Knowledge of Pharmacists about Pharmacy Infection Control in Saudi Arabia

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ABSTRACT

Objectives: In this study, we aimed to assess pharmacists' knowledge about pharmacy infection control in the Kingdom of Saudi Arabia. **Methods:** This cross-sectional survey study was conducted to assess pharmacists' knowledge about pharmacy infection control in Saudi Arabia. We used a self-reported electronic survey questionnaire and distributed it to pharmacists, including dentists from interns to consultants and pharmacy specialists in Saudi Arabia. The survey collected demographic information of the responders and their knowledge regarding some of the selected pharmacy infection control elements in dental care. We also collected information regarding the resources they use to obtain knowledge of pharmacy infection control. We used 5-point Likert response scale system with close-ended questions to obtain their responses. The data were collected through the Survey Monkey system and analyzed using Statistical Package of Social Sciences (SPSS), Jeffery's Amazing Statistics Program (JASP), and Microsoft Excel (version 16) software. **Results:** A total of 435 pharmacists responded to the questionnaire, with one-quarter of them coming from the central region (97 (22.35%)), and northern region (92 (21.2%)), with non-statistically significant differences between regions (p=0.637). Of the total responders, 212 (48.96%) were female, and 221 (51.04%) were male responders, with non-statistically significant differences between them (p=0.665). Most of the responders were in the age group of 24–30 years (151 (34.87%)) and 36–40 years (101 (23.33%)), with statistically significant differences between them (p=0.000). The total average score of pharmacy infection control assessment for basic knowledge was 3.34, with high scores obtained for the elements knowledge of hand hygiene (3.86) and personal protective equipment (3.83). In comparison, the lowest scores were obtained for the elements knowledge of the accidental sharp devices immunization system (2.80), and the infection control pharmacist gets more salary than regular pharmacist (2.91). The total average score of knowledge of frequently used disinfection and antiseptics products at your healthcare institution (3.60) and the high scores were obtained for the elements knowledge of peroxygens (hydrogen peroxide) (4.63) and alcohol (isopropyl alcohol 70%) (4.63). In comparison, the lowest scores were obtained for the element knowledge of phenolics (ortho-benzyl-para-chlorophenol) (2.76) and the iodophors (povidone-iodine ointment 10%) (2.99). The score for the single-test reliability analysis of McDonald's ω was 0.927, Cronbach's αwas 0.924, Gutmann's λ2 was 0.933, Gutmann's λ6 was 0.973, and Greater Lower Bound was 0.989. **Conclusion:** Pharmacists' knowledge about pharmacy infection control was inadequate in the Kingdom of Saudi Arabia. Therefore, targeting to provide the necessary education and training for undergraduate and postgraduate students to improve patient infection control within pharmaceutical care in Saudi Arabia.
Key words: Knowledge, Pharmacist, Pharmacy, Infection Control, Saudi Arabia.

INTRODUCTION

The pharmacy department consists of several sections, including inpatient pharmacy, outpatient pharmacy, and ambulatory care unit in addition to the intravenous admixture unit, the extemporaneous preparation or compounding unit, drug information section, and clinical pharmacy section.[1] Daily, the pharmacist is involved in various activities, such as procurement, storage of medications, preparation, drug distribution, and dispensing of medication.[2] Furthermore, they are involved in medication monitoring, preparing interventions and physician order suggestions, drug information consultation, and independent prescribing.[2,3] All previous pharmaceutical care activities needed to be contacted and delivered to healthcare providers, pharmacy staff, and patients. The communication with pharmacy clients was either direct face-to-face contact or via online mode. Those previous contact experiences need clean or sterile weather to prevent pharmacy customers from disseminating microbial bugs or viruses. Various studies have reported mistakes committed by pharmacists in preventing transmission of infection to their patients, which have inadvertently led to the death of the patient.[4-16] Therefore, various international pharmacy organizations such as the United States Pharmacopeia and the American Society of Health-System Pharmacists have set up regulations for infection and biohazard prevention of medications.[17-20] Each

medication class has different regulations and standards of preparation, such as regular intravenous medications, chemotherapy, and radiopharmaceutical medications.[17-20] Therefore, pharmacists must have knowledge of infection, prevention, and control in a pharmacy setting. So far, various studies have been conducted to assess infection control and physician's or nurse's knowledge of infection control.[21-25] However, to the best of our knowledge, no studies are conducted to assess pharmacists' knowledge about pharmacy-related infection control activities.[26,27] Therefore, in this study, we aimed to declare pharmacists' knowledge about the prevention and control of pharmacy infection in the Kingdom of Saudi Arabia.

