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Original article

Status of infectious disease content in the professional pharmacy curriculum in Saudi Arabia: Results of a national survey

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ABSTRACT

Objectives: Antimicrobial resistance is one of the main global problems faced by healthcare institutions. Healthcare professionals as service providers must have a basic understanding of this emerging threat; additionally, considering the evolving role of pharmacists in both the community and hospital setting, it is crucial that pharmacists are part of the fight against this threat. Therefore, this study aimed to assess infectious disease subjects covered in the pharmacy curriculum in Saudi Arabia, to evaluate teaching and knowledge assessment strategies concerning infectious diseases, and to explore challenges faced by faculty members in teaching infectious disease courses.

Methods: We constructed a questionnaire with 26 items and sent it to infectious disease faculty members at 26 Saudi Arabian pharmacy colleges. It included questions regarding the faculty and institution, infectious disease topics, hours dedicated to each topic, and tools and strategies used in the courses for better understanding and assessment of students. In addition, we enquired about the faculty members' current satisfaction of, and future plans for, the curriculum.

Results: The questionnaire was completed by infectious disease faculty members, department chairs, or college deans. Among the respondent schools, 85.5% were governmental and 14.5% were private institutions. The majority of colleges (98.2%) followed a semester format schedule, with 67.3% offering solely the Doctor of Pharmacy (PharmD) program. More than 78% of respondents covered all tier 1 infectious disease topics from the American College of Clinical Pharmacy Pharmacotherapy Didactic Curriculum Toolkit. The main tool used for teaching was lectures (94.5%), while patient case application was the main teaching strategy (54.5%). Approximately 63% of respondents thought that the curricula were adequate when they were asked about their opinion of the curricula coverage, and 63.64% thought that the curriculum provided adequate baseline knowledge on infectious diseases for the following 5 years.

Conclusions: The study revealed variations in infectious disease topics covered and the time dedicated to them among pharmacy colleges in Saudi Arabia. The faculty members who responded to our questionnaire were generally satisfied with their infectious disease curriculum. To the best of our knowledge, this is the first study to assess infectious disease curricula among Saudi pharmacy colleges. Thus, the findings of this study may encourage faculty members to advocate for the standardization of infectious disease courses offered at Saudi Arabian pharmacy colleges.

1. Introduction

Antimicrobial resistance (AMR) is one of the main global problems faced by healthcare institutions. In Saudi Arabia, there is a high prevalence of AMR and emergence of rare and multidrug-resistant bacteria (Al-Tawfiq et al., 2020; Farman et al., 2019; Zowawi, 2016). AMR can arise due to different factors, such as inappropriate use of antibiotics and nonadherence to infection control practices (Baadani et al., 2015; Zowawi, 2016). Importantly, as Makkah and Madinah are cities of utmost importance for Muslims around the world, many pilgrims visit to perform Hajj and

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Umrah which poses a high risk in terms of transmitting resistant strains of infectious diseases (IDs) (Al-Tawfiq and Memish, 2021; Zowawi, 2016). Because pharmacists are the gatekeepers of antimicrobial prescription, all pharmacy students should obtain sufficient ID education to be effective antimicrobial stewards (Bishop et al., 2019; Blanchette et al., 2018; Revolinski et al., 2020). Given the fact that the pharmacist's role in both a community and hospital setting is evolving, they should have sufficient knowledge and skills that enable them to contribute effectively to the fight against AMR.

