Original Article

Development, validation and psychometric evaluation of the Plagiarism and Research Ethics Questionnaire (PRE-Q) among pharmacy students in Karachi, Pakistan

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Abstract

Objective: Plagiarism is one of the most pressing challenges faced by higher education institutions which compromises the academic integrity and negatively impact the quality and credibility of scientific research. Therefore, this study aimed to assess undergraduate pharmacy students' knowledge, attitudes, and practices regarding research ethics and plagiarism using the Plagiarism and Research Ethics Questionnaire (PRE-Q).

Method: This multi-centric, cross-sectional study aimed to validate the PRE-Q among final-year pharmacy students from universities in Karachi, Pakistan. Internal consistency was assessed using Cronbach's alpha, and construct validity was evaluated via principal component analysis with Varimax rotation. Sampling adequacy and item correlations were confirmed using KMO and Bartlett's tests. Key predictors of student practices were identified using decision tree analysis.

Results: The response rate of the current study was 72.2%. Female respondents comprised 73.5% (n = 480) of the sample, with a mean age 22.3±0.82 years. The cut-off value for good KAP and experience was achievement of ≥ 70% scoring in all the constructs. According to that good knowledge was found in 26.4% (n = 173) respondents only. Only 7% (n = 46) displayed a positive attitude about plagiarism. Sixty-seven percent of students (n = 438) demonstrated good practice, consistent with their limited involvement in research activities. Only 11% (n = 72) respondents attended courses or workshops regarding ethics or responsible research.

The most frequently reported reasons for academic plagiarism among students were academic pressure (n=119, 18.2%), followed by lack of time (n=103, 15.7%) and lack of knowledge (n=89, 13.6%).

Conclusions: The current study showed that the developed PRE-Q was successfully validated and had good reliability and construct validity. The findings revealed patterns in plagiarism-related practices and highlighted the key predictors that may guide the development of targeted educational or policy interventions.

Keywords: Plagiarism, research ethics, pharmacy students, knowledge, attitude, Pakistan

Introduction:

Plagiarism is primarily a breach of academic integrity and one of the most pressing challenges faced by higher education institutions that negatively impacts the scientific research[1]. It might be an outcome of deliberate misconduct that compromises scientific honesty or it can be the result of unintentional mistakes that go unreported as they aren't usually considered scientific breaches. The increasing prevalence of plagiarism is often driven by the fact that students consider it as an easy way for attaining higher grades [2]. This approach fosters dishonesty, and when they enter in their professional life, they may lack the capability and knowledge expected of competent professionals. Plagiarism might be due to number of factors, including online data accessibility and an inadequate support for nurturing students' writing skills. Students now have many options to plagiarize the work of other individuals since information technology advancements have made it easier to obtain data, articles, and other students' assignments online[3]. Another major reason might be the

transition of traditional teaching to online education. It has been observed that trend of "contract cheating," in which students employ online instructors to take exams or prepare their projects, has significantly increased during the COVID-19 pandemic[4]. Moreover, inadequate knowledge about plagiarism detection tools, poor writing skills, poorly designed assignments, a lack of interest, a lack of time, a fear of missing deadlines, a lack of familiarity with what is expected of students in honest academic writing due to cultural differences, and a lack of knowledge and instruction on ethics and intellectual property rights may contribute to ethical misconducts [5].

Sustainable Development Goal (SDG) 4 emphases on providing high-quality education and encouraging opportunities for lifelong learning, particularly in developing nations [6]. University education contribute significantly in achieving these goals by increasing access to higher learning and training of students [7]. Since plagiarism threatens the standards and values that have been developed within the institution, the higher education institutions are quite concerned about the matter. In this context, addressing the issue of plagiarism becomes critical, as academic integrity directly impacts the personal and professional growth of students as well as the reputation of universities. The Committee on Publication Ethics (COPE), recommended the guiding principles on good publication practice, stating that plagiarism can occur at any stage of research, writing, or publication [8]. A balanced strategy that incorporates preventative initiatives, institutional policies against identified plagiarists and plagiarism detection technologies can help control plagiarism [9]. Several universities are offering professional degree programs including Learning Management Systems (LMS) with plagiarism detection tools like Blackboard/SafeAssign and Canvas/Turnitin [10].

Research on plagiarism and ethical misconduct remains limited in Pakistan. Existing evidence indicates that students are not well instructed, have differing opinions, and are unaware of plagiarism repercussions [11]. Evaluating students' attitudes and knowledge is essential to provide baseline data about how they view plagiarism. By assessing the association

between knowledge level and their application, possible gaps can be identified for the recommendation of an intervention to lower the prevalence of plagiarism among university students. Therefore, this study aimed to assess undergraduate pharmacy students' knowledge, attitudes, and practices regarding research ethics and plagiarism, using the Plagiarism and Research Ethics Questionnaire (PRE-Q) in Karachi, Pakistan.

Methodology

Study Design and setting:

The current study employed a multi-centric, cross-sectional design to validate and analyze the psychometric properties of developed PRE-Q. The questionnaire was administered to final-year pharmacy students from various universities in the Karachi metropolis. The study was conducted according to the STROBE guidelines [12].

Participants eligibility criteria:

The participants were considered eligible if they were in their final-year of pharmacy, belonged to the accredited public and private institutions, approved by the Pharmacy Council of Pakistan and the Higher Education Commission of Pakistan and gave prior written informed consent to participate in the study. Responses were deemed invalid if a respondent left any question unanswered within a single section of the questionnaire, and such responses were excluded from the study.

