Risk Management and Healthcare Policy

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Factors Influencing Drug Shortages and Their Resolution in South Korean Community Pharmacies

Yong Hwa Lee[1,*], Dasom An[1,*], Youngsuk Baek[1], Kyungsook Yoo[2], Sumi Hyun[1], Sun-Kyeong Park[3], Eui-Kyung Lee[1]

[1]School of Pharmacy, Sungkyunkwan University, Suwon, Gyeonggi-do, South Korea; [2]School of Pharmacy, Kangwon National University, Chuncheon, Gangwon-do, South Korea; [3]College of Pharmacy, The Catholic University of Korea, Bucheon, Gyeonggi-do, South Korea

*These authors contributed equally to this work

Correspondence: Sun-Kyeong Park, College of Pharmacy, The Catholic University of Korea, 43 Jibong-ro, Bucheon-si, Gyeonggi-do, 14662, South Korea, Tel +82221644094, Email sk.park@catholic.ac.kr; Eui-Kyung Lee, School of Pharmacy, Sungkyunkwan University, 2066, Seobu-ro, Jangan-gu, Suwon-si, Gyeonggi-do, 16419, South Korea, Tel +82312907786, Email ekyung@skku.edu

Purpose: Drug shortages directly affect the final stage in the pharmaceutical supply chain, prescription fulfillment in community pharmacies (CPs). This study investigated the current state of drug shortages, their resolution, and influencing factors within CPs.

Methods: A cross-sectional online survey was conducted among pharmacists working at pharmacies in Seoul between 7 and 31 October 2022. The survey gathered data on pharmacies and pharmacists' characteristics, drug distribution, information, communication, and administrative practices. Logistic regression was used to identify the factors influencing these rates. Regression results are presented as odds ratios (OR) and 95% confidence intervals (CIs).

Results: Of the 1200 pharmacists approached, 713 participated, yielding a response rate of 59.4%. After excluding incomplete responses, data from 671 respondents were analyzed. Pharmacies with higher prescription drug sales demonstrated a lower OR for drug shortages (OR=0.66, 95% CI=0.60–0.72) compared to those with lower sales volumes. Resolution rates were significantly higher when pharmacies were located near clinics (OR=3.30, 95% CI=2.3–4.74) and general hospitals (OR=3.45, 95% CI=2.35–5.07) compared to those without nearby medical facilities. Additionally, good communication with prescribers increased the resolution rates (OR=1.46, 95% CI=1.26–1.69).

Conclusion: This study examines the influence of pharmacy purchasing power on drug shortages, identifying proximity to healthcare facilities and communication with prescribers as factors affecting the resolution rates. These findings provide valuable insights for pharmacists, policymakers, and future researchers to optimize drug supply chain management and mitigate shortages in community settings.

Keywords: drug shortage, drug shortage resolution, community pharmacy, pharmaceutical supply chain

Introduction

The increasing prevalence of drug shortages, especially amid the coronavirus disease of 2019 (COVID-19) pandemic, are critical healthcare concerns. Globally, shortages have increased due to deficits in essential ingredient and excipients, logistic challenges, shipping delays, and restrictions on pharmaceutical exports and imports.[1] From 2019 to 2020, the United States had a 37% increase in shortages, while Australia experienced a 300% rise.[2] Similar trends are anticipated in China, particularly effecting essential and anti-cancer drugs,[3,4] and in Korea, where the pandemic and Ukrainian war have resulted in shortages in COVID-19 therapeutics and other medications, such as acetaminophen.[4]

Drugs are essential for treating diseases and maintaining patient health. These shortages hinder patient access to essential medications, significantly jeopardizing the quality of care,[3,5] and potentially leading to treatment delays, interruptions, or failure. Additionally, drug shortages increase the risk of medication errors.[6] Therefore, many countries

Received: 18 June 2024
Accepted: 23 August 2024
Published: 30 August 2024

have developed a variety of strategies to prevent, mitigate, and respond to the drug shortages.[3] The United States FDA has implemented the Drug Shortage Program, and Canada has established Multi-Stakeholder Steering Committee on Drug Shortages (MSSC) to address drug shortages. Additionally, many countries have adopted and are utilizing advanced notification systems.[7] In addition to establishing organizations or improving systems, strategies to mitigate drug shortages include managing current inventories and enhancing related policies, such as enabling expedited drug reviews.[3]

Understanding the causes of drug shortages and developing effective intervention strategies is crucial. However, previous studies have predominantly explored drug shortages from the perspective of hospital pharmacists, with limited attention paid to the experiences of community pharmacists. Existing research on hospital pharmacies have mainly focused on pharmacists' perceptions of the prevalence of shortages and impact on patient care and pharmacy operations.[6,8–10] Despite their crucial role in medication access, limited research has explored the perspectives and environments of community pharmacists,[5,6,10] with even fewer studies conducting quantitative analyses of the factors influencing drug shortages and their resolution rates.

Community pharmacies play a vital role in healthcare systems by directly providing patient medication and significantly influencing their access.[11] Drug shortages present a particular challenge within this context, as community pharmacies often serve as a final step for patients to obtain necessary drugs. This issue is particularly pronounced in South Korea, as evidenced by 2020 data showing that 69.1% (KRW 13.8 trillion out of KRW 20 trillion) of total prescription drug expenditure occurs within community pharmacies.[12] Highlighting that medication expenditures in community pharmacies exceed those of hospital pharmacies two-fold. This study aimed to empirically explore the status and resolution of drug shortages, and identify factors influencing their occurrence and resolution in this context.

