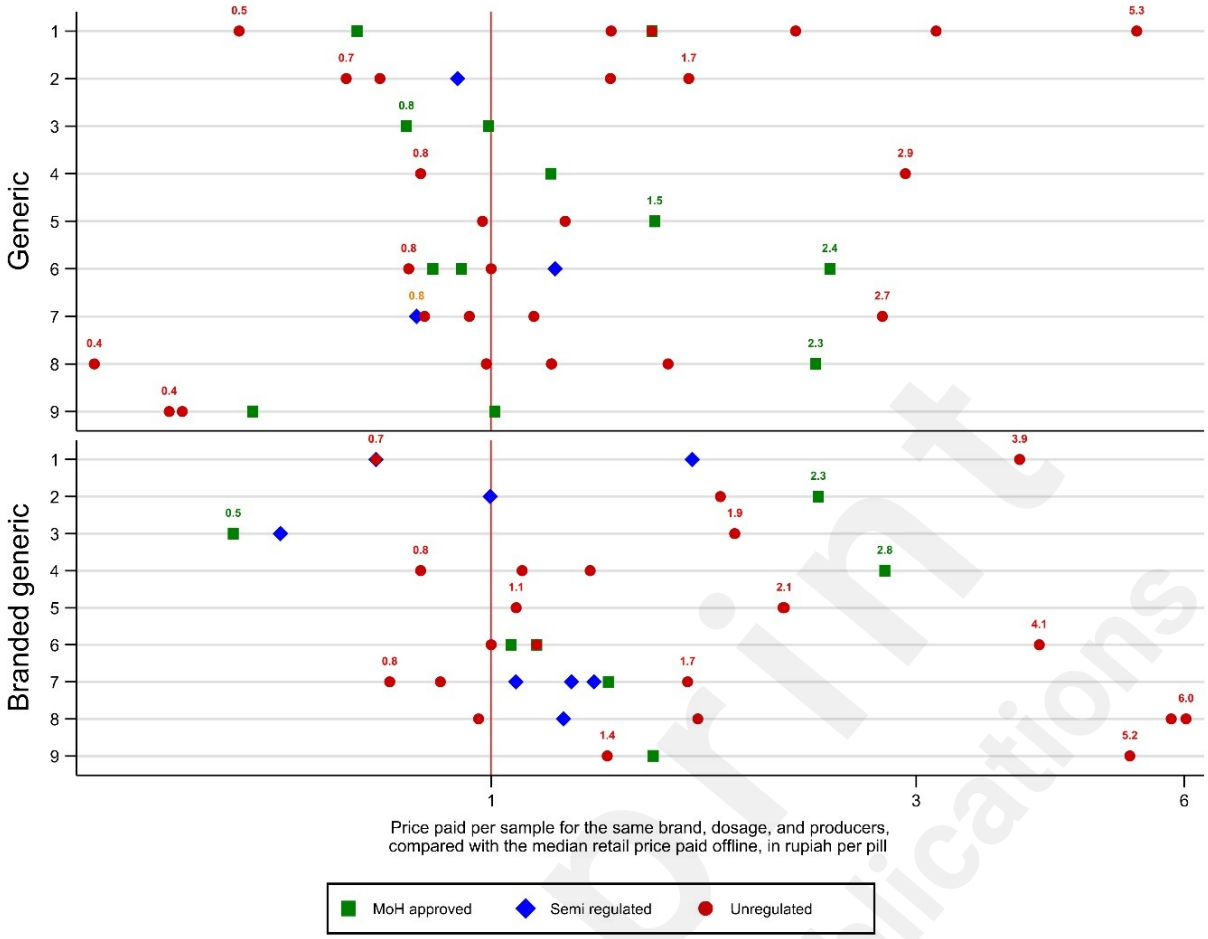
offline median. Figure 3 shows how prices vary.

Figure 3 Price paid per sample compared to the median retail price of medicine paid offline for the same active ingredient, dose and formulation.



We were also able to compare online and offline prices for 33 brands or manufacturer-specific unbranded generic -- a total of 229 samples. Of these, 43.67% sold online above their median offline retail price. Those with the most samples are shown in Figure 4. The price of the same brand in unregulated sellers has broader price variation, both in generic and non-generic (0.2 – 6.1 times the median offline-retail price), and the MoH-approved sellers had the narrowest price variations (0.5 – 2.7 times the median retail price offline for the identical product).

