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Exploring the Attitudes, Beliefs and Perceptions of Undergraduate and Graduate Students in Bangladesh towards Precision Medicine and Pharmacogenomics Practice: A Qualitative Study

Nashrifa Israt Khanom[1,2], Saima Nur[1,3], Sheikh Sabrina Mustari[1,4], Omme Jamila[1,5], Abu Sa A Dat[1,6], Md Mehade Hasan[1,6], Mushfiquzzaman Mahim[1,7], Farhana Faiza Bristy[1,8], Nasrin Tamanna[1,9,11], Md. Moshrraf Hossen[1,10,11], Swapan Kumar Das[1,12], Tanvir Ahmed[1,13], Md. Ashrafuzzaman Sapon[11], Md. Shafiqul Islam[1,14], Md. Monirul Islam[1]*

[1]Division of Pharmacogenomics and Precision Medicine Research, BioIcon Academy, Dhaka, Bangladesh; [2]Dept. of Theoretical & Computational Chemistry, University of Dhaka, Bangladesh; [3]Dept. of Biotechnology & Genetic Engineering, University of Development Alternative, Bangladesh; [4]Dept. of Genetic Engineering & Biotechnology, East West University, Bangladesh; [5]Dept. of Biochemistry & Molecular Biology, Tejgaon College, National University, Bangladesh; [6]Dept. of Biochemistry & Molecular Biology, Siddheswari College, Bangladesh; [7]Science Group, Dhaka Residential Model College, Bangladesh; [8]Dept. of Pharmaceutical Sciences, North South University, Bangladesh; [9]Dept. of Applied Genomics, Kongju National University, South Korea; [10]Dept. of Biotechnology, Bangladesh Agricultural University, Bangladesh; [11]Department of Biotechnology & Genetic Engineering, Islamic University, Bangladesh; [12]Production Department, Eskayef Bangladesh Limited, Bangladesh; [13]Dept. of Emergency & Outdoor, Islami Bank Central Hospital, Dhaka, Bangladesh; and [14]Dept. of Physical Science, Independent University Bangladesh, Dhaka, Bangladesh.

*Correspondence: info@thebioicon.com (Dr. Md. Monirul Islam, Chief Mentor, Research Internship Program, BioIcon Academy, 64/1 (B1), Dolphin Goli, Kalabagan, Dhaka-1205, Bangladesh).

ABSTRACT

This paper aims to explore the perception of precision medicine (PM) and pharmacogenomics (PGx) among undergraduate and graduate students in Bangladesh. A cross-sectional survey was conducted among students from different universities across the country. The results of the survey showed that the majority of students had a positive attitude towards precision medicine and pharmacogenomics, perceiving it as a means to improve diagnosis and treatment accuracy. Furthermore, the majority of students also expressed a willingness to learn more about precision medicine and pharmacogenomics, suggesting that there is potential for these practices to be utilized in Bangladesh. Particularly in this study, 337 students from life science and relevant programs participated. The results of our study showed that 84% of graduate students and 74% of undergraduate students thought PM was a promising healthcare model. In addition, 39% of students are highly encouraged to pursue their post-graduation in the subject areas of PGx and PM in order to support patients. The majority (62%) thought that patient privacy was the ethical concern most closely related to pharmacogenomic testing, while 19% of respondents thought that data confidentiality was the key issue. The findings of this study provide insight into the potential of precision medicine and pharmacogenomics in Bangladesh, and suggest that further research into the attitudes of healthcare professionals should be conducted in order to take full advantage of the potential of these practices.

Keywords: Pharmacogenomics, Precision medicine, Ethical, Genetic testing, Legal, and Social implications.

INTRODUCTION:

Precision medicine is a novel approach to medical care that considers a person's genetic background, lifestyle, and environmental circumstances. It has gained popularity in recent years (Prajapat *et al.,* 2020; Cheung *et al.,* 2021). It is a strategy that is made probable by

molecular diagnostics and contradicts the conventional method of treating all patients with the same state with the same medication and dosage (Mahmutovic *et al.,* 2018). However, personalized medicine uses data about a parson' particular genes or proteins to repel, diagnose or treat disease (Saud & Syed, 2022). Noticeably, it has the ability to shape various aspects of clinical practice from preclusion and early diagnosis to treatment of disease (Moses III & Martin, 2001).

The study of numerous genes or gene patterns while simultaneously examining the structure and expression of large sets of genes is required by pharmacogenomics research, which calls for a greater use of techniques specialized for such studies (Dhawan & Padh, 2013). Pharmacogenomics (PGx) investigates how variations in the human genome affect how an individual reacts to drugs. In twenty centuries, the human genome project (HGP) reported that humans have approximately 20,500 genes and that 99.5 percent of the genes are analogous, whereas 0.5 percent of the genes have differences that are accountable for the specific groups and cause specific disease (Abou Diwan *et al.,* 2019; Relling & Evans, 2015). Now, the emphasis has shifted to using genetic techniques to identify markers of therapeutic response. The number of SNPs linked to medication reactions will increase at a never-before-seen rate during the coming years. The task is to sort through the pertinent SNPs and show the clinical validity and efficacy of these SNPs as Pharmacogenomics indicators (Norton, 2002). SNP is the most prevalent type of DNA sequence variation observed in the human genome (Robert & Pelletier, 2018). There are approximately 11 million SNPs in the human genome, with an average of one every 1,300 base pairs (Madsen *et al.,* 2007). A genomic investigation found that more than 99% of those assessed had at least one genotype linked to an increased likelihood of drug sensitivity (Reisberg *et al.,* 2019).

