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The Use of Computer-Assisted Learning in Pharmacokinetic Practical Career: A Pioneer Trial in Sudan

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ABSTRACT

Objectives: To evaluate the first use of a modified simulated pharmacokinetic program and its future impact in pharmacy education in Sudan.
Methods: A survey, using semi-structured questionnaire was conducted. A total of 410 undergraduate pharmacy students were enrolled, whilst five or six computer-simulated pharmacological experiments were performed during two different academic years (2013/2014-2014/2015). Students' opinions on the objectives, effectiveness and utility of these simulated experiments were assessed.
Results: The majority (60 and 57 %) of the students indicated that they achieved their learning objectives and their understanding level was enhanced. Also, most of them (70 and 76 %) preferred computer simulations over the wet experiments.
Conclusion: Computer-assisted learning is useful and effective educational tool to demonstrate the hardest pharmacological practical's; Pharmacokinetic.

1. Introduction

Pharmacy education worldwide, particularly in the United States, Europe and Japan, has made great strides in the last fifty years [1]. Global changes in pharmacy profession and pharmaceutical education have occurred as a result of huge developments in pharmacy practice, bio-medical research and technology [2] For instance, in Europe; pharmacy programs have been restructured and expanded to culminate to a master degree instead of a bachelor degree. Today in USA all pharmacy programs are required to offer the doctor of pharmacy (Pharm. D.) as the sole degree for licensure [3].

In the Sudan, pharmaceutical education today requires a new vision. Needless to say, that the needs of the Sudanese communities differ from those in America or Europe. However, it is clear that neither pharmaceutical education nor pharmacy profession has made adequate progress within the last forty-five years in this country [2].

The first pharmacy college affiliated to University of Khartoum was established in (1965) with intake of only twenty students per year. This policy of admission continued with no substantial annual increase in the number of students enrolled in the college of pharmacy. However, after the revolution of higher education in the (1990s), extraction, the number of governmental and national pharmacy colleges has multiplied extremely [4]. Today there are about thirteen pharmacy colleges with possibly more in the pipeline [4]. The selection of students to Sudan pharmacy schools is based on two criteria; the first criterion is to obtain high degrees in the Sudan School Certificate (SSC) which is a school leaving examination held after spending eleven years in basic and secondary schools. The second criterion is based on a large extent upon the financial affordability to pay the high fees of private medical schools, and some (amounting to 15% of the total intake) of the seats in public schools. Unfortunately, many pharmacy [l] schools, pay a little attention to the academic performance in SCC and accept students with poor performance (even with SCC rates as low as 50%), in contrast to a minimum of 85% for government-sponsored schools' entrants [1,5]. As mentioned above the public schools are allowed to accept extra intake (15% of the total intake) with lower rates in SCC, but admitted-students should pay high fees. This situation results in presence of two kinds of students in the same class with largely different academic performance which will affect the quality of the graduates [5].

The curricula in the pharmacy colleges offer replicate courses of five years leading to B. Pharm. degree of general nature which qualifies the graduate pharmacist as a general practioner. These B. Pharm. Degrees are not in harmony with regard to contents and standardization of the general subjects taught [2]. The curricula usually do not place a great emphasis on local health problems. In the same time, there is overcrowding and over

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representation of certain subjects of less relevance to future professional practice [6- 7]. Also, the 'spoon feeding' format of teaching in our schools does not encourage students to be self-directed learners, life-long active learners and critical thinkers. As a result; they might find difficulties in pursuing their postgraduate studies or to initiate independent research activities. As well the students who depend on passive teaching cannot cope with constant changes in their societies' needs and demands [7].

In view of the recent enormous advancement in pharmaceutical sciences and related technological fields, the colleges of pharmacy in Sudan should restructure their curricula and make new arrangements to meet the challenges of today. Furthermore, colleges of pharmacy have to improve the quality of their academic programs and introduce a systematic assessment of student's performance [2].