Figure 4. The ratio of price paid per sample compared with the median retail price paid offline for the identical brand, manufacturer, dosage and formulation.



Authenticity

We contacted all 78 pharmaceutical companies authorised to sell any of the products collected in our study. We provided them with details of each sample of their medicine collected (batch number, expiration date and maximum retail price printed on the packaging) along with high-resolution photographs, and requested that they verify that these details matched their production records. 51 pharmaceutical companies verified a total of 569 samples (42.7% of all 1333 samples collected, and 44.7% of those tested for quality.) These included 157 samples bought online (47.9%). A total of 21 samples were confirmed as inconsistent with production records: 6 samples had falsified batch numbers, and 15 had expiry dates inconsistent with the batch number We also bought an additional sample of a locally-authorised brand, but packaged for a market other than Indonesia. Of the 22 illegal or confirmed falsified products, 17 were purchased online, 16 of them from unregulated sellers. Ten of the 17 passed quality tests.

Discussion

In a 2017 report on substandard and falsified medicines based on an analysis of cases reported to its medicine quality surveillance database, the WHO warned that internet sales provided a door through which substandard and falsified products could easily reach patients(28). Other authors have confirmed the risk(5,29). This study shows that the risk is particularly high if the medicine is bought from an unregulated seller. However, when looking at the general picture of product quality (which means in a chemical aspect), there was nothing to worry about as long the medicine was bought from legitimate online sellers.

Previous authors have suggested that online medicine sales may increase the availability of medicines to people in remote areas, or with limited access to physical stores(30). We did not find this to be true in geographically remote areas in Indonesia. Indonesia was known as a country of a thousand islands, so the development of online shopping in Indonesia was impossibly the same in each region and island. It depends on internet access coverage and quality (31). Online sales in Indonesia are concentrated on Java island, especially in Greater Jakarta (Jakarta, Bogor, Depok, Tangerang, and Bekasi)(31). No wonder because 95% of pharmaceutical industries were established on Java island(32). However, the failure to sample online medicines in the three districts in this study does not mean buyers from these areas cannot obtain medicines online at all. It only indicates that the number of online sellers was very limited in those areas. However, people still can purchase medicine online with the consequence that it will take longer delivery time compared with if the seller was available in these areas. Moreover, limited options in seller types pose challenges, where locating regulated sellers may prove impractical in remote rural areas.

The purchase of medicines from unregulated sellers was found to be comparatively difficult in comparison to other online medicine sellers. Patients will simply not take more time to go page by page to find what they want, let alone deliberately search for medicines sold by unregulated sellers, especially using the street name of the medicine. They will switch to alternative platforms if they face challenges when searching for medicines, such as facing a complicated registration process, requesting prescriptions they do not have, not finding the brand of medicine they want, or not being able to contact the seller. In contrast, regulators do not have the same freedom to seek other options. Although the time spent searching for medication does not significantly impact the patient's perspective, it has significant weight for regulators in conducting sampling activities.

The waiting time to receive the medicine is critical because people buy medicines to cure their illnesses, which differs from the regulatory purpose. They certainly hope to get the medicine quickly. The waiting time for online medicines may not be a problem if the patient is buying the medicine as a preparation or to replenish the stock of their usual medicine, as indicated by Fittler et al research in Hungary in 2018(30). However, if the medicine is an immediate treatment for the current illness, then it will be a problem. From the perspective of acute disease patients, it is better to buy medicines from MoH-approved sellers, because the medicines can be received and consumed immediately.

From a patient safety point of view, the relatively poor quality of medicines from unregulated online sellers interacts with another of our findings, related to convenience. It took time and persistence to buy medicines from unregulated sellers. The vast majority of patients with a clinical need for a common essential medicine will not deliberately bypass hundreds of offers from approved sellers to deliberately search for medicines sold by unregulated sellers (often at higher prices than in regulated stores online and offline). In Indonesia, where convenience-driven online shopping is entrenched at all levels of society, most buyers will simply switch to another platform at the first challenge when searching for medicines, then consider a physical store. The overall public health risk posed by low-quality medicines sold on the internet in Indonesia is thus very low.