Methods

Survey Development

This study employed a cross-sectional online survey to evaluate the status of drug shortages and their resolution and identify factors linked to the occurrence and resolution of these shortages. The survey instrument was developed based on existing literature and was refined through consultations with experienced community pharmacists and academic experts in pharmacy practices, education, and statistics to ensure validity and relevance.[6,11,13–17] Three pretests were conducted with community pharmacists to correct inappropriate or inaccurate survey questions.

The survey questions were divided into seven sections: current status of drug shortages and resolution at the time of the survey, pharmacy characteristics, characteristics of pharmacists, information about drug shortages, drug distribution, communication with patients and prescribers, and administrative burden due to drug shortages. The first section, investigated the prevalence and impact of drug shortages experienced by pharmacists to provide a comprehensive overview of the current situation. Respondents were also asked to quantify the average daily drug shortages over a month and report the number of prescriptions affected by these shortages, differentiating between successfully filled and unfilled prescriptions. The second section, covered pharmacy characteristics, including location (eg, proximity to medical facilities such as tertiary hospitals, general hospitals, clinics), size (such as, $<33m^2$, $\geq 33m^2$,$<50m^2$, $\geq 50m^2$, $<66m^2$, and $\geq 66m^2$), and number of pharmacists employed in the pharmacy.[14] Average monthly prescription sales volume (eg, <$50K, ≥$50K,<$200K, and ≥$200K) was also included as a proxy for purchasing power of pharmacies. The third section, focused on the sociodemographic characteristics of pharmacists, such as gender, age, employment status (eg, owner or employed), and participation in counseling services (eg, multiple medication management service, medication safety use education, etc).[10,14] The fourth section, centered on information, querying whether respondents were informed in advance about drug shortages and their causes.[3] The fifth section, drug distribution, included questions about procurement sources for shortage drugs (eg, wholesaler, pharmaceutical company, nearby pharmacies, pharmacist network, etc.) and number of drug suppliers.[11] The sixth section, assessed respondents' communication skills with healthcare providers and patients, along with their ability to effectively substitute and modify prescriptions, and the impact of their communication on changes in prescribing patterns.[10,11,15] The seventh section, addressed the administrative burden on pharmacists resulting from prescription changes.

Ethics Statement

The study protocol received approval from the Institutional Review Board of Sungkyunkwan University (IRB no. SKKU 2022–08-038).

Survey Implementation

The survey was conducted over three weeks from 7 to 31 October 2022, targeting pharmacists working at community pharmacies in Seoul, South Korea. Using an area-sampling method, we ensured geographic diversity in the sample. Seoul is divided into four distinct regions: eastern, western, southern, and northern. Two districts were selected from each region, resulting in a total of eight sample areas: Gangdong and Songpa in the east; Gangseo and Seodaemun in the west; Dongjak and Seocho in the south; and Dobong and Nowon-gu in the north. We aimed to obtain a representative sample from various Seoul Pharmacy branches. The survey questionnaire's URL link was distributed on KakaoTalk. Following a briefing on the survey's purpose and content, participants provided informed consent to participate in the study. Data collection was restricted to completed surveys submitted through the Korea Science Data Center.

The minimum sample size was determined to be 375 pharmacists, following the guidelines outlined in "Determining Sample Size, PEOD6" with a 95% confidence interval (CI) and ±5% precision.[18] As of 2021, the Seoul Pharmacy Association had 5959 registered pharmacists. Anticipating a 50% response rate, we sent the survey link to 1200 pharmacists to meet the minimum sample size. The target population was notified about the study and participation was voluntary.

Statistical Analysis

Data collected from respondents were analyzed using descriptive statistics compiled for each question. Categorical variables are presented as frequencies and percentages, and continuous variables are presented as mean ± standard deviation. The drug shortage is the number of prescriptions per day, including the drug shortage divided by the average number of prescriptions per day, and the drug shortage resolution rate is the number of resolved drug shortages divided by the number of drug shortages. The unfilled prescription rate was defined as the number of unfilled prescriptions due to the drug shortage divided by the total prescription number. To test for significant differences in medicine shortage rates and resolution of shortages across various factors, *t*-tests, and analysis of variance (ANOVA) were employed. ANOVA was conducted with Levene's test for homogeneity of variances. Post-hoc analyses were employed, utilizing the Least Significant Difference method when the assumption of homogeneity of variances was satisfied, and alternatively, Dunnett's method when this assumption was violated.

Multiple logistic regression analysis was conducted to determine the relationship between these factors and drug shortages and their resolution. The model analyzed the factors associated with drug shortage rates and included variables pertaining to pharmacy characteristics, information on advanced notifications and shortage reasons, and the pharmacy distribution status. The second model investigated factors influencing drug shortage resolution rates and incorporated additional variables pertaining to pharmacist characteristics, communication with prescribers and patients, and the administrative burden associated with prescription changes. The variable for advanced notification was excluded from the second model. Results were presented as odds ratios (OR) with 95% CI, and statistical significance was determined at an alpha level of 0.05. All statistical analyses were performed using SAS® version 9.4.

Results

A total of 1200 community pharmacists were invited to participate, and 713 responded, resulting in a 59.4% response rate. After excluding respondents with missing values, data from 671 pharmacists were analyzed. Most were females (64.1%) and 42.4% were aged ≥50 years. Most pharmacies were situated near clinics (71.4%), 15.6% were near general hospitals, 10.0% were near tertiary hospitals, and 3.0% with no nearby medical facilities. Nearly half of the pharmacies (47.5%) reported sales below $50K, 43.7% had sales between $50K and <$200K, while the remaining 8.8% exceeded $200K (Table 1).

