EAHRC
EAST AFRICAN HEALTH RESEARCH COMMISSION
Research for Health and Prosperity

ORIGINAL ARTICLE

# Knowledge and Perception Towards Pharmacogenomics Among Healthcare Students in Tanzania

Mohamed Zahir Alimohamed[a,b,c]*, Bondo Sizwe Aidan[d], Ummuabiha Karim Manji[b,e], Sabina Mugusi[d]

[a]Department of Biochemistry and Molecular Biology, School of Biomedical Sciences, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania; [b]Tanzania Human Genetics Organization, Dar es Salaam, Tanzania; [c]Department of Genetics, University Medical Center Groningen, Groningen, Netherlands; [d]Department of Clinical Pharmacology, School of Biomedical Sciences, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania; [e]Faculty of Biology, Ludwig-Maximilians Universität, Munich, Germany.

Correspondence to Mohamed Zahir Alimohamed (mzahir89@gmail.com)

## ABSTRACT

**Background:** Pharmacogenomics, a critical component of precision medicine, examines how genetic variations affect individual responses to medications. This field is essential for tailoring treatments to enhance drug safety and efficacy. Despite its growing importance, there is a knowledge gap among healthcare professionals that hinders the integration of pharmacogenomics into clinical practice, particularly in Tanzania.

**Objectives:** This study aimed to assess pharmacogenomics knowledge and perceptions among senior healthcare students in Tanzania and to provide a baseline assessment of their preparedness for future pharmacogenomics education and clinical practice.

**Methods:** A cross-sectional survey was conducted from September to November 2020 among senior healthcare students from five Tanzanian universities. All 122 eligible consenting responses in the final Google Forms dataset were included. The English-language questionnaire was adapted from previously published pharmacogenomics surveys, underwent supervisor-led face and content review, and was pilot-tested for clarity and online functionality. Objective knowledge was assessed using five true/false/not-sure items; perceptions were assessed using a 17-item three-point item set and additional item-level questions. Descriptive statistics, 95% confidence intervals, non-parametric subgroup comparisons, and multivariable regression analyses were performed.

**Results:** Of 122 respondents, 104 (85.2%; 95% CI, 77.9–90.5) had previously heard of pharmacogenomics. Among 99 respondents with complete objective knowledge data, the mean score was 2.86/5 (SD 0.96), and 20 (20.2%; 95% CI, 13.5–29.2) scored at least 4/5. The largest knowledge gaps concerned whether genetic determinants of drug response change over a person's lifetime (19.6% correct) and whether pharmacogenomic testing is available for most medications (41.6% correct). The exploratory 17-item perception composite had high internal consistency (Cronbach's alpha= 0.95); 75.8% agreed that pharmacogenomics should be added to the curriculum and 78.8% considered it relevant to future practice. Knowledge scores did not differ significantly by sex, institution, course, or year of study (all $p$>.05).

**Conclusion:** This multicentre baseline survey identified high awareness but limited objective pharmacogenomics knowledge among senior healthcare students, alongside strong support for further pharmacogenomics education. The findings support integrating clinically oriented pharmacogenomics competencies within existing genetics, pharmacology, and therapeutics teaching and strengthening continuing professional education. Because data were collected in 2020 using convenience-based online recruitment, the findings should be interpreted as a baseline rather than a current national prevalence estimate.

## BACKGROUND

Pharmacogenomics examines how inherited genetic variation contributes to inter-individual differences in drug response and is an important component of precision medicine. Its clinical application can support drug selection, dose optimisation, and prevention of avoidable adverse drug reactions.[1] Precision medicine more broadly integrates genomic and other individual-level information to improve the safety and effectiveness of treatment.[2]

Despite expanding evidence and an increasing number of actionable drug-gene associations, implementation of pharmacogenomics remains uneven. Knowledge and confidence among healthcare professionals are consistently reported as important barriers to clinical adoption.[3] Recent systematic reviews of pharmacy and medical students show that favourable attitudes toward pharmacogenomics often coexist with limited objective knowledge and insufficient curricular exposure.[4,5]

