

# The Impact of Pharmaceutical Electronic Bidding Procurement on Prices of Medicines: A Systematic Review

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## **Pentrakan *et al.*: Pharmaceutical Electronic Bidding Procurement**

**An electronic bidding system promises to save resources in procurement procedures for many industries. While the results of previous studies in several countries sounded promising, it is concerning that more evidence would be needed to support changes in practice for the pharmaceutical sector. The objective of this study was to determine the prevalence of price saving in bidding-based electronic procurement setting and to clarify the main factors contributing to drug price changes. A comprehensive literature search was retrieved from five databases (Scopus, PubMed, ProQuest, Web of Science, Medline) to identify articles that studied the prices of medicines as a case study before and after the implementation of the electronic bidding system. Articles that were published in English from January 2012 to December 2021 were eligible for inclusion. The result showed that a total of 3214 records articles were identified in the electronic databases after the exclusion of duplicate articles. After the initial review, we found 13 studies that fulfilled our inclusion criteria. The review presented the important information suggesting that the use of the electronic bidding system likely results in a reduction in procurement prices of medicines. The prevalence of price saving for pharmaceutical procurement ranged from 7.24 % to 40 %. Additionally, the following factors were indirectly associated with drug price changes; bid volume, procurement location, contract characteristics, level of competitiveness and procurement organization. Further research may need to examine the functioning of e-bidding policies to address problems like supply disruptions to preserve the integrity of bidding-based pharmaceutical systems.**

**Key words:** Electronic bidding, pharmaceutical procurement, medicine prices, systematic review

Pharmaceutical market can face imperfect competition and become a challenge in controlling drug prices<sup>[1,2]</sup>, such as it can be a major barrier to entry by other companies among monopoly and oligopoly markets. The price of medicines can vary based on a number of features, such as differences in formulations, suppliers, packaging, sales volume, trade name or brand<sup>[3]</sup>. Each nature of the procurement system may have unique procedures. This means that the problem was also identified for a specific system. The decision in the bidding system was usually taken by looking at the lowest price<sup>[4-6]</sup> and sometimes other further criteria were also considered<sup>[7]</sup>, such as quality of the products, ability to supply and a share of the market or competition with non-exclusion. One example of the impact of bidding on the purchase prices of generic medicines was the reduction in the omeprazole price in

the Netherlands<sup>[8]</sup>. The omeprazole drug often showed a very widely used medication that it was not expensive, but because of the large volume, the spending on the healthcare system thus was very high. In bidding systems, the price was reduced even further to 2 Euro cents, which means that it was possible to use for treating patients for 60 Euro cents per month. This was a very aggressive mechanism where pharmaceutical companies had to offer their reservation price in order to win the particular market.

Even though the e-bidding system showed that it can save costs in the procurement process for many industries<sup>[9-11]</sup>, it was concerning that more evidence was needed to support changes in the pharmaceutical market. Some literatures pointed out that bidding commonly led to a significant reduction in prices and

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showed very success in the short term, whereas it might pose a threat to competition and disruptive innovation in the long term<sup>[12,13]</sup>. Therefore, the objective of this review focused on examining the impact of the introduction of e-bidding systems on price savings and to identify the risk factors that affect the change in drug purchase prices.

## METHODS

This section presented the processes of a systematic review. The review started with the search strategy and databases used. It was conducted in accordance with the guideline of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)<sup>[14,15]</sup>. This was followed by the methods of study selection, quality assessment, data extraction and data synthesis, respectively.

### Search strategy:

A comprehensive literature search was retrieved from five databases (Scopus, PubMed, ProQuest, Web of Science and Medline) to identify articles that have studied the prices of medicines before and after the implementation of the electronic bidding system. In the study, Population Intervention Comparison Outcomes (PICO) frame work<sup>[16]</sup> was performed to define a well-formulated question and select the relevant terms; problem (pharmaceutical procurement system), intervention (electronic bidding approach), comparison (there had no specific defined comparison group) and outcome (the purchase price of medicines). Therefore, the search terms used in each database to identify potentially relevant articles were; (pharmaceutical\* or drug\* or medicine\*) and (electronic\* or online or digital\*) and (bid\* or tender\*) and (price\* or cost\*) and (procure\* or purchase\* or buy\*). Publication date and English language were restricted in the initial literature search. Articles published in English from January 2012 to December 2021 were eligible to be included.