With wide-spread use of computers among pharmacy students and the abundance of computer-based resources available for supporting teaching and learning in the medical sciences, there was apparent need that pharmacy graduates need to be familiar with and have competency in information technology field application and computing skills. Recently, there is a huge demand and increasing interest in introducing Computer Assisted Learning (CAL) techniques in education. A variety of computing programs have been developed for undergraduate and postgraduate upon teaching of pharmacology [8-12]. Several pharmacy schools across the world in India, United Kingdom, Canada, United States, Australia, Germany, Balkan countries, Malaysia and Korea had adopt CAL in pharmacy education.

Although, the outbreak of pharmacy education in Sudan, the lack of facilities still a challenge that affect the quality of the new graduated generations, thus urgent need for efficient, cheap tool is required. This study was set out to evaluate the use of a modified simulated pharmacokinetic program for the first time in pharmacy collages in Sudan.

2. Material and Methods

2.1. The simulated Software under evaluation

An old DOS-based pharmacokinetic program written in 1984 was subjected to upgrade modification and packaging to work under windows environment using interactive interface as seen in Fig. 1. Then simulated practical lessons were taught to the 3rd year pharmacy students to cover the pharmacokinetic syllabus during two subsequent academic years. The outcomes of using such program were evaluated using well-designed data collection forms.

2.2. Study design and study area

Cross-sectional, descriptive study was conducted at the Department of Pharmacology, Faculty of Pharmacy, Omdurman Islamic University.

2.2.1. Sample size

A total of 410 pharmacy students from both sex registered in the third academic year during, 2013/2014 and 2014/2015 were enrolled in this study.

2.2.2. Data collection tool

An inclusive questionnaire was used for each participant to elicit the general opinions of the students on different assigned variables and to best address the study's objectives. The questionnaire had twelve questions, ranging from the students' demographic characteristics to the utility and the effectiveness of the simulated experiments.

2.2.3. Time frame

This study was conducted during the two academic years 2013/2014 and 2014/2015.

3.3. Ethical considerations

Verbal inform consent was obtained from each student before voluntarily participate actively in filling the questionnaire.

3.4. Data analysis

Statistical analysis was performed by using the Statistical Package for Social Sciences (SPSS) windows version (16.0). The differences in the participants' responses were analyzed with Chi-square test. The ≤ 0.05 level of significance was used as statistical significance.

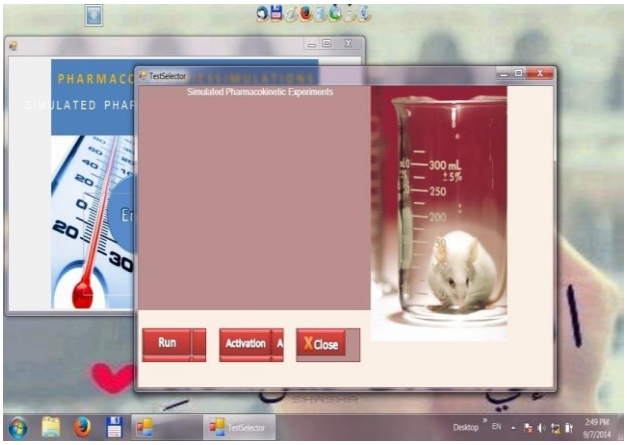

Fig. 1 Screen-shot of the modified program interface running under Windows 7 environment.

3. Results

3.1. Population characteristics

All the participants appeared similar regarding their Sex, Residence and Registration type, as shown in Table 1.

Table 1 Population characteristics

Patterns	2013(n=205)	2014(n=205)	P-value
	(Frequency/percent)		
Sex			
Male	89 (43.4)	91 (44.4)	0.84
Female	116 (56.6)	114(55.6)	
Residence			
Home	117 (57.1)	118(57.6)	0.92
Dormitory	88 (42.9)	87(42.4)	
Registration type			
General	131(64.9)	128(62.4)	0.83
Special	39(19)	46(22.4)	
Parallel	25(12.2)	22(10.7)	
Others	8 (3.9)	9(4.4)	

4.2. Special variables correlations

Among the all students, the generally-registered students scaled good patterns (55.7, 60.2, 53 and 35%) regarding general perception about program, objectives achievement, understanding level and practical contents than other types of registration, Table 2 and Table 3.