Figure 1 illustrates the relationships among drug shortage rates, resolution rates, and unfilled prescription rates concerning average monthly sales volume for prescribed medications and pharmacy locations. Significant disparities and

Table 1 Characteristics of Survey Responders Who Experienced Drug Shortage (n=671)

Variable		Category	n	%
Sociodemographic characteristics of pharmacists				
Sex		Female	430	64.1
		Male	241	35.9
Age		20–39	217	32.3
		40–49	170	25.3
		50–59	197	29.4
		≥60	87	13.0
Employment Status		Owner	526	78.4
		Employed	145	21.6
Providing pharmacy services	Management of multiple medications	No	547	81.5
		Yes	124	18.5
	Medication safety education program	No	459	68.4
		Yes	212	31.6
Pharmacy characteristics				
Location		No medical facility nearby	20	3.0
		Near a tertiary hospital	69	10.0
		Near a general hospital	105	15.6
		Near a clinic (doctor's office)	479	71.4
Size		<33m^2	111	16.5
		≥33m^2 to<50m^2	204	30.4
		≥50m^2 to <66m^2	151	22.5
		≥66m^2	205	30.6
Average prescription drug cost per month		<$50K	319	47.5
		≥$50K to <$100K	194	28.9
		≥$100K to <$200K	99	14.8
		≥$200K	59	8.8
Number of pharmacists		1	292	43.5
		≥2	379	56.5
Information of drug shortages				
Timely notification of drug shortages in advance		Never or infrequently	581	86.6
		Sometimes	53	7.9
		Frequently or always	37	5.5

(*Continued*)

Table 1 (Continued).

Variable	Category	n	%
Major reason for drug shortages	Supply imbalance	252	37.5
	Insufficient imports of raw materials or subsidiary materials, or etc.	293	43.7
	Unknown	126	18.8
Drug distribution			
Number of distributors	≤10	425	63.3
	≥11	246	36.7
Main external source for short supply	Manufacturer or wholesaler	483	72.0
	Pharmacy nearby or others through personal network	188	28.0
Communication on drug shortages			
Good communication with prescribers	No	126	18.8
	Yes	545	81.2
Substitutions or prescription changes done well after discussion with prescribers	No	112	16.7
	Yes	559	83.3
Any changes of prescribing pattern for drug shortages	No	237	35.3
	Yes	434	64.7
Good communication with patients regarding substitutions or prescription changes	No	135	20.1
	Yes	536	79.9
Administrative burden for pharmacists due to changing prescriptions			
Feeling uncomfortable to contact prescribers to ask for substitutions or prescription changes	No	51	7.6
	Yes	620	92.4

Note: K, thousand.

trends were observed, particularly in drug shortages and unfilled prescription rates. As prescription drug sales increased, drug shortages decreased from 25.7% to 11.8% across the groups (p-value < 0.05). The unfilled prescription rate ranged from approximately 2% to 4%, declining with increased average prescription sales volume. Increased purchasing power appears to contribute to a decrease in drug shortage rates and unfilled prescription rates. These trends remained consistent across the different types of medical institutions in proximity to the pharmacies (Figure 2). Pharmacies located in areas lacking nearby medical facilities exhibited the highest drug shortage rates, while their resolution rates were the lowest. Unfilled prescription rates varied depending on the type of medical facility in proximity to the pharmacy, ranging from approximately 2% to 13%. Pharmacies near tertiary hospitals experienced lower unfilled prescription rates compared to those in areas with limited or no access to medical facilities. The resolution of drug shortages was significantly higher in pharmacies with average monthly sales between $50K and $100K, compared to those with sales < $50K. Pharmacies without nearby medical facilities had the significantly lowest rate of drug shortage resolution, at 59.0%, compared to pharmacies with a nearby medical facilities.