Current guidelines and rules are insufficient to optimize the practice of prescribing antimicrobial agents. Interventions by the ID clinician and clinical pharmacist has proven to be crucial in AMR and antimicrobial stewardship programs (ASPs) (Blanchette et al., 2018). ASPs improve the infection cure rate, reduce treatment failure, increase the frequency of proper antibiotic prescription, and reduce the rate of antibiotic resistance (Davey et al., 2017). In 2014, the Saudi Ministry of Health (MOH) issued a national strategy to reduce AMR. The plan included the adoption of ASPs in various hospitals and private clinics (Ya, 2017). A survey conducted in 2017 revealed that only a small number of hospitals reported implementing ASPs; the majority of MOH hospitals lack the necessary resources and expertise to implement these systems (Alghamdi et al., 2021). Education is a major factor for successful antimicrobial practices. Raising awareness of the policies and guidelines through workshops and educational training may lead to adequate implementation of ASPs. In this regard, ID clinical pharmacist play a significant role; however, there is insufficient ID specialty in Postgraduate Year Two (PGY2) pharmacy residency programs (Gauthier et al., 2015). Therefore, the Doctor of Pharmacy (PharmD) program is the primary source of ID information. In addition, the education that pregraduates receive in pharmacy schools is a key element to good clinical practice enabling fulfillment of their role and decreasing the gap between education and actual practice.

Based on our belief regarding the importance of their role in providing the best patient care, we approached academic faculty members of 26 pharmacy colleges around the kingdom—from both Bachelor of Science (BSc) in Pharmacy and PharmD programs—about the ID curriculum followed at their pharmacy colleges. The objective of this study was to describe the subjects covered in the ID curriculum and the teaching and assessment strategies used. We also aimed to explore the challenges faced by faculty members in teaching the ID curriculum.

2. Materials and methods

This was a cross-sectional study concerning the hours dedicated to ID education at Saudi Arabian pharmacy schools. The study was approved by the King Saud University ethical committee (KSU-HE-20-378).

We followed a quantitative approach to design the questionnaire; it comprised 26 items based on data by Jeffres and colleagues (Jeffres et al., 2019) in their comprehensive survey of the ID curriculum among US pharmacy schools. The first section of the questionnaire included the demographic characteristics of the respondents, type of institutions, and curriculum format. The second section focused on the ID content in the curriculum, number of hours devoted to ID content, and methods of active learning and assessments. In this regard, the American College of Clinical Pharmacy (ACCP) Pharmacotherapy Didactic Curriculum Toolkit was used to assess and compare the ID topics covered at each college (Flannery et al., 2020). The toolkit employs three tiers to recommend specific topics based on their level of importance (tiers 1, 2, and 3). In addition, the current satisfaction of faculty members and their future plans for changes to the curriculum were also investigated.

In December 2020, the questionnaire was distributed via email to the deans of 26 pharmacy colleges in Saudi Arabia; it was to be answered by college deans, heads of departments, or ID faculty members, with no limit to the number of replies from each college. The contact information of the deans was obtained online. Nonrespondents were contacted telephonically within the first 6 weeks after the questionnaire was open.

Data were analyzed using the Statistical Package for Social Studies (SPSS Version 22.0; IBM Corp., Armonk, NY, USA). Categorical variables are expressed as percentages and were analyzed using the chi-square test. Statistical significance was set at $p < 0.05$.

3. Results

The completed questionnaire was submitted by 21 pharmacy colleges (80% response rate) from different regions across Saudi Arabia (Fig. 1). As intended, the questionnaires were completed by ID faculty members, department chairs, or college deans.

Among the respondents, 85.5% were from governmental colleges and 14.5% from private institutions. The majority of colleges have existed for 11–20 years, representing 43.6%; only 1.8% have existed for fewer than 5 years. Most (67.3%) of the respondents were assistant professors, 18.2% were associate professors, and 14.5% were professors. In total, 58.2% were aged 30–40 years, and 41.8% were older than 40 years.

The majority of colleges (98.2%) had a semester format, with 67.3% offering solely the PharmD program, 12.7% offering only a BSc in Pharmaceutical Science, and 20% offering both programs. The pharmacy curriculum extended over 6 and 5 years at 61.8% and 27.3% of colleges, respectively, while the remaining colleges offered both 5- and 6-year courses, depending on the degree. The ID curriculum formed part of the 3rd and 4th years of study, according to 20% of the respondents (Table 1). An average of 25, 50, and 100 students per class was reported by 52.7%, 27.3%, and 10.9% of the respondents, respectively, while an average of more than 100 students per class was reported by 9.1%.