Adverse drug reactions (ADRs) are the fourth major cause of mortality in the United States, and it is thought that 2.74 million ADRs and 128,000 fatalities are caused each year by prescription medications (Shepherd *et al.,* 2012). As a result, one out of every five wounds or deaths among hospitalized patients are caused by ADRs, which have an annual cost of $136 billion greater than the combined expenditures of treating diabetes and cardiovascular disease (Shepherd *et al.,* 2012). The goal of PGx discoveries is to maximize the advantages of drugs while minimizing any negative effects and healthcare expenses (Uddin *et al*., 2022; Reisberg *et al.,* 2019).

According to the recent pharmacogenomics report, the Food and Drug Administration's (US-FDA) collection of medications that have been labeled before use currently includes more than 350 drugs (Koutsilieri *et al.,* 2020). These drugs are often referring to multiple pharmacogene, resulting in ~15% of all approved drugs having pharmacogenomics information on their labels (Relling & Evans, 2015; Kinsella & Monk, 2012). In order that pharmacogenomics and personalized medicine approach played a crucial role in preventing genetic disorder. However, the concern arises with genetic testing that must satisfy specific requirements with respect to their clinical utility, clinical validity, and analytical validity before use in clinical context (Burke, 2009; Issa & Keyserlingk, 2000). In addition, concerns about the security and privacy of a patient's pharmacogenomics data are also raised by personalized medicine approaches (Robertson, 2001).

The public's awareness of the molecular uses and characterization of PGx and PM during the COVID-19 outbreak in Bangladesh has increased because to the advancement of genome sequencing research (Khan *et al.,* 2021; Ahammad *et al.,* 2021; Akter, n.d.; Rahman *et al.,* 2021). Surprisingly, there are presently no local studies that address the public's knowledge of and perceptions of PM, PGx, and genetic testing, as well as the coverage of PGx and PM education at the undergraduate and graduate level. Information is scarce from other regions of the world such as Bangladesh, but few studies are available from Asia (Cheung *et al.,* 2021; Saud & Syed, 2022). The majority of the reported initiatives are concentrated in the USA and Europe (Swen *et al.,* 2018; Volpi *et al.,* 2018).

On the other hand, knowledge and awareness of these are crucial since they could be used as a guide when developing national policy and curriculum. This research article explores the attitudes, beliefs, and perceptions of undergraduate and graduate students in Bangladesh towards precision medicine and pharmacogenomics practice. A qualitative approach was emp-

loyed in order to gain insight into the participants' perspectives. The aim of the study was to gain insight into the views and opinions of students in Bangladesh towards precision medicine and pharmacogenomics practice, and to provide a foundation for future research on the topic. This study is significant as it provides valuable insight on the views of the student population towards precision medicine and pharmacogenomics practice, which in turn can be used to provide a better understanding of the general population's perspective, can also be used to inform future research on the topic, as well as provide a platform for further discussion on the implications of precision medicine and pharmacogenomics practice (Bienfait *et al.,* 2022; Cecchin *et al.,* 2020).

METHODOLOGY:

Study Design

This Cross-sectional research was carried out over the course of four months, from July 1 to October 25, 2022. The purpose of this population-based cross-sectional study was to examine the understanding, attitudes, and application of pharmacogenomics and personalized medicine. A combination of qualitative and quantitative data was used to conduct the study. Current students from a number of Bangladeshi universities qualified as participants.

The total number of 337 graduate and undergraduate students contributing to the survey were from life science backgrounds, as well as those with backgrounds in various fields outside of molecular life science and health science. They could communicate in English, ranged in age from 18 to 60, and were citizens of Bangladesh with various socio-economic backgrounds and educational institutions. On the basis of a question from the Mahmutovic *et al.* study, an online questionnaire was made and updated and given to participants to answer in order to learn how undergrads studying molecular life sciences and health felt about PGx and PM (Mahmutovic *et al.,* 2018). Each and every participant was fully informed of the study's purpose prior to the data collection.

Sampling and Data collection

The 39 questions in the survey were separated into three groups as follows: Part 1 consists of demographic information, including ages, gender, and educational attainment. Part-2 consisted of 15 to 20 questions about pharmacogenomics and personalized medicine and was concerned with the knowledge and awareness related questionnaire. Part-3 of the survey included five to seven multiple-choice questions about respondents' opinions about pharmacogenomics and the practice of personalized medicine. Key definition of personalized medicine and pharmacogenomics/ pharmacogenetics tests were provided to the participants in the instructions section of the survey. There were yes/no/I don't know (not sure) questions in the survey. The survey also included multiple-choice questions and a Likert scale for rating of agreement with various statements (i.e., agree, disagree, no opinion, neutral). An introductory cover page was attached describing the purpose and objectives of the study and inviting the students to participate in it.