Sample size estimation

The estimated population of final-year pharmacy students across universities in Karachi was 1,000 enrolled students at the time of the study. The anticipated response rate was set at 70%, with a confidence limit (margin of error) of 5%. The design effect (for cluster surveys, DEFF) was assumed to be 1. Based on these assumptions, the calculated sample size was 245 at a 95% confidence level and 359 at a 99% confidence level.

After excluding all invalid questionnaires, the final sample size obtained for the study was 653.

Research Instrument:

The PRE-Q was developed after a thorough review of the literature [13-15]. The PRE-Q comprised a total of 34 items covering plagiarism and research ethics to assess knowledge (15 items), attitude (12 items), practice (3 items), and experience (4 items). Additionally, the questionnaire included items inquiring the students' demographic information, their publications, previous use of plagiarism detection software, their perceived reasons for plagiarism, and opinions on reducing plagiarism practices. These items were organized into five main constructs: demographic details, experience, knowledge, attitude, and practice.

The questions related to knowledge, practice and experience were a three-point Likert scale (from 0 – 2) No to yes / I know to I don't know. Questions related to attitude were rated on a 5-point Likert scale ranging from 5 (strongly disagree) to 1 (strongly agree).

Practice score was calculated by summing item responses mentioned in table 6. A score ≥70% of total possible score was categorized as "good practice."

Validity and reliability of the questionnaire:

The questionnaire was validated by pilot study with 30 pharmacy students, data of which were not included in the study. Internal consistency reliability was examined using Cronbach's alpha, and item-level performance was evaluated through corrected item–total correlations and the effect of item deletion on overall alpha. Sampling adequacy for factor extraction was assessed using the Kaiser–Meyer–Olkin (KMO) statistic and Bartlett's test of sphericity.

Construct validity was examined using both exploratory factor analysis (EFA) and principal component analysis (PCA). PCA was first applied to determine the underlying component structure using Kaiser's criterion (eigenvalues >1). Subsequently, EFA with varimax rotation was performed to refine factor loadings and identify interpretable latent dimensions.

Items with loadings ≥0.45 were considered acceptable. Based on the factor structure, extracted components were grouped into broader theoretical constructs.

Ethical considerations

The study was approved by the Ethical Review Committee of Hamdard University, Karachi, Pakistan (Reference No: ERC-FOP-2024-019). All methods were performed in accordance with the relevant guidelines and regulations. The study was conducted in accordance with the principles of the Declaration of Helsinki. The students were explained about the scope of study and their written consent was obtained. The questionnaire included a consent statement, and respondents were able to proceed only after clicking the “I Agree” button.

Data collection

Following ethical approval, the questionnaire was converted into a Google Form. The form link was distributed via WhatsApp groups of the target population by faculty members, who invited students to complete it. Data were collected over a three-month period, from 1 October 2024 to 31 December 2024. The PRE-Q was administered in its original English version. Since participants were proficient in English, formal forward–back translation and cognitive interviews were not required.

Statistical Analysis

Data were subjected to descriptive analysis using the Statistical Package for the Social Sciences (SPSS) for Windows, version 27, and are presented as frequencies and percentages. Data was further analyzed for test of normality using Kolmogorov-Smirnov test and Shapiro-Wilk tests. Due to a large data and to avoid bias, tests of multicollinearity were performed and correlation, tolerance, variance inflation rate and condition indices were calculated. As data was found with non-normal distribution decision tree test was performed using Chi-squared automatic interaction detection (CHAID) algorithm to identify key predictors of practice. The dependent variable was practice scores (1 – 6) whereas knowledge, attitude and

experience scores were independent variables. CHAID method was chosen as it allows multiway splitting of data based on Chi squared splitting criterion with significance level $p < 0.05$. Risk estimates and cross-validation accuracy was calculated to assess model performance. For the purpose of combined effects of independent variables on the dependent variable a classification and regression tree model (CRT) was also applied. The combined effect of components (identified via principal component analysis) on practice were observed. Binary Logistic Regression analysis was conducted to determine the effect of gender, university and publication history on the dependent variable inclusive of basic independent variable i.e. Knowledge, attitude and experience (practice on plagiarism). Additional analyses were conducted using component variables to examine the detailed effects of multiple independent variables on plagiarism-related practices. Logistic regression analysis was conducted to examine associations between the outcome and 13 predictor variables. The events-per-variable (EPV) ratio was 29.2 (380/13), well above the recommended minimum of 10, indicating adequate sample size for stable parameter estimates. Based on the current sample size (N = 653) and number of events (n = 380). A post-hoc power analysis for logistic regression ($\alpha = 0.05$, power = 80%) indicated that the study was adequately powered to detect odds ratios of approximately 1.9 or greater for the included predictors. An interaction term between Knowledge and Attitude was included in the logistic regression to explore potential moderation effects. All the results were considered significant when $p < 0.05$.

Results

Demographic details:

The questionnaire was distributed among 905 final-year pharmacy students from eight universities out of which 5 universities were from private sector and 3 universities were from public sector. Private vs public university response rate varied from 66.9% - 79.7%. Among them, 653 students filled the online questionnaire, and their responses were analyzed

in this study, resulting in total response rate calculated to be 72%. A post-hoc power analysis was conducted using G*Power 3.1. Based on the observed effect size in the final regression model (Cohen's d = 0.1312, f^2 = 0.0043), with α = 0.05, N = 653, and 13 predictors, the achieved statistical power was approximately 0.32. This indicates that the study had limited power to detect the small observed effect.