Table 2 Correlation between registration type and different variables, 2013

Patterns	General	Special	Parallel	Others
	(Frequency/percent)			
1-General perception about program				
Excellent	15 (11.4)	4(10.5)	2(8)	0(0)
Very good	12(9.2)	7(18.4)	4(16)	0(0)
Good	73(55.7)	21(55.3)	16(64)	5(62.5)
Poor	31(23.7)	6(15.8)	3(12)	3(37.5)
P-value				0.5
2-Achievement of objectives				
Excellent	7(5.5)	3(7.9)	3(12)	0(0)
Very good	18(14)	6(15.8)	4(16)	1(12.5)
Good	77(60.2)	24(63.2)	15(60)	6(75)
Poor	26(20.3)	5(13.1)	3(12)	1(12.5)
P-value				0.9
3-Understanding level				
Excellent	5 (3.8)	1(2.6)	1(4)	0(0)
Very good	22(16.7)	5(13.2)	5(20)	2(25)
Good	70(53)	21(55.3)	16(64)	5(62.5)
Poor	35(265)	11(28.9)	3(12)	1(12.5)
P-value				0.8
4-Practical contents				
Excellent	9(7)	4(10.5)	3(12.5)	1(12.5)
Very good	3(17.8)	3(7.9)	9(37.5)	1(12.5)
Good	46(35.7)	15(39.5	10(41.7)	4(50)
Poor	51(39.5)	16(42.)	2(8.3)	2(25)
P-value				0.08

Table 3 Correlation between registration type and different variables, 2014

Patterns	General	Special	Parallel	Others
	(Frequency/percent)			
1-General perception about program				
Excellent	16(12.5)	7(15.2)	1(4.6)	0(0)
Very good	25(19.5)	5(10.9)	2(9)	2(22.2)
Good	67(52.4)	28(60.9)	14(63.7)	7(77.8)
Poor	20(15.6)	6(13)	5(22.7)	0(0)
P-value				0.4
2-Achievement of objectives				
Excellent	6(4.7)	10(21.7)	0(0)	1(11.1)
Very good	29(22.7)	8(17.4)	4(18.2)	3(33.3)
Good	73(57)	25(54.4)	14(63.6)	4(44.5)
Poor	20(15.6)	3(6.5)	4(18.2)	1(11.1)
P-value				0.03
3-Understanding level				
Excellent	9(7)	3(6.5)	1(4.5)	1(11.1)
Very good	34(26.6)	13(28.3)	1(4.5)	2(22.2)
Good	65(50.8)	28(60.9)	16(72.8)	4(44.5)
Poor	20(15.6)	2(4.3)	4(18.2)	2(22.2)
P-value				0.2
4-Practical content				
Excellent	10(8)	1(2.9)	0(0)	1(11.1)
Very good	15(12.1)	7(20.6)	3(14.3)	0(0)
Good	56(45.2)	18(53)	10(47.6)	6(66.7)
Poor	43(34.70	)8(23.5)	8(38.1)	2(22.2)
P-value				0.6

4.3. Participants response to variety of questions

The majority of students (69.9 and 75.8 % for male and 55.9 and 65.4 % for female sector) especially in 2014 prefer simulation experiments over animal ones, besides, ability to get real data that allow them to calculate drug parameters, also to get the taste of experimental pharmacology and to gain the spirit of group-working skills, Table 4 and Table 5.

Table 4 Students answers for a number of questions, 2013

Question	Male	Female	p-value
	(Frequency/percent)		
Preference over animal			
Yes	58 (69.9)	62 (55.9)	0.05
No	25 (30.1)	49 (44.1)	
Getting taste of experimental pharmacology			
Yes	47 (54)	64 (57.7)	0.6
No	40 (46)	47 (42.3)	
Getting realistic data			
Yes	42 (49.4)	66 (58.4)	0.2
No	43 (50.6)	47 (41.6)	
Creativity encourage			
Yes	30 (36.6)	50 (49.5)	0.08
No	52 (63.4)	51 (50.5)	
Gain spirit of group working skills			
Yes	62 (71.3)	66 (59)	0.07
No	25 (28.7)	46 (41)	