While occasional accidental misspellings of desirable brand names may lead to higher-risk sellers, we believe the people most likely to use strategies such as searching by street name or deliberate misspelling are those who are seeking medicines for recreational or off-label use, such as narcotics, anabolic steroids or abortifacients. The Indonesian medicine regulator targets only these medicines in its surveillance of online markets; our study suggests that this is a resource-effective strategy.

One of the contrasts between purchasing medicine in a physical pharmacy and online is that for the latter, a subscription is obligatory, and buyers are required to provide personal information. However, from the patient's point of view, buying medicines online respects their privacy more than going to a physical pharmacy. This could be because they are less worried about being embarrassed or judged for buying these medicines (1,16,33).However, none of our sampled medicines includes those types of medicines.

Many studies state the lack of online prescription requirements (5,6,15,16,29,33), our study found that even unregulated sellers have better access to prescription compliance compared with the physical pharmacy. The experience found while seeking the validation for prescription shows us that prescription requirements in online medicine sales were not essential and indicates the seller's effort to comply with regulatory requirements. It was also proved that by the technology helps sellers to organise this requirement, and this is still improved protection for patient safety. This allows regulators to improve the supervision of online sellers, either by tightening up rules on the sales system or by tightening up online sales reporting.

The accuracy means the seller's reliability, and based on the results, the MoH-approved seller was the most reliable. The reason for this was that the data collector had been contacting the sellers the most to confirm the order, so the chance of getting the wrong medicine was getting low, but the chance of failing the attempt to buy got higher. But, from a patient's point of view, it is rare for patients to be able to check the availability of medicine before placing an order, as they usually assume that as long as they can click on the order, it means that the medicine is in stock and can be ordered.

We first assumed it would be the MoH-approved sellers, but the semi-regulated sellers were the most convenient in this study. Even if it only took a half day to deliver the medicine from approved sellers, compared to the registration process, time to search for the right medicine, the choices availability of brand or price, and the success rate of the transaction, the approved sellers can not beat the convenience of semi-regulated sellers. In this study, although it was difficult to find the unregulated sellers, we still managed to obtain samples from those sellers because we were deliberately try to found them. This means the public demand to buy medicine from those types of sellers still exist.

As for the price, buying medicine online in Indonesia is not always cheaper than buying it offline as other studies found (5,16). Empirically, our results show that some medicines were cheaper online than offline, but many medicines cost more than they sold offline. The definition of cheaper depends on which price is chosen by buyers based on their ability to pay. Due to the ability of patients to choose the price or the seller, and with the added insight into chemical quality from our samples, it is recommended that patients should avoid buying medicines from unregulated sellers.

The study found products that were confirmed to be falsified but still passed the quality test. We assume that these medicines may have been through a repackaging process. Falsified medicines that pass the test may not pose any direct harm to patients as long as they can still provide therapeutic effects for patient recovery. However, the act of selling counterfeit medicines is illegal and considered a crime. Therefore, there is a need for further investigation to prevent risk and protect patients from such medicines. As the results show about the quality and conveniences, we hope regulators may focus on unregulated sellers that pose a potential risk to patients by selling substandard and falsified medicines.

Limitation

During the sampling, it was challenging to document every failed attempt to buy medicine, especially when we abandoned a search because the medicine was not available on a site. For this reason, we were not always able to track the time from first browsing to final delivery accurately.

Conclusion

This study has revealed that purchasing medicine online is not consistently convenient for all online sellers, and prices are not always lower compared to offline options. In terms of quality, there is no significant difference between medicine bought online and offline. Moreover, the findings have underscored the significance of the regulatory status on online platforms, as directly impacts the quality of the medicines they offer for sale.

As the potential to obtain medicines from unregulated sellers was low, purchasing medicines from those sellers does not increase public health risks. Therefore, an effective strategy for national

medicines authorities to reduce public health risks would be to prioritise more supervision against unregulated sellers.