### Study selection:

There were two reviewers who independently screened the titles and abstracts of the studies identified in the literature search by the included criteria prior to the full-text review. If titles and abstracts cannot provide enough information, a full-text article would be sought. Reviewers then selected articles for screening of eligible content based on inclusion criteria. The types of studies included in this study can be specified as follows; intervention study or observational study designs reporting before and after introducing electronic

bidding system, must include procurement data in the pharmaceutical sector, must include data about the prices of medicines and must be peer-reviewed journal articles. Studies published in books, letters, editorials, reports, conferences, literature reviews, abstracts and systematic reviews were excluded. Studies were also excluded if they recruited the non-pharmaceutical sector and the bidding procedure was not included in electronic or online platforms. In this study, when a disagreement arose between two reviewers, there were discussions to reach a consensus and a third reviewer was consulted when necessary.

### Quality assessment:

Two reviewers independently assessed the quality of articles by applying the critical assessment checklist established by the Joanna Briggs Institute (JBI) and the checklist was modified based on the type of study reviewed<sup>[17]</sup>. The JBI technique was used because it was the efficient method and the ease of use for the systematic analysis in prevalence studies<sup>[18-20]</sup>. Each checklist was graded as "yes," "no," "unclear" and "not applicable". The JBI critical appraisal checklists for the quasi-experimental study consisted of 9 items and the cross-sectional study consisted of 8 items. Reviewers conducted in-depth reviews based on each eligible study. As recommended by Liberali<sup>[21]</sup> that the assessment results can be classified as follows; high quality (>5 "yes" responses), moderate quality (3-4 "yes" responses) or low quality (0-2 "yes" responses). The disagreements between reviewers were resolved by discussion.

### Data extraction and synthesis:

First of all, the data of each article was extracted by one reviewer. It was then independently rechecked by a second reviewer. The following information included authors and year of publication, country of study, study design, study duration, setting, sample size, intervention and comparison group, outcome measurement, proportion of price saving, the finding of the impact of potentially identified variables associated with the pricing of medicines in the different bidding-based online setting. The data were recorded in an Excel 2010 spreadsheet (Microsoft Corp., Redmond, WA). Discrepancies in data extraction were resolved through discussion of the two reviewers or participation of a third reviewer.

This review applied a narrative synthesis method to identify the proportion of price savings in bidding-based

electronic procurement settings and to clarify the main factors affecting the change in drug prices<sup>[22,23]</sup>. Data on related additional outcomes were also extracted from those studies which related to a primary outcome. No ethical approval was requested for this study because the study did not include human participants or patient clinical outcomes<sup>[24]</sup>.

In this study, the main outcome was to determine the proportion of price reductions in e-biddings systems and to clarify the main factors influencing the change in drug prices. The results of the effect of e-bidding system on medicine prices were represented through a systematic review. Results in this review include; the results of search and included studies, the results of quality assessment through critical appraisal checklists established by the JBI, the results of study characteristics and data extraction as presented in Table 1 and the results of outcome measurement.

### Results of search and included studies:

Each database was searched on January 10<sup>th</sup> 2022 and 3308 records identified were resulted through five database searches; 165 results from Scopus, 3123 results from ProQuest, 8 results from PubMed, 9 results from Medline and 3 results from Web of Science. After checking for duplicate citations, a preliminary search returned 3214 results, excluding 94 records due to duplication. The process of the search strategy and its documentation was outlined according to PRISMA guideline. At the screening stage, the initial records screened using title and abstract came up with 64 results, of which 3150 were excluded due to irrelevance; 160 from records that were a book, 10 from duplicate citations screened, 115 from records that were not related to the e-bidding system, 2513 from records that not studied in pharmaceuticals, 23 from records that not studied in price outcome, 324 from records that were abstract and report, and 5 from records that were not English articles. Then, in the full-text screening stage, 64 articles were assessed for eligibility. 32 items did not measure the price change, 16 items were not in the inclusion criteria of the study, 2 items cannot access the full-text and 1 item was not peer-reviewed. Thus, final results consisted of 13 studies. The study identification and selection process were shown in Prisma diagram as shown in fig. 1.

