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Assessment of knowledge, attitude and practice (KAP) on pharmaceutical bioinformatics among academicians of health-care institutions of Qassim University, KSA

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Abstract
This study aims to evaluate the knowledge, attitude and practice (KAP) of health care professionals for the use of pharmaceutical bioinformatics as a tool in clinical practice. The study was a cross-sectional questionnaire-based survey. 82 professionals who are involved in teaching the health-care programs in the Qassim University of Kingdom of Saudi Arabia were surveyed to assess their KAP about pharmaceutical bioinformatics. The data was collected through online and interviews and analyzed on a spreadsheet in excel file. Statistical significance was measured by using One-way ANOVA followed by non-parametric analysis to indicate the level of significance. The results of the study indicated that majority (>70%) of the participants had responded correctly to the questionnaires about the basic information of knowledge, attitude and practice of pharmaceutical bioinformatics. However, some questions that were marked as critical for KAP received less than average response (20 – 50%). A significant influence (p<0.05) of gender, age and experience was observed in the replies of the academicians. The analysis of the results indicated that the academician has thorough basic information about the knowledge, attitude and practice of pharmaceutical bioinformatics in the medicine. However, there is a need to update the advanced information on the emerging field of pharmaceutical bioinformatics and its application in new drug discovery**.**

Keywords: knowledge, pharmaceutical bioinformatics, attitude, software, practice, drug discovery

Introduction
Bioinformatics is the branch of science that combines the application of computers, databases, statistics and graphs. During new drug development process, it was reported that only 10% of the drug molecules, which are identified in research area, make through the final phase. The elaborate testing results in many of the potential drugs do not make it to market, and expensive time and resources which has been invested suffer a heavy loose without much benefits [1]. There are reports that suggest that simulation and informatics can significantly help in improving the efficiency of drug development, cutting costs, and improving margins [2]. This has highlighted the importance of many bioinformatics resources that can understand and predict absorption, distribution, metabolism, excretion and toxicity of both existing drugs and potential drug leads [3].The application of bioinformatics in pharma industry can reduce the time, cost and make the people understand the complex mathematical and statistical equation in simple and easily readable form in order to facilitate drug discovery, drug development, structure-activity relationship and product development at a faster rate [4]. Besides, there are reports that suggests that bioinformatics can be used in drug target identification and validation and in the development of biomarkers and toxicogenomic and pharmacogenomic tools to maximize the therapeutic benefit of drugs [3, 4]. There are reports indicating that bioinformatics tools / softwares can predict the drug metabolism in the body, the fate of metabolites, the type of metabolic reaction (s) a drug molecule will undergo in the body and the most likely organ that will cause the metabolism of the drug [5]. The drug discovery and development process involve the employment of computer-aided drug design (CADD) methods. CADD methods are reported to be dependent on bioinformatics tools, application and databases [6]. Although it is emerging as an important field in the management of disease and its treatment, many health care providers lacks complete knowledge about this field. Hence, this survey study was planned to evaluate the level of knowledge among the faculty members of health care institutions under Qassim University, Kingdom of Saudi Arabia. The data can be used to design new strategies to enlighten the knowledge about the fast and emerging field in the pharmacotherapy.

Material and methods
The purpose of the present study is to assess the knowledge, and measure the professional attitude and practice among the academician associated with teaching and training the health care programs under Qassim University.

A. Study setting and population
This is a survey-based study conducted in Qassim province of Saudi Arabia, among the faculty members. Both male and female participants interested in participation were enrolled with this study (N=82). The participants were from the institutions of medical, dental, pharmacy and applied medical sciences. Participants having a degree in medical or allied profession, involved in teaching and training and, willing to participate in the survey were considered as the inclusion criteria and *vice versa* was considered as exclusion criteria.

B. Study tool
The questionnaire was targeted to faculty members of health care programs evaluate their knowledge, attitude and practice about

the pharmaceutical bioinformatics.

C. Questionnaires development

A questionnaire was developed in English and Arabic language**.** The questionnaires were divided in to two part *viz*., socio-demographic section and KAP section. In socio-demographic part information about the respondents such as age, sex, profession, qualification and experience was collected. While in the KAP, prepared questions related to knowledge, attitude and practice was asked with set answer such as 'Yes', 'No' and 'Don't know' for knowledge, attitude and practice questions [7].

