

# Pharmacogenomics: Knowledge, Attitude and Practice among Future Doctors and Pharmacists-A Pilot Study

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## ABSTRACT

Rational application of genomics into practice would lead to safer chemotherapy through individualized medicine. The increasing trends of genetic discoveries coupled with increased adoption of pharmacogenomics in developed countries pose challenges to the presence and future healthcare professionals, not only in Malaysia. This research, aimed to assess knowledge, attitude and practice of final-year future healthcare professionals towards pharmacogenomics. A cross-sectional study was conducted by administering self-completed questionnaire (Reliability 0.82) to 247 participants, among which 68.4% responded. More than half were female medical students. The mean knowledge scores in percentage were  $57.57 \pm 20.2$  with a significant difference between the two groups ( $p = 0.002$ ). Positive attitude, but low practice were observed which differs between pharmacy and medical students,  $p < 0.05$ . Association between knowledge, attitude and practice, were investigated. The majority has demonstrated good knowledge and attitude towards pharmacogenomics, but with low practice. Studies are required to large sample and to examine barriers to adoption of pharmacogenomics.

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## INTRODUCTION

Adverse Drug Reactions (ADRs) is responsible for a significant number of hospital admissions ranging from 0.3% to 11% (Jeetu and Anusha, 2010; WHO, 2002; Islam *et al.*, 2014b). Pharmacogenomics (PG) is the study of how individual genetic makeup influences the response to a therapeutic intervention. The marked increase in the cases of ADRs involving drugs known to be metabolize, transport and or affected by genetic polymorphism and the fact that only about 60% of the patients respond adequately to the available drugs (Sadee, 2011), with or without ADRs called for an urgent implementation of PG into Practice. In addition, a lot of developments have been made in the field of PG over six decades, and its promising roles in ADRs, drugs safety and efficacy. However, the practical application of PG has been below expectation (Bannur *et al.*, 2014; de Denus *et al.*, 2013). In general, PG is not yet seen as an essential tool in drug safety, therefore not an important

component of routine medical practice. Several studies reported the knowledge and practice gap, lack of formal training and awareness toward PG among current Physicians and pharmacists (Yau *et al.*, 2015a; Bannur *et al.*, 2014; Stanek *et al.*, 2012; Johansen Taber and Press, 2014; Yau *et al.*, 2015b). In all cases, less attention has been paid to future Doctors and Pharmacists despite their reported knowledge gap on PG (Filipitsova *et al.*, 2015; Moen and Lamba, 2013). This research for the first time would assess Knowledge, attitude and practice (KAP) towards PG among Malaysian Medical and Pharmacy students for possible educational and concrete recommendations.

## MATERIALS and METHODS

A cross-sectional pilot study of final-year pharmacy and medical students was conducted using a valid and reliable survey instrument. The questionnaire and the informed consent were distributed to the participants via face to face at their respective schools. The questionnaire development, validation and psychometric analysis were explained and published in another article (Yau *et al.*, 2015c). The study was conducted at one of the four randomly selected Malaysia universities. This article reported only the PG part of the pilot the study.

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The population involved registered Final-year Medical and Pharmacy students sampled from faculty of Pharmacy and faculty of medicine of Universiti Sains Malaysia (USM). Only those interested to participate in the study (with informed consent) were included, while for exclusion criteria involved final year Medical or Pharmacy students that participated in the face validity and reliability studies, and or those decided not to participate by disagreeing in the consent form. The sample size was calculated with formula using these variables:  $Z =$  critical value (reliability coefficient) = 1.9,  $p =$  power = 80%,  $d =$  acceptable error (0.05%) and  $n =$  sample size, and  $n$  (sample size) was found to be 247 after adding 7% drop out (Charan, and Biswas, 2013). Therefore, this study was conducted on 247 final-year medical and pharmacy students to assess their level of KAP towards PG in drug safety. **Study Location:** This pilot study was conducted at USM: established as the second university in the country in 1969, USM was first known as Universiti Pulau Pinang. According to their website in 2015, there are approximately 30,000 students at its 17 Academic Schools on the main campus in the island of Penang; 6 Schools at the Engineering Campus in Nibong Tebal (approximately 50 km from the main campus); and 3 at the Health Campus in Kubang Kerian, Kelantan state of Malaysia (approximately 300km from the main campus). **Data Analysis:** The data were statistically analyzed using version 20.0 of the statistical Package for Social Sciences (IBM® SPSS®) for Windows. Descriptive statistics was used in representing the respondents' demographic information. The Pearson Chi-Square test was used for determining differences between categorical variables (Steve, 1998). The analysis for the continued variables was done using the independent/student t-test and one-way ANOVA with Post Hoc Tukey HSD (honestly significant difference) were used where the F statistic was significant and presented as a mean and standard deviation. For skewed data if 25% or more of the cells in the table have expected frequencies of less than 5, or if any expected frequency is less than 1, Fisher Exact test was preferred over the chi-square test (Field, 2009; Hinton, 2014; Pallant, 2013). The level of significant was considered at  $p < 0.05$ . **Ethical Approval:** The study has been reviewed by the Universiti Sultan Zainal Abidin (UniSZA) and UHREC (UniSZA Human Research Ethics Committee) and granted approval with reference number: UniSZA.N /1/628- (69) dated 21<sup>st</sup> July, 2014 (23<sup>rd</sup> Ramadhan 1435H) before commencement of the research. Permission to approach the students was officially obtained from the Deans of their respective faculties. All Participants were briefed on the researcher physically. All the participants were given and had signed the informed written consent form before participating in the study.