More than 78% of respondents covered all tier 1 ID topics included in the ACCP Pharmacotherapy Didactic Curriculum Toolkit. Antimicrobial regimen selection was the tier 1 topic that was offered by the most colleges (92.7%); there was little variation in the dedicated hours reported between colleges, where 36.36% of respondents indicated dedicating 2 h, 30.91% dedicating 1 h, and 0.7.27% dedicating 3 or more hours to the topic (Tables 2 and 3). Among the colleges that covered tier 2 ID topics in their required curricula, most offered tuberculosis (94.5%)—2 h of dedicated time was reported by most of the respondents (43.64%)—while only 34.5% offered travel medicine as a topic—with 3 h of dedicated time reported by 49.09% of the respondents (Tables 2 and 3). Among the tier 3 topics, most (92.7%) of the colleges offered the topics of miscellaneous viral and bacterial infections, with most respondents (40%) reportedly dedicating 2 h to each; 58.2% of colleges had mycobacterial infections, non-tuberculosis, as a required topic offered as part of the curriculum, with most respondents (47.27%) reporting 1 dedicated hour to the topic. The most commonly covered elective topics were antimicrobial prophylaxis in surgery and other procedures (12.7%), prostatitis (10.9%), and travel medicine (10.9%) (Tables 2 and 3).

Most colleges used more than one strategy to teach and deliver content. Lectures and laboratories were the most consistently used (94.5% and 52.7%, respectively). There were variations in the use of active learning strategies, with patient case application having the highest percentage of consistent use (54.5%) and student-generated questions having the highest percentage of frequent

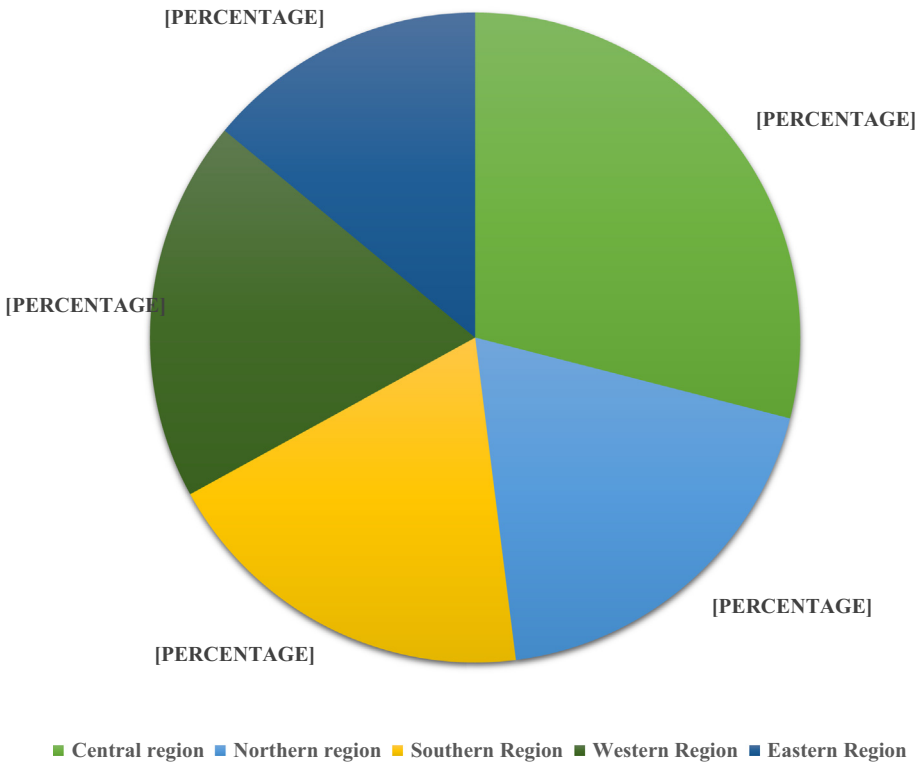

Fig. 1. Responses received from participating Saudi pharmacy colleges.