Statistical analysis

All categorical variables were presented as frequencies and percentages, including participant demographics, professional information, and responses to questions concerning participants' opinions of PGx and PM. Data analysis was conducted using Microsoft excel and SPSS software. In order to calculate proportions, descriptive statistics were utilized. The understanding, perception, and practice of pharmacogenomics and precision medicine were tested using the Chi-square test to determine the relationship between demographic factors and responses.

The p values were determined via chi-square analysis. All statistical tests were performed with a significance threshold of 5%, and the odd ratio (OR) and the correspondence 95% confidence intervals (CI) were computed.

RESULTS:

Participants' demographics

Table 1 summarizes the student's demographic information as well as their employment history. The current study included 337 students who consented to fill out the questionnaire. Most of the students were aged between 19-26 years. Among the 337 participants, 257 were undergraduates and 80 were graduates. Among them, 180 (53%) were the female and 157 (47%) were male.

Table 1: Student's demographic characteristics and professional information.

	Total	Undergraduate student	Graduate student	*MLS & HS	**Non-MLS & HS	P value
Gander						
Male	157	111	46	131	26	0.025
Female	180	146	34	166	14	
Age						
<19	7	7	0	3	4	P<1
19-26	262	234	27	234	28	
27-40	67	16	51	60	7	
41-50	2	0	2	1	1	
51-60	0	0	0	0	0	
>60	0	0	0	0	0	
Number of family member						
<4	61	40	21	50	11	0.094
4-6	227	177	50	200	27	
6-10	31	27	4	29	2	
>10	18	13	5	18	0	
Family income						
<25000 TK	89	72	17	81	8	0.546
25000-50000 TK	147	107	40	132	15	
50000-100000 TK	82	63	19	66	16	
>100000 TK	19	15	4	18	1	
Level of education						
HSC	26	26	0	23	3	P<1
BSc	231	231	0	207	27	
MSc	77	0	77	67	10	
MPhil	0	0	0	0	0	
PhD	3	0	3	3	0	

*__MLS & HS__= Molecular Life Science & Health Science**,** this area includes Biochemistry & Molecular Biology, Genetics and Biotechnology, Medicine, Health Studies, Microbiology, Pharmaceutical Sciences. **__Non-MLS & HS__= Non- Molecular Life Science & Health Science**,** it includes Computer Science, Electrical and Electronic Engineering, Journalism, Anthropology, BBA.

Students' attitudes towards pharmacogenetics practice and personalized medicine

Table 2 shows the various questions and responses used to assess pharmacogenomics knowledge. Participants' replies to almost all survey questions regarding their awareness and attitudes towards genetic testing, pharmacogenomics, and personalized medicine. A particular drug did not work for roughly 40% of participants from the fields of medicine, pharmacy, health studies, genetics, and bioengineering, while 31% of these students had an adverse drug reaction.

Table 2: Students' attitudes towards pharmacogenomics practice and personalized medicine.

	Total	Undergraduate student	Graduate student	*MLS & HS	Non-MLS & HS	P value
Do you know some genetic disease transmitted by inheritance from one generation to another?						
Yes	284	219	65	259	25	0.678
No	32	22	10	23	9	
Don't know	10	7	3	9	1	
Not sure	11	9	2	6	5	
Do you think; Genetic Counselor can help you to refer to the right doctor about genetic disease related issues?						

Yes	284	212	72	254	30	0.175
No	13	9	4	11	2	
Don't know	18	16	2	16	2	
Not sure	22	20	2	16	6	
Do you know; action of drugs can vary person to person. For this reason, personalized medicine is very important.						
Yes	303	230	73	268	35	0.024
No	12	6	6	12	0	
Don't know	9	8	1	9	0	
Not sure	13	13	0	8	5	
Do you know about 'companion diagnostics'?						
Yes	115	84	31	110	5	0.078
No	161	127	34	136	25	
Don't know	33	21	12	29	4	
Not sure	28	25	3	22	6	
Have you heard about personal genome testing companies?						
Yes	152	104	48	136	13	0.009
No	136	116	20	120	22	
Don't know	30	22	8	24	4	
Not sure	19	15	4	18	1	
Have you ever had an adverse drug reaction?						
Yes	106	73	33	95	11	0.155
No	167	131	36	147	20	
Don't know	44	36	8	38	6	
I have never taken any medication	20	17	3	17	3	
Have you ever found that a particular drug not work for you?						
Yes	137	103	34	126	11	0.697
No	123	92	31	113	10	
Don't know	56	44	12	42	14	
I have never taken any medication	21	18	3	16	5	
To what extend do you think that genes influence your health?						
Completely	127	81	46	120	7	0.0001
Moderately	129	110	19	113	16	
Not at all	19	18	1	14	5	
Don't know	62	48	14	50	12	
Would you consider heaving a genetic test done to find out what illness you might develop the future?						
Yes	248	183	65	224	24	
No	43	33	10	35	8	0.080
Don't know	46	41	5	38	8	
Do you agree that personalized medicine represents a new and promising healthcare model?						
Yes	262	195	67	239	23	0.334
No	17	14	3	12	5	
Don't know	58	48	10	46	12	
Would you consider contacting a personal genome testing company and ordering a pharmacogenomic test for yourself?						
Yes	157	106	51	150	7	0.0002
No	68	50	18	56	12	