The educational gap is particularly important in African settings, where pharmacogenomics must be

implemented alongside constrained laboratory capacity, limited genomic data, competing health priorities, and shortages of trained personnel. Recent African implementation work identifies education and workforce development, together with laboratory, regulatory, and health-economic capacity, as central requirements for sustainable pharmacogenomics translation.[6,7] Evidence from Zimbabwe has similarly shown that pharmacy students and pharmacists may have positive perceptions while demonstrating gaps in objective pharmacogenomics knowledge.[8] Recent evidence from neighbouring Kenya also found low physician involvement in pharmacogenomics and widespread absence of formal genetics training, underscoring continuing regional workforce challenges.[9]

Tanzania has substantial burdens of infectious and non-communicable diseases for which variability in drug response is clinically relevant. However, there has been little empirical evidence on the preparedness of future healthcare professionals to interpret and apply pharmacogenomic information. During study preparation, review of the programme curricula available to the study team indicated that pharmacogenomics was not offered as a dedicated stand-alone subject in the participating programmes, although related genetics and pharmacology concepts were embedded within broader teaching. This study therefore aimed to assess pharmacogenomics awareness, objective knowledge, and perceptions among senior medical, pharmacy, and nursing students across five Tanzanian universities and to identify educational priorities for future curriculum development.

# METHODOLOGY

## Study Design and Duration

This was an exploratory cross-sectional survey conducted between September and November 2020 among senior healthcare students.

## Study Area

The study involved five health-professional training institutions located in four regions of Tanzania: Muhimbili University of Health and Allied Sciences (MUHAS) in Dar es Salaam Region; Catholic University of Health and Allied Sciences (CUHAS) in Mwanza Region; Kilimanjaro Christian Medical University College (KCMUCo) in Kilimanjaro Region; and the University of Dodoma (UDOM) and St John's University of Tanzania (SJUT) in Dodoma Region. The participating institutions included public and private universities and were selected to provide representation across multiple geographic regions and health-professional training programmes.

## Target Population

The target population comprised senior students enrolled in Doctor of Medicine (MD), Bachelor of Pharmacy (BPharm), and Bachelor of Science in Nursing (BScN) programmes in Tanzania.

## Study Population and Eligibility Criteria

The study population comprised third-, fourth-, and fifth-year students enrolled in the MD, BPharm, or BScN programmes at the participating universities. Students outside these programmes or institutions and students below the third year of study were not eligible. Participation was voluntary and required electronic informed consent before completion of the questionnaire. No additional exclusion criteria were prespecified for otherwise eligible students.

## Sample Size Determination and Selection of Participants

No formal a priori sample-size calculation was performed. The study used convenience-based online recruitment during the prespecified three-month data-collection period and sought to recruit eligible senior students accessible during that period. The survey link was distributed through class and institutional email channels, class representatives, and Google Forms link sharing. Because these distribution routes overlapped and unique invitation records were not maintained, the total number of eligible students who received the survey invitation could not be established and response rates could not be calculated. All eligible respondents who provided electronic informed consent and submitted the questionnaire during the study period were included in the final dataset (N=122).

## Data Collection and Research Instrument

Data were collected using an English-language structured online questionnaire adapted from previously published pharmacogenomics knowledge, attitude, and perception surveys conducted in Zimbabwe, Ethiopia, Ghana, and Malaysia.[8,10-12] Face and content validity of the adapted questionnaire were reviewed by the two study supervisors, with attention to relevance, clarity, wording, and applicability to Tanzanian health-professional students. The questionnaire was then pilot-tested among students to assess comprehensibility, sequencing, and Google Forms functionality; pilot feedback informed the final wording and flow. Pilot data were not retained as a formal analytical dataset. The final questionnaire included socio-demographic information, previous awareness of pharmacogenomics, five objective knowledge items, and structured attitude and perception items.

For objective knowledge, the five items were scored using the published answer key: True, False, True, True, and False, respectively.[8] A correct response received 1 point and an incorrect or "not sure" response received 0 points, giving a maximum score of 5. Respondents with complete answers to all five items were included in the total knowledge score analysis. In the published Zimbabwe study using these five items, scores ≥4/5 were interpreted as above-average knowledge and scores ≤3/5 as average-to-below-average knowledge.[8] We retained the continuous 0 to 5 score as the primary outcome for subgroup comparisons and used ≥4/5 only as the dichotomous outcome for the exploratory logistic regression. For the 17 three-point perception items, Disagree, Neutral, and Agree were coded 1, 2, and 3, respectively. A respondent-level mean was calculated when at least 14 of 17 items (≥80%) were completed; higher values indicated greater endorsement of favourable perception statements. Because the item set was adapted rather than formally validated as a unidimensional scale in this population, this mean was treated as an exploratory composite. The four final five-point perception questions were analysed separately because they used a different response scale and included a negatively framed ethical item. No arbitrary overall percentage cut-off was applied to define a "positive" perception.