### Results of quality assessment:

The quality assessment through critical appraisal checklists established by the JBI was shown in

Appendix. The checklist was modified based on the type of study reviewed; 12 articles were assessed by the quasi-experimental study (included 9 items checklists) criteria and 1 article was assessed by the cross-sectional study (included 8 items checklists). The study data were appraised in their entirety by two reviewers.

The study assessments were classified as follows; high quality when the total score of "yes" was greater than 5 or equal, moderate quality when the total score of "yes" responded to 3-4 or low quality when the total score "yes" responded to 0-2<sup>[21]</sup>. In the process, one disagreement was resolved by discussion between two reviewers. Overall, the articles had high-quality scores and were included in this study. Thus, 13 articles were retained in the final selection.

### Study characteristics and findings:

The information on study characteristics and the results regarding the e-bidding finding of 13 selected studies were shown in Table 1. Included studies were published from January 1<sup>st</sup> 2012 to December 31<sup>st</sup> 2021 and were written in English. The geographical distribution of the studies included 3 studies from the Slovak Republic<sup>[25-27]</sup>, 1 in Brazil<sup>[28]</sup>, 1 in Czech<sup>[27]</sup>, 4 in China<sup>[13,29-31]</sup>, 1 in South Africa<sup>[32]</sup>, 1 in Cyprus<sup>[33]</sup>, 1 in Chile<sup>[34]</sup>, 1 in European countries<sup>[35]</sup> and 1 in India<sup>[36]</sup>.

Most of the articles (n=12) were quasi-experimental studies<sup>[13,25-36]</sup> and one was a two cross-sectional study<sup>[30]</sup>. Nine of the 13 studies showed the evaluation of only the e-bidding system without a comparison system<sup>[13,26-35]</sup>. There were four studies with comparison systems: Two studies comparing with negotiation system<sup>[25,27]</sup>, one study comparing with non-government procurement systems<sup>[36]</sup> and another one comparing with zero mark-up drug policy<sup>[13]</sup>.

### Outcome measurement:

This systematic review used a narrative synthesis format that did not involve the reanalysis of raw data to determine the proportion of price saving in bidding-based electronic procurement settings and clarify the essential factors affecting the change in drug prices.

### Proportion of price saving in the e-bidding system:

Electronic bidding systems were a great way to supply medicines to organizations. The major outcome of changes in the drug prices after using the system has been well documented by many authors. The findings showed different results from country to country.

TABLE 1: DATA EXTRACTION OF THE INCLUDED STUDIES

Author	Countries	Type of study	Setting	Study period	Intervention	Comparison group	Outcome measures	Sample size	Proportion of saving	Findings
Gavurova et al.	Slovak Republic	Quasi-experimental approach	Two types of procurements reporting from the public procurement office	2014 - 2017	Public procurement tenders, online platform	Negotiation system	Drug price savings	1545 contracts (88.2 % in online bidding system and 11.8 % in negotiation system)	12.3 %	Probability of achieving positive savings in the event of a public bidders (p<0.0001) compared to a negotiated procedure and the saving increased by a number of bids (p=0.015). The procurement year and territorial level also showed statistically significant explaining in saving
Gavurova et al.	Slovak Republic	Quasi-experimental approach	Number of bids in individual years reporting from journal of the government office	2014 - 2017	Public procurement tenders, online platform	NA	Drug price saving	1544 contracts	NA	The ratio of the final price and the average forecast price positive changed 0.975 times when the bid number rose by one unit. That can increase by 2.45 % (p=0.39) in price savings of medicine
Kohler et al.	Brazil	Quasi-experimental approach	Paraiba state and São Paulo in Brazil, there were different socioeconomic conditions in these two states	2002-2013	Banco de Preços em Saúde (BPS), web based procurement bid portals	NA	Unit price of medicines	1553 transactions including 19 drugs that met the criteria	NA	This system has not led to lower prices for 25 widely used drugs in both states. Especially in high-economic cities such as São Paulo. It also did not differentiate between the prices of different suppliers
Nemec et al.	Czech and Slovak Republic	Quasi-experimental approach	Competitiveness levels and two types of procurements reporting from the Czech and Slovak health services	During 2019	Public procurement tender (online platform)	Negotiation system	Drug price savings	2196 records of registered public procurements	24.3 %	An increased number of bids clearly resulted in a decreased price both in Czech (p<0.0001) and Slovak (p=0.013). However, the association between the price reduction and the purchasing method was not statistically significant in this study

