Journal of King Saud University – Science 35 (2023) 102767

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Contents lists available at ScienceDirect

Journal of King Saud University – Science

journal homepage: www.sciencedirect.com

Original article

Pharmacists' knowledge, familiarity, and attitudes towards biosimilar drugs among practicing Jordanian pharmacists: A cross sectional study

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ARTICLE INFO

Article history:
Received 29 August 2022
Revised 21 May 2023
Accepted 12 June 2023
Available online 16 June 2023

Keywords:
Pharmacists
Biosimilar drugs
Biological drugs
Jordan

ABSTRACT

Objective: Biosimilar (BSM) drugs are currently being manufactured and dispensed in several pharmaceutical markets worldwide, including Jordan. They are clinically similar to biological drugs in terms of safety, purity, and potency, but with lower cost, hence they are of great interest. Pharmacists play a fundamental role as health care providers, due to their direct contact with patients, in terms of providing information and guidance about BSM drugs and their use for patients. Thus, the aim of this study was to assess the knowledge, familiarity, and attitude with BSM drugs among practicing Jordanian pharmacists.

Materials and Methods: A questionnaire which was composed of 25 close-ended questions, was distributed via email and various social media applications to Jordanian pharmacists working in different fields.

Results: A total of 400 pharmacists responded to the questionnaire. Overall, the level of knowledge and familiarity about BSM drugs among Jordanian pharmacists was low, as 75% of the respondents had a knowledge score of 66.7%. Poor knowledge was noticed in terms of variability of biological drug formulation lots and the BSM drug, the approval process of BSM drugs, and their cost, with correct answers of the respondents being 30.8%, 16%, and 7.5%, respectively. Nevertheless, the attitude of respondents towards BSM drug dispensing, and increasing patients' access to a variety of treatment options (73.8% and 82.3%, respectively) was rather favorable.

Conclusions: The results of our study recognized three knowledge gaps: the variability between the biological drug formulation lots and the BSM drug, the cost of biological and BSM drugs, and understanding the approval process of biological and BSM drugs. So, these findings highlight a significant need for evidence-based education about BSM drugs among Jordanian pharmacists.

1. Introduction

Currently, recombinant DNA biotechnology has enabled a large commercial production of different products, such as biological drugs, to improve the therapeutic approach of several diseases. Biological drugs are identical or nearly identical to human proteins (Schellekens, 2002) and they are derived from living organisms, such as *Escherichia coli*, yeast, or Chinese Hamster ovary cells (Mellstedt et al., 2008; Dranitsaris et al., 2011). Several classes of biological drugs are produced, such as enzymes, hormones, monoclonal antibodies, biological response modifiers, peptides, and hematopoietic growth factors (Crommelin et al., 2003).

However, biological drugs production is considered a proprietary knowledge (Mellstedt et al., 2008) and has patents, some of which had expired (Kumar & Singh, 2014). In addition, biological drugs are expensive, thus causing an economical burden on the health care system. Hence, the introduction of cheaper protein products was needed. Considering the expiry of the patents of some biological drugs (Kumar & Singh, 2014), the development of new protein products, namely biosimilar (BSM) drugs, was

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.jksus.2023.102767
1018-3647/

introduced and they are available at a lower cost (Beck et al., 2017). BSM drugs are also known as, among other names, follow-on proteins, follow-up biologics, or off-patent biotech products (Woodcock et al., 2007; Kumar & Singh, 2014).