### Statistical Analysis

The final Google Forms dataset was re-audited against the source questionnaire before analysis. Descriptive statistics were reported as frequencies and percentages, means with standard deviations (SD), or medians with interquartile ranges (IQR), as appropriate. Wilson 95% confidence intervals (CI) were calculated for key proportions. Because the knowledge and perception scores were bounded and not assumed to be normally distributed, Mann-Whitney U and Kruskal-Wallis tests were used for subgroup comparisons, as appropriate. Multivariable logistic regression was used to examine factors associated with above-average knowledge (≥4/5), while multivariable linear regression with heteroskedasticity-robust standard errors was used for the exploratory perception composite. Because of small numbers in some disciplines, courses were grouped as MD versus non-MD, and institution was not included in adjusted models to avoid unstable estimates. Statistical significance was set at $P<.05$. Internal consistency of the 17-item perception set was assessed using Cronbach's alpha, which was not interpreted as evidence of construct validity. The five factual knowledge items were criterion-scored and covered distinct concepts, so internal consistency was not used as evidence of knowledge-scale validity. All statistical analyses were performed using Python version 3.13.5. Reporting was reviewed against the STROBE recommendations for cross-sectional studies.[13]

### Ethical Considerations

Ethical approval was obtained from the Muhimbili University of Health and Allied Sciences Institutional Review Board (reference no. 2016-04-09739) before data collection, and administrative permission was obtained from the participating institutions. Participation was voluntary and electronic informed consent was obtained before data collection. No names or registration numbers were collected. Survey data were stored in restricted-access electronic files and analysed in de-identified form.

## RESULTS

### Characteristics of the Study Participants

A total of 122 eligible consenting responses were included. The mean age was 23.6 years (SD 2.1; range 19-36); 94 (77.0%) participants were male and 28 (23.0%) were female. Most respondents were from MUHAS (66, 54.1%) and were enrolled in the MD programme (90, 73.8%). The distribution of participants across institutions, programmes, and years of study is shown in Table 1.

### Awareness, Objective Knowledge, and Perceptions Toward Pharmacogenomics

Of 122 participants, 104 (85.2%; 95% CI, 77.9 to 90.5) reported having previously heard of pharmacogenomics. In accordance with the questionnaire's intended skip instruction, respondents who answered "No" were not included in subsequent knowledge and perception score analyses. Among the 104 aware respondents, 99 had complete responses to all five objective knowledge questions. Their mean knowledge score was 2.86/5 (SD 0.96), with a median of 3 (IQR 2 to 3). Twenty (20.2%; 95% CI, 13.5 to 29.2) scored ≥4/5, corresponding to above-average knowledge in the published comparator, while 79 (79.8%) scored ≤3/5 (average-to-below-average).[8]

Item-level results identified substantial variation across knowledge domains. Almost all respondents recognised that genomic differences can influence medication response (97.1% correct), whereas only 19.6% correctly recognised that genetic determinants of drug response do not change over a person's lifetime. Correct responses were 67.0% for the statement that genetic variants may account for substantial variability in drug disposition and effects, 63.4% for the warfarin package-insert item, and 41.6% for recognising that pharmacogenomic testing is not currently available for most medications (Table 2).

**TABLE 1: Socio-demographic Characteristics of Study Respondents (N=122)**

| Characteristic | n (%) |
|---|---|
| Age group | |
| 19-22 | 31 (25.4) |
| 23-26 | 82 (67.2) |
| >=27 | 9 (7.4) |
| Sex | |
| Male | 94 (77.0) |
| Female | 28 (23.0) |
| University | |
| MUHAS | 66 (54.1) |
| CUHAS | 15 (12.3) |
| KCMUCo | 7 (5.7) |
| UDOM | 16 (13.1) |
| SJUT | 18 (14.8) |
| Course | |
| MD | 90 (73.8) |
| BPharm | 26 (21.3) |
| BScN | 6 (4.9) |
| Year of study | |
| Fifth year | 38 (31.1) |
| Fourth year | 42 (34.4) |
| Third year | 42 (34.4) |

**Abbreviations:** MUHAS, Muhimbili University of Health and Allied Sciences; CUHAS, Catholic University of Health and Allied Sciences; KCMUCo, Kilimanjaro Christian Medical University College; UDOM, University of Dodoma; SJUT, St John's University of Tanzania; MD, Doctor of Medicine; BPharm, Bachelor of Pharmacy; BScN, Bachelor of Science in Nursing.