METHODS

It was a 6-month cross-sectional study conducted to assess pharmacist's knowledge of pharmacy infection control in Saudi Arabia. We used a self-reported electronic survey questionnaire and distributed it to pharmacists from interns to consultants and specialists in Saudi Arabia. All non-pharmacists, students, and incomplete surveys were excluded from this study. The survey collected demographic information of the responders and their knowledge of selected pharmacy infection control elements in medical care, such as knowledge of frequently used disinfection and antiseptics products used at their institution. In addition, the resources of knowledge of pharmacy infection control elements in medical care were analyzed. We used 5-point Likert response scale system with close-ended questions to obtain responses. According to the previous literature with unlimited population size, in this study, the sample size was calculated for a cross-sectional study model, with the following parameters: the confidence level was 95%, with a *z* score of 1.96 and margin of error of 5–6.5%, the population percentage of 50%, and drop-out rate of 10%. As a result, the sample size was calculated as 418 with a power of study of 80%.[28-30] The response rate required for the estimated sample size was at least 60–70%.[30,31] The survey was distributed through social media such as WhatsApp and Telegram and direct face-to-face contact. A reminder message was sent once every 1-2 weeks. Expert reviewers and pilot testing validated the survey data. Moreover, reliability tests such as McDonald's ω, Cronbach's α, Gutmann's λ2, and Gutmann's λ6 were calculated. The data were collected through the Survey Monkey system and analyzed by using Microsoft Excel (version 16), Statistical Package of Social Sciences (SPSS), and Jeffery's Amazing Statistics Program (JASP) software. We conducted descriptive and frequency analysis, the goodness of fit analysis, correlation analysis, and inferential analysis on factors affecting pharmacists' knowledge about pharmacy infection control. The STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guided the reporting of this study.[32-34]

RESULTS

A total of 435 pharmacists responded to the questionnaire, with one-quarter of them coming from the central region (97 (22.35%)) and northern region (92 (21.2%)), with non-statistically significant differences between the areas (p=0.637). Of them, most of the responders were from a community pharmacy (81 (18.62%)), Ministry of Health (MOH) hospitals (69 (15.86%)), and military hospitals (49 (11.26%)), with statistically significant differences between them (p=0.000). Of the total responders, 212 (48.96%) were female, and 221 (51.04%) were male responders, with non-statistically significant differences between them (p=0.665). Most of the responders were in the age group of 24–30 years (151 (34.87%)) and 36–40 years (101 (23.33%)), with statistically significant differences between all age groups (p=0.000). Most of the pharmacists were pharmacy staff (192 (44.55%)) and supervisors (104 (24.13%)), with statistical significance between them (p=0.000). The majority of responders held Bachelor in Pharmacy degree (281 (64.75%)), Master in Pharmacy degree (94 (21.66%)), and Pharm D (90 (20.74%)). Most of the pharmacists had work experience of 7–9 years (117 (27.08%)) and 4–6 years (116 (26.85%)), with statistically significant between experience level (p=0.000). Almost one-fifth of the pharmacists practiced in clinical pharmacy (62 (18.08%)), outpatient pharmacy (61 (17.78%)), and inpatient pharmacy (555 (16.03%)), with statistically significant between all sites of pharmacy practice (p=0.000). There is a strong positive correlation between age (years) and years of experience at the pharmacy center based on Kendall's tau_b (0.576) or Spearman's rho (0.701) correlation, with statistically significant differences between them (p<0.001) (Tables 1 and 2).