Table 1
Details of the pharmacy degrees offered by the included colleges.

		%
Professional degree offered	Doctor of Pharmacy (PharmD)	67.3
	Bachelor of Pharmaceutical Science (BSc)	12.7
	Both	20.0
Length of curriculum	5 years	27.3
	6 years	61.8
	Both for dual-degree programs	10.9
Format of the academic curriculum schedule	Semester	98.2
	Block	1.8

use (49.1%) (Table 4). The majority of the respondents reported that there has been no change in the ID curriculum over the previous 5 years (70.91%), and that there was no plan to change it over the following 5 years (65.45%). With regard to their satisfaction with the curriculum, 63.4%, 21.82%, and 12.73% believed it to be adequate, optimal, and inadequate, respectively, whereas only 1.82% believed it to be excessive. For the efficiency of the curriculum over the following 5 years considering emerging new infections, 63.64%, 20%, and 12.73% of the respondents' faculties reported that the current curriculum provided adequate, optimal, and inadequate baseline knowledge of ID, respectively, whereas 3.64% believed it to be excessive and reported that an update was necessary.

4. Discussion

Owing to the growing and evolving role of clinical pharmacists in antimicrobial stewardship and the limited number of ID postgraduate training programs, pharmacy graduates depend entirely on the ID knowledge gained at pharmacy colleges (Ernst et al., 2009; DiazGranados and Abd, 2011; Gauthier et al., 2015; Jeffres et al., 2019). This necessitates attention to the ID content of the pharmacy curriculum. The results of our study revealed that the tier 1 topics of the ACCP Pharmacotherapy Didactic Curriculum Toolkit were all covered by 78% of Saudi pharmacy colleges. These topics should prepare and enable students to offer collaborative, patient-centered care upon graduation and licensing.

Among the tier 1 topics, the antimicrobial regimen selection was that which was covered by most of colleges, with mainly 1 or 2 h dedicated to it. Given the emerging pattern of AMR and the prevalence of inappropriate antibiotic prescription, the current time dedicated to this topic can be considered insufficient. Enhancing pharmacists' understanding of antimicrobial regimen selection will assist in the proper implementation of ASPs.

Regarding tier 2 topics, many pharmacy colleges taught antimicrobial stewardship; however, even with its high importance, it is notable that a considerable number of colleges did not include it in their curriculum. This could be due to differences in the professional degrees offered at the various colleges, with antimicrobial stewardship only being a focus in the PharmD curricula. The results of our study are comparable to those of a previous study by Kufel et al. (2018), who reported that 68% of pharmacy schools in the US offer antimicrobial stewardship in their didactic curriculum (Kufel et al., 2018). However, this percentage increased to 75% in a recent study conducted in 2019 (Jeffres et al., 2019). In our study, most tier 2 topics were commonly included in the curriculum of pharmacy colleges, apart from travel medicine. Although travel medicine was not taught in various colleges, nearly half of those who dedicated time to this topic dedicated 3 h; this could be due to the importance of Hajj—where many pilgrims travel to Saudi Arabia—increasing the risk of ID transmission. Respiratory tract infections, meningococcal disease, and waterborne IDs are most frequently reported among pilgrims (Salmon-Rousseau et al., 2016), emphasizing the importance of raising awareness regarding travel medicine.