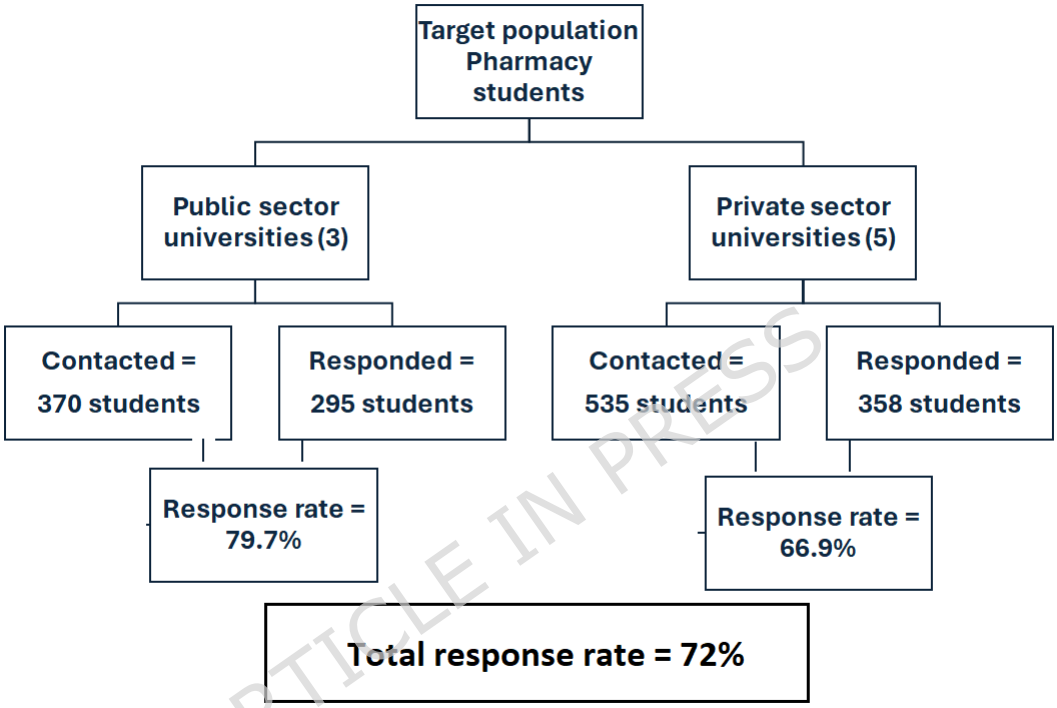

Figure 1: Flow diagram of participant recruitment and response rates for the survey among pharmacy students according to STROBE guidelines
This flowchart outlines the recruitment process for pharmacy students across public and private sector universities. A total of 370 students from three public sector universities and 535 students from five private sector universities were contacted. Of these, 295 students from public institutions (response rate: 79.7%) and 358 from private institutions (response rate: 66.9%) completed the survey, yielding an overall response rate of 72%. All participants who completed the questionnaire were included in the final analysis.

The mean age of the respondents was 22.3±0.82 years. Female respondents comprised 73.5% (n = 480) of the sample. Among the respondents, 45.1% (n = 295) were from public sector universities, while 54.8% (n = 358) were from private sector universities. (Table 1) More than half, 55.2% (n = 361) of respondents considered themselves knowledgeable about plagiarism. The most frequently reported reasons for academic plagiarism among students were academic pressure (n=119,

18.2%), followed by lack of time (n=103, 15.7%) and lack of knowledge (n=89, 13.6%).

Table 1: Demographic and initial data analysis details

Variables		Frequency	Percentage	(95% CI)
Gender	**Male**	173	26.5	19.9 – 33%
	Female	480	73.5	69.6 – 77.5%
University	**Private**	358	54.8	49.7 – 59.9%
	Public	295	45.2	39.5 – 50.9%
How would you rate your knowledge about plagiarism	**<7 Bad**	292	44.7	50.1 – 60.4%
	> 7 Good	361	55.2	39.0 – 50.4%
Experience	**Bad**	581	88.9	86.4 – 91.5%
	Good	72	11	3.7 – 18.2%
Knowledge	**Bad**	480	73.5	69.5 – 77.5%
	Good	173	26.5	19.9 – 33.1%
Attitude	**Negative**	607	92.96	90.9 – 94.99%
	Positive	46	7.04	-3.5 – 14.4%
Practice	**Bad**	215	32.9	26.6 – 39.2%

	Good	438	67.1	62.7 – 71.5%
Which of the following is the major reason of academic plagiarism among students?	**Lack of time**	103	15.8	8.7 – 22.8%
	Lack of knowledge	89	13.6	6.5 – 20.7%
	Lack of interest	56	8.6	1.2 – 15.9%
	Language problem	30	4.6	-2.8 – 12%
	Academic pressure	119	18.2	11.2 – 25.2%
	Perceived ease	28	4.3	-3.2 – 11.8%
	Fear to failure	59	9.03	1.7 – 16.4%
	Inadequate research skills	68	10.4	3.1 – 17.6%
	Peer influence	25	3.8	-3.7 – 11.4%
	Procrastination	29	4.4	-3.1 – 11.9%
	Other	47	7.2	-0.1 – 14.5%
In your opinion how we can reduce plagiarism practices	**Guidance on effective paraphrasing**	70	10.7	3.4 – 17.9%
	Utilize plagiarism software	27	4.1	-3.3 – 11.6%

	Workshops and tutorials to avoid plagiarism	143	21.9	15.1 – 28.7%
	Accessible guidelines for students	53	8.1	0.7 – 15.4%
	All of above	360	55.1	49.9 – 60.3%
Have you ever published a research paper or involved in the process for publication?	**No**	431	66	61.5 – 70.5%
	Maybe	51	7.8	0.4 – 15.2%
	Yes	171	26.2	19.6 – 32.8%
Have you ever used a plagiarism detecting software?	**No**	204	31.2	24.9 – 37.6%
	Maybe	44	6.7	-0.6 – 14.2%
	Yes	405	62	57.2 – 66.7%

Results presented as frequency (%age) 95% confidence interval in percent. CI = Confidence interval.