The total average score for the element basic knowledge about pharmacy infection control was 3.34, with high scores obtained for the elements knowledge of hand hygiene (3.86) and personal protective equipment (3.83), followed by hearing about the concept of pharmacy infection control (3.80) and disposal of and injuries from sharp objects (3.62). In comparison, the lowest scores were obtained for the element knowledge of the accidental sharp devices immunization system (2.80). The infection control pharmacist gets more salary than a regular pharmacist (2.91), followed by the element job description of an infection control pharmacist (2.92) and the resources of pharmacy infection control (2.96), with statistically significant differences between the responses (p=0.000). Moreover, all the elements of basic knowledge were statistically significant between answers (p=0.000) (Table 3). The total average score for the element knowledge of frequently used disinfectants and antiseptic products at your healthcare institution (3.60), with high scores obtained for the element knowledge of peroxygens (hydrogen peroxide) (4.63), alcohol (isopropyl alcohol 70%) (4.63), and glutaraldehyde (ortho-phthalaldehyde) (4.15). In comparison, the lowest scores were obtained for the elements, knowledge of phenolics (ortho-benzyl-para-chlorophenol) (2.76), iodophors (povidone-iodine ointment 10%) (2.99), and the quaternary ammonium compounds (Alkyl Dimethyl Benzyl Ammonium Chloride) (3.20), with statistically significant differences between the responses. Moreover, all answers were statistically significant (p=0.000) (Table 4). Drug information resources (e.g., Lexicomp-drug information, Micromedex, and Epocrates) 280 (64.67%), medical association literature/guidelines/recommendations (227 (52.42%)), and awareness lectures at primary healthcare center (193 (44.57%)) were the majority of the resources used (Table 5). The scores for the single-test reliability analysis of McDonald's ω was 0.927, Cronbach's α was 0.924, Gutmann's λ2 was 0.933, Gutmann's λ6 was 0.973, and Greater Lower Bound was 0.989.

Factors influencing the pharmacy infection control assessment of knowledge and infection control products

Various factors were affecting the pharmacist's knowledge of infection control and the pharmacy infection control products. We adjusted the significant values by using the independent samples Kruskal–Wallis test and the Bonferroni correction for multiple comparison tests. The various factor might influence the knowledge of infection control. We assessed 13 work-level sites for the basic knowledge of pharmacy infection control. The lowest average score was obtained for national guard hospitals (3.1295) and community pharmacy (3.0593), with statically significant differences between different sites (p=0.000). Next, we assessed six separate age groups for the basic knowledge of pharmacy infection control with the lowest average score (2.9469) obtained for the age group 24–30 years, with

Table 1: Demographic, social information.			
Locations	**Response Count**	**Response Percent**	***p*-value (X2)**
Central area	97	22.35%	0.637
North area	92	21.20%	
South area	83	19.12%	
East area	79	18.20%	
West area	83	19.12%	
Answered question	**434**		
Skipped question	**1**		
Site of work	**Response Count**	**Response Percent**	***p*-value (X2)**
MOH Hospitals	69	15.86%	0.000
Military hospitals	49	11.26%	
National Gaurd Hospital	25	5.75%	
Security forces hospitals	41	9.43%	
KFSH&RC	2	0.46%	
University hospital	24	5.52%	
MOH primary care centers	23	5.29%	
Private hospitals	25	5.75%	
Private ambulatory care clinics	26	5.98%	
Private primary healthcare center	26	5.98%	
Community pharmacy	81	18.62%	
Pharmaceutical companies	38	8.74%	
Non-employment	3	0.69%	
Intern	3	0.69%	
Answered question	**435**		
Skipped question	**0**		
Gender	**Response Count**	**Response Percent**	
Male	221	51.04%	0.665
Female	212	48.96%	
Answered question	**433**		
Skipped question	**2**		
Age	**Response Count**	**Response Percent**	
24-30	151	34.87%	0.000
31-35	89	20.55%	
36-40	101	23.33%	
41-45	60	13.86%	
46-50	30	6.93%	
> 50	2	0.46%	
Answered question	**433**		
Skipped question	**2**		