## RESULTS

A response rate of 68.4% ( $n = 169$ ) was recorded, six incomplete responses were excluded. The respondents' characteristics, the majority were medical students and female students accounting for 63.3% and 69.85% respectively, with a

significant ( $p = 0.001$  at  $\alpha = 0.05$ ) difference between the professions (Table 1). The mean age of the respondents was  $22.98 \pm 1.03$  years old, with pharmacy students ( $22.03 \pm 0.44$ ) younger than the medical students ( $23.53 \pm 0.85$ ) at  $p$ -value = 0.001. The majority (52.7%) of the respondents were Malay, followed by Chinese (37.9%), then Indian (7.7%), Bumiputra (1.2%) and others (0.6%) ( $p = 0.080$ ). "The association between demographic information and mean KAP scores among the respondents (Table 2)": There are statistically significant differences for knowledge scores gender, age and professions: Pharmacy students have higher mean knowledge score  $9.23 \pm 2.02$  against medical students  $7.38 \pm 3.00$  with  $t$  and  $p$ -value of 18.485 and  $< 0.005$  respectively. In terms of gender, females demonstrated higher mean knowledge score  $8.73 \pm 2.90$  compared to  $7.77 \pm 2.75$  for males students with  $p$ -value  $< 0.001$  and  $t = 4.150$ . For the age of the participants, 21 – 22 years old have higher mean knowledge scores of  $9.18 \pm 2.02$ , followed by 23 – 24 years old category with  $7.45 \pm 3.01$ , and 25-26 years old with  $7.14 \pm 3.15$ , with  $p = 0.008$ . The mean attitude score was same across the professions, gender and age of the respondents. The mean attitude score of Pharmacy students was ( $27.77 \pm 3.61$ ) and that of Medical students ( $26.22 \pm 3.33$ ) with no statistical significant  $F$  and  $p$ -values of 21.83 and 0.367 respectively. Females demonstrated high mean attitude score of  $26.40 \pm 3.71$  against  $25.57 \pm 3.44$  of males, with  $f$ -value = 1.9 and  $p = 0.170$ , which is statistically not significant at  $\alpha = 0.05$ . Across the age range of the respondents, 21-22 years old have more attitude towards PG ( $27.66 \pm 3.62$ , followed by 26-26 years old participants ( $26.15 \pm 4.11$ ) and then 23-24 years old ( $25.19 \pm 3.26$ ), with  $F$ -value = 9.476 and  $p < 0.001$ , which is statistically significant at alpha level of 0.05. The practice among the respondents varies with age and professions, but not with gender. The practice level of pharmacy students ( $16.45 \pm 4.29$ ) is higher than that of medical students ( $10.74 \pm 3.69$ ), with  $t$ -value = 83.196 and  $p < 0.001$  at 95% level of significant. The level of practice for males is  $12.59 \pm 5.10$  which is very similar to that of female ( $12.94 \pm 4.67$ ), with  $t$ -value = 0.192 and  $p$ -value = 0.662 at an alpha level of 0.05. The exposure of the participants towards PG, it can be seen that, all of the pharmacy students do ask information about ADRs at least one time in their program while 93.46% of medical students do (Table 3). Also 91.94% of pharmacy students have had attended lecture that was associated with effects of genetic variations on drug therapy during their study period, against 57.01% of medical students that ever had. In addition, about half (47.66%) of medical students have never related genetic variation to ADRs, while only 8.06% of pharmacy students that have never do. Moreover, more than two third (69.16%) of the medical students have never employed the idea of human genetic variation when trying to solve a given drug-related case study questions, while only about one-third (38.71%) of pharmacy students that have never had. In term of updating the PG knowledge, about half (45.79%) of medical students have never updated my knowledge on genetic information in relation to drugs, in contrast to only 19.35% of pharmacy students that have never updated their knowledge of PG.