Not sure	77	70	7	62	15	
Don't know	35	31	4	29	6	
If a pharmacogenomics test revealed that a prescribed drug would either be ineffective or cause severe side effect, would you take the drug anyway?						
Take the drug anyway	19	16	3	14	5	0.108
Accept the test result, and not take the drug	143	100	43	133	10	
Accept the test results and take the drug only if the disease might be life-threatening	127	104	23	110	17	
Not sure	48	37	11	40	8	
To what extent do you think that genes influence your health?						
Completely	134	87	47	126	8	0.001
Moderately	123	104	19	106	17	
Not at all	18	14	4	14	4	
Don't know	62	52	10	51	11	
If you know your genetic tendency to develop a disease, would you be ready to make necessary changes in your lifestyle, to reduce disease risk?						
Yes	289	217	72	259	30	0.463
No	13	12	1	9	4	
Not sure	18	15	3	15	3	
Don't know	17	13	4	14	3	
Do you agree that personalized medicine represents a new and promising healthcare model?						
Yes	263	195	68	240	22	0.179
No	18	14	4	12	6	
Don't know	56	48	8	44	12	

*MLS & HS= Molecular Life Science and Health Science.

Significance of pharmacogenomics education

The findings in **Table 3** and **Table 4** show that medical, pharmacy and heath studies students have similar perspectives on their study curriculum and future plans for PGx. Overall, 84% of graduates and 76% of undergraduates believed that PM is promising healthcare model. The majority of undergraduates, 82% (212/257) agreed that PGx should be relevant to their curriculum, and 42% (108/257) thought their curriculum was well-designed for PGx.

The curriculum wasn't well-designed for PGx, according to 31% of respondents (81/-257) and 39% (100/257) want to continue their postgraduate education (masters, PhD, specializations) in the field of personalized medicine. According to our findings, students' opinions toward their course of study and their desire to pursue postgraduate research in the field of personalized medicine are both highly influenced by the subject of study. When compare to other responders, it seems that more Biochemistry and Molecular biology students would like to pursue post-graduate study in this area.

Additionally, our findings imply that students are more likely to pursue postgraduate studies in the field of personalized medicine if they consider their degree program is well-designed to give them a sufficient understanding of PG. In their future practices, more than 70% of undergraduates and recent graduates feel that they should be able to recognize patients who might benefit from genetic testing, as well as be able to address patients' inquiries about PG and PM and recognize medications that call for pharmacogenomics testing before being administered to the patient.

Table 3: Students opinion regarding the study curriculum and their future plans in pharmacogenomics.

	Total	Undergraduate student	Graduate student	*MLS & HS	Non-MLS & HS	P value
Pharmacogenomics should be an important part of my study curriculum.						
Agree	283	212	71	264	19	0.029
Disagree	1	1	0	0	1	
Neutral	39	36	3	24	15	
No opinion	14	8	6	9	5	
Do you think that the curriculum of your study program is well designed for understanding pharmacogenomics?						
Yes	158	108	50	148	10	0.010
No	100	81	19	82	18	
Don't know	36	32	4	29	7	
Not sure	43	36	7	38	5	
Would you like to continue your postgraduate education (Masters, PhD, specialization) in the field of personalized medicine?						
Yes	150	100	50	148	2	0.001
	102	83	19	89	13	
Don’t know	40	36	4	30	10	
No	45	38	7	30	15	

*MLS & HS= Molecular Life Science & Health Science.

Table 4: Students attitudes towards continued education in pharmacogenomics.

	Total	Undergraduate student	Graduate student	*MLS & HS	Non-MLS & HS	P value
In my future practice, I should be able to identify patients that could benefit from genetic testing.						
Agree	251	191	60	231	20	0.0002
Disagree	5	0	5	5	0	
Neutral	41	36	5	29	12	
No opinion	40	30	10	32	8	
In my future practice, I should be able to answer patient’s questions regarding pharmacogenomics and personalized medicine.						
Agree	250	189	61	228	22	0.862
Disagree	6	5	1	3	3	
Neutral	46	37	9	40	6	
No opinion	35	26	9	26	9	
In my future practice, I should be able to identify drugs that would require pharmacogenomics testing prior to their administration to the patient.						
Agree	228	170	58	212	16	0.559
Disagree	16	12	4	14	2	
Neutral	48	37	11	38	10	
No opinion	45	38	7	33	12	

*MLS & HS= Molecular Life Science & Health Science.