Table 2: Demographic, social information.			
Pharmacist's Qualifications	**Response Count**	**Response Percent**	***p*-value (X2)**
Diploma in Pharmacy	1	0.23%	
Bachelor in pharmacy	281	64.75%	
Master	94	21.66%	
Pharm D	90	20.74%	
Ph. D	12	2.76%	
PGY 1	9	2.07%	
PGY 2	15	3.46%	
PGY 3	7	1.61%	
Fellowship	4	0.92%	
Other (please specify)	2	0.46%	
Answered question	**434**		
Skipped question	**1**		
Position Held	**Response Count**	**Response Percent**	
Director of Pharmacy	46	10.67%	0.000
Assistant Director of Pharmacy	51	11.83%	
Supervisor	104	24.13%	
Pharmacy staff	192	44.55%	
Intern	38	8.82%	
Answered question	**431**		
Skipped question	**4**		
Years of experience at Dentists career	**Response Count**	**Response Percent**	
Less than one year	69	15.97%	0.000
1-3	83	19.21%	
4-6	116	26.85%	
7-9	117	27.08%	
10-12	25	5.79%	
>12	22	5.09%	
Answered question	**432**		
Skipped question	**3**		
Pharmacy practice	**Response Count**	**Response Percent**	
Pharmacy adminstration	1	0.29%	0.000
Inpatient Pharmacy	55	16.03%	
Outpatient Pharmacy	61	17.78%	
Satellite Pharmacy	17	4.96%	
Narcotics and Controlled	22	6.41%	
Extemporaneous Preparation	8	2.33%	
Clinical Pharmacy	62	18.08%	
Inventory Control	26	7.58%	
Drug Information	17	4.96%	
IV admixture	19	5.54%	
Community pharmacy	33	9.62%	
Pharmaceutical companies	22	6.41%	
Answered question	343		
Skipped question	92		

Table 3: Pharmacy infection control assessment of basic knowledge.

	No knowledge		Little knowledge		Partial knowledge		Incomplete knowledge		Complete knowledge		Total	Weighted Average	*p*-value
Have you ever heard about the concept of pharmacy infection control?	11.49%	50	14.94%	65	10.34%	45	8.51%	37	54.71%	238	435	3.80	0.000
Have you ever heard about the concept of an infection control pharmacist's job?	17.32%	75	10.62%	46	9.70%	42	43.42%	188	18.94%	82	433	3.36	0.000
Are you familiar with Ministery of Heath infection control guidelines and regulations	5.30%	23	9.91%	43	41.01%	178	22.12%	96	21.66%	94	434	3.45	0.000
Do you know the job description of an infection control pharmacist?	18.39%	80	25.29%	110	17.93%	78	22.99%	100	15.40%	67	435	2.92	0.007
In Saudi Arabia, the infection control pharmacist get more salary than regular pharmacist	28.80%	125	11.75%	51	17.51%	76	23.73%	103	18.20%	79	434	2.91	0.000
Do you know Hand hygiene?	10.88%	47	9.03%	39	7.41%	32	28.24%	122	44.44%	192	432	3.86	0.000
Do you know Personal protective equipment	5.06%	22	14.02%	61	10.57%	46	33.56%	146	36.78%	160	435	3.83	0.000
Do you know the operation levels of infection control for sterile product preparations,	6.67%	29	18.16%	79	19.77%	86	26.90%	117	28.51%	124	435	3.52	0.000
Do you know the type of sanitizer?	7.39%	32	19.17%	83	18.24%	79	32.56%	141	22.63%	98	433	3.44	0.000
Do you know about the facilities and engineering infection control of the preparation of intravenous medications?	8.99%	39	18.43%	80	19.59%	85	25.58%	111	27.42%	119	434	3.44	0.000
Do you know about microbiological air and surface controlling during the compounding of Intravenous medications?	9.20%	40	21.61%	94	17.47%	76	34.25%	149	17.47%	76	435	3.29	0.000
Do you know the cleaning and disinfecting for the preparation of medications?	9.22%	40	19.35%	84	16.82%	73	38.02%	165	16.59%	72	434	3.33	0.000
Do you know the international guidelines of pharmacy infection control?	14.39%	62	17.17%	74	16.47%	71	27.38%	118	24.59%	106	431	3.31	0.000
Do you know the infection control clinical pharmacist?	15.70%	68	18.24%	79	16.17%	70	29.33%	127	20.55%	89	433	3.21	0.000
Do you know the disposal of and injuries from sharp objects?	8.31%	36	10.62%	46	14.32%	62	43.88%	190	22.86%	99	433	3.62	0.000
Do you know the infection control during packaging and repacking of medications?	10.85%	47	11.55%	50	20.79%	90	36.26%	157	20.55%	89	433	3.44	0.000
Do you know infection control in the unit dose system?	11.92%	51	17.52%	75	13.79%	59	36.68%	157	20.09%	86	428	3.36	0.000
Do you know the pharmacy infection pharmacy of medications storage?	11.26%	49	18.16%	79	20.00%	87	34.02%	148	16.55%	72	435	3.26	0.000
Do you know the resources of pharmacy infection control	14.78%	64	26.56%	115	18.94%	82	27.71%	120	12.01%	52	433	2.96	0.000
Do you know the immunization system for new pharmacy staff or pharmacy trainees	12.41%	54	27.82%	121	22.30%	97	21.15%	92	16.32%	71	435	3.01	0.000
Do you know the accidental sharp devices immunization system	20.00%	87	26.21%	114	20.92%	91	19.77%	86	13.10%	57	435	2.80	0.001
Answered											**435**		
Skipped											**0**		

Table 4: The Knowledge and frequency used the disinfection and antiseptics products at healthcare institution.