Table 2
Required and elective infectious disease topics covered in the pharmaceutical curricula followed by the included colleges

	Required Topics		Elective Topics		None	
	Number	%	Number	%	Number	%
Tier 1 topics						
Urinary tract infections, uncomplicated	50	90.9	0	0	5	9.1
Antimicrobial regimen selection	51	92.7	1	1.8	3	5.5
Fungal infections, superficial	50	90.9	2	3.6	3	5.5
Lower respiratory tract infections	49	89.1	1	1.8	5	9.1
Skin and soft tissue infections	45	81.8	1	1.8	9	16.4
Upper respiratory tract infections	48	87.3	2	3.6	5	9.1
Influenza virus infection	44	80	5	9.1	6	10.9
Clostridium difficile infection*	43	78.2	3	5.5	9	16.4
Immunization	46	83.6	3	5.5	6	10.9
Tier 2 topics						
Human immunodeficiency virus infection	48	87.3	2	3.6	5	9.1
Tuberculosis	52	94.5	1	1.8	2	3.6.
Sexually transmitted infections	41	74.5	5	9.1	9	16.4
Central nervous system infections	44	80	2	3.6	9	16.4
Hepatitis, viral	51	92.7	1	1.8	3	5.5
Urinary tract infections, complicated#	46	83.6	1	1.8	8	14.5
Fungal infections, invasive	47	85.5	2	3.6	6	10.9
Infections in immunocompromised patients	37	67.3	3	5.5	15	27.3
Infective endocarditis	41	74.5	3	5.5	11	20
Intra-abdominal infections	40	72.7	3	5.5	12	21.8
Sepsis and septic shock	42	76.4	2	3.6	11	20
Bone and joint infections	32	58.2	3	5.5	20	36.4
Bacterial resistance	46	83.6	4	7.3	5	9.1
Microbiology labs	47	85.5	2	3.6	6	10.9
Gastrointestinal infections	41	74.5	2	3.6	12	21.8
Antimicrobial stewardship	35	63.6	3	5.5	17	30.9
Bloodstream and catheter infections	36	65.5	4	7.3	15	27.3
Antimicrobial prophylaxis in surgery and other procedures	33	60	7	12.7	15	27.3
Parasitic diseases	39	70.9	3	5.5	13	23.6
Prostatitis	26	47.3	6	10.9	23	41.8
Tickborne illnesses	26	47.3	5	9.1	24	43.6
Health care–acquired infections: preventive measures	36	65.5	2	3.6	17	30.9
Travel medicine	19	34.5	6	10.9	30	54.5
Spirochaetal diseases	30	54.5	5	9.1	20	36.4
Tier 3 topics						
Mycobacterial infections, non-tuberculosis	32	58.2	4	7.3	19	34.5
Viral infections, miscellaneous	51	92.7	2	3.6	2	3.6
Bacterial infections, miscellaneous	51	92.7	1	1.8	3	5.5

*Significant differences ($p < 0.05$) between male and female sex.
#Significant differences ($p < 0.05$) between types of academic institutions—government vs. private.

Among the tier 2 topics, many colleges taught tuberculosis as a required topic in their curriculum, dedicating 2 h to it. Tuberculosis is highly contagious and has a fixed and complicated treatment regimen, highlighting the importance of it being clearly understood. Fungal infections, superficial and invasive, were taught over only 1 h at most colleges offering each of these topics. This can be considered insufficient given that over 600,000 people in Saudi Arabia are affected by serious fungal infections each year (Alothman et al., 2017). A better and more detailed coverage of topics could raise pharmacists' awareness and, as a result, reduce disease prevalence. The variation in the reported classroom hours dedicated to each topic in our study may be due to the low number of respondents, the study's period, and the fact that the questionnaire was completed by faculty members teaching ID.

In accordance with previous studies (Jeffres et al., 2019; Kufel et al., 2018), this study showed that the coverage of ID topics among pharmacy college curricula varies. This may be attributed to the variability between pharmacy colleges regarding the time dedicated to ID education and the utilization of active learning approaches, which may result in greater knowledge retention. Despite this variation, 63.4% of faculty members claimed that the current ID topics were adequately covered. The same response was obtained when respondents were asked their opinion regarding the adequacy of the ID curriculum at the time, in consideration of ongoing changes, to provide basic knowledge over the following 5 years. Nevertheless, such variation may lead to marked differences in students' knowledge scores between pharmacy colleges, as reported by Justo et al. (Justo et al., 2014). In their study, they found that 90% of pharmacy students wanted more information on antimicrobial use, and discrepancies in knowledge scores among several pharmacy schools were observed (Justo et al., 2014).