Students’ awareness about the ethical, legal and social implications

According to our findings, 54% of all the students who took part in the study are aware of the various ethical issues surrounding genetic testing. Most of the responders (62%) believe that patient privacy was the ethical concern most closely associated to pharmacogenetic testing, whereas just 19% thought that data confidentiallity was the main problem. Other ethical issues, such as racial issues, non-incidental findings and stigma, were selected by 5%, 7% and 5% of students, respectively. Our findings indicate that 74% of students are concerned that PG test results might be disclosed to unauthorized parties. This concern was echoed by students in all faculties. Furthermore, 53% of students trust that revealing an unfavorable test result would be a disadvantage at work or in job-searching and they are also worried that they would feel “helpless” or “pessimisti”.

Table 5: Students awareness and opinion regarding the ethical, legal and social implication.

	Total	Undergraduate student	Graduate student	*MLS & HS	Non-MLS & HS	P value
Are you aware of different ethical aspect of genetic testing?						
Yes	182	135	47	167	15	0.015
No	84	69	15	70	14	
Not sure	36	32	4	29	7	
Don't know	35	21	14	31	4	
What ethical issues do you believe might be related to genetic or pharmacogenomics testing?						
Patient privacy	210	147	63	186	24	0.001
Racial issues	16	16	0	14	2	
Non-incidental findings	23	21	2	22	1	
Data confidentiality	64	49	15	56	8	
Stigma	18	18	0	15	3	
Other	6	6	0	4	2	
Are you worried about the possibility that the result of a pharmacogenomics test may be passed to unauthorized persons?						
Very worried	135	86	49	124	11	0.0001
Not worried	29	25	4	26	3	
Slightly worried	113	98	15	99	14	
I don't know	60	48	12	48	12	
In case of any unfavorable test result should be disclosed, do you believe that you would be disadvantages at work or job seeking?						
Yes	177	123	54	161	16	0.007
No	51	41	10	44	7	
No opinion	109	93	16	92	17	
In case of unfavorable test results, do you believe that you would feel "helpless" or "pessimistic"?						
Yes	178	126	52	158	20	0.003
No	73	54	19	65	8	
No opinion	86	77	9	74	12	
In case of an unfavorable test result, do you believe that you would feel "different" or "inadequate"?						
Yes	182	129	53	164	18	0.014
No	64	49	15	56	8	
No opinion	91	79	12	77	14	

*MLS & HS= Molecular Life Science & Health Science.

Table 6: Students awareness toward diagnosis of diseases and treatment option.

	Total	Undergraduate student	Graduate student	*MLS & HS	Non-MLS & HS	P value
Have you been diagnosed with any of the following diseases? You can choose multiple options.						
Cardiovascular (heart problems, athero-sclerosis, hypertension)	19	16	3	17	2	0.700
Psychiatry (depression, anxiety)	48	38	10	41	7	
Oncology (any type of cancer)	4	3	1	4	0	

Metabolic diseases (diabetes, metabolic syndrome)	23	20	3	22	1	
No	232	172	60	203	29	
Other	11	8	3	10	1	
Did you ever take a drug that is used to treat any of the following diseases? You can choose multiple options.						
Cardiovascular	14	13	1	14	0	0.160
Psychiatry	16	14	2	12	4	
Metabolic disease (Diabetes)	13	11	2	12	1	
Oncology	2	1	1	2	0	
I do not take drugs	266	195	71	235	31	
Other	26	23	3	22	4	
How much money are you willing to spend to examine the effectiveness of a specific drug in your body using a pharmacogenomic test?						
<5000 TK	160	110	50	145	15	0.027
5000-8000 TK	33	25	8	27	6	
8000-12000 TK	11	9	2	11	0	
>12000 TK	10	8	2	10	0	
Not sure	123	105	18	104	19	
Do you think, cost of precision medicine & Pharmacogenomics testing will be reduced in the near future like general diagnostics screening						
Yes	176	137	39	155	21	0.018
No	41	24	17	41	0	
Don't know	65	49	16	56	9	
Not sure	55	47	8	45	10	
Do you believe that in the future pressure may be exerted on patient to agree to perform a pharmacogenomics test?						
Yes	201	141	60	182	19	0.004
No	51	42	9	43	8	
No opinion	85	74	11	72	13	

*MLS & HS= Molecular Life Science & Health Science.

DISCUSSION:

One of our study's unique features is that it is the first study to examine graduate and undergraduate students from multiple different universities in Bangladesh about their knowledge of and attitudes on the part of pharmacogenomics and precision medicine. Our findings indicated that molecular life science and health students are typically aware of pharmacogenomics and have a basic understanding of personal genome testing companies. Students in non-molecular life sciences, as opposed to, appear to be less aware of these companies and less interested in using PM as a novel healthcare model than students in molecular life science. Here, we also demonstrated that the majority of graduate and undergraduate students think that PGx should play a significant role in their academic program and that higher than 50% of these students would like to pursue post-graduate studies in the area of customized medicine (Guy *et al.,* 2020; Nickola *et al.,* 2012). Most of the faculties may not have PGx-related courses included in their curriculum, as just one-third of all students who took part in our survey believed that their study curriculum is properly prepared to understand PGx. In a recent survey, it was discovered that the vast majority of the students in California's eight pharmacy schools were knowledgeable about pharmacogenomics, concurred that pharmacogenomics is significant for future pharmacists, and expressed interest in following a PGx residency, fellowship, or career. However, Latif (Latif & McKay, 2005) noted that only a basic understanding of PGx was being taught in the USA by 2005, emphasizing the requirement to include PGx in the pharmacy curriculum. Direct-to-consumer genetic testing (DTC-GT) companies have risen in recent years, offering