	I am not familiar with these products		Never		Rare		Sometime		Most of the time		Always		Total	Weighted Average	*p*-value
Peroxygens (Hydrogen peroxide)	10.88%	47	8.56%	37	4.40%	19	12.73%	55	9.49%	41	53.94%	233	432	4.63	0.000
Glutaraldehydes (Ortho-phthalaldehyde)	17.32%	75	9.70%	42	3.00%	13	12.47%	54	25.40%	110	32.10%	139	433	4.15	0.000
Peroxygens (Peracetic acid)	18.65%	80	6.06%	26	6.06%	26	14.22%	61	43.36%	186	11.66%	50	429	3.93	0.000
Chlorhexidine gluconate	11.09%	48	7.85%	34	15.01%	65	16.17%	70	41.80%	181	8.08%	35	433	3.94	0.000
Alcohol (Isopropyl Alcohol 70%)	2.86%	12	8.10%	34	5.00%	21	22.38%	94	30.24%	127	31.43%	132	420	4.63	0.000
Iodophors (Povidone-iodine solution topical 5%)	10.39%	45	12.47%	54	15.24%	66	36.03%	156	11.32%	49	14.55%	63	433	3.69	0.000
Phenolics (ortho-phenylphenoL)	18.52%	80	14.35%	62	28.01%	121	20.37%	88	12.96%	56	5.79%	25	432	3.12	0.000
Phenolics (ortho-benzyl-para-chlorophenol)	27.78%	120	15.74%	68	25.46%	110	17.13%	74	11.11%	48	2.78%	12	432	2.76	0.000
Iodophors (Povidone-iodine ointment 10%)	23.79%	103	18.71%	81	16.86%	73	24.94%	108	6.47%	28	9.24%	40	433	2.99	0.000
Alcohol (Ethyl alcohol)	13.51%	57	13.74%	58	14.69%	62	18.72%	79	14.69%	62	24.64%	104	422	3.81	0.000
Quaternary ammonium compounds (Alkyl dimethyl benzyl ammonium chloride)	21.48%	93	19.86%	86	12.93%	56	21.94%	95	10.39%	45	13.39%	58	433	3.2	0.000
Quaternary ammonium compounds (Benzyl dimethyl octyl ammonium chloride)	18.48%	80	20.09%	87	15.47%	67	21.02%	91	20.32%	88	4.62%	20	433	3.18	0.000
Quaternary ammonium compounds (didecyl dimethyl ammonium chloride)	19.17%	83	19.40%	84	12.93%	56	25.17%	109	11.55%	50	11.78%	51	433	3.26	0.000
Chlorine and chlorine compounds (Hypochlorites)	21.53%	93	11.81%	51	13.19%	57	22.69%	98	17.13%	74	13.66%	59	432	3.43	0.000
Chlorine and chlorine compounds (Chlorine dioxide)	19.35%	84	13.82%	60	12.21%	53	13.82%	60	28.34%	123	12.44%	54	434	3.55	0.000
Chlorine and chlorine compounds (Chloramine-t trihydrate)	21.71%	94	14.78%	64	10.16%	44	17.32%	75	26.79%	116	9.24%	40	433	3.4	0.000
Answered														**434**	
Skipped														**1**	

statistically significant differences between different age groups (p=0.000). Then, we assessed 12 practice areas for the basic knowledge of pharmacy infection control. The highest average score was obtained for the IV admixture section (4.2115), with a statistically significant difference between different practice areas (p=0.000). Six levels of experience affected the basic knowledge of pharmacy infection control, with the lowest score (2.8477) obtained for the experience of less than one year, with a statistically significant difference between all levels (p=0.000). Five current positions affected the basic knowledge of pharmacy infection control, with the lowest score (2.8731) obtained for interns with a statistically significant difference between all positions held (p=0.000). There was a medium relationship (R=0.479 with p=0.000) between pharmacy infection control knowledge and its factors. Three out of seven factors did not show any significant differences (p>0.05). However, worksite explained 26.1% negative relationship, gender explained 10.7% positive relationship, practice area described 26.4% positive relationship, and current position held explained a 28% negative relationship to the variation. They were a statistically significant difference between them (p=0.000, 0.036, 0.000, and 0.000, respectively) through the multiple regression model and confirmed by the Bootstrap model. The relationship was verified by the non-existence of multi-collinearity

Table 5: The pharmacy infection control (to authorities) currently is the responsibility of the following.