Table 5 Students' answers for a number of questions, 2014

Question	Male	Female	p-value
	(Frequency/percent)		
Preference over animal			
Yes	69 (75.8)	70(65.4)	0.11
No	22 (24.2)	37(34.6)	
Getting taste of exponential Pharmacology			
Yes	58 (66.7)	63 (57)	0.16
No	29 (33.3)	48 (43)	
Getting realistic data			
Yes	61 (68.5)	75 (69)	0.96
No	28 (31.5)	34 (31)	
Creativity encouragement			
Yes	41(50.6)	49 (49.5)	0.88
No	40 (49.4)	50 (50.5)	
Gain spirit of group working skills			
Yes	77 (86.5)	74(67.3)	0.00
No	12 (13.5)	36 (32.7)	

4.4. Students' interactions with simulation program

Both sexes showed similar perception about simulation program during the two different academic years, whilst the 2013 female students showed better perception than male ones, Fig. 2. On the other hands, both students achieved good learning objectives regarding the use of the simulation program, Fig. 3. The students of 2014 showed higher understanding level using the simulation program than those of 2013, Fig. 4.

4.5. The relationship between different factors

Moreover, the male students of the year, 2014 showed better perception about the practical contents than the student of 2013, whilst vice versa was noticed in female, Fig 5. In both years 2013 and 2014, the students whom lived in their homes appear better understanding level and objectives achievement than those whom lived in dormitory, Figs. 6 and 7.

The generally-registered students in 2014 showed better ability to get real data that allow them to calculate drug parameters than those in 2013, Fig. 8. Almost half of the students (53 and 58), regardless their registration type, appear potential encouragement in their creativity to device an experiment and to test hypothesis, Fig. 9.

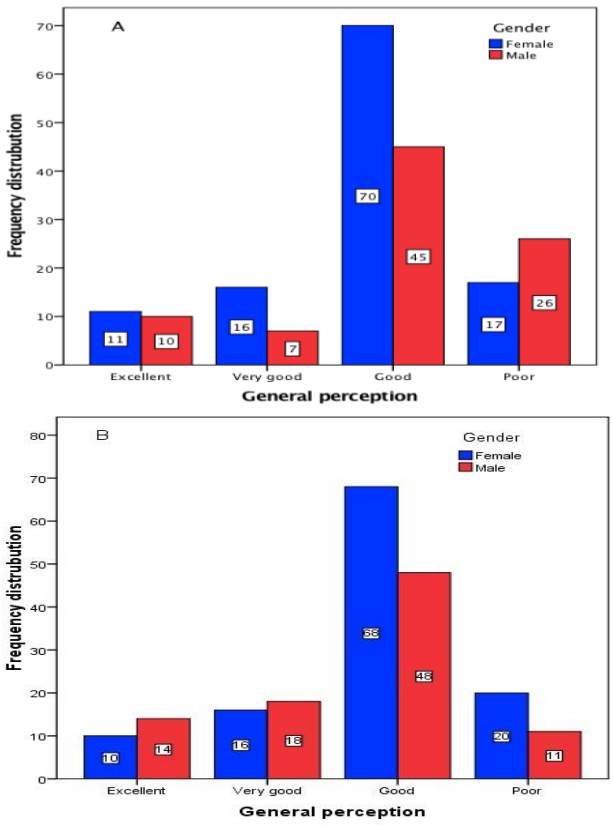

Fig. 2 The relationship between sex and general student's perception about simulation program, during academic year, 2013(A) and 2014 (B).