The majority of respondents 55.1% (n=360) believed that a combined approach including guidance on effective paraphrasing, the use of plagiarism detection software, workshops and tutorials, and accessible guidelines are the most effective way to reduce plagiarism among students. Specifically, 21.8% (n=143) emphasized the importance of workshops and tutorials, while 10.7% (n=70) highlighted the need for guidance on paraphrasing.

KAP details:

The cut-off value for good KAP and experience was achievement of ≥ 70% scoring in all the constructs. According to that good knowledge was found in 26.4% (n = 173) respondents only. Others had a bad score for knowledge questions. Only 7% (n = 46) displayed a positive attitude about plagiarism. Sixty-seven percent of students (n = 438) demonstrated good practice, consistent with their limited involvement in research activities. There were only 11% (n = 72) participants who attended courses or workshops regarding ethics or responsible research.

Missing value analysis showed that missingness per variable ranged from 0% to 1.7%. Little's MCAR test indicated that the missing data were missing completely at random (MCAR), $\chi^2(4) = 1.924$, $p = 0.748$. Given the very low proportion of missing values and the MCAR pattern, listwise deletion was considered appropriate.

Reliability Analysis: The questionnaire demonstrated good internal consistency, (Cronbach's alpha = 0.810). Deletion of individual items did not meaningfully improve alpha, supporting retention of all items. Although a few items had corrected item–total correlations below 0.30, their exclusion reduced the overall alpha, indicating that all items contributed adequately to the scale. Sampling adequacy for factor analysis was confirmed by a KMO value of 0.841 and a significant Bartlett's test of sphericity ($p < 0.001$). Principal component analysis extracted nine components with eigenvalues >1, explaining 54.6% of the total variance, and exploratory factor analysis with varimax rotation confirmed these nine factors, with all items loading above 0.45 on their respective components. Composite reliability values were acceptable for all constructs—Practice (CR = 0.804), Attitude (CR = 0.857), and Knowledge (CR = 0.937).

Principal Component Analysis (PCA) with varimax rotation was performed for data reduction and to explore the underlying dimensional structure of the instrument. Components with eigenvalues greater than 1 were retained. Nine components were extracted, explaining 54.6% of the total variance. All retained items demonstrated factor loadings ≥0.45 on their respective components. The extracted components were subsequently

organized into four overarching conceptual domains (Knowledge, Attitude, Practice, and related subdomains) for further analysis. All factor loadings exceeded 0.45 for their corresponding components, as shown in Table 2.

Table 2: Principal component analysis of Total items of the questionnaire with Varimax rotation.

	Component								
	1	2	3	4	5	6	7	8	9
	Research ethics violation	Justification of Plagiarism	Types of Plagiarism	Self-justification to academic mis-conduct	Knowledge of ethical principals	Training and education of research ethics	Resue of work	Perception of language barriers	Under-graduate research experience
E1: Have you ever attended research methodology course?						0.686			
E2: Have you ever attended a Research Ethics (RE) course or workshop?						0.766			
E3: Have you ever attended research misconduct training?						0.61			

E4: Do you have undergraduate research experience?									0.703
K1: Responsible conduct of research					0.704				
K2: Informed consent					0.617				
K3: Declaration of Helsinki	0.497				0.46				
K4: Disclosure of conflict of interest	0.45				0.576				
K5: Self-Plagiarism			0.732						
K6: Citation Plagiarism			0.635						
K7: Paraphrasing Plagiarism			0.746						
K8: Misrepresentation	0.414		0.484						
K9: Authorship Misconduct	0.586								
K10: Duplicate Publication	0.465		0.403						
K11: Data Suppression	0.762								
K12: Data Fabrication	0.786								

K13: Data Falsification	0.832								
K14: Institutional Review Board (IRB)	0.485								
K15: Ethical Violation	0.599								
P1: Have you ever copied and pasted from someone else's work into your research project or assignment without crediting or citing them?							0.665		
P2: Have you ever used something that was previously published without giving adequate credit in another publication?							0.771		
P3: Have you ever submitted your work to another class and then reused it without permission?							0.652		
A1. At times, it is unavoidable to utilize others' expressions without proper attribution, as there are few methods to articulate a concept								0.73	

A2. Using earlier explanations of a method is justified as the method itself remains the same.								0.722	
A3. Since self-plagiarism is harmless (one cannot steal from oneself), it is not penalized.				0.748					
A4. If a manuscript has significant scientific value, portions of it that include plagiarism may be ignored.				0.491					
A5. The same penalties that apply to plagiarism should not be applied to self-plagiarism.				0.655					
A6. Plagiarism penalties should be less severe for young researchers who are still learning the ropes.				0.556					
A7. It is acceptable to replicate portions of a similar article that has already been published in a foreign language if one is not proficient in that language (for example, English).				0.484					

A8. Writing an academic paper without plagiarism is impossible for me.		0.628							
A9. Imminent deadlines justify a degree of plagiarism.		0.719							
A10. When I cannot decide what to write, I translate a portion of a paper from a foreign language.		0.691							
A11. It is acceptable to use one's own previous work that was published without citation to finish the present work.		0.652							
A12. If a colleague enables me to copy something from her/his paper, I am not doing anything wrong because I've obtained his/her permission.		0.556							

*(*PCA value above 0.4 was considered significant and retained in the table)*

Regression diagnostics

All predictors demonstrated acceptable tolerance (>0.70) and low VIF values (<1.40). Condition indices ranged from 1.00 to 18.48, with no dimension exceeding the critical threshold of 30, and no clustering of high variance proportions across the same dimension. These findings indicated absence of problematic multicollinearity, supporting the stability of the regression estimates.