**Table 1:** Demographics of Respondents.

Personal characteristics	Pharmacy Students (N = 62)		Medical Students (N = 107)		Total (N169)		p-value
	N	(36.69) %	N	63.31%	N	100 %	
Gender							
Male	11	6.5	40	23.7	51	30.2	X <sup>2</sup> = 21.35 p = 0.005*
Female	51	30.2	67	39.6	118	69.8	
Age group							
21-22	60	35.5	2	1.2	62	36.7	X <sup>2</sup> = 152.41 p<0.001*
23-24	1	0.6	92	54.4	93	55	
25-26	1	0.6	13	7.7	14	8.3	
Ethnicity							
Malay	37	21.9	52	30.8	89	52.7	X <sup>2</sup> = 7.178 p = 0.08
Chinese	24	14.2	40	23.7	64	37.9	
India	1	0.6	12	7.1	13	7.7	
Bumiputra	1	0.6	2	1.2	2	1.2	
Others	0	0.0	1	0.6	1	0.6	

Chi-square with Fischer Exact test statistic significant at 0.05 level+

**Table 2:** KAP Scores of Respondents Towards PG with Some Selected Demographic Variables.

Variables	Total Knowledge score		Total Attitude Score		Total Practice Score		F-Stats	P value	Mean±SD	F-Stat	p-Value
	N	Mean±SD	F-stats.	P value	Mean±SD	F-stats					
Discipline											
Pharmacy	62	9.33±2.02	18.49	0.005	27.77±3.61	21.83	0.367	16.45±4.29	83.196	<0.001	
Medics	107	7.38±3.00			26.22±3.33			10.74±3.69			
Age(Year)											
21-22	62	9.18±2.02	8.453	0.008*	27.66±3.62	9.476	<0.001	16.39±4.55	39.298	0.001*	
23-24	93	7.45±3.01			25.19±3.26			10.72±3.51			
24-26	14	7.14±3.15			26.15±4.11			11.14±4.11			
Gender											
Male	51	8.73±2.90	4.150	0.303	25.57±3.44	1.90	0.170	12.59±5.10	0.192	0.662	
Female	118	7.77±2.75			26.40±3.71			12.94±4.67			

Student t-test; \*One-way ANOVA

**Table 3:** Showing the Participants' Practice towards PG

Statement	Final Year Medical Students				
	Always	At least once in one month N (%)	At least once in a semester N (%)	At least once in the program N (%)	Never N (%)
1 I do ask information about ADRs	25 (23.36)	28 (26.17)	26(24.30)	21(19.63)	7 (6.54)
2 I related genetic variation to ADRs.	1 (0.93)	8 (7.48)	20(18.69)	27(25.23)	51(47.66)
3 I attended lecture that is associated with effects of genetic variations on drug therapy	4 (3.73)	8 (7.48)	23(21.50)	26(24.30)	46(42.99)
4 I employed the idea of human genetic variation when trying to solve a given drug-related case study questions	1 (0.93)	2 (1.87)	14(13.08)	16(14.95)	74(69.16)
5 I update my knowledge on genetic information in relation to drugs	1 (0.93)	7 (6.54)	21(19.63)	29(27.10)	49(45.79)
Final year Pharmacy students					
1 I do ask information about ADRs	38(61.29)	15 (24.19)	7 (11.29)	2 (3.23)	0 (0.0)
2 I related genetic variation to ADRs	7 (11.29)	20 (32.26)	18(29.03)	12(19.35)	5(8.06)
3 I attended lecture that is associated with effects of genetic variations on drug therapy	30(48.39)	4 (6.45)	14(22.58)	9 (14.52)	5(8.06)
4 I employed the idea of human genetic variation when trying to solve a given drug-related case study questions	10(16.13)	5 (8.06)	8 (12.90)	15(24.19)	24(38.71)
5 I update my knowledge on genetic information in relation to drugs	7 (11.29)	13(20.97)	9 (14.35)	21(33.87)	12(19.35)

“The illustration of the association between knowledge and practice, knowledge and attitudes, and attitude and practice of PG of drug safety among respondents (Table 4)”: There is strong statistic association between knowledge and attitude of PG among respondents as evident with p = 0.008 at 95% confident interval. Similarly, a statistical significant was observed between knowledge and practice (p = 0.018), and very same to the association between attitude and practice (p = 0.009) at 95% CI. One hundred and two respondents (60.36%) have mean knowledge score of more than 50%, with and were considered

average to above average considering that 50% is most commonly used pass mark in both medical and pharmacy schools. All of the respondents that have high knowledge scores also demonstrated excellent attitude (60.36%). For the attitude scores, 99.4% of the respondents showed good to the excellent attitude with mean attitude score of 50% to 100%. Out of 168 (94.40%) respondents, only 82 (48.81%) have shown average level of practice. More than half (51.20%) of the respondents have shown a low level of practice, with mean percentage scores of less than 50% despite the excellent attitude and good knowledge of PG.