According to the findings of the current study, active learning strategies represented approximately half of the classroom time, with patient cases being the most used approach. A lower percentage of active learning utilization (25%) has been reported by other researchers (Jeffres et al., 2019). In our study, the optimal classroom time to be dedicated to active learning was not addressed; however, another study reported a relationship between the theme of the employed classroom teaching strategy and interest in ID careers among graduated medical residents (Bonura et al., 2016). Medical residents who were not interested in pursuing a career in IDs reported that standard lectures accounted for 78% of their ID education. Conversely, those who applied for an ID fellowship reported that traditional lectures accounted for 48% of their education, while case-based discussions represented 40% (Bonura et al., 2016). Thus, the adoption of case-based learning and a lack of memorization-based teaching methods were the strongest predic-

Table 3
Time dedicated to each infectious disease topic offered as part of the pharmaceutical curricula by the included colleges

	1 Hour		2 Hours		3 Hours		≥ 3 Hours	
	No.	%	No.	%	No.	%	No.	%
Tier 1 topics								
Urinary tract infections, uncomplicated	27	49.09	15	27.27	11	20	2	3.64
Antimicrobial regimen selection	17	30.91	20	36.36	14	25.45	4	7.27
Fungal infections, superficial	31	56.36	12	21.82	10	18.18	2	3.64
Lower respiratory tract infections	18	32.73	23	41.82	9	16.36	5	9.09
Skin and soft tissue infections	21	38.18	18	32.73	12	21.82	4	7.27
Upper respiratory tract infections	23	41.82	19	34.55	9	16.36	4	7.27
Influenza virus infection	31	56.36	15	27.27	9	16.36	0	0
Clostridium difficile infection	29	52.73	10	18.18	15	27.27	1	1.82
Immunization	18	32.73	22	40	11	20	4	7.27
Tier 2 topics								
Human immunodeficiency virus infection	24	43.64	16	29.09	12	21.82	3	5.45
Tuberculosis	20	36.36	24	43.64	8	14.55	3	5.45
Sexually transmitted infections	20	36.36	17	30.91	16	29.09	2	3.64
Central nervous system infections	18	32.73	16	29.09	17	30.91	4	7.27
Hepatitis, viral	20	36.36	21	38.18	8	14.55	6	10.91
Urinary tract infections, complicated	28	50.91	16	29.09	11	20	0	0
Fungal infections, invasive	28	50.91	10	18.18	11	20	6	10.91
Infections in immunocompromised patients	25	45.45	11	20	16	29.09	3	5.45
Infective endocarditis	21	38.18	13	23.64	18	32.73	3	5.45
Intra-abdominal infections	24	43.64	13	23.64	16	29.09	2	3.64
Sepsis and septic shock	19	34.55	15	27.27	16	29.09	5	9.09
Bone and joint infections	20	36.36	12	21.82	21	38.18	2	3.64
Bacterial resistance	21	38.18	16	29.09	12	21.82	6	10.91
Microbiology labs	12	21.82	18	32.73	10	18.18	15	27.27
Gastrointestinal infections	18	32.73	18	32.73	16	29.09	3	5.45
Antimicrobial stewardship	17	30.91	17	30.91	20	36.36	1	1.82
Bloodstream and catheter infections#	21	38.18	14	25.45	20	36.36	0	0
Antimicrobial prophylaxis in surgery and other procedures *	24	43.64	12	21.82	18	32.73	1	1.82
Parasitic diseases	18	32.73	16	29.09	13	23.64	8	14.55
Prostatitis#	25	45.45	6	10.91	22	40	2	3.64
Tickborne illnesses#	23	41.82	8	14.55	24	43.64	0	0
Health care–acquired infections: preventive measures#	26	47.27	13	23.64	16	29.09	0	0
Travel medicine#	21	38.18	6	10.91	27	49.09	1	1.82
Spirochaetal diseases#	23	41.82	10	18.18	22	40	0	0
Tier 3 topics								
Mycobacterial infections, non-tuberculosis#	26	47.27	10	18.18	19	34.55	0	0
Viral infections, miscellaneous	14	25.45	22	40	8	14.55	11	20
Bacterial infections, miscellaneous	9	16.36	22	40	8	14.55	16	29.09

*Significant differences ($p < 0.05$) between academic positions.
#Significant differences ($p < 0.05$) between types of academic institutions—governmental vs. private.