Perception analyses focused primarily on the 17 three-point items, summarized as an exploratory composite rather than a formally validated unidimensional scale. The item set demonstrated high internal consistency (Cronbach's alpha=0.95 among 82 complete cases). Ninety-eight respondents completed at least 14 of 17 items and contributed to the composite score; the median was 2.65/3 (IQR 2.41-2.82). Item-level findings showed that 72/95 (75.8%; 95% CI, 66.3–83.3) agreed that pharmacogenomics should be added to the curriculum, 74/96 (77.1%; 95% CI, 67.7–84.4) supported its inclusion in continuing education, and 78/99 (78.8%; 95% CI, 69.7–85.7) considered pharmacogenomics relevant to future practice. In contrast, only 31/97 (32.0%; 95% CI, 23.5–41.8) agreed that they knew a reliable source of pharmacogenomics information and 19/98 (19.4%; 95% CI, 12.8–28.3) agreed that they knew pharmacogenomic

tests used in Tanzania. Among the four additional five-point perception items, 82.0% agreed or strongly agreed that pharmacogenomic testing could help identify a drug or dose with fewer side effects, 83.0% that it could identify a more effective drug or dose, and 73.0% that it could help prevent use of the wrong medicine or dose. However, 59.6% agreed or strongly agreed that patients might in future be pressured to accept pharmacogenomic testing, highlighting an ethical concern alongside generally favourable perceptions of clinical utility. Knowledge scores did not differ significantly by sex, university, course, or year of study. Exploratory perception composite scores were higher among female than male students (median 2.74 vs 2.65; $P$=.026), while no significant differences were observed by university, course, or year of study (Table 3).

In adjusted analyses, sex, course group, and year of study were not significantly associated with above-average knowledge. Female sex was associated with a higher exploratory perception composite score (adjusted beta 0.30; 95% CI, 0.13–0.47; $P$=.001), whereas course group and year of study were not significantly associated with the perception composite (Table 4).

**TABLE 2: Responses to the Five Objective Pharmacogenomics Knowledge Items Among Respondents Who Had Previously Heard of Pharmacogenomics**

| Knowledge statement | Correct Answer | Responses True n (%) | False n (%) | Not Sure n (%) | Correct n (%) [95% CI] |
|---|---|---|---|---|---|
| Subtle differences in a person's genome can have a major impact on how the person responds to medications | True | 100 (97.1) | 1 (1.0) | 2 (1.9) | 100 (97.1) [91.8–99.0] |
| Genetic determinants of drug response change over a person's lifetime | False | 62 (60.8) | 20 (19.6) | 20 (19.6) | 20 (19.6) [13.1–28.4] |
| Genetic variants can account for as much as 95% of the variability in drug disposition and effects | True | 67 (67.0) | 12 (12.0) | 21 (21.0) | 67 (67.0) [57.3–75.4] |
| The package insert for warfarin includes a warning about altered metabolism in individuals who have specific genetic variants | True | 64 (63.4) | 5 (5.0) | 32 (31.7) | 64 (63.4) [53.6–72.1] |
| Pharmacogenomic testing is currently available for most medications | False | 26 (25.7) | 42 (41.6) | 33 (32.7) | 42 (41.6) [32.5–51.3] |

Among the 104 respondents who had previously heard of pharmacogenomics, item-level missing responses resulted in valid denominators ranging from 100 to 103 across the five knowledge items. Percentages were calculated using the non-missing denominator for each item. Ninety-nine respondents completed all five knowledge items and were included in the total knowledge-score analysis. Percentages may not total exactly 100% because of rounding. CI, confidence interval.