The questionnaires used for the knowledge domains were; Q-1: Do you have knowledge about pharmaceutical bioinformatics? Q-2: Do you think bioinformatics is a fast emerging field in pharmaceutical industry? Q-3: Do you know that bioinformatics is the application of computer technology for the management and analysis of biological information? Q-4: Do you know that pharmaceutical bioinformatics can be used in drug target identification? Q-5: Do you agree that pharmaceutical bioinformatics can be used in the development of toxicogenomic and pharmacogenomic tools to maximize the therapeutic benefits of drugs? Q-6: Do you know that pharmaceutical bioinformatics can be used in designing the best formulation for drug delivery system? Q-7: Is it true that the use of pharmaceutical bioinformatics in designing of experiments provides accurate results? Q-8: Do you know that several major pharmaceutical companies outsource the bioinformatics studies? Q-9: Do you agree that pharmaceutical bioinformatics in drug development process reduce the number of human subjects needed for testing the safety and efficacy of new drugs? Q-10: Do you know that designing a 'receptor-based pharmacophore' revolutionized the drug design and discovery? Q-11: Do you know that 'sparse logistic regression' is utilized in predicting the response of chemotherapeutic agents in breast cancer?

The attitude domain questions were; Q-1: Do you believe that the major challenge in pharmaceutical bioinformatics is to establish a relationship between the pathogenesis of diseases to vast genomic data? Q-2: In your view does the available pharmaceutical bioinformatics software package determine all the biological responses of the body? Q-3: In your opinion does KinetDS® software is used for designing of experiments methods for optimizing development of products and processes? Q-4: Do you think that pharmaceutical bioinformatics can be used in the diagnosis of a disease? Q-5: In your opinion can Stat-Ease® software is used for determining the possible release mechanism of drug substances from the dosage forms? Q-6: Do you think that more topics needed to be included in our curriculum on pharmaceutical bioinformatics? Q-7: Do you think that our students from health sciences can make their career in pharmaceutical bioinformatics?

The practice domain questions were; Q-1: Do you believe that the application of pharmaceutical bioinformatics during drug development process can reduce the drug-related complications? Q-2: Is it true that use of pharmaceutical bioinformatics can reduce the cost and duration of new drug development? Q-3: Can we use the application of pharmaceutical bioinformatics in evidence-based medicine? Q-4: Do you agree that Human Genomic Project is an application of bioinformatics? Q-5: Do you believe pharmaceutical bioinformatics can solve the issues related to the synthesis of oral insulin tablet? Q-6: Is it true that 'Meropenem' the potent drug against superbug was unveiled through bioinformatics research? Q-7: Do you like to prescribe / dispense a drug that has bioinformatics data to your patients? Q-7a: Would you prefer to see the bioinformatics details in the product monograph before prescribing / dispensing the medication? Q-8: Have you ever used pharmaceutical bioinformatics tools in your profession? Q-8a: If your answer is 'Yes', then attempt the following questions: Do you found that the bioinformatics tool (s) was useful in its application?

The questionnaires were validated by the expert committee constituted by the department. Among the set of questions, Q-10,11 from knowledge domain, Q-3, 5 from attitude domain and Q-5,6 from practice domain were considered to be a critical thinking questions and the correct response was considered to indicate whether the participant has basic or complete information on pharmaceutical bioinformatics. A pilot study was done before the questions were circulated for the data collection.

D. Study design

This was a cross-sectional questionnaire-based survey. The professionals who are involved in teaching and training the health care programs such as professors, associate professors, assistant professors and lecturers were surveyed to assess their KAP about pharmaceutical bioinformatics [8]. The potential participants were contacted through e-mail and the response was collected either through online or by interviews. The study was conducted at the most suitable time fixed by the participants.

E. Statistics

All completed survey forms were evaluated and their response was recorded in an excel spreadsheet. The data was analyzed and statistical significance of the results was done through One-way ANOVA followed by non-parametric post-hoc test [9]. The non-parametric tests include: Spearman's rho Correlation was used to find the association between knowledge, Attitude and Practices. Mann-Whitney U was used to compare scores of each domain with binary demographic groups: (Gender and Nationality). Kruskal-Wallis H was used to compare scores of each domain with demographic with more than two categories (Age, Qualification and Experience). Chi-square test was used to determine whether there is a significant association between each domain scores of the participants and Demographics.

Results

A. Demographic characteristics of participants

The demographic details of the participants are summarized in table-1.