A BSM drug is similar and not identical to the reference originator biological drug that is already approved by health regulatory institutions and available in pharmaceutical markets (Mellstedt et al., 2008; Kumar & Singh, 2014). A BSM drug does not have the exact chemical structure and is not considered a generic to the originator biological drug. This is in part due to the production process in which biotechnology products are produced (Schellekens, 2002). Moreover, as biological drugs are proteins which must be folded in a specific manner in order to have an active three-dimensional structure (Crommelin et al., 2003), a BSM drug must also have similar protein structure and folding to result in a similar clinical effect (Dranitsaris et al., 2011). This contrasts with the traditional small-molecule pharmaceutical drugs in which a generic has the same chemical structure to the originator (Mellstedt et al., 2008). Also, biological and BSM drugs, being recombinant human proteins, are considered immunogenic and elicit antibodies production (Schellekens, 2002; Schellekens & Casadevall, 2004; Brinks et al., 2011). Furthermore, the United States Food and Drug Administration (US FDA) declares that biological and BSM drugs have "no clinically meaningful differences" in terms of safety, purity, and potency (Alvarez et al., 2020). Nevertheless, the US FDA has several requirements for pharmaceutical companies to follow and prove to approve BSM drugs (Woodcock et al., 2007; Alvarez et al., 2020). Such requirements include, amongst others, the manufacturing process, structural similarity, in vivo studies, immunogenicity clinical efficacy and safety, and clinical pharmacokinetics and/or pharmacodynamics. However, not all BSM drugs are interchangeable with their reference biological drugs. To substitute a biological drug with a BSM drug, further requirements need to be met, such as clinical outcomes to be the same for both drugs in any given patient and no change in risk or efficacy when switching or alternating both drugs (Alvarez et al., 2020).

Europe has established a regulatory approval pathway in 2004 and approved its first BSM drug in 2006 (Commission, 2022). BSM drugs have enriched the global pharmaceutical markets by providing a better access to the health care services, including Jordanian market. A guideline regarding the registration of BSM drugs was issued by the Jordan Food and Drug Administration (JFDA) (Administration, 2022). Much of the information used to develop the Jordanian guideline was adopted from the European Medicines Agency (EMA) guidelines (Administration, 2022; Agency, 2022), since the EMA has the most well-developed regulatory framework for BSM drugs approval. Jordanian local manufacturers and agents of international pharmaceutical companies had submitted and continue to submit registration dossiers for BSM drugs to provide the local pharmaceutical market with BSM drugs that have a competitive price compared to the expensive reference biological drugs (Kelly, 2010).

Biological and BSM drugs are usually dispensed for patients in pharmacies and/or hospitals. However, according to sample studies performed in Belgium (Barbier et al., 2021), the US (Cohen et al., 2017), and Tunisia (Hadoussa et al., 2020), not all healthcare providers, such as pharmacists and physicians, and/or patients are aware of the nature of these drugs or even the differences between them. Pharmacists are among the healthcare providers that need to ensure patients' safety and knowledge about their administered drugs. Hence, pharmacists' knowledge about BSM drugs is essential. Moreover, BSM drugs are becoming marketed worldwide and are gaining further importance. The aim of our study is to assess the knowledge, attitude, and familiarity with BSM drugs among practicing Jordanian pharmacists. These include pharmacists who work in community pharmacies, hospital pharmacies, pharmaceutical companies and factories, drug stores, as well as other pharmaceutical sectors, such as the JFDA and Jordanian Pharmacists Association (JPA).

2. Materials and Methods

2.1. Sample recruitment

The questionnaire of this study was performed online using Google Forms. An approval from the IRB of Al-Zaytoonah University of Jordan (ZUJ) was granted to conduct the study. By adopting snowball method for sampling recruitment, the questionnaire's link was distributed via email and various social media applications, as was previously performed (Akour et al., 2021), between November 2021 and April 2022. The inclusion criteria for the study were licensed and practicing pharmacists in Jordan who are adept in English and use of online surveys. Questions regarding years of experience, place of work, and field of work were included in the questionnaire to ensure that participants met the inclusion criteria. The Krejcie and Morgan method for nonspecific population size was used to determine the required sample size (Krejcie & Morgan, 1970). The required number of participants for this study was calculated at a 95% confidence interval and 5% confidence level and was equal to 385 participants (Krejcie & Morgan, 1970). A total of 400 respondents submitted completed questionnaires. The questionnaire was sent to pharmacists in Jordan, as in the criteria specified for the study, who work in community pharmacies, hospital pharmacies, drug stores, pharmaceutical companies and factories and other pharmaceutical sectors, such as the JFDA and JPA. Data collection and analysis were anonymous.