substitute information on genetic testing (GT) and personalized medicine (PM), while highlighting the remarkable benefits of genomic medicine for particular healthcare management. Although students' knowledge about genetic testing, precision medicine, and pharmacogenomics may be largely based on information and advertisements from the direct-to-consumer genetic testing (DTCGT) industry, which may contain inaccuracies and overstatements, rather than more accurate information acquired from their academic curriculum (Zayts & Luo, 2017; Rafiq *et al.,* 2015). As seen by the low number of students expecting to continue their postgraduate studies in PM, undergraduates find it challenging to acquire a great interest in future exploration of such topics without a thorough knowledge of PM, PGx, and GT. So, by focusing more attentions and resources on academic study and profession development in PM and PGx, there is a high chance that genomic medicine will be promoted thanks to a strong base of knowledge and widespread support. According to our finding, 76% of undergraduate students believed PM to be a promising healthcare model, and 54% said they would think about getting a genetic test. Initial instruction in genetics and genomics starts in high school in Bangladesh, but it does so in kindergarten through primary school in other western nations like the United States. Kindergarten students in the USA are exposed to the fundamental ideas of genetic inheritance through the application of relatable cases, such as cats giving birth to kittens with distinct markings, to show how features can vary. Due to this, the educational system in the USA provided evidence that genomic education could be implemented and a solid foundation in genetics could be built at an early learning stage (Campion *et al.,* 2019; Learning & Curriculum, 1964). The general issue of inadequate education and talent progress in PM and PGx may be exaggerated due to the slow local progress of PM and PGx until recent years. Bangladesh's practice of PGX is still in its infancy compared to other countries.

Negative attitude toward genetic testing results due to ethical, legal and social implications

It has been established that students who took part in our survey are aware of the various ethical issues surrounding genetic testing. Interestingly, our findings showed that majority of the students seem to be concerned about the patient's privacy and data confidentiality. More than 40% of Bangladeshi undergraduates demonstrated a negative outlook in the event of a poor GT result, including feelings of "helplessness or pessimism," "different or inadequate," and "disadvantaged" job seeking, with students older than the age of 19 more inclined to agree with this statement (Hunt *et al.,* 2003). The propensity of pessimism among local undergraduates may be explained by the fact that Asians are typically more pessimistic than other ethnic groups. According to a research by Chang *et al.* Asians Americans are generally more pessimistic than caucasian Americans (Chang, 1996). Similarly, results were found in another study by Lee *et al.* which showed that Caucasia American students and Chinese American students both had higher levels of pessimism than mainland Chinese students and Chinese American students, respectively (Brookfield, 1984). Although the tendency of pessimism about poor GT results id particularly pronounced and widespread among Bangladeshi undergraduates, the highlighting causes of pessimism as well as potential solutions to reverse the trend should be thought about and carefully addressed. Surprisingly, our study showed that nearly half of all respondents were concerned that PGx test results would be disclosed to unauthorized parties. Students who are concerned that PGx testing would show they have extra risk factors for other disease would similarly feel "different" and "inadequate" in the event of negative test findings. Otherwise, numerous participants claimed that they wouldn't feel "helpless," "pessimistic," "different," or "inadequate." This meant that every person would respond to the genetic test results differently. Patients are thought to need sufficient counseling in order to understand the significance of the test results in relation to their particular health (Winkler & Wiemann, 2016; Howard & Borry, 2013).

One of the most significant strengths of our study was the recruitment of a diverse group of health science students from across the nation in three different settings (medicine, pharmacy, and health studies), as well as genetic students and students from other non-molecular life science and non-health science departments. Our findings were further strengthened by the comparison of the thoughts and attitudes of students who had taken the PGx course and those who had not. Our

survey explored student's interest in the learning more about PGx.

CONCLUSION:

This study provides evidence of how undergraduate and graduate students in Bangladesh perceive PM and PGx. Our findings show that, with the exception of graduate students from Bangladesh, the majority of undergraduate students who participated in our survey are enrolled in life science programs. However, they believe that PM is a promising new healthcare model but their knowledge, understanding regarding the technologies, applications and implications of the field are very poor. The vast majority of students studying molecular life and health science made it apparent that they wanted to learn more about this area of study. This suggests that study programs in the field of PG should be developed in order to offer future healthcare professionals with the knowledge, abilities, and attitude necessary to conduct personalized medicine. Thus, it would be vital to improve coordination between universities, healthcare organizations, and governing bodies in order to include more training and continuing education themes about pharmacogenomics and personalized medicine. In order to ensure the widespread clinical adoption of personalized medicine, it is crucial to expand the pharmacogenomic path of biological education.