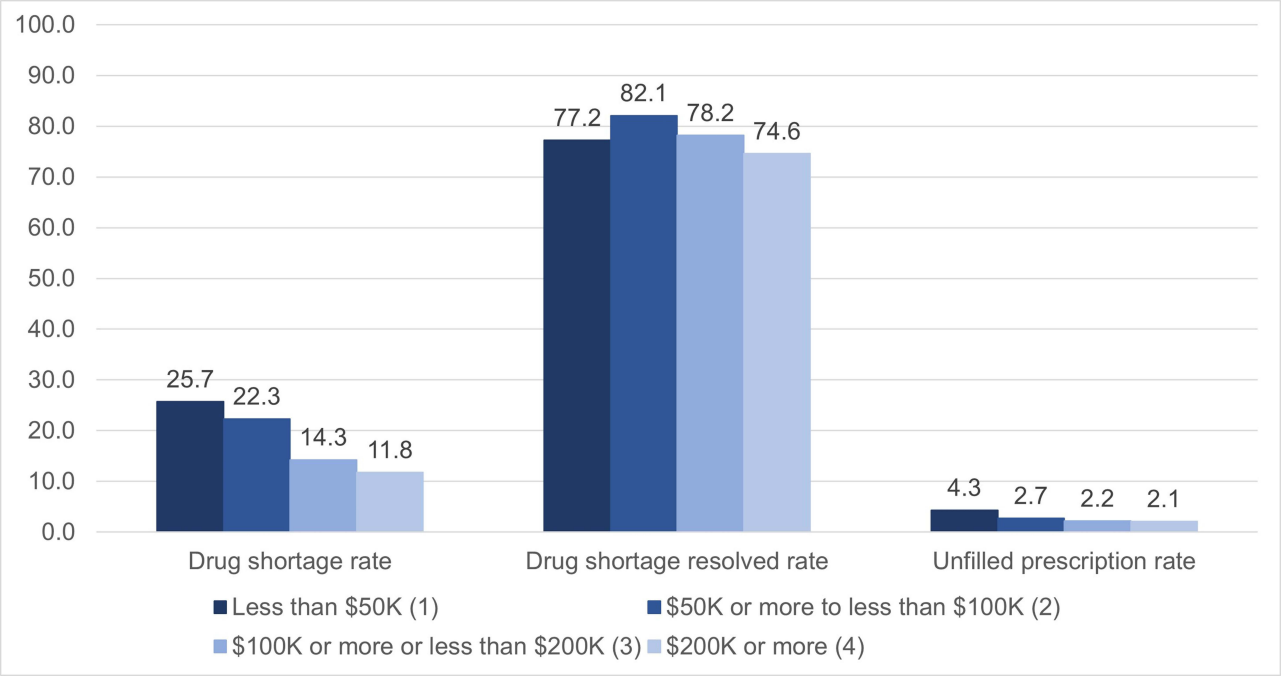

Figure 1 Drug shortage rates, drug shortage resolved rates, and unfilled prescription rates by pharmacy purchasing power.
Notes: Statistically significant comparisons. Drug shortage rate: 1 vs 3, 1 vs 4, 2 vs 3, 2 vs 4; Drug shortage resolved rate: 1 vs 2; Unfilled prescription rate: 1 vs 2, 1 vs 3, 1 vs 4.

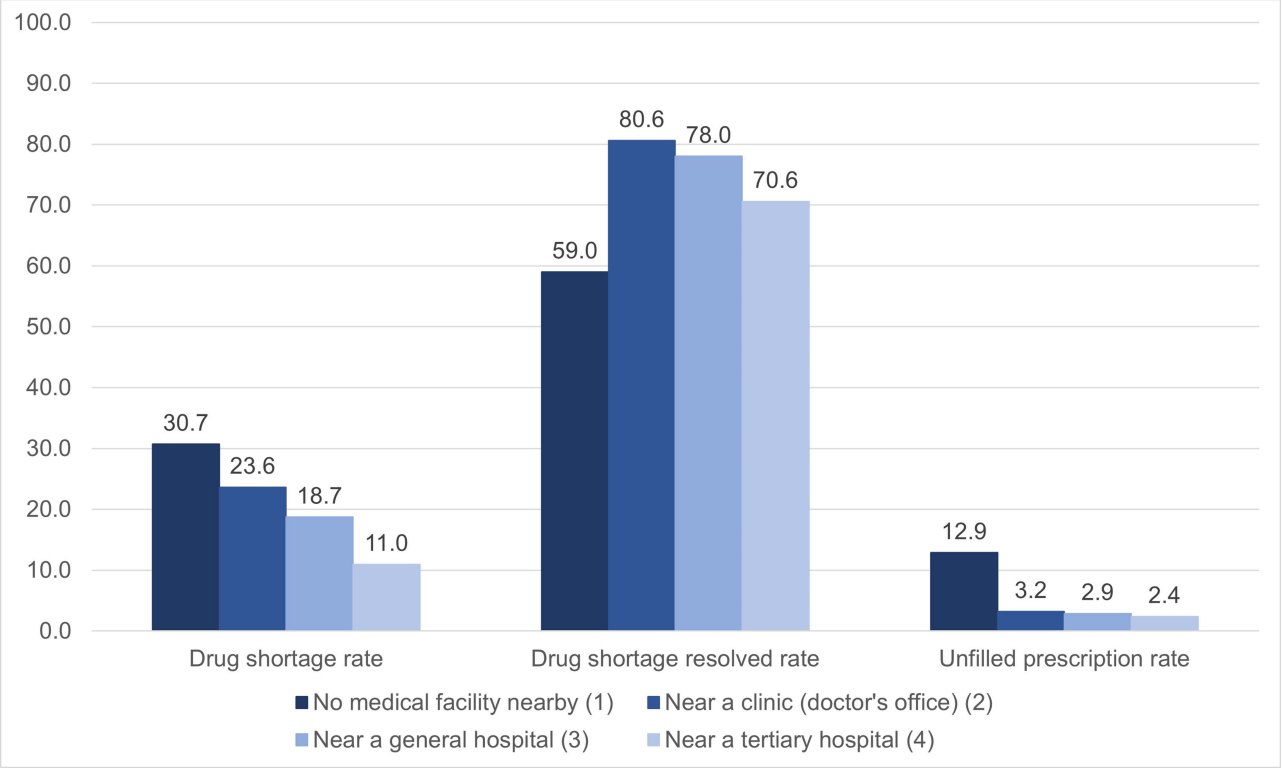

Figure 2 Drug shortage rates, drug shortage resolved rates, and unfilled prescription rates by type of medical facility near pharmacies.
Notes: Statistically significant comparisons. Drug shortage rate: 1 vs 3, 1 vs 4, 2 vs 3, 2 vs 4, 3 vs 4; Drug shortage resolved rate: 1 vs 2, 1 vs 3, 2 vs 4; Unfilled prescription rate: 1 vs 2, 1 vs 3, 1 vs 4.