**TABLE 3: Comparison of Knowledge Score and Exploratory Perception Composite Across Participant Characteristics**

| Characteristic | Knowledge Median (IQR) | Exploratory Perception Composite Median (IQR) |
|---|---|---|
| Sex | | |
| Male | n=82; 3 (2-3) | n=80; 2.65 (2.34-2.76) |
| Female | n=17; 3 (2-4) | n=18; 2.74 (2.60-2.98) |
| *P* value | .724 | 0.026 |
| University | | |
| MUHAS | n=52; 3 (2-3) | n=55; 2.65 (2.42-2.85) |
| CUHAS | n=11; 3 (1.5-3) | n=10; 2.71 (2.16-2.81) |
| KCMUCo | n=5; 3 (3-3) | n=4; 2.50 (2.10-2.62) |
| UDOM | n=15; 3 (2.5-3) | n=13; 2.59 (2.59-2.71) |
| SJUT | n=16; 3 (3-4) | n=16; 2.62 (1.99-2.84) |
| *P* value | .062 | .886 |
| Course | | |
| MD | n=69; 3 (2-3) | n=70; 2.69 (2.47-2.82) |

*Continue*

**TABLE 3: Continued**

| Characteristic | Knowledge Median (IQR) | Exploratory Perception Composite Median (IQR) |
|---|---|---|
| BPharm | n=26; 3 (3-4) | n=24; 2.62 (2.31-2.82) |
| BScN | n=4; 3 (3-3.25) | n=4; 2.06 (1.82-2.32) |
| *P* value | .053 | 0.185 |
| Year of study | | |
| Fifth year | n=27; 3 (2-3) | n=28; 2.53 (2.22-2.84) |
| Fourth year | n=39; 3 (2-3) | n=38; 2.65 (2.53-2.76) |
| Third year | n=33; 3 (3-4) | n=32; 2.64 (2.40-2.84) |
| *P* value | .083 | 0.837 |

*P* values are from Mann-Whitney U tests for sex and Kruskal-Wallis tests for university, course, and year of study. Knowledge score range 0 to 5; exploratory perception composite range 1 to 3. IQR, interquartile range

**TABLE 4: Adjusted Associations with Above-Average Knowledge and Exploratory Perception Composite**

| Predictor | Adjusted OR for knowledge ≥4/5 (95% CI) | *P Value* | Adjusted beta for exploratory perception composite (95% CI) | *P Value* |
|---|---|---|---|---|
| Female vs male | 1.59 (0.46–5.51) | .462 | 0.30 (0.13–0.47) | .001 |
| Non-MD vs MD | 2.42 (0.85–6.89) | .099 | -0.21 (-0.46–0.04) | .096 |
| Year of study (per one-year increase) | 0.62 (0.29–1.29) | .200 | -0.05 (-0.19–0.09) | .477 |

Knowledge model: multivariable logistic regression, n=99, with above-average knowledge defined as ≥4/5. Perception model: multivariable linear regression of the exploratory composite with heteroskedasticity-robust standard errors, n=98. The course was collapsed as MD versus non-MD because of sparse numbers in the BScN subgroup. Institution was not included in adjusted models because sparse outcome counts across five institutions would have produced unstable estimates.
Abbreviations: CI, confidence interval; MD, Doctor of Medicine; OR, odds ratio.

## DISCUSSION

This multicentre survey provides a baseline assessment of pharmacogenomics preparedness among senior healthcare students in Tanzania. Awareness was relatively high, with 85.2% having previously heard of pharmacogenomics, but objective knowledge remained limited: the mean score was 2.86/5 and only 20.2% of respondents with complete knowledge data answered at least four of five items correctly. These findings are consistent with the broader literature showing that healthcare students frequently express interest in pharmacogenomics while having incomplete objective knowledge.[4,5]

The item-level pattern is particularly informative for curriculum development. Knowledge that genomic differences may affect medication response was nearly universal, whereas the statement on whether genetic determinants of drug response change over a person's lifetime was correctly answered by only 19.6%, and fewer than half correctly recognised that pharmacogenomic testing is not available for most medications. Similar misconceptions have been reported in Zimbabwe and Ethiopia using comparable knowledge items.[8,10] Rather than interpreting cross-country percentage differences as statistically significant, these comparisons indicate recurring conceptual gaps that may be suitable targets for education.