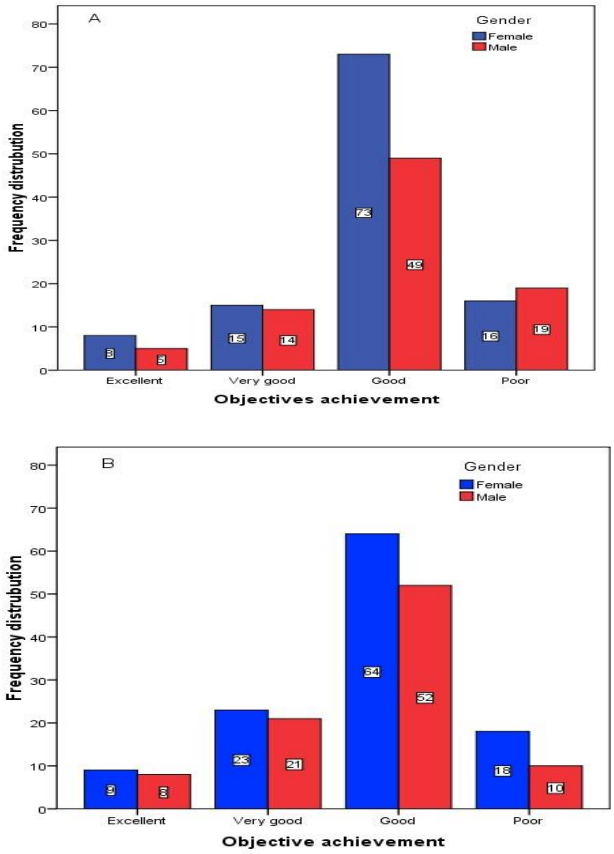

Fig. 3 The relationship between sex and achievement of learning objectives, during academic year, 2013(A) and 2014 (B).

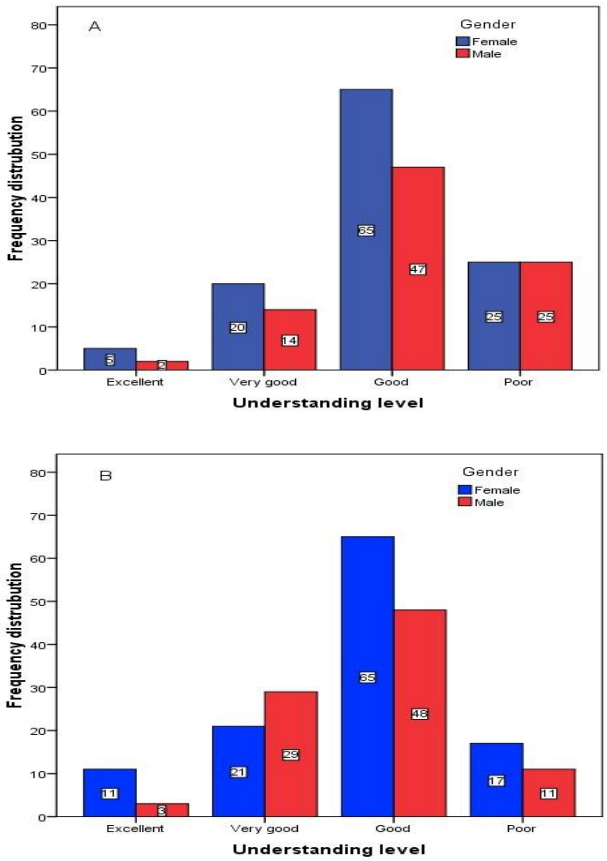

Fig. 4 The relationship between sex and the students' understanding level, during academic year 2013(A) and 2014 (B).