Chen <i>et al.</i>	China	Quasi-experimental approach	Centralized drug procurement survey was conducted from 346 medical institutions, Shenzhen 2019	2017-2019	National Centralized Drug Procurement (NCDP)	NA	Structure effects, price effects, volume effects and expenditures changes	32 720 purchase transactions (38 generic name)	36.9 %	Prices for all types of medicines have dropped after the system was introduced. This finding resulted in a positive role in controlling all terms of structural effects, price effects and volume effect  This system developed access to insulin by reducing price and tax and increasing reimbursement rates. Real selling price played a more significant part in the insulin price component (74.15 % to 77.70 % before and 74.86 % to 91.51 % after using the bidding system). The study found that prices in community hospitals were lower than at other levels
Wang <i>et al.</i>	China	Two cross-sectional studies	56 different-level hospital pharmacies in Nanjing city (25 community hospitals, 11secondary hospitals, 20 tertiary hospitals)	Both in 2016 and 2018	Online centralized procurement bidding policy	NA	Drug price of insulin products	1079 records (529 recorded in 2016 and 550 recorded in 2018)	NA	The system can be an effective policy to reduce medical costs. Prices of medicines in data of the public sector were most often lower than data in private systems. Whereas there were some products that increase over time, and some types of bidders were less competitive
Wouters <i>et al.</i>	South Africa	Quasi-experimental approach	Healthcare departments in private and public sectors in Pretoria, South Africa	2003-2016	Pharmaceutical tendering in health care system	NA	Drug prices and market concentration	8701 contracts (2198 drugs)	40 %	The bidding process provided a substantial saving in prices (p=0.006). Bid types were an important factor. Bids by alternatives were associated with significant savings in drug prices across all categories than by other types (p<0.0001). Bids by group were associated with significant savings in only some categories (p= 0.045), while bids by INN were not associated with significant savings
Petrou and Talias	Cyprus	Quasi-experimental approach	Cyprus health procurement setting (bid types were divided by INN, group, alternative)	During 2011	Online tendering process for pharmaceuticals (centralized procurement of medicines)	NA	Drug price reduction	178 medical products	NA	

Raventós and Zolezzi	Chile	Quasi-experimental approach	Drugs procurement information of public hospitals	2001-2006	Electronic tendering by the public sector	NA	Drug price reduction	1566 tender records for drug and 2301 for medical devices	8.25 %	The system supported price reduction of fraud between purchasing officials and suppliers, effective rules that were more relevant to the use of online platforms and increased bidders in the related organizations. When extending the time for half a day, it had resulting in an indirect price reduction of 0.4 %
Qendri <i>et al.</i>	European countries	Quasi-experimental approach	Procurement system for purchasing HPV vaccines from both national or regional levels	2007-2018	Tenders Electronic Daily (TED) for HPV vaccines procurement	NA	Price saving of vaccine	178 procurements announced in 15 European countries	8.90 %	The average bid price was four times lower than the list price. The difference in quantity, types of vaccine, duration of the contract, purchasing level (region or country) and the number of proposals received had a significant impact on the price saving of vaccines
Roy	India	Quasi-experimental approach	Drugs procurement information on health agencies in both the public and private sectors of Delhi	1995-2009	Delhi Government's Central Procurement Agency (CPA)	Non-government's agencies	Drug price reduction	31 medicines based on morbidity data	33.3 %	The CPA in Delhi procurement prices was much lesser than the international reference prices. Saving in costs of medicines has been achieved in comparison to procurement by local open tender, the procedure being followed routinely by individual health facilities. Larger bid volume by public sector of procurement organizations and agencies competitively has been seen to achieve saving