Answer Choices	Responses	
Health practitioners	170	39.26%
Scientific literature	131	30.25%
Peer discussions	151	34.87%
Medical association literature/guidelines/recommendations	227	52.42%
Drug information resources (Lexicomp-drug information, Micromedex, Epocrates ..etc	280	64.67%
SFDA website	131	30.25%
Drug Bulletin	59	13.63%
Relatives and friends	72	16.63%
Pharmacy infection control education courses	132	30.48%
Internet	94	21.71%
The drug information center at the hospital	158	36.49%
Awareness lectures in a hospital	170	39.26%
Awareness lectures primary healthcare center	193	44.57%
Healthcare care awareness events at the market	69	15.94%
Answered	**433**	
Skipped	**2**	

between the years of experience factor with variance inflation factor (VIF=1.342, 1.120, 1.239, and 1.410, respectively) for less than 3 or 5[35-37] (Table 6).

On the contrary, 5 locations affected the pharmacy infection control products with the low average scores (3.3210 and 3.3156) obtained for the central and western region, with statistically significant differences between all areas (p=0.000). Next, among the 13 levels of the worksite that affected the pharmacy infection control, the lowest score (3.0564) was obtained for the pharmaceutical company, with statistically significant differences between different worksites (p=0.000). Then, we tested six different age groups for their knowledge of pharmacy infection control products. The lowest average score (2.9753) was obtained for the age group 24–30 years, with statistically significant differences between different age groups (p=0.000). Then, we tested 12 practice areas that affected the knowledge of pharmacy infection control products, with the highest

Table 6: Multiple regression of Factors with the Pharmacist infection control assessment of basic knowledge.[a]

Model		R	R Square	F	Sig.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
						B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.479 [b]	.229	14.164	.000[b]	3.403	0.280		12.161	0.000	2.852	3.953		
	Location					0.016	0.026	0.031	0.633	0.527	−0.034	0.067	0.954	1.048
	Site of work					−0.054	0.012	−0.261	−4.680	0.000	−0.077	−0.032	0.745	1.342
	Age (years)					0.041	0.043	0.070	0.949	0.343	−0.044	0.125	0.427	2.340
	Pharmacist gender					0.165	0.078	0.107	2.101	0.036	0.011	0.319	0.893	1.120
	Practice area					0.061	0.012	0.264	4.925	0.000	0.037	0.086	0.807	1.239
	Current Position					−0.190	0.039	−0.280	−4.911	0.000	−0.266	−0.114	0.709	1.410
	Years of experiences					0.073	0.040	0.130	1.837	0.067	−0.005	0.150	0.461	2.170

a. Dependent Variable: Pharmacist infection control assessment of basic knowledge, Predictors b: (Constant), Location, Site of work, Age (years), Pharmacist gender, Practice area, years of experience, and current Position.

Bootstrap for Coefficients							
Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	3.403	0.013	0.315	0.001	2.772	4.008
	Location	0.016	0.000	0.028	0.588	−0.043	0.068
	Site of work	−0.054	0.000	0.013	0.001	−0.079	−0.029
	Age (years)	0.041	−0.002	0.043	0.343	−0.038	0.124
	Pharmacist gender	0.165	−0.003	0.082	0.051	0.001	0.328
	Practice area	0.061	0.000	0.015	0.001	0.030	0.090
	Current Position	−0.190	−0.002	0.040	0.001	−0.271	−0.116
	Years of experiences	0.073	0.001	0.042	0.096	−0.009	0.163