Table 1: Demographic characteristics of participants

Demographic Variables		**Academician** N (%)
Gender	Male	34 (41.5%)
	Female	48 (58.5%)
Age (years)	Less than 35	24 (29.3%)

	36-45	40 (48.8%)
	46-55	16 (19.5%)
	56 and above	2 (2.4%)
Qualification	Bachelor	12 (14.6%)
	Master	24 (29.35)
	Ph.D	46 (56.1%)
Experience	Less than 5 years	20 (24.4%)
	6-10 years	14 (17.1%)
	11-15 years	32 (39%)
	16-20 years	14 (17.1%)
	Above 21 years	2 (2.4%)

The gender distribution of the academicians are 41.5% are male and 58.5% are female faculty. Among them, maximum academicians (48.8%) are between the age of 36 – 45 years. The minimum percentage was observed at 56 years or above (2.4%). In qualification category, majority of academicians were having doctoral degree (56.1%) and the least number was found to hold the bachelor degree (14.6%). The experience criteria indicated that most of the academician has an experience of 11 – 15 years (39%) and the lowest percentage was found to be above 21 years of experience (2.4%).

B. **Frequency of response of academicians for KAP questionnaires.**

The response of academicians to the knowledge domain-based questions indicated that majority (above 60%) as 'Yes' except for questions Q-7,8,10,11). For Q-7, 43.9% indicated as 'Yes', 14.6% as 'No' and 41.5% as 'Don't know'. In Q-8, 48.8% answered as 'Yes', 14.6% as 'No' and 36.6% as 'Don't know'. The Q-10 response was 46.3% 'Yes', 22% 'No' and 31.7% 'Don't know'. The reply to Q-11 is 14.6% 'Yes', 41.5% 'No' and 43.9% 'Don't know'. In the attitude domain, Q-1,6 and 7 received more than 70% response to 'Yes', while Q-2,3 and 5 received less than 20% for 'Yes' and Q-4 received 48.8% response as 'Yes'. The maximum 'No' response for these questions was found in Q-2 and Q-3 and 5 got maximum 'Don't know' (> 70%). The observation for practice domain survey indicated that Q-1,2,3,4 and 8a received above 60% 'Yes' response. The lowest 'No' reply (0%) was found to be for Q-4,5 and highest for Q-8 (51%). The lowest response for 'Don't know' was found to be for Q-1, 8a (< 20%) and highest reply for Q-6 (> 70%).

C. **Mean score of academician's response on the domains of KAP with respect to demographic characteristics.**

The analysis of mean scores and its comparisons indicated that there is no-significant variation in knowledge domain with demographic characteristics in gender, qualification and experience. However, a significant variation (p=0.009) was observed when the mean scores of age group of the participants was compared. In attitude domain, the comparison of data of gender and experience revealed a significant variation. The p value for gender was found to be 0.010 and for experience 0.002. Other characteristics such as age and qualification did not show significant variation among them. The mean scores' analysis of practice domain indicated significant variation for experience (p=0.005) while other parameters like gender, age and qualification did not reveal any significant difference among the faculty members (Table-3).

D. **Correlation between various domains of KAP for academician's response.**

The analysis to find the correlation of KAP domains is represented in table-4. The data suggested a positive Rho value when the comparison was done between knowledge – attitude, knowledge – practice and attitude – practice domains. The comparison of these domains indicated significant (p<0.01) variation.

E. **Analysis of academician's response on the domains of KAP.**

The table-5 represented the analysis of academicians' response according to the demographic parameters. The comparison of these parameters in the knowledge domain indicated a non-significant variation in gender, qualification and experience, while a significant difference (p=0.003) was observed in age category. The attitude domain analysis indicated non-significant variation in none of the demographic distinguished group.

The analysis of practice domain revealed a significant different in the gender (p=0.014), age (p=0.033) and experience (p=0.001) categories and, insignificant difference in the qualification category.

Discussion

Bioinformatics is the branch of science in which the technology of computers is used to study those activities that occur in the living cells. It is an emerging field in new drug discovery where the design, structure-activity relationship, interactions with biomolecules of the new therapeutic agents are studies [10,11]. The data from these studies provides most-likely outcome of the actions of the new drug molecule when it is tested in living organism and is a useful tool in the new drug discovery [12].

In this study, we evaluated the knowledge, attitude and practice of pharmaceutical bioinformatics among the academicians affiliated to medical profession involved in both teaching and practice. The demographic data indicated that there were 34 male and 48 female academicians who took part in this survey-based study. Majority of them were in the age group of 36 – 45 years, with PhD qualification and having 11 – 15 years of professional experience (Table-1).

Table 2: Frequency of response of academicians for KAP questionnaires.