He <i>et al.</i>	China	Quasi-experimental approach	Two intervention 2012-2014 points, ZMDP and CPMP from 22 general hospitals in Sanming city	2012-2014	Centralized Procurement of Medicine Policy (CPMP)	Zero Mark-up Drug Policy (ZMDP)	Expenditure and total health expenditure of medicines	24 mo time records (12 data records before and 12 data records after using the system)	NA	Significant changes in the prices of medicines resulted immediately after ZMDP was implemented. However, the introduction of CPMP did not have a significant result in drug price savings and the total health expenditure, especially in the inpatient sector. The drug expenditures was reduced expenditures on outpatient (p<0.05) but the price went up significantly on inpatient (p<0.01)
Yao and Tanaka	China	Quasi-experimental approach	Different bids level of pharmaceutical procurements in Guangdong city	2007-2009	Provincial-level pharmaceutical procurements bidding in Guangdong	NA	Prices of medicines	The sample contains 19 818 observations that were classified into 157 product groups	NA	The system supported various drug price reductions depending on the location, competitiveness and product type. The high level of competition and more winning experiences can encourage manufacturers to take serious action and offer lower prices. While using multiple bids did not significantly expand the price gap

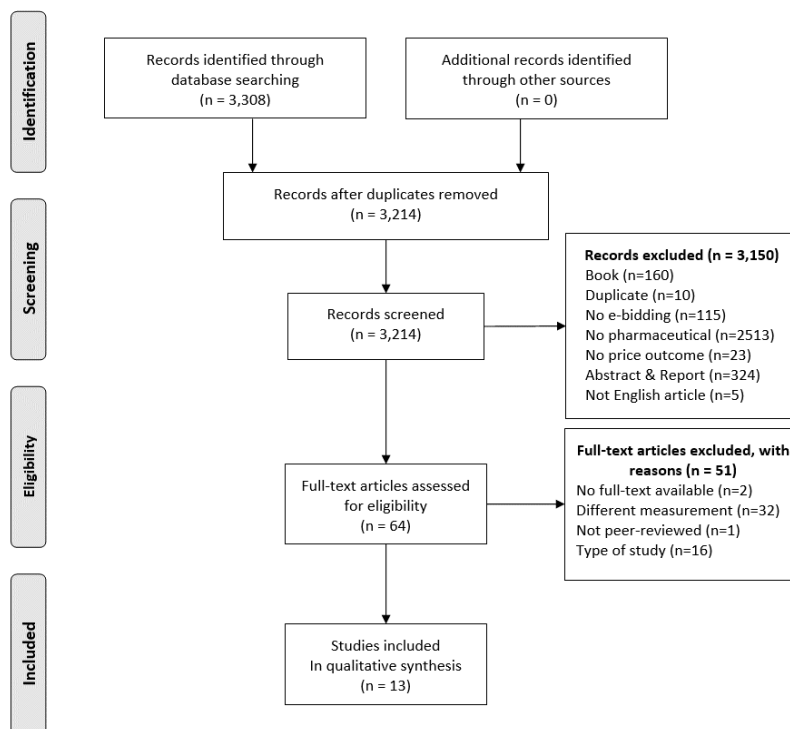


Fig. 1: Prisma diagram of the literature search process

The proportion of drug purchase price saving in seven included studies varied from 7.24 % to 40 %<sup>[25-36]</sup>, as shown in Table 1. These results supported hypothesis 1. The remaining articles did not measure the proportion of drug price reductions<sup>[13,26-33]</sup>; however, they provided the important findings on the relevant factors affecting drug prices in the system.

In the studies conducted in China, South Africa and India<sup>[29,32,36]</sup>, the proportion of price reduction was shown greater than 30 %. The study of Chen<sup>[29]</sup> examined price changes of 25 medicines after implementing a national centralized drug procurement policy in mainland China. They found that the model was successful in reducing drug costs by 36.9 %. In the finding of Wouters study<sup>[32]</sup>, they investigated the prices of drugs bought in an online bidding system in South Africa. They found that the system can be an effective policy to reduce drug costs and the prices of medicines in most categories dropped by an average of about 40 %. Some studies compared the e-bidding system to other different systems<sup>[13,25,27]</sup>. In the study by Gavurovz<sup>[25]</sup>, they examined two types of procurements in Slovakia between public e-bidding system and negotiation system. They found that the probability of positive savings of 12 % in price was achieved in the case of public tender ( $p < 0.0001$ ) compared to a negotiated procedure. While Namac<sup>[27]</sup> also compared these systems in the Czech and Slovakia on the final

price of a contract. The association between price savings and purchasing approaches used were not statistically significant. They found that there was higher price saving in e-bidding system in the Czech, but the negotiation system led to higher savings in Slovakia. Additionally, the study of He examined the use of centralized e-bidding system in China<sup>[13]</sup>. They observed no significant instant-level changes in drug expenditures after the implementation of this system.