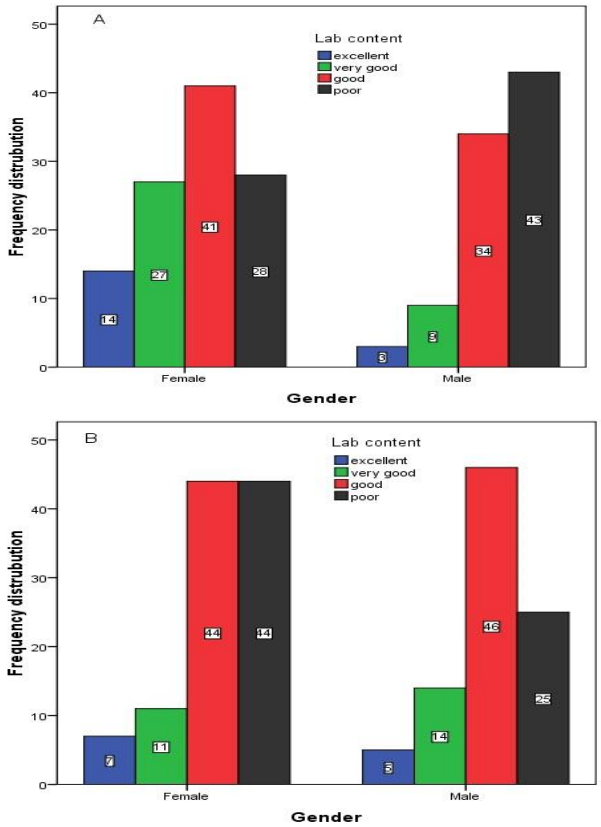

Fig. 5 The relationship between sex and practical's contents, during academic year, 2013(A) and 2014 (B).

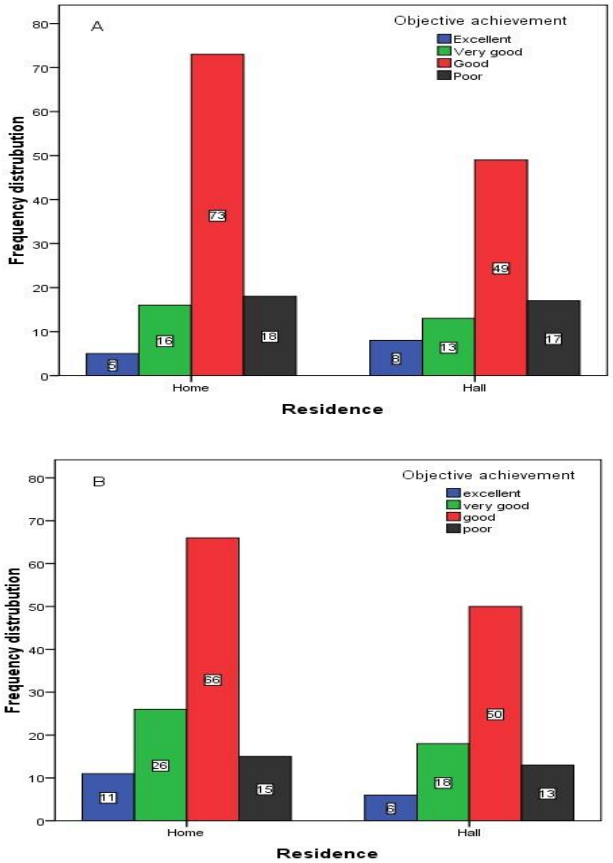

Fig. 6 The relationship between residence and achievement of learning objectives, during academic year 2013(A) and 2014 (B)

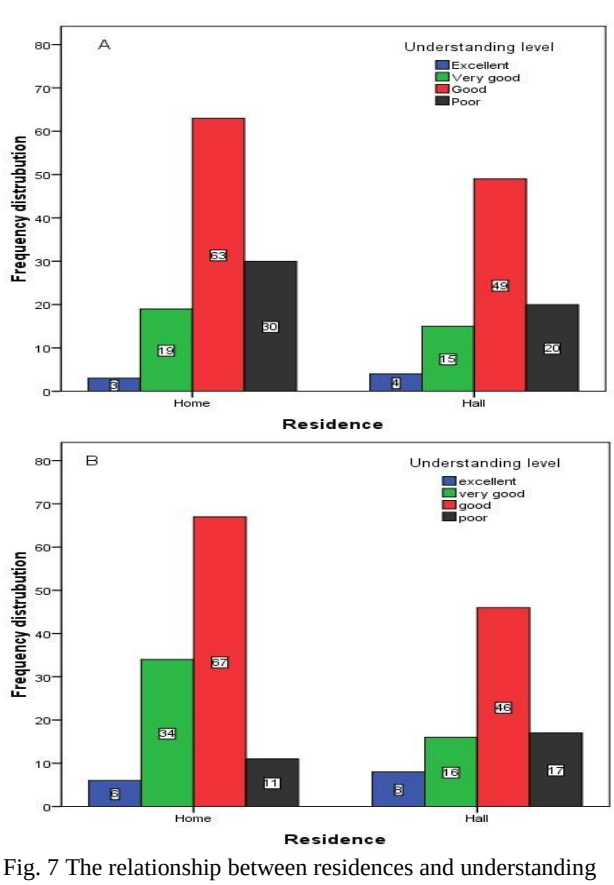

Fig. 7 The relationship between residences and understanding level, during academic year 2013(A) and 2014 (B).