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CONFLICTS OF INTEREST:

There is no conflict of interest in the publication of this work.

REFERENCES:

1) Abou Diwan, E., Zeitoun, R. I., & Khoueiry Zgheib, N. (2019). Implementation and obstacles of pharmacogenetics in clinical practice: An international survey. *British J. of Clinical Pharmacology*, **85**(9), 2076–2088. https://doi.org/10.1111/bcp.13999
2) Ahammad, I., Hossain, Chowdhury, Z. M., & Salimullah, M. (2021). Wave-wise comparative genomic study for revealing the complete scenario and dynamic nature of COVID-19 pandemic in Bangladesh. *PLoS ONE*, **16**(9 September), 1-21. https://doi.org/10.1371/journal.pone.0258019
3) Akter, S. (n.d.). Genome sequencing and genetic characterization of 17 SARS-CoV-2 viruses and spike protein analyses of isolates from Bangladeshi patients. *Research Square*, 1-20.
4) Brookfield, S. (1984). from the SAGE Social Science Collections. All Rights. *Hispanic J. of Behavioral Sciences*, **9**(2), 183-205.
5) Burke, W. (2009). Clinical validity and clinical utility of genetic tests. *Current Protocols in Human Genetics*, *SUPPL.* **60**, 1-7. https://doi.org/10.1002/0471142905.hg0915s60
6) Bienfait, K, Aparna Chhibber, and Charles Paulding. (2022). Current challenges and opportunities for pharmacogenomics: perspective of the Industry Pharmacogenomics Working Group (I-PWG). *Human Genetics*, **141**, P1165-1173
7) Cecchin, E., and Stocco G. (2020). Pharmacogenomics and Personalized Medicine. *Genes*, **11**(6), 679. https://doi.org/10.3390/genes11060679
8) Campion, M. A., Prows, C. A., & Dasgupta, S. (2019). Genomic education for the next generation of health-care providers. *Genetics in Medicine*, **21**(11), 2422-2430. https://doi.org/10.1038/s41436-019-0548-4
9) Chang, E. C. (1996). A Test of a General Negativity Hypothesis, **21**(5), 819-822.
10) Cheung, N. Y. C., Mak, C. C. Y., & Chung, B. H. Y. (2021). Perception of personalized medicine, pharmacogenomics, and genetic testing among undergraduates in Hong Kong. *Human Genomics*, **15**(1), 1-12. https://doi.org/10.1186/s40246-021-00353-0
11) Dhawan, D., & Padh, H. (2013). Pharmacogenomics and personalized medicine for cancer. In *Omics for Personalized Medicine*. https://doi.org/10.1007/978-81-322-1184-6_11
12) Guy, J. W., Patel, I., & Oestreich, J. H. (2020). Clinical Application and Educational Training for Pharmacogenomics. *Pharmacy*, **8**(3), 163. https://doi.org/10.3390/pharmacy8030163
13) Howard, H. C., & Borry, P. (2013). Survey of European clinical geneticists on awareness, experiences and attitudes towards direct-to-con-

sumer genetic testing. *Genome Medicine*, **5**(5), 0-31. https://doi.org/10.1186/gm449

14) Hunt, S., Wisocki, P., & Yanko, J. (2003). Worry and use of coping strategies among older and younger adults. *J. of Anxiety Disorders*, **17**(5), 547-560. https://doi.org/10.1016/S0887-6185(02)00229-3

15) Issa, A. M., & Keyserlingk, E. W. (2000). Apolipoprotein E genotyping for pharmacogenetic purposes in Alzheimer's disease: Emerging ethical issues. *Canad. J. of Psyc.*, **45**(10), 917-922. https://doi.org/10.1177/070674370004501007

16) Khan, S., Hasan, S., & Hossain, M. (2021). Whole genome mapping and identification of single nucleotide polymorphisms of four Bangladeshi individuals and their functional significance. *BMC Research Notes*, **14**(1), 1-6. https://doi.org/10.1186/s13104-021-05514-x

17) Kinsella, M., & Monk, C. (2012). NIH Public Access. **23**(1), 1-7. https://doi.org/10.1038/tpj.2013.33

18) Koutsilieri, S., Tzioufa, F., Sismanoglou, D. C., & Patrinos, G. P. (2020). Unveiling the guidance heterogeneity for genome-informed drug treatment interventions among regulatory bodies and research consortia. *Pharm. Res.*, **153**, 104590. https://doi.org/10.1016/j.phrs.2019.104590

19) Latif, D. A., & McKay, A. B. (2005). Pharmacogenetics and pharmacogenomics instruction in colleges and schools of pharmacy in the United States. *American J. of Pharmaceutical Education*, **69**(2), 152-156. https://doi.org/10.5688/aj690223

20) Learning, K., & Curriculum, A. (1964). Science Education. *Physics Today*, **17**(11), 94. https://doi.org/10.1063/1.3051259