2.2. Questionnaire

The beginning of the questionnaire was a short sentence describing the purpose of the study, the confidentiality of the collected data, the respondents being anonymous, and respondents' informed consent. Some questions were adopted from several related articles (Beck et al., 2017; Cohen et al., 2017; Teeple et al., 2019a; Teeple et al., 2019b; Hadoussa et al., 2020; Barbier et al., 2021) and others were developed by the research team. There were 25 close-ended questions in the questionnaire. A panel of 6 academic licensed pharmacists at the Faculty of Pharmacy at ZUJ performed face and content validations. The panel included PhD holders in Pharmacology, Pharmacogenomics, and Pharmaceutics, who had also worked in community pharmacies before. Their suggestions were taken into consideration to further develop and amend the questions. The questions were translated from English to Arabic through forward–backward-forward technique (Beaton et al., 2000) as the official language in Jordan is Arabic. The questionnaire was later pilot tested on 12 academic licensed pharmacists in the Faculty of Pharmacy at ZUJ to assess their comprehension of the questionnaire and the time spent in completing it. The results of the pilot study were excluded from the analysis.

The questionnaire was divided into 4 sections. The first section was demographic characteristics of the participant (Table 1). The second section was the knowledge level of the participant about BSM and biological drugs in which 9 statements were included with the following possible answers: "True", "False", and "I do not know". Knowledge scoring was calculated by granting one point for every correct answer, and zero for every incorrect response. The maximum possible knowledge score was nine (Table 2). The third section had 3 statements using 5-Point Likert response scale to assess the familiarity of the respondents with BSM drugs, the response options for these items were "Always", "Most of the time", "Usually", "Rarely", and "Never". The scoring

Table 1
Demographic characteristics of the respondents of the study.

		Frequency (%)
Gender	Male	112 (28.0%)
	Female	288 (72.0%)
Age	≤30	203 (50.7%)
	≥31–40	86 (21.5%)
	≥41–50	84 (21.0%)
	>50	27 (6.8%)
Academic Level	Diploma	29 (7.2%)
	Bachelor	316 (79.0%)
	Postgraduate	55 (13.8%)
Experience	Less than 5 years	187 (46.8%)
	5–10 years	77 (19.3%)
	11–15 years	46 (11.5%)
	>15 years	90 (22.5%)
Place of work	Private sector	254 (63.5%)
	Public sector	146 (36.5%)
Location of work	Amman	253 (63.2%)
	Irbid	33 (8.3%)
	Zarqa	30 (7.5%)
	Others	84 (21.0%)
Field of work	Community Pharmacies	172 (43.0%)
	Hospital pharmacies (Inpatients/ outpatients)	121 (30.3%)
	Drug stores	29 (7.2%)
	Pharmaceutical Companies/factories	17 (4.3%)
	Other pharmaceutical sectors	61 (15.3%)

Table 2
Participants' responses to knowledge items about biosimilar drugs.

		Frequency (%) or Median (25–75)
1. A biosimilar drug has no clinically meaningful differences (similar safety and efficacy) compared to the biologic reference drug (True).	Incorrect	38 (9.5%)
	Correct	362 (90.5%)
2. A biosimilar has similar immunogenicity compared with the biologic reference drug (True).	Incorrect	93 (23.3%)
	Correct	307 (76.8%)
3. A biosimilar drug is a generic, has same chemical structure, as the biologic reference drug (False).	Incorrect	130 (32.5%)
	Correct	270 (67.5%)
4. A biosimilar drug must have the exact amino acid sequence as the biologic reference drug (False).	Incorrect	34 (8.5%)
	Correct	366 (91.5%)
5. A biosimilar drug is interchangeable with the biologic reference drugs (False).	Incorrect	94 (23.5%)
	Correct	306 (76.5%)
6. There is similar variability between the biologic reference drug formulation lots as there is a variability in biosimilar drug formulation lots (True).	Incorrect	277 (69.3%)
	Correct	123 (30.8%)
7. All FDA-approved biosimilar drugs undergo an extensive assessment to make sure that patients can trust their efficacy, safety, and quality (True).	Incorrect	336 (84.0%)
	Correct	64 (16.0%)
8. A biosimilar drug manufacturing cost is higher than that of the biologic reference drug (False).	Incorrect	370 (92.5%)
	Correct	30 (7.5%)
9. A biosimilar drug is an FDA-approved version of a biologic reference drug that is manufactured after the expiry of the biologic reference drugs patent (True).	Incorrect	169 (42.3%)
	Correct	231 (57.8%)
Knowledge Score		**5.00 (4.00–6.00)**