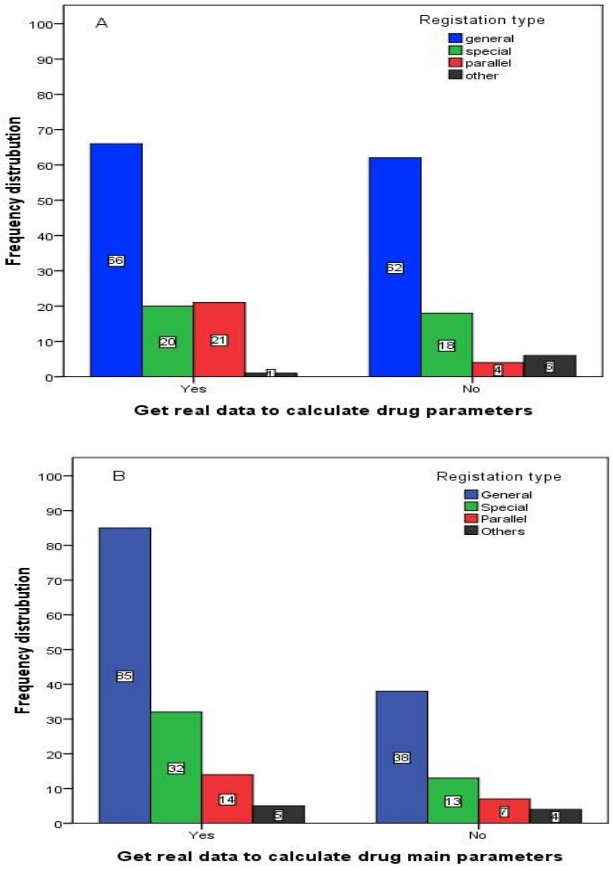

Fig. 8 The relationship between registration types and ability to get real data to calculate drug parameters, during academic year, 2013(A) and 2014 (B).

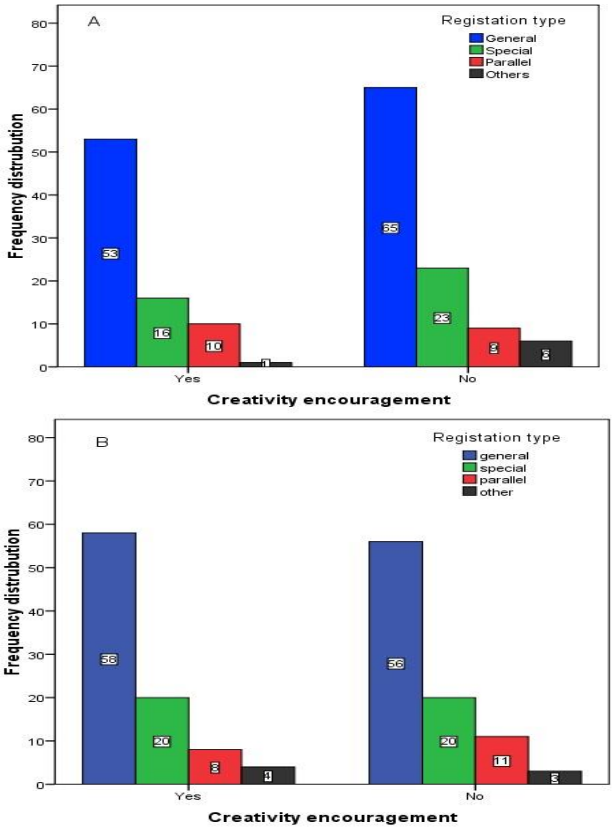

Fig. 9 The relationship between registration types and the student creativity encouragement to devise experiment and to test hypothesis, during academic year, 2013(A) and 2014 (B).