Acknowledgements

We thank the study participants and the study advisory board. We are also grateful to Badan POM for guidance and insights during the conceptualisation of the study. Some part of the study results were presented at the ISIUM Conference, Chiang Mai-Thailand in October 2023.
All authors were closely involved throughout the conceptualisation and review of the manuscript. In addition: EP led and designed the conceptualisation of this paper. EP, MR, WN, HU, and SK actively conducted data collection and data analysis. MR drafted the first manuscript. SV and YA gave comments and insights for the overall manuscript.

Conflict of Interest

The study was funded by UK National Institute for Health and Research. The authors have no conflicts of interest.

Data availability

All the data used in this study were available on the STARmeds Repository, developed by the STARmeds consortium.(23)

Abbreviations

MoH: Ministry of Health
BPOM: Indonesian Food and Drugs Administration a.k.a national medicines regulator
ISIUM: International Society to Improve the Use of Medicines

References:

1. Orizio G, Merla A, Schulz PJ, Gelatti U. Quality of Online Pharmacies and Websites Selling Prescription Drugs: A Systematic Review. J Med Internet Res. 2011 Sep 30;13(3):e1795.

2. S. Quon B, Firszt R, J. Eisenberg M. A Comparison of Brand-Name Drug Prices between Canadian-Based Internet Pharmacies and Major U.S. Drug Chain Pharmacies. Ann Intern Med [Internet]. 2005 Sep 20 [cited 2023 May 22]; Available from: https://www.acpjournals.org/doi/10.7326/0003-4819-143-6-200509200-00004

3. Gong Y, Jiang N, Chen Z, Wang J, Zhang J, Feng J, et al. Over-the-counter antibiotic sales in community and online pharmacies, China. Bull World Health Organ. 2020 Jul 1;98(7):449–57.

4. Eichenberg C, Hübner L. [Self-Medication, Health and Online Orders: An Online Survey]. Gesundheitswesen Bundesverb Arzte Offentlichen Gesundheitsdienstes Ger. 2017 Feb;79(2):80–5.

5. Cicero TJ, Ellis MS. Health Outcomes in Patients Using No-Prescription Online Pharmacies to Purchase Prescription Drugs. J Med Internet Res. 2012 Dec 6;14(6):e2236.

6. Rahman MS, Yoshida N, Sugiura S, Tsuboi H, Keila T, Kiet HB, et al. Quality of omeprazole purchased via the Internet and personally imported into Japan: comparison with products sampled in other Asian countries. Trop Med Int Health TM IH. 2018 Mar;23(3):263–9.

7. Boyd SE, Moore LSP, Gilchrist M, Costelloe C, Castro-Sánchez E, Franklin BD, et al. Obtaining antibiotics online from within the UK: a cross-sectional study. J Antimicrob Chemother. 2017 May 1;72(5):1521–8.

8. Blix H, Viktil K, Moger T, Reikvam A. Drugs with narrow therapeutic index as indicators in the risk management of hospitalised patients. Pharm Pract. 2010 Mar 15;8.

9. Mills D. Cybermedicine: The Benefits and Risks of Purchasing Drugs Over The Internet. J Technol Law Policy [Internet]. 2000 [cited 2023 Jan 4];5(2). Available from: https://scholarship.law.ufl.edu/jtlp/vol5/iss2/1

10. Jairoun A, al Hemyari S, Abdulla N, El-Dahiyat F, Jairoun M, Al-Tamimi S, et al. Online medication purchasing during the Covid-19 pandemic: potential risks to patient safety and the urgent need to develop more rigorous controls for purchasing online medications, a pilot study from the United Arab Emirates. J Pharm Policy Pract. 2021 Apr 30;14:38.

11. Angell B, Lung T, Praveen D, Maharani A, Sujarwoto S, Palagyi A, et al. Cost-effectiveness of a mobile technology-enabled primary care intervention for cardiovascular disease risk management in rural Indonesia. Health Policy Plan. 2021 May 17;36(4):435–43.

12. Lee KS, Yee SM, Zaidi STR, Patel RP, Yang Q, Al-Worafi YM, et al. Combating Sale of Counterfeit and Falsified Medicines Online: A Losing Battle. Front Pharmacol. 2017;8:268.

13. Monteith S, Glenn T. Searching online to buy commonly prescribed psychiatric drugs. Psychiatry Res. 2018 Feb 1;260:248–54.