**Table 4:** The Association Between KAP of the Respondents Using Chi-Square Test of Statistics.

Variable	Attitude Score			Practice Scores		
	Less positive N (%)	More positive N (%)	P value	Less Practice N (%)	More practice N (%)	p value
Knowledge Scores (<50%)	1 (2.0)	48 (98.0)	0.008	31 (63.3)	18 (36.7)	0.040
Scores (>50%)	0 (0.0)	120 (100.0)	0.290	55 (45.8)	65 (54.2)	
Attitude Less positive (<50%)	-	-	-	0 (0.0)	1 (100)	0.491
More positive (>50%)	-	-	-	86 (51.2)	82 (48.8)	

Chi-square test.

## DISCUSSION

Most of the respondents have shown high familiarity and understanding of PGs with excellent attitudes. The knowledge of PGs among the respondents varies with the course of study and Age, with statistically significant difference 0.005 and 0.008 respectively, similar findings were revealed with attitude. Despite the demonstrated good knowledge and positive attitude towards PG, only about one-third of the respondents felt comfortable to read PGs, with significant differences between the pharmacy and Medical students. The majority (91.94%) of pharmacy students were exposed to some aspect of PGs, while about half (42.99%) of medical students were not at exposed at all. Moreover, about eighty percent of pharmacy students update their PG knowledge at least once in the program, while only about half of medical students had never updated. Our findings revealed strong statistic association between knowledge and attitude of PG among respondents as evident with  $p = 0.008$  at 95% confident interval. Similarly, a statistical significant was observed between knowledge and practice ( $p = 0.018$ ), and very same to the association between attitude and practice ( $p = 0.009$ ) at 95% CI. One hundred and two respondents (60.36%) have mean knowledge score of more than 50%, with and were considered average to above average considering that 50% is most commonly used pass mark in both medical and pharmacy schools. All of the respondents that have high knowledge scores also demonstrated excellent attitude (60.36%). For the attitude scores, 99.4% of the respondents showed that PG is important, has benefits to patients and with mean attitude score of 50% to 100%. Out of 168 (94.40%) respondents, only 82 (48.81%) have shown average level of practice. More than half (51.20%) of the respondents have shown a low level of practice, with mean percentage scores of less than 50% despite the excellent attitude and good knowledge of PG.

Previous researches have demonstrated knowledge gap, good attitude and low practice towards PG among current Doctors and Pharmacists (Yau *et al.*, 2015; Bakhouché and Slanař, 2012; Benzeroual *et al.*, 2012; Bernhardt *et al.*, 2012; Bonter *et al.*, 2011; Stanek *et al.*, 2012; Johansen Taber and Press, 2014; Yau *et al.*, 2015b); Moreover, study conducted in Ukraine among Pharmacy students revealed similar results (Filipitsova *et al.*, 2015). However, study carried out in Malaysia, have discovered that current healthcare practitioners have good knowledge, attitude and consider PG to be a relevant field of clinical practice, but with low adoption (Bannur *et al.*, 2014), and other studies have

demonstrated healthcare students agree that PG is critical to patient care (Drozda *et al.*, 2013; Gurwitz *et al.*, 2005; McCullough *et al.*, 2011; Moen and Lamba, 2013). Although about half of the participants have never attended lectures related to PG, a good knowledge and attitude was reported, and this could be related to advancement in technology and social media or News feeds especially when the President Barack Obama of USA talked about precision Medical at the White House to the media (The White House, 2015). The significant differences observed in KAP towards PG, could be related to the fact that PG is more of pharmacy profession than of medicine profession. Moreover, the pharmacy profession has been mainly drug and patients oriented field while medicine profession has been mostly diagnostics, surgery and patients oriented.

The low level of practice observed among both pharmacy and medical students might be related to the fact that PG is a relatively new field of study and also PG is not yet seen as an essential tool in drug safety, therefore not an important component of routine medical practice. Furthermore, it might be due to the wrong assumption that less has been known about the clinical evidence and guidelines on PG, which could facilitate their mentors to expose them to it. More in depth prospective studies are advocated to produce highly professional and devoted health professionals (Islam *et al.*, 2014a; Salam *et al.* 2013a; Salam *et al.* 2013b; Salam *et al.* 2013c).

## CONCLUSION

Majority of participated Malaysian future Doctors & Pharmacists demonstrated good knowledge and attitude towards PG. Researches are required with large sample to investigate the barriers to the application of PG into practice. The curriculum should be revisited especially that of medical schools.

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