ranged from 1 point for "Never" to 5 points for "Always" except for the item "How frequent do you depend on the use of the brand name to distinguish biosimilar drugs?", in which reverse scoring was applied. The highest maximum possible score for the familiarity scale was 15 (Table 3). The fourth section had 6 statements to evaluate the attitude of the participants towards BSM drugs. A 5-Point Likert response scale was used ("Strongly Agree", "Agree", "Neutral", "Disagree", and "Strongly Disagree"), and scoring ranged from 5 for "Strongly Agree" to 1 for "Strongly Disagree". The maximum possible score for the Attitude scale was 30 (Table 3).

2.3. Statistical analysis

Categorical variables were presented as frequencies and percentages, and continuous variables were presented as medians and 25–75 quartiles. The internal consistency of the three latent variables (knowledge, familiarity, and attitude scores) were evaluated by computing Cronbach's and values above 0.7 were considered acceptable. The participants were categorized according to their scores in the three computed scales (knowledge, familiarity, and attitude) to high- and low-level groups, as those who scored above the median were included in the high level and the rest were included in the low-level groups. Three binary regressions with knowledge, familiarity, and attitude levels as dependent variables and different sample characteristics as independent variables were constructed to identify variables associations with participants' level of knowledge, attitude and practices towards BSM drugs. The data were analyzed using SPSS version 27.

3. Results

3.1. Demographic characteristics

Demographic characteristics of the 400 participants who took part in the study are listed in Table 1. Most of the participants were females (72%). Half of the respondents (50.7%) were below 30 years old and 79% were bachelor's degree holders. Almost half of the respondents (46.8%) have less than 5 years of experience. About two thirds of the participants (63.2%) worked in Amman (the capital city) and 63.5% worked in the private sector. Almost half of the participants worked in community pharmacies (43%) and a good share of respondents worked in hospital pharmacies (30.3%) while the rest were working in drug stores (7.2%), pharmaceutical companies/factories (4.3%), and other pharmaceutical sectors (15.3%), such as the JFDA and JPA.

3.2. Knowledge

Results revealing the knowledge level of our survey respondents about BSM drugs are shown in Table 2. Knowledge scores were computed based on the knowledge items for all the participants, the median for the knowledge score was 5 (quartiles = 4–6) out of a maximum possible score of 9. Accordingly, 50% of the respondents had a total knowledge score of 55.6% or below and 75% of the respondents had a knowledge score of 66.7% or below.

The questions with the highest number of correct answers in the knowledge domain were "A biosimilar drug must have the exact amino acid sequence as the biologic reference drug" (91.5%) and "A biosimilar drug has no clinically meaningful differences (similar safety and efficacy) compared to the biologic reference drug)" (90.5%), followed by "A biosimilar has similar immunogenicity compared with the biologic reference drug" (76.8%), "A biosimilar drug is interchangeable with the biologic reference drugs" (76.5%), "A biosimilar drug is a generic, has same chemical structure, as the biologic reference drug" (67.5%), and "A biosimilar drug is an FDA-approved version of a biologic reference drug that is manufactured after the expiry of the biologic reference drugs patent" (57.8%). The lowest correct answers were for "A biosimilar drugs manufacturing cost is higher than that of the biologic reference drug" (7.5%), "All FDA-approved biosimilar drugs undergo an extensive assessment to make sure that patients can trust their efficacy, safety, and quality" (16%) and "There is similar variability between the biologic reference drug formulation lots as

Table 3
Participants' responses to Familiarity and Attitudes' items.