Table 2 presents the findings of the multivariate logistic regression analysis for the drug shortage rate. Among community pharmacies, those near hospitals exhibited a significantly lower drug shortage rate compared to those without nearby medical facilities. The OR for the drug shortage rate was 0.71 (95% CI = 0.59–0.85) for pharmacies near a clinic and 0.34 (95% CI = 0.28–0.42) for those near a tertiary hospital, compared to pharmacies without nearby clinics. An inverse relationship was observed between average monthly prescription drug sales and the drug shortage rate. The OR for the drug shortage rate was 0.66 (95% CI=0.60–0.72) for higher average monthly sales of dispensed drugs, compared to lower sales. Individuals who were frequently or consistently notified of drug shortages before their occurrence experienced a significantly lower drug shortage rate (OR=0.77, 95% CI=0.70–0.85) compared to those uninformed regarding the shortages. Conversely, the OR for the drug shortage rate was 1.13 (95% CI = 1.07–1.18) for individuals procuring shorted drugs through neighborhood pharmacies or pharmacist networks, compared to those obtaining drugs directly from pharmaceutical companies or wholesalers.

Table 2 Logistic Regression Result of Drug Shortage Rate

Variable	Category	Odds Ratio	Confidence Interval	p-value
Pharmacy characteristics				
Location	No medical facility nearby	[Reference]		
	Near a tertiary hospital	0.34	(0.28–0.42)	<0.0001
	Near a general hospital	0.61	(0.51–0.74)	<0.0001
	Near a clinic (doctor's office)	0.71	(0.59–0.85)	0.003
Size	<33m^2	[Reference]		
	≥33m^2 to<50m^2	0.74	(0.69–0.79)	<0.0001
	≥50m^2 to<66m^2	0.89	(0.83–0.95)	0.0008
	≥66m^2	0.81	(0.76–0.87)	<0.0001
Average prescription sales volume per month	<$50K	[Reference]		
	≥$50K to <$100K	0.88	(0.84–0.93)	<0.0001
	≥$100K to <$200K	0.58	(0.54–0.63)	<0.0001
	≥$200K	0.66	(0.60–0.72)	<0.0001
Number of pharmacists	1	[Reference]		
	≥2	0.90	(0.86–0.95)	<0.0001
Information				
Timely notification of drug shortages in advance	Never or infrequently	[Reference]		
	Sometimes	0.72	(0.66–0.78)	<0.0001
	Frequently or always	0.77	(0.70–0.85)	<0.0001
Major reason for drug shortages	Unknown	[Reference]		
	Insufficient imports of raw materials or subsidiary materials, or etc.	0.78	(0.74–0.82)	<0.0001
	Imbalance in supply	0.83	(0.78–0.87)	<0.0001

(*Continued*)

Table 2 (Continued).

Variable	Category	Odds Ratio	Confidence Interval	p-value
Drug distribution				
Number of distributors	≤10	[Reference]		
	≥11	1.28	(1.22–1.33)	<0.0001
Main external source for short supply	Manufacturer or wholesaler	[Reference]		
	Pharmacy nearby or others through personal network	1.13	(1.07–1.18)	<0.0001

Note: K, thousand.

The results showed significant associations between various pharmacist characteristics and rates of resolving drug shortages (Table 3). Pharmacists aged 50–59 had a lower OR for drug resolution (OR = 0.65, 95% CI = 0.56–0.76), a trend similarly observed among pharmacists aged ≥60 (OR = 0.56, 95% CI = 0.46–0.65). Employed pharmacists had lower ORs

Table 3 Logistic Regression Result of Drug Shortage Resolution Rate

Variable	Category	Odds Ratio	Confidence Interval	p-value
Sociodemographic characteristics of pharmacists				
Sex	Female	[Reference]		
	Male	0.99	(0.88–1.11)	0.878
Age	20–39	[Reference]		
	40–49	0.95	(0.83–1.09)	0.497
	50–59	0.65	(0.56–0.76)	<0.001
	≥60	0.56	(0.46–0.68)	<0.001
Employment Status	Owner	[Reference]		
	Employed	0.65	(0.57–0.75)	<0.001
Providing "Management of multiple medications" service	No	[Reference]		
	Yes	1.34	(1.15–1.55)	<0.001
Providing "Medication safety education program"	No	[Reference]		
	Yes	0.92	(0.81–1.04)	0.168
Pharmacy characteristics				
Location	No medical facility nearby	[Reference]		
	Near a tertiary hospital	2.14	(1.42–3.22)	<0.001
	Near a general hospital	3.45	(2.35–5.07)	<0.001
	Near a clinic (doctor's office)	3.30	(2.30–4.74)	<0.001

(*Continued*)

Table 3 (Continued).