In the final regression model, attitude emerged as the strongest predictor of practice ($\beta = 0.242$, $p < 0.001$). Knowledge showed a significant positive association ($\beta = 0.094$, $p = 0.030$), and gender was also significantly associated with practice ($\beta = –0.176$, $p < 0.001$). Experience demonstrated a borderline effect ($\beta = –0.084$, $p = 0.053$), while university sector was not statistically significant ($p = 0.918$).

Binary logistic regression

Logistic regression analysis was conducted to examine the effect of various predictors on the likelihood of engaging in plagiarism-related practices (Fig. 1). The independent variables included gender, university sector, experience, knowledge, attitude and components derived from the PCA. The overall model was found statistically significant (χ^2 (11) = 790.69, $p < 0.001$). The Hosmer–Lemeshow test indicated a good model fit ($\chi^2 = 12.63$, $p = 0.125$). The model explained 20.4% (Nagelkerke R^2) of variance in the plagiarism practice and was correctly classified as 71%.

Regression coefficients revealed that knowledge, gender and components 1 – 3 & 5 had a statistically significant effect on the likelihood of good plagiarism-related practices. Particularly, knowledge was found to be a strong positive predictor (Exp (B) = 1.621 (1), $p < 0.001$) indicating that individuals with higher knowledge scores were more likely to engage in ethical practices. Experience, however, showed no significant association with plagiarism-related practices (Exp(B) = 1.042 (1), $p > 0.05$).

Among the PCA derived components, Component 2 (Justification of plagiarism [attitude], Exp (B) = 1.178 (1), $p < 0.001$) was found to be the

strongest and most influential predictor of good practice. On the other hand, Components 1 (Research ethics violation, Exp (B) = 0.714 (1), p = 0.001), Component 3 (Types of plagiarism; Exp(B) = 0.726 (1), p = 0.006) & Component 5 (Knowledge of ethical principles; Exp(B) = 0.607 (1), p < 0.001) were significant predictors with lower odds of good practice (OR < 1), indicating that higher scores in these components were associated decreased likelihood of good practices. Component 6 (Training & Education of research; Exp(B) = 0.955 (1), p = 0.903) also showed a negative relationship but was not statistically significant. Overall, the findings suggest that ethical violations, poor understanding of plagiarism types, and lack of knowledge of ethical principles were associated with an increased likelihood of engaging in unethical practices.

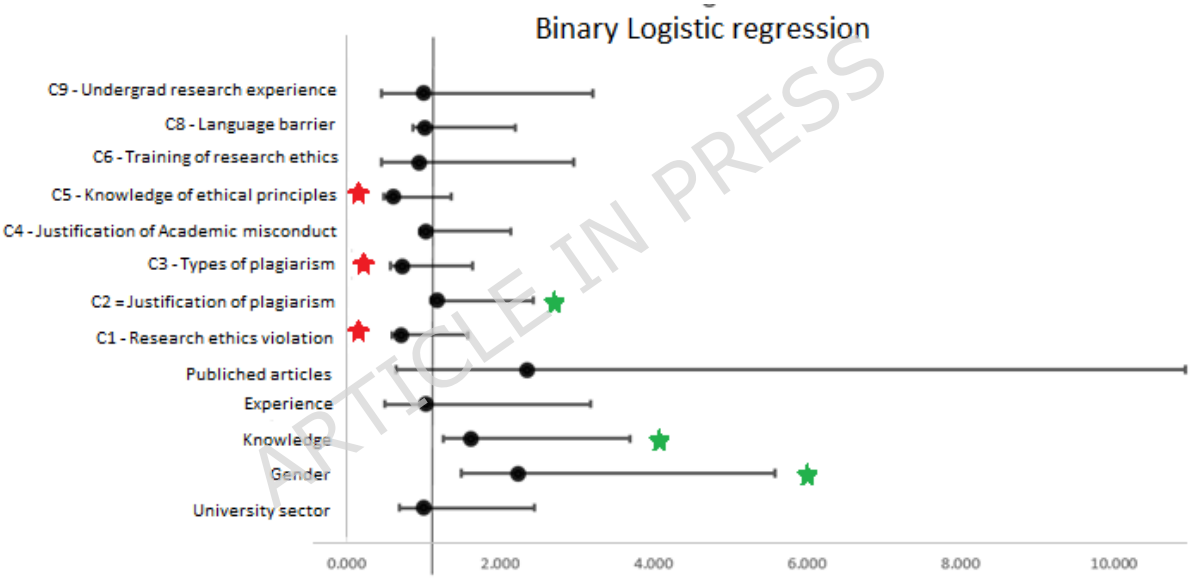

Figure 2: Forest Plot of Binary Logistic Regression Predictors of Research Misconduct

* = reduced odds of good practice, * = positive relationship

The diagram summarizes how different academic, demographic, and ethical-knowledge–related factors contribute to the likelihood of supporting or engaging in research misconduct. Variables such as C1 – Research ethics violation, C2 – Justification of plagiarism, C3 – Types of plagiarism, C4 – Justification of academic misconduct, and C5 – Knowledge of ethical principles show significant associations, indicated by the star markers. Predictors with OR > 1 increase the likelihood of misconduct-supporting behaviors, while those with OR < 1 have a protective effect.