		Median (25–75)	Frequency (%)
Familiarity			
How frequent have you ever dispensed a prescription that has biosimilar drugs?	Always	3 (2–4)	27 (6.8%)
	Most of the time		121 (30.3%)
	Usually		91 (22.8%)
	Rarely		93 (23.3%)
	Never		68 (17.0%)
How frequent do you depend on the use of suffix in the non-proprietary name (active ingredient) and four-character suffix to distinguish Biosimilar drugs?	Always	2 (2–3)	75 (18.8%)
	Most of the time		130 (32.5%)
	Usually		96 (24.0%)
	Rarely		63 (15.8%)
	Never		36 (9.0%)
How frequent do you depend on the use of the brand name to distinguish biosimilar drugs?	Always	3 (2–4)	60 (15.0%)
	Most of the time		122 (30.5%)
	Usually		112 (28.0%)
	Rarely		70 (17.5%)
	Never		36 (9.0%)
Familiarity Score		**8.00 (7.00–10.00)**	
Attitude			
I am in favor of dispensing biosimilar drugs	Strongly agree	2 (2–3)	63 (15.8%)
	Agree		232 (58.0%)
	Neutral		94 (23.5%)
	Disagree		7 (1.8%)
	Strongly disagree		4 (1.0%)
I think that biosimilar drugs increase patients' access to variety of treatment options	Strongly agree	2 (2–2)	87 (21.8%)
	Agree		242 (60.5%)
	Neutral		62 (15.5%)
	Disagree		8 (2.0%)
	Strongly disagree		1 (0.3%)
I am willing to substitute a biologic reference drug with a biosimilar drug if the physician approved it	Strongly agree	2 (1–2)	102 (25.5%)
	Agree		232 (58.0%)
	Neutral		48 (12.0%)
	Disagree		13 (3.3%)
	Strongly disagree		5 (1.3%)
I feel that I am trained enough to dispense and counsel patients of biosimilar drugs	Strongly agree	2 (2–3)	75 (18.8%)
	Agree		142 (35.5%)
	Neutral		113 (28.2%)
	Disagree		56 (14.0%)
	Strongly disagree		14 (3.5%)
I think that patient should participate in taking decision to use biosimilar drugs	Strongly agree	2 (2–3)	67 (16.8%)
	Agree		196 (49.0%)
	Neutral		89 (22.3%)
	Disagree		37 (9.3%)
	Strongly disagree		11 (2.8%)
In your opinion, pharmacist should be allowed to substitute a biologic reference drug with a biosimilar drug after patient agreement	Strongly agree	2 (2–3)	65 (16.3%)
	Agree		155 (38.8%)
	Neutral		90 (22.5%)
	Disagree		73 (18.3%)
	Strongly disagree		17 (4.3%)
Attitude Score		**13.00 (12.00–15.00)**	

there is a variability in biosimilar drug formulation lots" (30.8%). The computed Cronbach's of this scale was 0.711 indicating acceptable internal consistency.

3.3. Familiarity

Familiarity scores were computed based on the answers of the respondents to the familiarity items, the median for the total familiarity score was 8 (quartiles = 7–10) out of a maximum possible score of 15 (Table 3). Accordingly, 50% of the respondents had a total familiarity score of 53.3% and 75% of the respondents had a knowledge score of 66.7% or below.

The highest medians for the familiarity items were reported in "How frequent have you ever dispensed a prescription that has biosimilar drugs?", and "How frequent do you depend on the use of the brand name to distinguish biosimilar drugs?" median of 3 (quartiles = 2–4). Regarding the question about the frequency of dispensing BSM drugs only 6.8% have always dispensed BSM drugs and 53.1% of the respondents answered "most of the time/usually" and the rest have either rarely (23.3%) or never (17%) dispensed BSM drugs. On the other hand, 15% of the respondents always use the brand name to distinguish BSM drugs, about 58.5% of the respondents reported that most of the time/usually they use the brand name to distinguish BSM drugs, and the rest have either rarely (17.5%) or never (9%) use the brand name.