Variable	Category	Odds Ratio	Confidence Interval	p-value
Size	<33m^2	[Reference]		
	≥33m^2 to <50m^2	1.09	(0.92–1.29)	0.306
	≥50m^2 to <66m^2	1.73	(1.44–2.07)	<0.001
	≥66m^2	1.31	(1.10–1.55)	0.003
Average prescription sales volume per month	<$50K	[Reference]		
	≥$50K to<$100K	1.14	(0.99–1.31)	0.062
	≥$100K to <$200K	0.79	(0.66–0.93)	0.006
	≥$200K	0.70	(0.55–0.89)	0.004
Number of pharmacists	1	[Reference]		
	≥2	1.07	(0.94–1.23)	0.305
Information				
Major reason for drug shortages	Unknown	[Reference]		
	Insufficient imports of raw materials or subsidiary materials, or etc.	0.98	(0.84–1.13)	0.759
	Supply imbalance	1.06	(0.92–1.24)	0.417
Drug distribution				
Number of distributors	≤10	[Reference]		
	≥11	1.23	(1.10–1.37)	<0.001
Main external source for short supply	Manufacturer or wholesaler	[Reference]		
	Pharmacy nearby or others through personal network	0.72	(0.64–0.81)	<0.001
Communication				
Good communication with prescribers	Not good	[Reference]		
	Good	1.46	(1.27–1.69)	<0.001
Substitutions or prescription changes done well after discussion with prescribers	Not good	[Reference]		
	Good	1.45	(1.25–1.69)	<0.001
Any changes of prescribing pattern for drug shortages	No	[Reference]		
	Yes	1.25	(1.10–1.41)	<0.001
Good communication with patients regarding substitutions or prescription changes	No	[Reference]		
	Yes	0.76	(0.66–0.86)	<0.001

(*Continued*)

Table 3 (Continued).

Variable	Category	Odds Ratio	Confidence Interval	p-value
Administrative burden for pharmacists due to changing prescriptions				
Feeling uncomfortable to contact prescribers to ask for substitutions or prescription changes	No	[Reference]		
	Yes	0.93	(0.77—1.14)	0.506

Note: K, thousand.

for resolving shortages compared to pharmacy owners (OR=0.65, 95% CI=0.57–0.75). The analysis also revealed significant associations between several pharmacy characteristics and drug shortage resolution rates. Pharmacies located near general hospitals exhibited the highest OR compared to those without any nearby medical facilities (OR = 3.45, 95% CI=2.34–5.07), followed by clinics (OR = 3.30, 95% CI=2.30–4.74) and tertiary hospitals (OR = 2.14, 95% CI=1.42–3.22). Larger pharmacies (≥66m^2) demonstrated higher OR than smaller pharmacies (≥50m^2 to <66m^2). Pharmacists providing multiple medication management services exhibited a higher OR for drug shortage resolution compared to those who did not offer such services (OR = 1.34, 95% CI = 1.15–1.55). For pharmacists obtaining drugs from neighborhood pharmacies or pharmacist networks had lower OR for resolving shortages compared to those acquiring drugs from pharmaceutical companies and wholesalers (OR = 0.72, 95% CI = 0.64–0.81). Pharmacists proficient in prescription changes during interactions with healthcare providers demonstrated higher OR for drug shortage resolution compared to their less adept counterparts (OR = 1.45, 95% CI = 1.25–1.69. Process burden due to substitution notification did not significantly affect drug shortage resolution rates (OR=0.93, 95% CI 0.77–1.14).

Discussion

Herein, we assessed the current state of drug shortages and their resolution at local pharmacies and identified associated factors. We observed that pharmacy characteristics were linked to shortages, with differences in drug shortages based on the purchasing power of pharmacies. This observation aligns with prior research indicating that larger pharmacies receive preferential treatment in drug supply.[15] Other research also indicates that the transaction size of a pharmacy or hospital influences its access to information regarding drug supply and demand.[16] The increased risk of drug shortages in pharmacies with lesser purchasing power highlights a prevalent issue of size-based discrimination within pharmaceutical supply chains. The consequence of this disparity could impact patient health outcomes owing to the failure to access appropriate medications. This situation underlines the critical need for a healthcare system that supports equitable drug distribution to ensure that effective medication is accessible to all, thereby preventing adverse health outcomes. Recently this policy was implemented in Korea and serves as a pertinent example. The Korea Pharmaceutical Association has initiated measures to regulate the distribution of certain pharmaceuticals, such as acetaminophen, magnesium hydroxide, and pseudoephedrine, which are currently experiencing shortages in the country. Specifically, medications were allocated to pharmacies based on their needs. For example, the Korea Pharmaceutical Association distributed 500 pseudoephedrine tablets per pharmacy to those who submitted applications.[17] These initiatives exemplify a strategy to ameliorate disparities in pharmaceutical distribution and propose a potential model for broader adoption. This study also revealed that drug shortage rates varied depending on pharmacy location. Pharmacies near tertiary hospital had lower odds of drug shortages compared to those without nearby medical facilities, echoing previous findings, suggesting an uneven distribution of drug supplies that favors these locations.[16]

Conversely, the resolution rate was lowest for pharmacies without medical facility nearby, and those with highest sales volume. Moreover, pharmacies with nearby tertiary hospitals had lower resolution rates than pharmacies with general hospitals and nearby clinics. Generally, neighborhood pharmacies in general hospitals and clinics operate pharmacy services based on their proximity to residents. These pharmacies may be based locally; therefore, they are

more accessible and proactive in resolving drug shortages. This assertion was reinforced by Campling et al, who emphasized that community pharmacies play a pivotal role in direct patient interactions and the delivery of patient-centered services.[11,14]

Moreover, effective communication with healthcare providers has emerged as a key factor in resolving drug shortages. Pharmacies that maintained better communication with healthcare professionals demonstrated higher drug shortage resolution rates through substitutions or prescription modifications. This spotlights the findings from previous studies emphasizing the critical role of communication among stakeholders, including physicians and pharmacists.[6,15,19,20] Tan et al emphasized the importance of pharmacists sharing information regarding drug shortages with physicians to prevent the prescription of unavailable drugs.[15] Furthermore, effective communication among community pharmacies, distributors, manufacturers, and regulatory authorities is essential for mitigating the impact of drug shortages, as poor coordination across these channels worsens this situation.[11,13,21,22]