14. Vida RG, Fittler A, Mikulka I, Ábrahám E, Sándor V, Kilár F, et al. Availability and quality of illegitimate somatropin products obtained from the Internet. Int J Clin Pharm. 2017 Feb 1;39(1):78–87.

15. Khan MH, Tanimoto T, Nakanishi Y, Yoshida N, Tsuboi H, Kimura K. Public health concerns for anti-obesity medicines imported for personal use through the internet: a cross-sectional study. BMJ Open. 2012;2(3):e000854.

16. Long CS, Kumaran H, Goh KW, Bakrin FS, Ming LC, Rehman IU, et al. Online Pharmacies Selling Prescription Drugs: Systematic Review. Pharmacy. 2022 Apr 1;10(2):42.

17. Mackey TK, Jarmusch AK, Xu Q, Sun K, Lu A, Aguirre S, et al. Multifactor Quality and Safety Analysis of Antimicrobial Drugs Sold by Online Pharmacies That Do Not Require a Prescription: Multiphase Observational, Content Analysis, and Product Evaluation Study. JMIR Public Health Surveill. 2022 Dec 23;8(12):e41834.

18. Kakio T, Nagase H, Takaoka T, Yoshida N, Hirakawa J, Macha S, et al. Survey to identify substandard and falsified tablets in several Asian countries with pharmacopeial quality control tests and principal component analysis of handheld raman spectroscopy. Am J Trop Med Hyg. 2018;98(6):1643.

19. Indonesia is the world's fastest-growing e-commerce market [Internet]. [cited 2023 Jan 19]. Available from: https://www.theneweconomy.com/business/indonesia-is-the-worlds-fastest-

growing-e-commerce-market

20. Bestsenny O, Gilbert G, Harris A, Rost J. Telehealth: A post-COVID-19 reality? | McKinsey [Internet]. McKinsey&Company; 2021 Jul [cited 2023 Feb 10] p. 15. Available from: https://www.mckinsey.com/industries/healthcare/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality

21. Minister of Health, Republic of Indonesia. Peraturan Pemerintah Republik Indonesia Nomor 21 Tahun 2020 Tentang Pembatasan sosial berskala besar dalam rencana percepatan penanganan corona virus disease 2019 (corona-10) [Internet]. 21/2020 Mar 31, 2020. Available from: https://jdih.setkab.go.id/PUUdoc/176085/PP_Nomor_21_Tahun_2020.pdf

22. Newton PN, Lee SJ, Goodman C, Fernández FM, Yeung S, Phanouvong S, et al. Guidelines for Field Surveys of the Quality of Medicines: A Proposal. PLoS Med. 2009 Mar 24;6(3):e1000052.

23. STARmeds Study Team. STARmeds study repository: Methods, protocols tools and code [Internet]. Harvard Dataverse; 2023 [cited 2023 Aug 8]. Available from: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/RKYICP

24. Ministry of Health, Republic of Indonesia. Penyelenggara Sistem Elektronik Farmasi (PSEF). [cited 2023 Jan 4]. Penyelenggara Sistem Elektronik Farmasi (PSEF). Available from: https://psef.kemkes.go.id/

25. Stata Corp. Stata. Texas, USA: Stata Corp; 2021.

26. United States Pharmacopeia. United States Pharmacopeia National Formulary (43rd edition NF38). USP; 2021.

27. Chinese FDA. Chinese Pharmacopoeia in English (CP-15) [Internet]. China Food and Drug Administration (CFDA); 2021 [cited 2023 Nov 22]. (Chinese Pharmacopoeia). Available from: https://www.webofpharma.com/2021/05/chinese-pharmacopoeia-in-english-cp-15.html

28. World Health Organization. WHO Global Surveillance and Monitoring System for substandard and falsified medical products [Internet]. Geneva, Switzerland: WHO; 2017 Nov [cited 2017 Dec 8]. Report No.: WHO/EMP/RHT/2017.01. Available from: https://www.who.int/publications/i/item/9789241513425

29. Vida RG, Fittler A, Mikulka I, Ábrahám E, Sándor V, Kilár F, et al. Availability and quality of illegitimate somatropin products obtained from the Internet. Int J Clin Pharm. 2017 Feb 1;39(1):78–87.