While the item "How frequent do you depend on the use of suffix in the non-proprietary name (active ingredient) and four-character suffix to distinguish Biosimilar drugs?" displayed a median of 2 (quartiles = 2–3). Regarding the question about the frequency of using suffix in the non-proprietary name (active ingredient) to distinguish BSM drugs, 18.8% answered that they always depend on the suffix while 56.5% of the respondents depended most of the time/usually on suffixes and the rest rarely (15.8%) or never (9%) use the suffix in the non-proprietary name

to distinguish BSM drugs. The internal consistency of the familiarity scale was confirmed by computing Cronbach's alpha, which was 0.76.

3.4. Attitude

The median of the Attitude scale score was 13.00 (quartiles = 12–15) out a maximum possible score of 30. Our study revealed that 73.8% of the respondents were in favor of dispensing BSM drugs (median = 2, quartiles = 2–3) and 82.3% believed that BSM drugs increase patients' access to a variety of treatment options (median = 2, quartiles = 2–2). Despite the favorable attitude of the respondents towards BSM drug dispensing, only 54.3% of the respondents feel that they are trained enough to dispense and counsel patients about BSM drugs (median = 2, quartiles = 2–3). Regarding the role of pharmacists, 55.1% of the respondents believed that pharmacists should be allowed to substitute a biological reference drug with a BSM drug after patient agreement (median = 2, quartiles = 2–3) and 83.5% of the respondents are willing to substitute a biological reference drug with a BSM drug if the physician approved it (median = 2, quartiles = 1–2). However, 65.8% of the respondents believed that patients should participate in taking decision to use BSM drugs (median = 2, quartiles = 2–3). Cronbach's alpha of the attitude scale was 0.82 confirming its internal consistency.

3.5. Variables associated with knowledge, familiarity, and attitude levels

Binary regression models were built to evaluate different sample characteristics associated with knowledge, familiarity, and attitude levels. The results indicated that there were no significant associations between any of the studied variables with knowledge level. Whereas the only variable that was significantly associated with familiarity level was field of work, as those who were working in pharmaceutical companies/factories and other pharmaceutical sectors, such as the JFDA and Jordanian Pharmacists association (JPA) had higher odds to be in the high level familiarity group ((OR = 2.975, p-value = 0.046, 95%CI = 1.021–8.669); (OR = 2.225, p-value = 0.026, 95%CI = 1.099–4.505), respectively), when compared with participants working in community pharmacies. The binary regression results indicated that respondent who work in pharmaceutical companies/factories or drug stores had higher odds to be in high attitude group ((OR = 3.474, p-value = 0.043, 95%CI = 1.040–11.606); (OR = 3.449, p-value = 0.011, 95%CI = 1.321–9.005), respectively), when compared to those who worked in community pharmacies. Moreover, participants who had low familiarity level had lower odds to be in the high attitude group (OR = 0.340, p-value = 0.000, 95%CI = 0.220–0.527).

4. Discussion and Conclusions

The importance of BSM drugs is becoming noticeable in the international pharmaceutical markets including the Jordanian market. Pharmacists have a fundamental role as educators and as health care providers in terms of providing BSM drugs information to patients and their use in clinical practice. They can play a significant role in the clinical utilization of BSM drugs to guarantee a safe and a cost-effective drug that is available for patients. So, this study was conducted to assess the Jordanian pharmacists' knowledge, familiarity, and attitude regarding BSM drugs.

Our results revealed relatively low level of knowledge about BSM drugs among Jordanian pharmacists. The results showed that there were no significant associations among pharmacists working in different fields in terms of knowledge level. The respondents in our study had good knowledge about the differences between BSM drugs and biological drugs in terms of their chemical structure and interchangeability. They also showed a high knowledge regarding the similarities of BSM drugs and biological drugs in terms of their clinical effects on patients (safety and efficacy). This most probably shows that pharmacists are exposed to similar knowledge through their university education, training, and during their professional practice. Previous studies that were conducted in the US, France, Poland, Tunisia, and Pakistan showed comparable or slightly higher knowledge levels of BSM drugs in comparison with our results (Beck et al., 2017; Pawłowska et al., 2019; Hadoussa et al., 2020; Shakeel et al., 2020; Olave et al., 2021). On the other hand, regarding questions about the exact procedure of assessment and approval of BSM drugs by the FDA as well as questions regarding the lower cost of BSM drugs, the respondents showed very low knowledge level.