The procurement source of unavailable medications influenced the prevalence and resolution rates of drug shortages in local pharmacies. When pharmacists acquire medications from informal channels, they are more likely to experience drug shortages than when they acquire them from formal channels. Additionally, the odds of resolving shortages were lower in such cases. This supports a previous study conducted by Campling et al, which accentuated the importance of providing a seamless supply of drugs through distribution channels, such as pharmaceutical companies or wholesalers, to prevent shortages in the pharmaceutical distribution process.[11]

Our findings show that community pharmacies experience lower drug shortage rates when they receive advance notices of such shortages, suggesting that the provision of information may contribute to inequities in drug supply distribution. Regarding policy, it is necessary for pharmaceutical companies and wholesalers to manage drug shortage information and establish a systematic and accessible information delivery system for it.[20,21,23] European studies also showed that reporting on impending drug shortages is essential for mitigating or preventing these shortages.[24] Accordingly, a frequently used measure to manage shortages is a national register where suppliers report current and upcoming shortages. In 20 of the 24 responding countries, the regulatory authority, usually the Medicines Agency or Ministry of Health, maintains a shortage register, and in all countries except Malta, suppliers are obliged to inform the register.[25]

Although community pharmacies dispense a larger volume of medications to patients, research on drug shortages has predominantly focused on hospital pharmacies. Therefore, there is insufficient data to guide practices and policies aimed at resolving or preventing drug shortages in community pharmacies. The findings of this study, which analyzed the prevalence and factors associated with drug shortages in community pharmacies, can inform evidence-based decision-making in the policy-making process for preventing and resolving drug shortages. Considering the study's finding that drug shortages are influenced by pharmacy sizes, government policies should prioritize ensuring a smooth and equitable supply of stocked drugs to smaller pharmacies to effectively prevent drug shortages. Additionally, implementing policies to establish a system for sharing drug shortage information can contribute to the prevention of drug shortages. The finding that effective communication between pharmacists and prescribers contributes to resolving drug shortages can serve as a basis for developing policies to establish collaboration mechanisms for this purpose.

Through our study, we provide quantitative insights into drug shortages and their resolution, filling a critical gap in the literature. This is a dimension limited in previous studies. However, despite these strengths, there are some limitations to be considered during interpretation of the results. One limitation of this study is that it was limited to Seoul which contained 25% of total community pharmacists employed within South Korea; therefore, it did not cover pharmacists working in community pharmacies across South Korea. According to data provided by the Health Insurance Review and Assessment Service, however, the eight districts where our survey was conducted contain a comprehensive mix of tertiary hospitals, general hospitals, and clinics.[26] Consequently, this variety allows for a thorough analysis of pharmacy characteristics, ensuring that our findings can be considered representative of Korea. Another limitation is that the survey was conducted in South Korea, when COVID-19 was prevalent, resulting in a high incidence of COVID-19-related medication shortages. Drug shortages remain a persistent threat to global healthcare systems, even in the aftermath of the COVID-19 pandemic, which was declared over by the World Health Organization (WHO) on May 5, 2023. In recognition of the seriousness of this ongoing challenge, the government has partnered with the Korea Pharmaceutical

Association and other relevant organizations to identify and implement solutions for drug shortages. Therefore, further studies are necessary to compare and analyze data on drug shortages during the COVID-19 pandemic using data from the post-pandemic era. In addition, this study is limited by the absence of data on the specific drugs affected by shortages. This inclusion of such data would be instrumental in developing more effective solutions. Further research should prioritize analyzing the specific drugs impacted by shortages to refine solutions. Lastly, the shortage status in this study was not measured based on an actual inventory but rather through an investigation of the pharmacists' perception of shortages, which introduces a potential limitation.

Conclusion

The COVID-19 pandemic triggered widespread drug shortages in Korean community pharmacies. These shortages were influenced by several factors, including pharmacy size, the timeliness of receiving shortage information, and procurement sources. Communication with doctors positively affected drug shortages resolution. Implementing policies considering the identified factors, such as establishing an information delivery system that prioritizes drug shortage alerts or enforcing drug distribution policies to resolve the distribution discrepancy between pharmacies, would mitigate drug shortages and improve their resolution. Enhancing collaboration between pharmacists and doctors is essential for optimal patient care amidst these shortages. By focusing on these strategies, achieving a more equitable drug distribution would improve patient access to drugs and benefit healthcare providers and patients.

Abbreviations

CI, confidence intervals; CP, community pharmacy; OR, odds ratio; COVID-19, coronavirus disease of 2019.

Acknowledgments

Yong Hwa Lee and Dasom An are co-first authors for this study. Sun-Kyeong Park and Eui-Kyung Lee are co-correspondence authors for this study. We would like to appreciate Editage (www.editage.co.kr) for editing and reviewing this manuscript for English language.

Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Coustasse A, Kimble C, Maxik K. Rethinking supply chain management strategies for ventilator related medications during COVID-19 pandemic in the United States. *Int J Healthc Manage*. 2020;13(4):352–354. doi:10.1080/20479700.2020.1801162
2. Cameron EE, Bushell MA. Analysis of drug shortages across two countries during pre-pandemic and pandemic times. *Res Social Adm Pharm*. 2021;17(9):1570–1573. doi:10.1016/j.sapharm.2020.12.001
3. Shukar S, Zahoor F, Hayat K, et al. Drug shortage: causes, impact, and mitigation strategies. *Front Pharmacol*. 2021;12:693426. doi:10.3389/fphar.2021.693426
4. Health Insurance Review & Assessment Service. *Recording History and Envisioning the Future: COVID-19*. Korean; 2023.
5. Kim DJ, Kwon KH. A study for identifying current drug shortages of public hospitals and improving drug shortage information delivery system. *YAKHAK HOEJI*. 2013;57(2):150–159. In Korean.
6. Omer S, Pan M, Ali S, Shukar S, Fang Y, Yang C. Perceptions of pharmacists towards drug shortages in the healthcare system of Pakistan and its impact on patient care: findings from a cross-sectional survey. *BMJ Open*. 2021;11(12):e050196. doi:10.1136/bmjopen-2021-050196
7. Acosta A, Vanegas EP, Rovira J, Godman B, Bochenek T. Medicine shortages: gaps between countries and global perspectives. *Front Pharmacol*. 2019;10:763. doi:10.3389/fphar.2019.00763
8. Said A, Goebel R, Ganso M, Zagermann-Muncke P, Schulz M. Drug shortages may compromise patient safety: results of a survey of the reference pharmacies of the drug commission of German pharmacists. *Health Policy*. 2018;122(12):1302–1309. doi:10.1016/j.healthpol.2018.09.005
9. Canadian Pharmacists Association. Canadian drug shortages survey. Final Report Ottawa Canada. 2010.
10. Miljković N, Gibbons N, Batista A, Fitzpatrick RW, Underhill J, Horák P. Results of EAHP's 2018 survey on medicines shortages. *Eur J Hosp Pharm*. 2019;26(2):60–65. doi:10.1136/ejhpharm-2018-001835
11. Campling N, Breen L, Miller E, et al. Issues affecting supply of palliative medicines into community pharmacy: a qualitative study of community pharmacist and pharmaceutical wholesaler/distributor perspectives. *Exp Rese Clinical and Social Pharmacy*. 2022;6:100132. doi:10.1016/j.rcsop.2022.100132
12. HIRA bigdata open portal. medication usage statistics. Available from: https://opendata.hira.or.kr/op/opc/olapMsupInfoTab4.do. Accessed March 21, 2024. Korean.

13. Alyami HS, Naser AY, Alyami MH, et al. Drug shortages in Najran region, Saudi Arabia: a cross-sectional survey. *Clin Epidemiol Global Health*. 2023;21:101305. doi:10.1016/j.cegh.2023.101305
14. Baek Y, Park S-K, Lee YH, et al. Comparison of perceived importance and performance of community pharmacists' role in South Korea during the coronavirus disease 2019 pandemic. *Disa Med Public Health Prepare*. 2024;17:e569.
15. Tan YX, Moles RJ, Chaar BB. Medicine shortages in Australia: causes, impact and management strategies in the community setting. *Int J Clin Pharm*. 2016;38(5):1133–1141. doi:10.1007/s11096-016-0342-1
16. Korea Institute for Pharmaceutical Policy Affiars. Establishment of a Drug Supply Monitoring System and Study on Public Information Disclosure for the Nation. Korean; 2021.
17. Korean Pharmaceutical Association. Applications for equal distribution of the pseudoephedrine (Pseudafed tab and Kopseu tab) to pharmacies accepted starting May 15, 2023. Available from: https://www2.kpanet.or.kr/news/press_view.jsp?s_class=kpa_news&rnum=3323&oid=6880&intPageNo=9&keyField=&searchField=&PageSize=10. Accessed March 21, 2024. Korean.
18. Israel GD. *Determining Sample Size*. Institute of Food and Agricultural Sciences (IFAS). University of Florida, PEOD-6; 2013:1–5.
19. Miljković N, Batista A, Polidori P, Kohl S, Horák P. Results of EAHP's 2019 Medicines Shortages Survey. *Eur J Hosp Pharm*. 2020;27(4):202–208. doi:10.1136/ejhpharm-2020-002341
20. Ventola CL. The drug shortage crisis in the United States: causes, impact, and management strategies. *P T*. 2011;36(11):740–757.
21. Dill S, Ahn J. Drug shortages in developed countries--reasons, therapeutic consequences, and handling. *Eur J Clin Pharmacol*. 2014;70(12):1405–1412. doi:10.1007/s00228-014-1747-1
22. Obiedalla M, Patel N. Exploring the experiences of pharmacists with drug shortages in the UK. *Int J Pharm Pract*. 2023;31(Supplement_2):ii40–ii41. doi:10.1093/ijpp/riad074.049
23. US Food Drug Administration. Drug shortages: root causes and potential solutions. A Report by the Drug Shortages Task Force; 2019.
24. Ravela R, Airaksinen M, Lyles A. State of the European Union's early notification obligation for drug shortages: enforcement and compliance in eight European countries (2020-2022). *J Pharm Policy Pract*. 2023;16(1):135. doi:10.1186/s40545-023-00646-w
25. Vogler S, Fischer S. How to address medicines shortages: findings from a cross-sectional study of 24 countries. *Health Policy*. 2020;124(12):1287–1296. doi:10.1016/j.healthpol.2020.09.001
26. HIRA bigdata open portal. status of medical facility. Available from: https://opendata.hira.or.kr/op/opc/olapYadmStatInfoTab2.do. Accessed March 21, 2024. Korean.