Perceptions were generally favourable. More than three-quarters of respondents supported adding pharmacogenomics to the curriculum or continuing education and considered training relevant to future practice. At the same time, only one-third reported knowing a reliable information source and fewer than one-fifth reported knowing pharmacogenomic tests used in Tanzania, suggesting that enthusiasm is not yet matched by practical familiarity. This combination of favourable perceptions and limited knowledge mirrors findings from recent systematic reviews.[4,5] Female students had higher exploratory perception composite scores in both unadjusted and adjusted analyses; because this was an exploratory analysis with multiple comparisons, the finding should be interpreted cautiously and requires confirmation in larger samples.

The results support a competency-based educational response rather than simply adding more factual content. Pharmacogenomics could be integrated within existing genetics, pharmacology, therapeutics, and clinical decision-making teaching through case-based exercises on drug-gene interactions, interpretation of test reports, evidence resources, ethical and data-governance issues, and interprofessional roles. At the time of data collection,

the study team's curriculum review indicated that pharmacogenomics was not offered as a dedicated stand-alone subject in the participating programmes, although related genetics and pharmacology content was embedded within broader courses. The present study did not conduct a formal institution-by-institution curriculum mapping; accordingly, the results should not be used to rank individual universities or to infer that pharmacogenomics content was completely absent. Recent African implementation work continues to identify workforce education and training as a major requirement for translating pharmacogenomics into practice.[6,7]

### Strengths and Limitations of the Study

The multi-institutional design, inclusion of students from three health-professional programmes, and use of item-level knowledge and perception measures provide a broader assessment of pharmacogenomics preparedness than a single-institution survey. The item-level analyses also identify specific conceptual and educational gaps that may inform future curriculum development.

Several limitations should be considered. Convenience-based online recruitment and the absence of a unique invitation denominator prevented calculation of response rates and may have introduced self-selection bias. Participation was uneven across institutions and programmes, with most respondents coming from MUHAS and the MD programme and very small numbers of nursing students, limiting the precision of interprofessional and institutional comparisons. The study was conducted during the COVID-19 period, when reliance on online communication may have influenced participation and access. Although the questionnaire was adapted from published instruments, reviewed for face and content validity, and pilot-tested, a formal construct validation study was not undertaken. The high Cronbach's alpha for the 17-item perception item set describes internal consistency but does not establish unidimensionality or construct validity. No a priori behavioural theory or conceptual framework was used, and a qualitative component was not included; consequently, the survey quantifies reported perceptions but cannot explain the underlying reasons for them. The questionnaire's intended skip pattern also means that objective knowledge could not be compared between respondents who had and had not previously heard of pharmacogenomics. Finally, the data were collected in 2020, and pharmacogenomics research, training, and implementation have continued to evolve since that time. The findings should therefore be interpreted as a historical baseline rather than as an estimate of current pharmacogenomics knowledge or preparedness among healthcare students in Tanzania. Nonetheless, the multi-institutional design and item-level assessment provide useful evidence on educational priorities.

Since 2020, African pharmacogenomics research and implementation initiatives have expanded, but recent literature continues to identify workforce preparation, infrastructure, policy, and implementation capacity as major barriers.[6,7] In Tanzania, a 2024 study developed and applied a targeted next-generation sequencing panel to investigate hydroxyurea pharmacogenomics in sickle cell disease, illustrating growing local research capacity while not yet demonstrating routine clinical implementation.[14] The present study did not assess current clinical service availability in Tanzania and therefore cannot establish the extent to which pharmacogenomics is now embedded in routine care. In neighbouring Kenya, a 2025 survey found that 87% of physicians had not received formal genetics training and only 29% reported involvement in pharmacogenomics, illustrating continuing regional workforce and implementation gaps.[9] These developments support interpreting the 2020 findings as a historical baseline and motivate contemporary curriculum mapping and repeat surveys using stronger sampling designs.

## CONCLUSION

This study provides a multicentre baseline of pharmacogenomics awareness, knowledge, and perceptions among senior healthcare students in Tanzania. Although most respondents had heard of pharmacogenomics and expressed favourable views about its future relevance, objective knowledge was limited and specific gaps were evident in core concepts and awareness of practical pharmacogenomic resources.

Educational priorities should include integrating clinically oriented pharmacogenomics competencies into existing genetics, pharmacology, and therapeutics curricula; using case-based and interprofessional teaching on drug-gene interactions and test interpretation; introducing students to reliable pharmacogenomics evidence resources; and providing continuing professional education for graduates. Future studies should use documented sampling frames, formal curriculum mapping, validated, theory-informed measurement approaches, and qualitative methods to evaluate how pharmacogenomics education and implementation have changed since this 2020 baseline.