30. Fittler A, Vida RG, Káplár M, Botz L. Consumers Turning to the Internet Pharmacy Market: Cross-Sectional Study on the Frequency and Attitudes of Hungarian Patients Purchasing Medications Online. J Med Internet Res. 2018 Aug 22;20(8):e11115.

31. Yahya S, Sugiyanto C. Indonesian Demand for Online Shopping: Revisited. J Indones Econ Bus. 2020 Sep 16;35:188.

32. Badan POM Industri Farmasi [Internet]. 2022 [cited 2023 Aug 12]. Badan Pengawas Obat dan

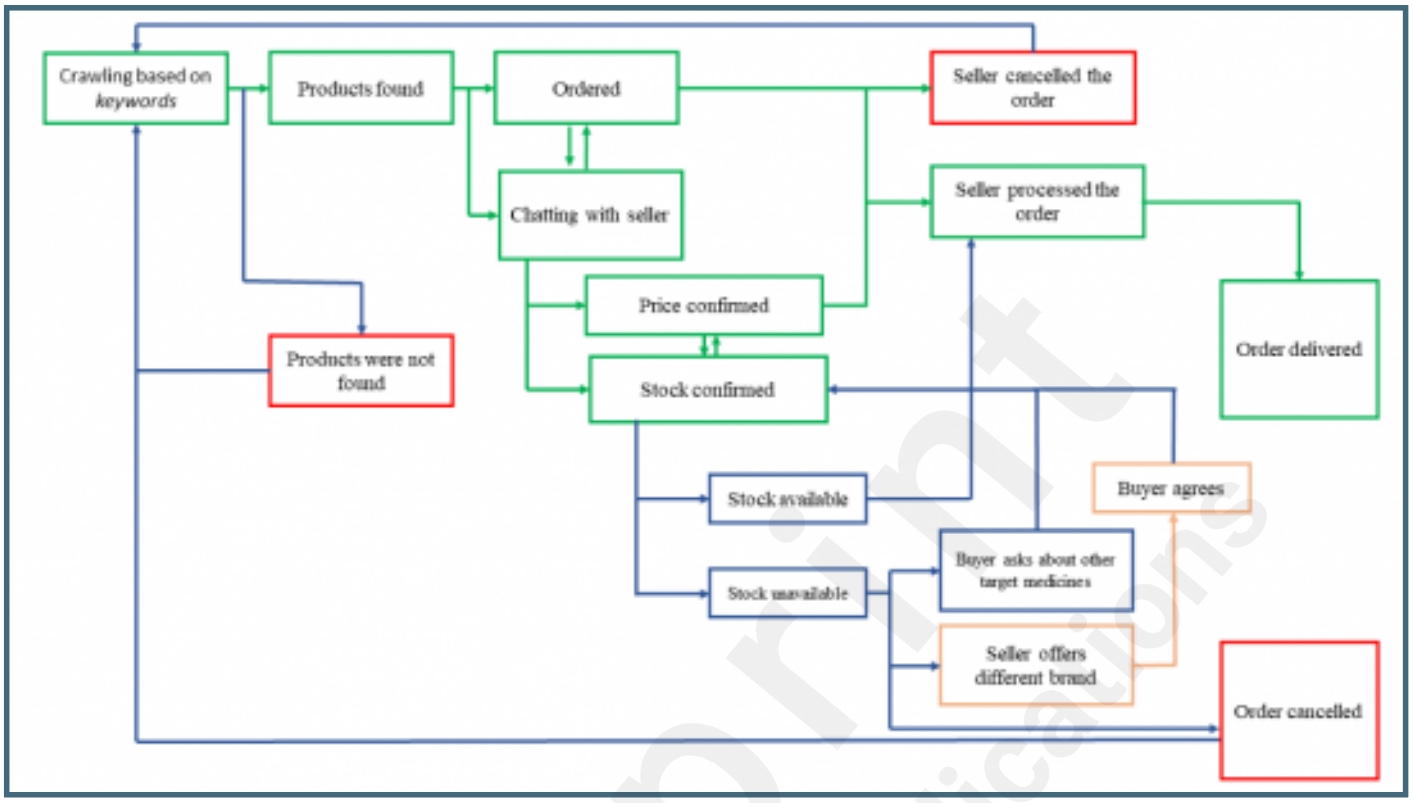
Makanan - Republik Indonesia. Available from: https://www.pom.go.id/new/view/direct/industri-farmasi

33. Almomani H, Patel N, Donyai P. Reasons That Lead People to End Up Buying Fake Medicines on the Internet: Qualitative Interview Study. JMIR Form Res. 2023 Feb 16;7(1):e42887.