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

average score obtained for the IV admixture section (4.3110), with statistically significant differences between all areas (p=0.000). Next, we tested five current positions held that affected the knowledge of pharmacy infection control products, and the lowest score (3.0467) was obtained for interns with a statistically significant difference between positions held (p=0.000). Next, six levels of years of experience affected the basic knowledge of pharmacy infection control, with the lowest score (2.8777) obtained for less than one year, with statistically significant differences between all levels of work experience (p=0.000). There was a medium relationship (R=0.433 with p=0.000) between knowledge of frequently used disinfection and antiseptics products and factors. Four out of seven factors did not show any significant differences between them (p>0.05). However, age explained 18% of the positive relationship, and the current position explained 18.7% of the negative relationship. Years of experience explained 15.8% of the variation in the knowledge of frequently used disinfection and antiseptics products and factors, with a statistically significant difference (p=0.018, 0.002, and 0.031, respectively) through multiple regression model and confirmed by Bootstrap model. The relationship was verified by the non-existence of multi-collinearity with the years of experience factor with the Variance Inflation Factor (VIF=2.340, 1.410, and 2.170, respectively) less than three or 5five[35-37] (Table 7).

DISCUSSION

Knowledge of infection control is required in the pharmacy practice.[17-20] All pharmacists should be aware of infection control during the preparation and dispensing of medications.[17-20] The infection control knowledge is also necessary for the preparation of intravenous admixtures, inpatient pharmacy, and outpatient pharmacy practice sections.[17-20] Furthermore, it is essential to prevent infection-related problems during a pandemic or regular period. Therefore, the description of pharmacist knowledge of infection control is critical. As a result, this study with convenient sampling obtained optimal sample size better than previous pharmacy studies or healthcare professional studies,[21-27] with non-significant differences (p>0.05) distribution of responder's geographic location and gender among male and female responders. On the contrary, the number of responders from the different worksites, age groups, different academic qualifications, and positions held were unequal. That's reflected the background information of a variety of types or groups of responders. Unfortunately, it cannot publish demographic data in actual practice. The average knowledge of pharmacy infection control of pharmacists was found to be inadequate, which resembled previous studies.[21,22,25] However, our results were better than two previous studies[23,25] and lower than another study.[24] Most pharmacists were familiar with daily activities

Table 7: Multiple regression of Factors with the Knowledge and frequency used the disinfection and antiseptics products.[a]

Model		R	R Square	F	Sig.	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
						B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.433 [b]	.188	10.991	.000[b]	3.308	0.364		9.087	0.000	2.592	4.024		
	Location					−0.003	0.033	−0.005	−0.104	0.917	−0.069	0.062	0.954	1.048
	Site of work					−0.029	0.015	−0.109	−1.904	0.058	−0.059	0.001	0.745	1.342
	Age (years)					0.133	0.056	0.180	2.379	0.018	0.023	0.242	0.427	2.340
	Pharmacist gender					0.129	0.102	0.066	1.264	0.207	−0.072	0.329	0.893	1.120
	Practice area					0.028	0.016	0.095	1.721	0.086	−0.004	0.060	0.807	1.239
	Current Position					−0.161	0.050	−0.187	−3.194	0.002	−0.260	−0.062	0.709	1.410
	Years of experiences					0.111	0.051	0.158	2.165	0.031	0.010	0.213	0.461	2.170

a. Dependent Variable: the Knowledge and frequency used the disinfection and antiseptics products, Predictors b: (Constant), Location, Site of work, Age (years), Pharmacist gender, Practice area, years of experience, and current Position

Bootstrap for Coefficients							
Model		B	Bootstrap[a]				
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
1	(Constant)	3.308	−0.014	0.393	0.001	2.543	4.058
	Location	−0.003	−0.001	0.037	0.909	−0.077	0.065
	Site of work	−0.029	0.001	0.016	0.073	−0.059	0.004
	Age (years)	0.133	6.559E−05	0.050	0.008	0.041	0.239
	Pharmacist gender	0.129	−0.002	0.105	0.235	−0.078	0.331
	Practice area	0.028	0.001	0.020	0.174	−0.011	0.064
	Current Position	−0.161	0.004	0.046	0.001	−0.245	−0.066
	Years of experiences	0.111	0.000	0.051	0.026	0.010	0.210

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

such as hand hygiene and personal protective equipment (PPE),[24] in addition to the concept of pharmacy infection control. This result is expected because some of the elements mentioned above are daily necessary practice. In contrast, pharmacists did not know some aspects such as immunization of accidental sharp devices and pharmacy job descriptions. Besides, the pharmacist infection control got additional salary and references used for pharmacy infection control.[22] Thus, we can say that there was no foundation for pharmacy infection control, or there were no pharmacists assigned for infection control jobs in pharmacy services.