## REFERENCES

1. Crews KR, Hicks JK, Pui CH, Relling MV, Evans WE. Pharmacogenomics and individualized medicine: translating science into practice. Clin Pharmacol Ther. 2012;92(4):467-475. doi:10.1038/clpt.2012.120.
2. Goetz LH, Schork NJ. Personalized medicine: motivation, challenges and progress. Fertil Steril. 2018;109(6):952-963. doi:10.1016/j.fertnstert.2018.05.006.
3. Hippman C, Nislow C. Pharmacogenomic testing: clinical evidence and implementation challenges. J Pers Med. 2019;9(3):40. doi:10.3390/jpm9030040.
4. Wondrasek A, Fryza A, Aziz MA, Leong C, Kowalec K, Al Maruf A. Knowledge, perceptions, and attitudes toward pharmacogenomics among pharmacists and pharmacy students: a systematic review. Health Sci Rep. 2024;7(1):e1844. doi:10.1002/hsr2.1844.
5. Li C, Su X, Sun Q, Huang Y. Knowledge and attitudes of medical and pharmacy students about pharmacogenomics: a systematic review and meta-analysis. Pharmacogenomics J. 2023;23(5):127-133. doi:10.1038/s41397-023-00306-x.
6. Alimohamed MZ, Obeng GD, Csanadi M, Masimirembwa C, Dandara C. Implementing health economics for pharmacogenomics research translation in Africa. Commun Med (Lond). 2025;5(1):241. doi:10.1038/s43856-025-00955-y.

7. Mukabyiringiro E, Kinyanjui AW, Nthenya GR, Ndiege OZ, Majok DA, Inshutiyimana S, Terefe EM. Strengthening pharmacogenomics implementation in Africa: challenges and opportunities - a narrative review. Health Sci Rep. 2026;9(4):e72276. doi:10.1002/hsr2.72276.

8. Muzoriana N, Gavi S, Nembaware V, Dhoro M, Matimba A. Knowledge, attitude, and perceptions of pharmacists and pharmacy students towards pharmacogenomics in Zimbabwe. Pharmacy (Basel). 2017;5(3):36. doi:10.3390/pharmacy5030036.

9. Sigilai H, Ogola E, Ilovi S. Utilization of genomic services among physicians in Kenya. PLoS One. 2025;20(12):e0319364. doi:10.1371/journal.pone.0319364.

10. Abdela O, Bhagavathula AS, Gebreyohannes EA, Tegegn HG. Ethiopian health care professionals' knowledge, attitude, and interests toward pharmacogenomics. Pharmacogenomics Pers Med. 2017;10:279-285. doi:10.2147/PGPM.S145336.

11. Kudzi W, Addy BS, Dzudzor B. Knowledge of pharmacogenetics among healthcare professionals and faculty members of health training institutions in Ghana. Ghana Med J. 2015;49(1):50-56. doi:10.4314/gmj.v49i1.9.

12. Bannur Z, Bahaman S, Salleh MZ, Teh LK. Pharmacogenomics based practice in Malaysia: the attitude, knowledge and adoption by the healthcare professionals. IIUM Med J Malaysia. 2014;13(1). doi:10.31436/imjm.v13i1.491.

13. von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-1457. doi:10.1016/S0140-6736(07)61602-X.

14. Nkya S, Nzunda C, Saukiwa E, et al. Towards genomic medicine: a tailored next-generation sequencing panel for hydroxyurea pharmacogenomics in Tanzania. BMC Med Genomics. 2024;17:190. doi:10.1186/s12920-024-01924-5.

**Peer Reviewed**

**Competing Interests:** Authors declare no competing interest.

**Funding:** The study did not receive any funding.

**Received:** 28 February 2025; **Accepted:** 10 September 2026

**Cite this article as** Alimohamed ZM, Aidan SB, Manji KU, Mugusi S. Knowledge and Perception Towards Pharmacogenomics Among Healthcare Students in Tanzania. *East Afr Health Res J.* 2026;10(2):255-261. https://doi.org/10.24248/eahrj.v10i2.346

© The East African Health Research Commission 2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are properly cited. To view a copy of the license, visit http://creativecommons.org/licenses/by/4.0/. When linking to this article, please use the following permanent link: https://doi.org/10.24248/eahrj.v10i2.346