Decision tree analysis

To further analyze the impact of these components on the plagiarism-related practices, a decision tree model was developed. The root node (Node 0) contained the total sample (n = 653) and classified participants into 6 different levels of practice. The largest category was Category 6, representing the best practice, with a distribution of 54.4% in the dataset. The first split was based on Component 2 (i.e. justification of plagiarism), indicating the greatest influence on classification. This subset of individuals showed better practices, with 60% falling into Category 6. Performance further improved with the inclusion of Component 1 in the next split (Node 1, Fig. 2). Knowledge of research ethics was associated with improved plagiarism-related practices. Other components did not make a statistically significant contribution, underscoring the complexity of factors influencing plagiarism-related behavior.

The decision tree analysis revealed that Node 1 accounted for 73.5% of the sample, with 60.6% of these cases classified as Category 6, indicating strong plagiarism-related practices. Node 2 represented 26% of the sample and showed a different distribution of practice levels, with 26.6% falling into Category 6. Subsequent splits were driven by Component 1 and Component 8, which further refined the classification outcomes.

Node 3 demonstrated an improvement over Node 1, with a larger proportion of individuals classified into higher practice categories (Improvement = 0.011). Similarly, Nodes 4, 5, and 6 provided additional granularity in differentiating practice levels. The final terminal nodes (Nodes 7-10) represented more refined subgroups, indicating that Components 8 and 4 played a significant role in the classification process.

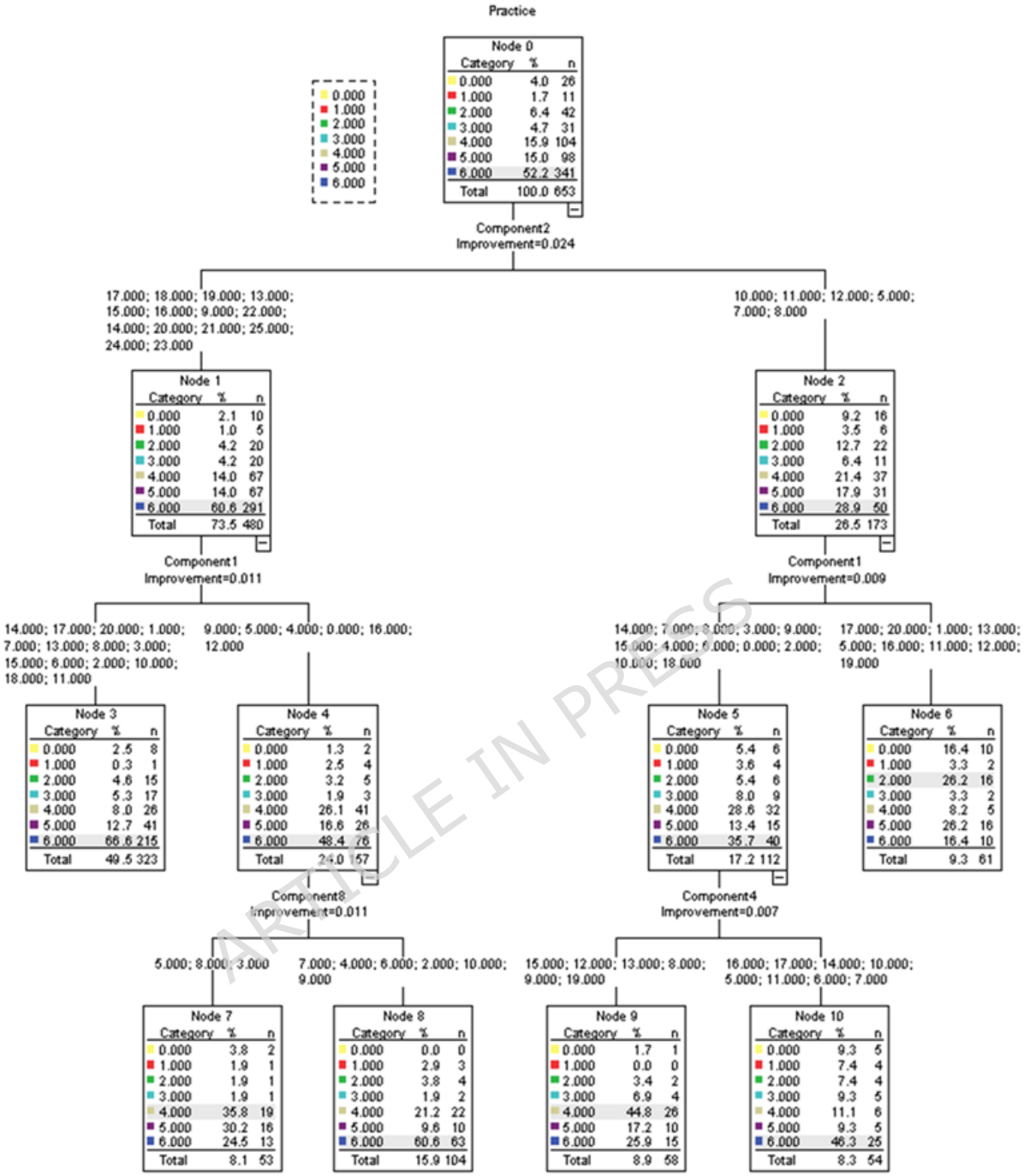

Figure 3: Classification Tree Diagram for Predictors of Research Practice Levels

This figure shows the decision tree used to classify participants into six levels of research practice based on key predictor components. Each node displays the number and proportion of participants in each category.