Domain	Item No.	Percentage response of academicians		
		Yes	No	Don't know
Knowledge	1	78.0 %	17.1 %	4.9 %
	2	73.2 %	17.1 %	9.8 %
	3	80.5 %	4.9 %	14.6 %
	4	82.9 %	2.4 %	14.6 %
	5	78.0 %	4.9 %	17.1 %
	6	65.9 %	24.4 %	9.8 %
	7	43.9 %	14.6 %	41.5 %
	8	48.8 %	14.6 %	36.6 %
	9	53.7 %	14.6 %	31.7 %
	10*	46.3 %	22.0 %	31.7 %
	11*	14.6 %	41.5 %	43.9 %
Attitude	1	70.7 %	0 %	29.3 %
	2	19.5 %	34.1 %	46.3 %
	3*	7.3 %	19.5 %	73.2 %
	4	48.8 %	19.5 %	31.7 %
	5*	17.1 %	7.3 %	75.6 %
	6	73.2 %	4.9 %	22.0 %
	7	70.7 %	4.9 %	24.4 %
Practice	1	73.2 %	7.3 %	19.5 %
	2	65.9 %	4.9 %	29.3 %
	3	73.2 %	4.9 %	22.0 %
	4	61.0 %	0 %	39.0 %
	5*	56.1 %	0 %	43.9 %
	6*	19.5 %	2.4 %	78.0 %
	7	43.9 %	9.8 %	46.3 %
	7.a	53.7 %	4.9 %	41.5 %
	8	19.5 %	51.2 %	29.3 %
	8.a	75.0 %	12.5 %	12.5 %
*Critical questions				

The study was conducted by circulating pre-validated questionnaires with set answers. There were 11 questions related to knowledge, 7 to attitude and 8 to practice. Each domain had couple of 'critical' questions that precisely reflected the KAP domains of pharmaceutical bioinformatics. The questions are Q-5,6 in knowledge, Q-3,4 in attitude and Q-5,6 in practice domain. The analysis of the data collected from the survey indicated that majority of the participants indicated correct reply to the questions of general knowledge about the pharmaceutical bioinformatics, however, the critical thinking questions such as Q-10 received 48.8% 'Yes', 22% 'No' and 43.9% 'Don't know' response. Further, majority 'Don't know' reply was found for Q-7 (41.5%) and Q-11 (43.9%) (Table-2). The observations suggest that although medical professionals have good knowledge about the general information of pharmaceutical bioinformatics but the in-depth knowledge on the 'receptor-based pharmacophore' and 'sparse logistic regression' is less than satisfactory when compared to other questions. These two terms are reported to play a vital role in the field by pharmaceutical bioinformatics. The receptor-based pharmacophore provides information about pharmacological interactions and sparse logistics regression provides classification and characterizing information encoded in population activity [13,14]. The analysis of attitude domain indicated that majority of academician (> 70%) indicated 'Yes' to the Q-1,6,7, however the response for Q-2,3,4,5 were less than 50% for 'Yes'. Among these, Q-3 received 73% 'Yes', 19.5% 'No' and 73.2% 'Don't know' and, Q-5 received 17.1% 'Yes', 73% 'No' and 75.6% 'Don't know'. In these two questions, it was observed that more than 70% respondents expressed 'Don't know' reply (Table-2). Q-3 and Q-5 were about KinetDS and Stat-Ease softwares. The KinetDS software is used for pharmacokinetics studies of a drug while Stat-Ease software is utilized for designing an experiment and studying the biological responses [15.16]. The data from the practice domain revealed that the response of the participants for Q-1,2,3,4,8a is above 60% and for the Q-5,6,7,8 were less than 60%. Among these questions, Q-5,6 were marked as 'critical' and their response were considered to indicate the actual practice of pharmaceutical bioinformatics in the profession. The reply for Q-5 was 56.1% 'Yes', 0% 'No' and 43.9% 'Don't know' and for Q-6 was 19.5% 'Yes', 2.4% 'No' and 78%% 'Don't know'. The most 'Don't know' response was found to be for Q-6 in this domain (Table-2). The Q-5 and 6 is related to application of bioinformatics in solving the issues regarding the oral insulin formulation and discovery of 'Meropenem' for superbug, respectively. A lot of research is under-progress to formulate the oral insulin preparation by utilizing the bioinformatics [17]. An extensive studies were carried out to discover the newer antibiotic 'Meropenem' against the multi-drug resistant 'superbug' [18]. The analysis of the KAP scores with respect to the demographic details indicated that there was a significant variation ($p<0.01$) in the scores among the age-group of the participants. A significant difference ($p<0.01$) was found in gender and experience categories for the attitude

domain. The practice domain indicated a significant variation ($p<0.01$) in the experience category (Table-3).