21) Madsen, B. E., Villesen, P., & Wiuf, C. (2007). A periodic pattern of SNPs in the human genome. *Genome Research*, **17**(10), 1414-1419. https://doi.org/10.1101/gr.6223207

22) Mahmutovic, L., Akcesme, B., & Feeney, O., (2018). Perceptions of students in health and molecular life sciences regarding pharmacogenomics and personalized medicine. *Human Genomics*, **12**(1), 1-15. https://doi.org/10.1186/s40246-018-0182-2

23) Moses III, H., & Martin, J. B. (2001). Academic Relationships With Industry. *Jama*, **285**(7), 933. https://doi.org/10.1001/jama.285.7.933

24) Nickola, T. J., Green, J. S., Harralson, A. F., & Obrien, T. J. (2012). The current and future state of pharmacogenomics medical education in the USA. *Pharmacogenomics*, **13**(12), 1419-1425. https://doi.org/10.2217/pgs.12.113

25) Norton, R. (2002). Pharmacogenomics: The Search for Individualized Therapies. In *Drug Discovery Today,* **7**(21). https://doi.org/10.1016/s1359-6446(02)02401-7

26) Prajapat, M., Shekhar, N., & Sarma, P. (2020). Virtual screening and molecular dynamics study of approved drugs as inhibitors of spike protein S1 domain and ACE2 interaction in SARS-CoV-2. *J. of Molecular Graphics and Modelling*, **101**, 107716. https://doi.org/10.1016/j.jmgm.2020.107716

27) Rafiq, M., Ianuale, C., Ricciardi, W., & Boccia, S. (2015). Direct-to-consumer genetic testing: A systematic review of european guidelines, recommendations, and position statements. *Genetic Testing and Molecular Biomarkers*, **19**(10), 535-547. https://doi.org/10.1089/gtmb.2015.0051

28) Rahman, M. M., Kader, S. B., & Rizvi, S. M. S. (2021). Molecular characterization of SARS-CoV-2 from Bangladesh: implications in genetic diversity, possible origin of the virus, and functional significance of the mutations. *Heliyon*, **7**(8), e07866. https://doi.org/10.1016/j.heliyon.2021.e07866

29) Reisberg, S., Krebs, K., & Lepamets, M. (2019). Translating genotype data of 44,000 biobank participants into clinical pharmacogenetic recommendations: challenges and solutions. *Genetics in Medicine*, **21**(6), 1345-1354. https://doi.org/10.1038/s41436-018-0337-5

30) Relling, M. V., & Evans, W. E. (2015). Pharmacogenomics in the clinic. *Nature*, **526**(7573), 343-350. https://doi.org/10.1038/nature15817

31) Robert, F., & Pelletier, J. (2018). Exploring the Impact of Single-Nucleotide Polymorphisms on Translation. *Frontiers in Genetics*, **9**(October), 1-11. https://doi.org/10.3389/fgene.2018.00507

32) Robertson, J. A. (2001). Consent and privacy in pharmacogenetic testing. *Nature Genetics*, **28**(3), 207-209. https://doi.org/10.1038/90032

33) Saud, K., & Syed, W. (2022). Knowledge, Attitude and Perception of University of Ibadan Pharmacy Students on Veterinary Pharmacy Practice. *Nigerian Journal of Pharmacy*, **56**(1). https://doi.org/10.51412/psnnjp.2022.17

34) Shepherd, G., Mohorn, P., Yacoub, K., & May, D. W. (2012). Décès suite aux effets indésirables rapportés aux États Unis en utilisant les statistiques de l'état civil entre 1999-2006. *Annals of Pharmacotherapy*, **46**(2), 169-175. https://doi.org/10.1345/aph.1P592

35) Swen, J. J., Nijenhuis, M., & Guchelaar, H. J. (2018). Pharmacogenetic Information in Clinical Guidelines: The European Perspective. *Clinical Pharmacology and Therapeutics*, **103**(5), 795-801. https://doi.org/10.1002/cpt.1049

36) Uddin ME, Sultana S, Imran MAS, and Mahmud S. (2022). Non-biotech student's per-ception of biotechnology and its applications in a university theology faculty student's: a brief survey study. *Int. J. Agric. Vet. Sci*., **4**(6), 116-129. https://doi.org/10.34104/ijavs.022.01160129

37) Volpi, S., Bult, C. J., & Relling, M. V. (2018). Research Directions in the Clinical Implementation of Pharmacogenomics: An Overview of US Programs and Projects. *Clinical Pharmacology and Therapeutics*, **103**(5), 778-786. https://doi.org/10.1002/cpt.1048

38) Winkler, E. C., & Wiemann, S. (2016). Findings made in gene panel to whole genome sequencing: data, knowledge, ethics–and consequences? *Expert Review of Molecular Diagnostics*, **16**(12), 1259-1270. https://doi.org/10.1080/14737159.2016.1212662

39) Zayts, O., & Luo, Z. (2017). Commodification and marketisation of genetic testing through online direct-to-consumer platforms in Hong Kong. *Discourse and Communication*, **11**(6), 630-647. https://doi.org/10.1177/1750481317726926

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