5. Discussion

Recently, an evolution of pharmacy education was appeared in Sudan, but the lack of facilities represents a real challenge and the need of urgent tool to overcome this problem is highly recommended. Computer assisted learning has become a vital part in the pharmacology curriculum and new trends in the information technology developments support such methods.
During both academic years, there is no differences between students concerning their residence, sex, registration type, and the sample is normally distributed and representative.

At both academic years, female constitute the majority of the students, which was observed in the United States [13], in different Arab countries [14] and most Sudanese colleges of pharmacy [15] . In the late 1970s, women constituted up to 20% of total medical students due to increase in the intake allowance to national schools and abroad mainly Egypt and Eastern Europe [5]. In Sudan, there is a dramatic increase in the intake of students and establishment of a number of new medical schools during the last 15 years, and the numbers of female medical students steadily increased to dominate the male counterpart. In the academic year of 2009/2010, female students constituted 63.9% of the total registered students in the Sudan's schools of medicine, 75.4% in dental schools, 69.3% in pharmacy schools and 73.7% in medical laboratories schools. Female students were dominant in most of the other fields in the year of 2009/2010, as in agriculture and natural sciences [5].

Although, the effect of gender differences in medical education present controversial results, our survey revealed that, female have higher performance level comparing to the male ones, this may be due to the differences in the capabilities, personalities and attitudes of both female and male, this in line with an Irish study that, reports a female predominance in the academic performance among the students [16]. While another study found no major difference in the academic performance of male and female students [17].

Most of the students live in their homes, where comfort, suitable environment is available, there is flexibility to sleep, study and socialize when they need, also most students are choosing to stay at home for financial reasons [18].

Although it is widely believed that living in dormitory helps students perform better in their universities [19] , this study revealed that students whom lived in their homes showed better understanding level and objectives achievement than those whom lived in dormitory. At home, in addition to the availability of suitable environment, the immediate surroundings can be a source of satisfaction that could affect the student academic success, while those whom live in dormitory have stress of being separated from their family and friends and there is waste of time to achieve needs, this may decrease their academic performance [20].

It is important to note that the number of pharmacy collages and pharmacy students increase dramatically, with the presence of different types of registration in the same class. This will affect their academic performance and will potentiate the problem of wet practical in low income countries such as Sudan. When using computer simulated program, many students can observe experiments at the same time, so it is more appropriate than wet practical when put into mind the large number of students with least facilities [21].

The generally-registered students predominate in the class, and they showed better perception about the program and its content, better understanding level and objectives achievement, this may reflect the usefulness and effectiveness of the program, since those generally registered students had obtained high score in SSC when compared to other type of registration.

The majority of the students (70 and 76 %) during 2013 and 2014, prefer computer simulated experiments over a live animal experiment, they showed that this program encourages their creativity to device an experiment and to test hypothesis, allow them to get real data to calculate important drug parameters, also they gain the spirit of group-working skills. Besides these, their understanding level is enhanced during the second academic year, and this may revealed that, this new program is accepted by the teachers and also they improve their knowledge about this program, their preparedness for lab sessions and their teaching method .A number of studies from various medical schools confirm these findings by documenting that computer assisted learning (CAL) successfully meets the learning objectives and improves overall study outcomes in pharmacology [11- 12][22, 26].

6. Conclusion and recommendations

6.1 Conclusion

This study was a pioneer for proofing substantial upgrade modification for an old program to cope an evolution of pharmacy education. It is clear from this study that CAL software is useful and effective educational tool to demonstrate the hard part of pharmacology practical (pharmacokinetic). It offers more accurate and consistent results, many experiments can be demonstrated in a short time, the use of animals is reduced and it is more flexible. So computer-simulations may serve as an alternative to the traditional live animal experiments.

6.2 Recommendations

Owing to the usefulness, effectiveness and feasibility of computer assisted learning, CAL should be integrated into the mainstream teaching either as a sole teaching tool, or as an adjunct to traditional teaching methods, in addition appropriate software programs need to be developed and modified to meet the local educational needs. Finally, there is a need to raise awareness among teachers about the advantages of this method of teaching.

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