Nevertheless, it seems that lack of knowledge of the cost as well as the procedure of assessment and approval of BSM drugs is related to limited familiarity of Jordanian pharmacists with BSM drugs. This is shown in our results in which we assessed the familiarity of the respondents with BSM drugs. In the familiarity part, we assessed how frequently Jordanian pharmacists dispensed BSM drugs and tried to clarify how Jordanian pharmacists differentiate BSM drugs from biological drugs (depending on brand name or the four-character suffix in the non-proprietary name "active ingredient"). The results revealed a relatively low familiarity level of the respondents. The low percentage regarding the differentiation of BSM drugs from biological drugs based on four-character suffix (always/most of the time) is another indicator that Jordanian pharmacists are not familiar with BSM drugs. However, our findings showed that respondents relied almost equally on both brand name as well as the four-character suffix in the non-proprietary name in distinguishing BSM drugs from biological drugs. Similar results of a study conducted in the US reported that there is greater comfort using brand name rather than four-character suffix in the non-proprietary name (Olave et al., 2021). This may refer to the fact that, the majority of the respondents who took part in our study are pharmacists working at community pharmacies and BSM drugs are rarely available in such locations.

Despite the favorable attitude of the respondents about dispensing BSM drugs and the respondents' belief that BSM drugs increase patients' access to a variety of treatment options, other questions regarding the attitude of respondents were not in high agreement from the respondents and neutral responses were noticed. In addition, our findings showed that most of the respondents are willing to substitute a biological reference drug with a BSM drug if the physician approved it, as the BSM prescription is linked to physicians. However, our findings showed that Jordanian pharmacists who are working at pharmaceutical companies/factories and other pharmaceutical sectors, such as the JFDA and JPA, were more familiar with BSM drugs when compared with participants working at community pharmacies. The results of this study also noted a significant positive association between the place of work and being in the high attitude group. This is shown as respondents who work at pharmaceutical companies/factories or drug stores had higher odds to be in the high attitude group when compared to those who worked at community pharmacies. This may refer to the fact that pharmacists working at pharmaceutical companies/factories or drug stores and other pharmaceutical sectors have occupied more knowledge and experience regarding BSM drugs through training programs as a part of their job development.

The current study recruited a statistically significant sample size from different locations in Jordan, which increases confidence in the study results and minimizes biases impact. Due to the study's data collection method, which was based on self-

completed online questionnaire, different biases may have influenced the study's result, including selectivity and recall biases. Nevertheless, literature has demonstrated that online surveys provide a private and secure environment for the participants which, may reduce any social pressure and allow them to provide accurate and honest responses and will also eliminate interviewer bias. Furthermore, the wide use of Internet in Jordan will produce a representative sample to the Jordanian pharmacist population (Cantrell & Lupinacci, 2007; Fenner et al., 2012). Future work may include organizing workshops for pharmacists to improve their knowledge, familiarity, attitudes, and practices towards BSM drugs and evaluate the influence of these workshops on the pharmacists.

In conclusion, the results of our study highlight a significant need for education about BSM drugs for Jordanian pharmacists in practice. Three major knowledge gaps were identified: the variability between the biological formulation lots and the BSM drugs, the cost of biological and BSM drugs, and understanding the approval process of the biological and BSM drugs. Accordingly, it seems that Jordanian pharmacists have only very vague knowledge about BSM drugs. Hence, improvement in different areas is proposed to increase the knowledge about BSM drugs among practicing pharmacists in Jordan. This improvement could be started by modifying the Pharmacy curriculum at universities to include modern trends in clinical practice and from other authorities to make intensive training programs periodically to provide further knowledge to practicing pharmacists.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors would like to thank Mrs. Yamam Alrefaie for her support and all the participants that have agreed to take part in our survey. All authors thank the Deanship of Scientific Research and Innovation at Al-Zaytoonah University of Jordan for partially funding this research.

Funding

This work was partially supported by Al-Zaytoonah University of Jordan, grant no. 32/11/2020-2021.

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