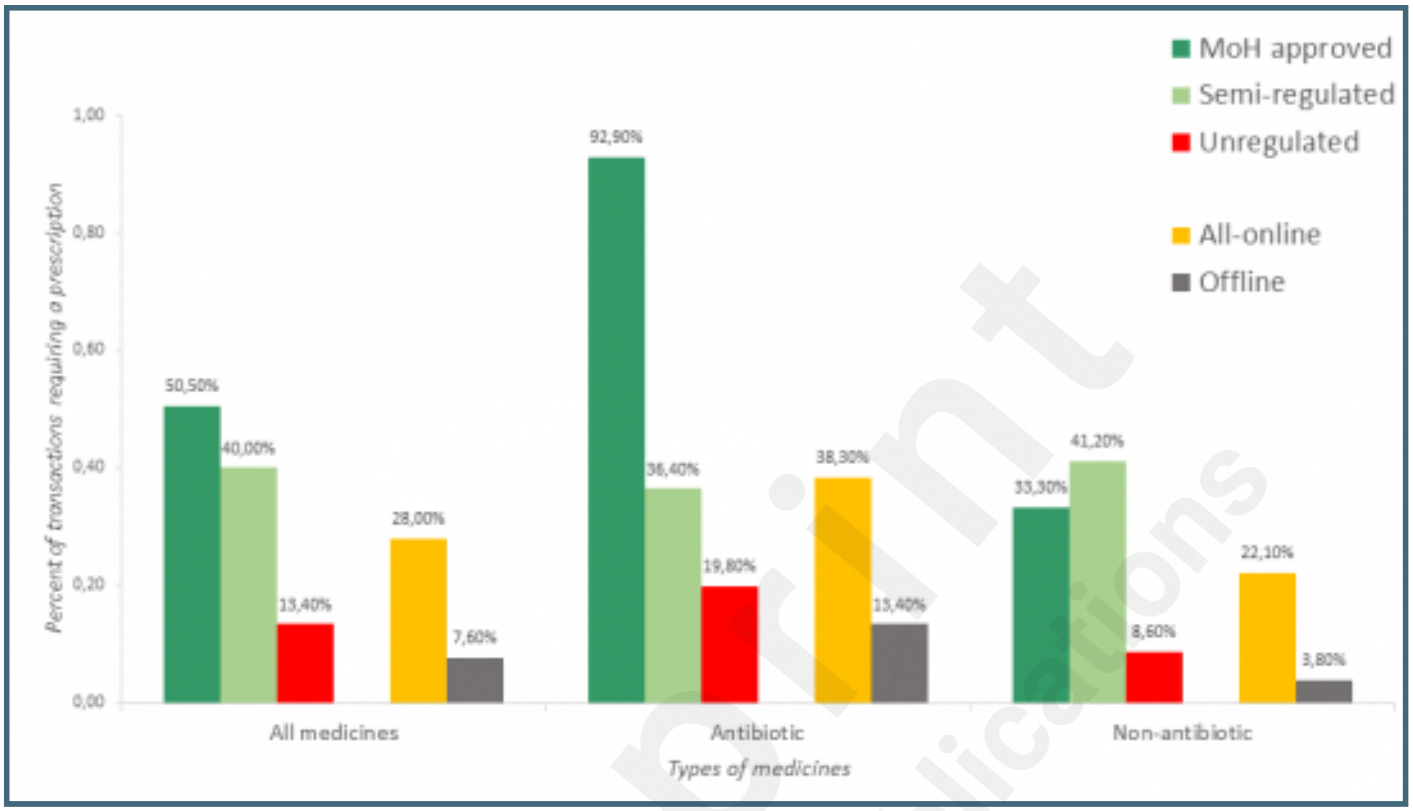
Supplementary Files

Figures

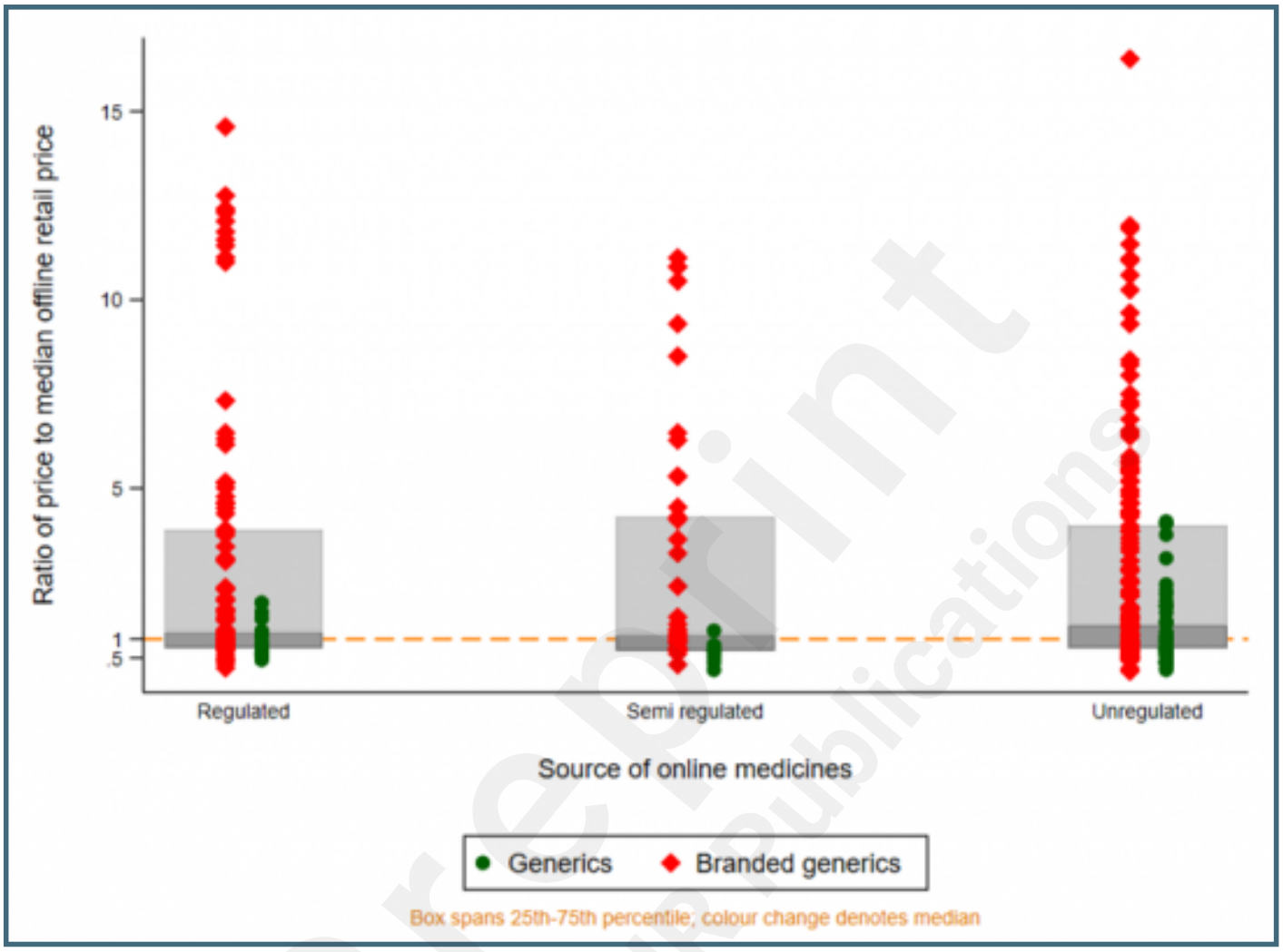
Buying medicine on online shopping platforms flowchart.



The prescription requirement in the STARmeds study, based on the seller's classification and medicines types.



Price paid per sample compared to the median retail price of medicine paid offline for the same active ingredient, dose and formulation.



Comparison price paid per sample to the median retail price paid offline.