Comparison of Methods and Interpretation

Component 2 was the most important factor in defining plagiarism-related activities, according to the results of both logistic regression and decision tree analyses. The decision tree demonstrated the hierarchical structure of these influences and showed critical thresholds that differentiated various practice levels, whilst logistic regression provided insights into the direction and statistical significance of these relationships.

Moderation effect

While Knowledge (OR = 1.021, 95% CI = 1.000 – 1.043, $p < 0.05$) and Attitude (OR = 1.093, 95% CI = 1.062 – 1.125, $p < 0.05$) were independently associated with good practice, the interaction term (Knowledge × Attitude) was not significant (OR = 1.002, 95% CI = 0.999 – 1.005, $p = 0.244$), indicating no evidence of moderation

Respondents' Knowledge about the terminologies related to research ethics

Table 3 depicted that a significant portion of participants lacks awareness of crucial terms such as the *Declaration of Helsinki* 85% (n=555) and the *Institutional Review Board* 67.7% (n=442), while others demonstrate some understanding or familiarity with terms like *informed consent* 44.4% (n= 290) and *paraphrasing plagiarism* 44.3% (n=289). On the other hand, terms like *self-plagiarism* 58.5% (n= 382) and *citation plagiarism* 65.2% (n= 426) showed a higher percentage of respondents being unaware.

Table 3: Respondents' Knowledge about the terminologies related to research ethics

	Don't know	Some understanding	I know
Responsible conduct of research	150 (23%) CI = 16.2 – 29.7%	269 (41.2%) CI = 35.3 – 47.1%	234 (35.8%) CI = 29.7 – 41.9%
Informed consent	122 (18.7%) CI = 11.8 – 25.6%	241 (36.9%) CI = 30.8 – 42.9%	290 (44.4%) CI = 38.7 – 50.1%
Declaration of Helsinki	555 (85%) CI = 82.1 – 87.9%	9 (1.4%) CI = -6.2 – 8.99%	78 (11.9%) CI = 4.7 – 19.1%
Disclosure of conflict of interest	252 (38.6)	244 (37.4%)	157 (24%)

	CI = 32.6 – 43.4%	CI = 31.3 – 43.4%	CI = 17.4 – 30.7%
Self-Plagiarism	382 (58.5%) CI = 53.6 – 63.4%	13 (2%) CI = -5 – 9.6%	253 (38.7%) CI = 32.7 – 44.7%
Citation Plagiarism	426(65.2%) 60.7 – 69.7%	11 (1.7%) CI = -5.9 – 9.2%	212 (32.5) CI = 26.2 – 38.8%
Paraphrasing Plagiarism	137 (21%) CI = 14.2 – 27.8%	227 (34.8%) CI = 28.6 – 40.9%	289 (44.3%) CI = 38.5 – 49.9%
Misrepresentation	153 (23.4%) CI = 16.7 – 30.1%	251 (38.4%) CI = 32.4 – 44.5%	249 (38.1%) CI = 32.1 – 44.2%
Authorship Misconduct	237 (36.3%) CI = 30.2 – 42.4%	239 (36.6%) CI = 30.5 – 42.7%	177 (27.1%) CI = 20.6 – 33.6%
Duplicate Publication	155 (23.7%) CI = 17.03 – 30.4%	236 (36.1%) CI = 30 – 42.3%	262 (40.1%) CI = 34.2 – 46.1%
Data Suppression	238 (36.4%) CI = 30.3 – 42.6%	237 (36.3%) CI = 30.2 – 42.4%	178 (27.3%) CI = 20.7 – 33.8%
Data Fabrication	221 (33.8%) CI = 27.6 – 40.1%	242 (37.1%) CI = 30.9 – 43.1%	190 (29.1%) CI = 22.6 – 35.6%
Data Falsification	211 (32.3%) CI = 26 – 38.6%	242 (37.1%) CI = 30.9 – 43.1%	200 (30.6%) CI = 24.2 – 37.0%
Institutional Review Board (IRB)	442 (67.7%) CI = 63.3 – 72.04%	10 (1.5%) CI = -6.1 – 9.1%	197 (30.2%) CI = 23.8 – 36.6%
Ethical Violation	183 (28%) CI = 21.5 – 34.5%	211 (32.3%) CI = 26 – 38.6%	259 (39.7%) CI = 33.7 – 45.6%

Results presented as frequency (%age) 95% confidence interval in percent. CI = Confidence interval. Totals may not equal 653 for some items due to missing responses. Row-specific denominators were used for percentage calculations.

Respondents' Attitude towards Plagiarism:

A large proportion 60.6% (n=396) agreed or strongly agreed that sometimes it's hard to avoid using others' words without citation and 50.9% (n=332) felt justified using previous method descriptions. Notably, 37% (n=242) felt plagiarized parts could be overlooked if the paper has scientific value, though 24.2% (n=158) disagreed. (Table 4)

On issues like language barriers and short deadlines, around 37.8% (n=247) and 43.2% (n=282) respectively agreed these can justify some level of copying. Notably, 49.5% (n=323) felt that copying with a colleague's permission was not wrong.