Table 3: Mean score of academician's response on the domains of KAP with respect to demographic characteristics.

Demographic Variables		K-Score 6.66 ± 3.30 Mean rank	*p*-value	A-Score 3.07 ± 1.48 Mean rank	*p*-value	P-Score 4.80 ± 2.26 Mean rank	*p*-value
Gender	Male	37.03	0.148	33.68	0.010*	39.03	0.424
	Female	44.67		47.04		43.25	
Age	Less than 35	39.67	0.009**	42.92	0.629	38.25	0.415
	36-45	37.45		38.50		42.85	
	46-55	57.75		47.13		45.75	
	56 and above	14.50		39.50		19.50	
Qualification	Bachelor	41.83	0.663	42.83	0.599	39.00	0.877
	Master	37.92		37.50		40.67	
	Ph.D	43.28		43.24		42.59	
Experience	Less than 5 years	43.20	0.494	33.70	0.002**	34.10	0.005**
	6-10 years	46.07		60.36		49.36	
	11-15 years	40.00		34.19		36.19	
	16-20 years	41.79		50.79		59.50	
	Above 21 years	14.50		39.50		19.50	

Note: K-Score = Average knowledge score, A-Score = Average attitude score and P-Score = Average practice score.
Statistics: One-way Anova followed by post-hoc analysis.
*p<0.05, **P<0.01 compared among different groups.

Similar observations were found when response of the academicians was categorized according to the demographic characteristics. A significant variation ($p<0.01$) among age-group was found in the knowledge domain and in practice an additional significant difference ($p<0.05$) was observed in gender and experience parameters (Table-4)

Table 4: Correlation between various domains of KAP for academician's response.

Variables	Rho value	*P*-value
Knowledge, Attitude	0.505	0.01**
Knowledge, Practice	0.587	0.01**
Practice, Attitude	0.846	0.01**

Statistics: One-way Anova followed by post-hoc analysis.
**P<0.01 compared among different groups.

Correlation among the various domains can be observed from the positive Rho values And significant difference ($p<0.01$) among them (Table-5).

Table 5: Analysis of academician's response on the domains of KAP.

Demographic Variables		Knowledge			*p*-value	Attitude			*p*-value	Practice			*p*-value
		Good	Fair	Poor		Good	Fair	Poor		Good	Fair	Poor	
Gender	Male	12	8	14	0.235	1	10	23	0.535	0	16	18	0.014*
	Female	18	18	12		3	18	27		8	12	28	
Age	Less than 35	8	6	10	0.003**	1	10	13	0.858	2	6	16	0.035*
	36-45	10	16	14		2	14	24		2	20	18	
	46-55	12	4	0		1	3	12		4	2	10	
	56 and above	0	0	2		0	1	1		0	0	2	
Qualification	Bachelor	4	4	4	0.756	1	2	9	0.725	2	2	8	0.143
	Master	8	6	10		1	9	14		0	12	12	
	Ph.D	18	16	12		2	17	27		6	14	26	
Experience	Less than 5 years	8	6	6	0.704	0	6	14	0.530	0	6	14	0.001**
	6-10 years	6	4	4		1	7	6		6	0	8	
	11-15 years	12	10	10		3	11	18		2	10	20	
	16-20 years	4	6	4		0	3	11		0	12	2	
	Above 21 years	0	0	2		0	1	1		0	0	2	

The results of the study indicate that in all the three domains, the medical professionals were found to possess satisfactory information only on the basics of pharmaceutical bioinformatics. Gender, age and experience might have influenced the response of academicians towards the emerging field of new drug discovery.

Limitations of the study

The study was conducted with survey based questionnaires through both online as well by interviews on academicians involved in both teaching and training. The study covered most of the health related professionals however; there is every possibility that the study might have missed the potential candidate having through information on pharmaceutical bioinformatics due to unavoidable reasons. Further, the study was done in the Qassim University of Saudi Arabia and hence does not reflect the opinion of whole province of the country.

Conclusion

The data from the study reveals that academicians affiliated to medical profession of Qassim University has basic knowledge, attitude and practice towards pharmaceutical bioinformatics. There is an influence of gender, age and experience on their response to the domains of KAP which needs update and can be achieved by encouraging the professionals to attend the conferences / workshops / seminars / other related activities to enlighten the information on the emerging field of medicine called pharmaceutical bioinformatics.

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