**Main factors for price saving among the e-bidding system:** This review used qualitative data synthesis that employed interpretive methods to synthesize the findings of risk factors for price saving from included studies. Data on related outcomes were extracted and categorized as follows; bidding types, procurement locations, contract characteristics, level of competitiveness and procurement organizations. The impact of these potentially identified variables was reported associating with medicine prices in the e-bidding system.

E-bidding had a huge impact on the reduction of medicine prices. However, the results were represented differently by subcategories of related factors in the system. Some studies identified that the differences in bidding types can influence the price changes in medicine for pharmaceutical procurement<sup>[25,27,33]</sup>. For example, the study of Petrou and Talias<sup>[33]</sup> examined three types



of bidding in Cyprus drug procurement; monopoly products (INN), group purchasing and alternative products. The findings showed that procurement by alternative or just one of many competitive products in the market had a significant association with the price saving in all medical categories. While bids by group purchased showed a significant association with a specific price saving only in the entire sample. Moreover, bids by INN had no significant association with price savings.

In the study of Nemač<sup>[27]</sup>, they suggested the price reduction correlated with the selection criteria of bidding systems such as using the lowest price and Most Economically Advantageous (MEAT) used in the Czech republic had a significant effect on the price saving of medicines. Similar to a study by Gavurova<sup>[25]</sup> that explored price saving in different settings of bid category in Slovakia (NUTS) indicated as the level of the general classification of territorial units in drug procurement. They found that different levels of NUTS codes can achieve significantly different price reductions, for example, at NUTS level 1, price reductions from government procurement were greater than at NUTS level 2 and NUTS level 3.

The prices of medicines represented the observed differences in findings among different procurement locations<sup>[28,31,35]</sup>. In the study by Qendri<sup>[35]</sup>, procurement in different regions in European countries had a significant effect on vaccine price. In addition, the current study by Yao and Tanaka<sup>[31]</sup> represented that purchasing medicine from local pharmaceutical firms had an advantage in price saving over non-local firms because of the costs of transportation. On the other hand, the findings of Kohler<sup>[28]</sup> argued that the online bidding system had driven up access to medicine information purchased in Brazil, but there was no consistent reduction in drug prices within two different socioeconomic states in Brazil; Paraíba (the poorest of Brazil's population) and Sao Paulo (the richest of Brazil's population).

The nature of contracts can influence drug price changes<sup>[13,34-36]</sup> which varied according to bid volume, contract duration, or types of medicines purchased. Raventós and Zolezzi<sup>[34]</sup> supported that the effect of higher quantity can lead to a reduction in drug prices and had an indirect price saving when the time between posting and award of the bidding process was extended by half a day. Some studies also suggested that larger contract volume and duration had a positive significant effect on price saving of medicines<sup>[13,35,36]</sup>.

Competitive levels can have a negative correlation with the bid price<sup>[25,27,-35]</sup>. A greater number of bidders resulted in a marked reduction of the final purchase price, both in the Czech ( $p < 0.0001$ ) and Slovakia ( $p = 0.0113$ ). Specifically, in Slovak, the ratio of the final price and the average forecast price had a positive change of 0.975 times when the bid number rose by one unit. That can increase by a 2.45 % in drug price savings. In South Africa, Wouters demonstrated that the prices of some medical products increased in the less competitive bidding category<sup>[32]</sup>. Similar to the studies of Qendri *et al.*<sup>[34]</sup> and Raventós and Zolezzi that conducted data in Chile and European countries respectively<sup>[35]</sup>, found that more bidders resulted in lower drug prices.

A recent study by Yao and Tanaka also confirmed this evidence in China<sup>[31]</sup>. The high level of competition and the more winning experience was a key factor affecting the price reduction. Although the information about participants in e-bidding systems was concealed by the online platform, observing a high number of potential participants can encourage drug companies to more actively offer lower prices.