In this study, the pharmacist had insufficient knowledge of infection control compounds. However, they were familiar with some materials such as hydrogen peroxide. The pharmacist dispenses the medications for oral dental disease. In comparison, Isopropyl alcohol was dispensed for intravenous admixture cleaning the laminar flow hood before and after sterile preparation. Besides, Gluteruldehyde is used for hard places cleaning in the pharmacy department. Some infection control products are not widely used in pharmacies, such as phenols products used for toilet cleaning and Indiofore for surgical cleaning or soft places cleaning. Also, other products not commonly used in pharmacy practice, such as quaternary ammonium compound for clothes washing laundry. However, these compounds should be familiarized with by pharmacists as they distribute them. Drug information resources and medical guidelines were the majority of the references which a pharmacist goes through.

Factors affecting the knowledge of pharmacists about pharmacy infection control and related products

Various factors might affect the knowledge of pharmacy infection control. For example, the worksite affected the knowledge of infection control, such as community pharmacy and non-MOH governmental sites. The finding showed that there is an inadequacy of awareness or education and training about pharmacy infection control. Additional factors affected the knowledge assessment of pharmacy infection control, such as young age, lower positive and few years of experiences, which agrees with the results of a previous study.[21,24,25] That was related to the responders needed some time to become familiar with pharmacy infection control procedures. However, the practice area such as the Intravenous admixture section showed higher knowledge of infection control because they deal with it daily. Two factors positively affected the knowledge of infection control, such as gender and practice area. The female responders practiced more accurate infection control methods than male responders, which might expand their knowledge about pharmacy infection control, different from the previous study.[22] Regression analysis confirmed it as a positive dependent factor; the pharmacy infection control knowledge increased with gender. The other two negative depending factors with negative proportion were the site of work and position held. That might be related to the practice and experiences of healthcare organizations. The knowledge of pharmacy infection was decreasing due to inadequate infection control practice by the healthcare workers. If the responders get higher positions or jobs, they will forget the pharmacy infection knowledge because they did not practice and were busy with the administration issues.

On the contrary, some factors might positively affect the knowledge of infection control products, such as location, central and western region. The pharmacist is not dealing with or disturbing the infection control products. The infection control department receives and distributes the products to all medical and non-medical sections at healthcare institutions. Additional factors such as young age, less experience, low position held, and less understanding of pharmacy infection control might affect the application of this knowledge, which agrees with the results of previous studies[21,24,25] and contrary to the other.[23] However, the intravenous admixture practice site showed high knowledge of infection control material. That was possible because they use the products daily. Two factors might have a positive effect on the knowledge, such as age and years of experience. However, with the higher position held, the knowledge of infection control products was found to be reduced because they do not deal with the infection control products on a daily basis.

Limitations

In this study, we aimed to assess the knowledge of pharmacists about infection control. As a result, we obtained some good results, such as the study having a good sample size and a high-reliability survey. Moreover, it had comparable demographic data based on region and gender. However, there were some limitations to this study. First, the demographic data was unequal such as age, years of experience, and current position held. In addition, there were only a few studies to compare with the results of this study. Therefore, further studies are required with equal demographic information and regular or periodic survey about knowledge pharmacy infection control in Saudi Arabia.

CONCLUSION

In summary, the knowledge of pharmacists about pharmacy infection control was found to be insufficient. The results were affected by various factors, such as young age, less work experience, lower position held, had inadequate knowledge. Therefore, education and training should be provided during the residency program to increase their knowledge about infection control. Consequently, we recommend that pharmacy infection control be founded at all healthcare organizations in Saudi Arabia.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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Consent for Publications

Informed consent was obtained from all the participants

Ethical Approval

This research is exempted from research and ethical committee or an institutional review board (IRB) approval.

https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html

ABBREVIATIONS

MOH: Ministry of Health; **KSA:** Kingdom of Saudi Arabia; **SPSS:** Statistical package of social sciences; **JASP:** Jeffery's Amazing Statistics Program; **STROBE:** Strengthening the reporting of observational studies in epidemiology; **VIF:** Variance Inflation Factor; **KFSHRC:** King Faisal Specialist Hospital and Research Center.

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