Table 4
Teaching tools utilized in the classroom to deliver infectious disease lectures at the included colleges

Strategy	Consistently Used		Frequently Used		Rarely Used		Never Used	
	No.	%	No.	%	No.	%	No.	%
Lectures	52	94.5	3	5.5	0	0	0	0
Laboratories	29	52.7	20	36.4	3	5.5	3	5.5
Demonstration	16	29.1	26	47.3	12	22	1	1.8
Active learning	25	45.5	14	25.5	15	27	1	1.8
Patient case application	30	54.5	16	29.1	7	13	2	3.6
Audience response systems#	14	25.5	15	27.3	15	27	11	20
Student-generated questions	12	21.8	27	49.1	12	22	4	7.3
Simulation	5	9.1	20	36.4	16	29	14	26
Think, pair, share	9	16.4	17	30.9	16	29	13	24
Ungraded quizzes*	15	27.3	13	23.6	16	29	11	20
Muddiest point	2	3.6	11	20	13	24	29	53
Concept maps	7	12.7	7	12.7	17	31	24	44
Puzzles	3	5.5	7	12.7	22	40	23	42

*Significant differences ($p < 0.05$) based on age.
#Significant differences ($p < 0.05$) between the male and female sex.

tors of pursuing a career in IDs (Jeffres et al., 2019). The results of our study revealed that audience reaction systems were the second most prevalent active learning approach indicated by faculty members, which is consistent with those of a previous study (Jeffres et al., 2019). This strategy promotes the development of an active learning atmosphere, enhances student engagement and attendance, and supports student comprehension and retention of information (Pradhan et al., 2005; Rubio et al., 2008).

The findings of this study revealed a noticeable lack of consistency in ID content among Saudi pharmacy college curricula.

Increased educational initiatives aimed at standardizing ID curriculum delivery may facilitate more consistent understanding of future pharmacists. Even though most faculty members who responded to our questionnaire believed the curriculum to be adequate and were fairly satisfied with the content, questions regarding the efficacy of what is provided needs to be assessed in future studies. To the best of our knowledge, this study is the first to assess the ID content of pharmacy college curricula in Saudi Arabia; it highlights an opportunity for academics to address the weaknesses and make further improvements.

However, there were several limitations to our study. First, if a member of the ID faculty did not respond to the questionnaire, we requested the dean of academic affairs or head of the department to complete it—their evaluation may vary from that of ID faculty members who actively teach courses. Second, more than one response from pharmacy colleges were submitted. Third, other ID topics that are not included in the ACCP Toolkit but were being taught at the included colleges were not identified in our study. Fourth, this study employed descriptive research; therefore, we were unable to identify effective teaching techniques or provide curricular suggestions regarding the ID topics covered. Further studies investigating the relationship between teaching practice and outcome measures—such as licensing examination scores, student performance, and career options—will need to be undertaken.

5. Conclusions

AMR is a global problem that necessitates the effective contribution of healthcare professionals. In order to prepare pharmacists to play their role in minimizing the AMR burden, didactic education concerning IDs and AMS should be developed. To the best of our knowledge, this is the first study to assess the ID curricula among Saudi pharmacy colleges. The results of this study revealed variations in ID topics and educational time dedicated to teaching IDs among Saudi pharmacy schools. This research can assist faculty members to advocate for a greater effort to standardize ID curricula in Saudi Arabian pharmacy schools.

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.

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