Some studies suggested that the purchase price of medicines in different procurement organizations was significantly different<sup>[13,30,32,33,35,36]</sup>. For example, Roy suggested that there was a high gap in prices in each medicine when comparing public and private agencies in India<sup>[36]</sup>. His study showed that there was higher cost saving in drug procurement by government in comparison to procurement by local private tender that the procedure was followed routinely by individual health facilities. The study of Wouters also supported that drug prices in public bidding sectors decreased more than those prices in the private sector of South African organizations<sup>[32]</sup>. In China, Wang presented recent evidence that the price saving at community hospital levels were higher than elsewhere<sup>[30]</sup>. This was due to being high competition in prices between different hospital levels. Moreover, the study of He showed significant price differences in levels of the organization<sup>[13]</sup>. Another study by Petrou and Talias<sup>[33]</sup> showed that when comparing smaller unit functions of hospitals in Cyprus, the cost of medicines in the outpatient unit was significantly more economical than in other units.

In this study, a systematic review was conducted to determine the proportion of price savings in medicines when introducing the e-bidding system and to clarify the main factors affecting the change in drug prices.

More evidence in several countries was revealed, and their findings can point out the changes in drug prices after implementation of the e-bidding system. To do so, a comprehensive literature search was retrieved from five databases (Scopus, PubMed, ProQuest, Web of Science and Medline) to identify articles that have studied the prices of medicines before and after the implementation of the e-bidding system. The articles included in this study must be published in English from January 2012 to December 2021. In the searching step, a total of 3214 records were uniquely identified in the electronic database. All records were screened and reviewed according to inclusion criteria by two reviewers. Finally, there were 13 articles were included in this study.

Evidence from experienced countries showed that the introduction of e-bidding systems for drug procurement was similar with other sectors that generally expected to improve quality, equity, efficiency and responsiveness in businesses and their work process<sup>[37-39]</sup>. The findings in this study suggested that the proportion of drug price reductions varied from country to country, ranging from 7.24 % to 40 %. In addition, some relevant factors in the system such as the difference in bidding types, procurement locations, contract characteristics, competitiveness levels and procurement organizations, were significantly associated with changes in drug prices.

Even though the results showed that it can save costs in purchasing any products for many countries, some debates argued that centralized purchasing through e-biddings could affect companies exiting the market and increase market concentration<sup>[12,39,40]</sup>. Over the long term, it could lead to higher drug prices with less competition and then may result in supply interruption<sup>[41]</sup>. As the suggestion by He<sup>[13]</sup> in this study (evidence from Sanming city, China), although e-bidding systems can reduce drug prices in the short term, the price then rose again and the overall results were not on target to control drug price growth and total healthcare costs.

However, the evidence in South Africa and Chile suggested that the use of e-bidding systems can significantly reduce drug prices and such reductions can persist over time. Wouter<sup>[32]</sup> found a drop in prices for medicines from 2003 to 2016 in South Africa's drug procurement after implementing public health e-bidding systems. They found that drug prices remained much lower than in private health systems that did not use the e-bidding system. This finding was

consistent with an earlier study in Chile by Raventós and Zolezzi<sup>[34]</sup> suggesting that e-bidding lowers prices in long term through reduced corruption in process between officials and suppliers, collusion between suppliers, rules related to better use of the platform, more integration of purchases and increased bidders in some medicines. In addition, there were many shorter studies<sup>[25-27,29-31,33,35,36]</sup> that found the pharmaceutical e-biddings were also associated with lower drug prices, although some studies observed no significant instant level changes<sup>[28]</sup>.

This study also supported a better understanding of the mechanisms and key factors that enable electronic bidding systems to bring down prices. This might allow decision-makers to monitor and develop a structure for drug procurement system. The study of Petrou and Talias<sup>[33]</sup> assessed the impact of potential factors (innovation status, total expenditure, purchase quantity, administering healthcare settings, patent status, wholesale price and types of bidding) to reduce drug price in the system. They revealed that the generic status of medicines was substantially correlated with higher price reductions than branded status. Bid by providing only one competitive product from multiple listings<sup>[3,42]</sup> and the large purchase volume had a relationship with the price reduction<sup>[43,44]</sup>. However, this review also supported that price control policies may limit Research and Development (R & D) and innovation of drug companies<sup>[45]</sup>.

Based on the Cyprus evidence, there was a finding that total value was negatively correlated with price reductions in bidding procedure<sup>[33]</sup>. The possible reason was that high-value medicines can be achieved with strong brand loyalty plans which interacted with customers and providers on an emotional level in addition to drug side effects and benefits. This was consistent with the study in United State by John and Rizzo<sup>[46]</sup>, suggesting that pharmaceutical advertising can reduce the price elasticity of drug demand. Berndt<sup>[47]</sup> also supported that the high value drug can make a difference in products by using marketing tools. This systematically reduces price sensitivity by increasing brand loyalty, at the same time increasing sales. Moreover, the study of Wouter<sup>[32]</sup> in this review further pointed out the nature of this procurement method that governments would benefit more from better precision drug demand forecasts; However, they found differences between estimated and purchased quantities in purchasing many medical products in South Africa. The estimated quantity in

the bidding contract sometimes exceeded the required amount, while in other cases sometimes the required quantity was insufficient<sup>[48]</sup>. This was difficult for pharmaceutical suppliers to plan production and deliveries when demand forecasting errors occurred<sup>[49]</sup>. It could increase the risk of supply disruptions and increase drug prices in some cases<sup>[50]</sup>. Thus, these risk factors were important considerations for policymakers to enhance their ability to work with the goal of saving more money and improving their policy. This review had some limitations. First, there were only articles published in peer-reviewed journals and in English that were included in the study. Therefore, there was a high likelihood of language and publication bias. Additionally, articles with significant findings were more likely to be accepted for publication than articles without significant findings, which may cause bias. However, due to a lack of resources, thus references in this review were retrieved only based on electronic searches. Second, this study had two articles that cannot access full-text available, even the researcher attempted to contact the authors but no responses. Thus, it may cause bias in the final results. Another limitation was that the included studies in this review differed at a high level in the research methodology, study design and statistical heterogeneity. This may limit the validity of the findings and the precise interpretation of the results. In the review registration, this study was not registered with PROSPERO because it did not meet the eligibility criteria for managing human and clinical outcomes.

## CONCLUSION

The study addressed several implications of drug purchasing policy. This would be helpful for policymakers to improve their systems. The governments in many countries have had success using the e-bidding platforms for drug procurement to signal a greater openness to investigations, reduce corruption and reduce collusion with suppliers to keep drug prices low in the short term. However, the return on such investments through sustainable or long-term price reductions was still difficult to determine due to different discoveries in different countries. Especially, in China, there was still room for improvement in the transparency of pharmaceutical market criteria to increase long-term entry into new manufacturers. This review also clarified that the context of bidding type, location, contract characteristics, competitiveness and procurement organization significantly influence drug prices. The price reductions observed in most countries were often due to monopsony capacity. In this case, it

was a single purchaser of the drug on behalf of multiple hospitals to get high power in aggressive negotiation with suppliers. Competitive pressure from bidders has caused drug prices to drop dramatically. This means that supporting competitiveness in the medical product market was essential for improving procurement performance. The wider product range also attracted companies to offer a lower price, but it had less impact compared to the number of bidders and previous winner experiences. Multiple bids also encouraged suppliers to weigh up possible combinations of offers and reductions. On the other hand, long distances from the purchasing site were associated with higher bids due to the sense that increased shipping costs would reduce their profits. Generally, higher volumes and contract periods in the e-bidding system led to a significant drop in prices. These findings were consistent with the principle of supply and demand. On the other hand, future concerns or caveats should be considered when implementing this system, such as low-cost centralized purchases with long-term deals could create a risk of eroding competition by forcing some rivals to withdraw from the market in the future. An accidental market failure can cause future price increases. The present data in this review referred to countries that have gained significant expertise in the e-bidding system and experienced their optimization. From these results of the review, taking advantage of correlating factors would benefit policymakers in designing and improving their systems. Therefore, this study expected that countries that would implement e-bidding systems can achieve and improve their drug procurement by learning these findings from experienced countries.

## Conflict of interest:

The authors declare that they have no conflict of interests.

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