Table 4: Respondents' Attitude towards Plagiarism

Questions	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
At times, it is unavoidable to utilize others' expressions without proper attribution, as there are few methods to articulate a concept	102 (15.6%) CI = 8.5 – 22.7%	294 (45%) CI = 39.3 – 50.7%	212 (32.5%) CI = 26.2 – 38.8%	31 (4.7%) CI = -2.7 – 12.2%	14 (2.1%) CI = -2.7 – 9.7%
Using earlier explanations of a method is justified as the method itself remains the same.	45 (6.9%) CI = -0.5 – 14.29%	287 (44%) CI = 38. 2 – 49.6%	260 (39.8%) CI = 33.9 – 45.8%	53 (8.1) CI = 0.76 – 15.27%	8 (1.2%) CI = -6.3 – 8.84%
Since self-plagiarism is harmless (one cannot steal from oneself), it is not penalized.	83 (12.7%) CI = 5.54 – 19.9%	246 (37.7%) CI = 31.6 – 43.7	245 (37.5%) CI = 31.4 – 43.5%	62 (9.5%) CI = 2.19 – 16.79%	17 (2.6%) CI = -4.9 – 10.17%
If a manuscript has significant scientific value, portions of it that include plagiarism may be ignored.	57 (8.7%) CI = 1.4 – 16.1%	185 (28.3%) CI = 21.8 – 34.8%	253 (38.7%) CI = 32.7 – 44.7%	124 (19%) CI = 12.1 – 25.9%	34 (5.2%) CI = -2.3 – 12.7%
The same penalties that apply to plagiarism should not be applied to self-plagiarism.	68 (10.4%) CI = 3.1 – 17.7%	237 (36.3%) CI = 30.2 – 42.4%	273 (41.8%) CI = 35.9 – 47.7%	63 (9.6%) CI = 2.35 – 16.9%	12 (1.8%) CI = -5.7 – 9.43%
Plagiarism penalties should be less severe for young researchers who are still learning the ropes.	54 (8.3%) CI = 0.92 – 15.6%	223 (34.2%) CI = 27.9 – 40.4%	273 (41.8) CI = 35.9 – 47.6%	90 (13.8%) CI = 6.7 – 20.9%	13 (2%) CI = -5.6 – 9.58%

It is acceptable to replicate portions of a similar article that has already been published in a foreign language if one is not proficient in that language (for example, English).	47 (7.2%) CI = -0.19 – 14.6%	200 (30.6%) CI = 24.3 – 37.1%	238 (36.4%) CI = 30.33 – 42.6%	138 (21.1%) CI = 14.3 – 27.9%	30 (4.6%) CI = -2.89 – 12.1%
Writing an academic paper without plagiarism is impossible for me.	32 (4.9%) CI = -2.7 – 12.4%	140 (21.4%) CI = 14.6 – 28.2%	253 (38.7%) CI = 32.7 – 44.7%	177 (27.1%) CI = 20.6 – 33.6%	51 (7.8%) CI = 0.45 – 15.2%
Imminent deadlines justify a degree of plagiarism.	52 (8%) CI = 0.6 – 15.3%	230 (35.2%) CI = 29.1 – 41.4%	217 (33.2%) CI = 26.9 – 39.5%	108 (16.5%) CI = 9.5 – 23.5%	46 (7%) CI = -0.35 – 14.4%
When I cannot decide what to write, I translate a portion of a paper from a foreign language.	52 (8%) CI = 0.6 – 15.3%	222 (34%) CI = 27.8 – 40.2%	227 (34.8%) CI = 28.6 – 40.9%	121 (18.5%) CI = 11.6 – 25.5%	31 (4.7%) CI = -2.7 – 12.2%
It is acceptable to use one's own previous work that was published without citation to finish the present work.	40 (6.1%) CI = -1.3 – 13.6%	142 (21.7%) CI = 14.9 – 28.5%	235 (36%) CI = 29.9 – 42.1%	185 (28.3%) CI = 21.8 – 34.8%	51 (7.8%) CI = 0.44 – 15.2%
If a colleague enables me to copy something from her/his paper, I am not doing anything wrong because I've obtained his/her permission.	75 (11.5%) CI = 4.2 – 18.7%	248 (38%) CI = 31.9 – 44.0%	199 (30.5%) CI = 24.1 – 36.9%	99 (15.2%) CI = 8.1 – 22.2%	32 (4.9%) CI = -2.6 – 12.4%

Results presented as frequency (%age) 95% confidence interval in percent. CI = Confidence interval.

Respondents' Undergraduate research experience:

Table 5 revealed that 62.8% (n=410) of respondents had not attended a research methodology course, while only 25.9% (n=169) reported attending one. Similarly, 75.3% (n=492) had not attended a research ethics course or workshop, and 84.8% (n=554) had never received training on research misconduct. Despite these gaps, over half of the respondents 56% (n=366) reported having undergraduate research experience.

Table 5: Respondents' Undergraduate research experience

Questions	No	Maybe	Yes
Have you attended research methodology course?	410 (62.8%) CI = 58.1 – 67.5%	74 (11.3%) CI = 2.5 – 17.1%	169 (25.9%) CI = 19.3 – 32.5%
Have you attended a Research Ethics (RE) course or workshop?	492 (75.3%) CI = 71.5 – 79.1%	44 (6.7%) CI = -0.7 – 14.1%	117 (17.9%) CI = 10.9 – 24.8%
Have you ever attended research misconduct training?	554 (84.8%) CI = 81.8 – 87.2%	41 (6.3%) CI = -1.1 – 13.7%	58 (8.9%) CI = 1.6 – 16.2%
Do you have Undergraduate research experience?	218 (33.4%) CI = 27.12 – 39.6%	69 (10.6%) CI = 3.3 – 17.8%	366 (56%) CI = 50.9 – 61.1%

Results presented as frequency (%age) 95% confidence interval in percent. CI = Confidence interval.

Respondents' Undergraduate research Practice

Regarding Practice, 19.9% (n=130) of respondents admitted to copying and pasting material from others' work without citation, while 65.1% (n=425) denied doing so. (Table 6) The respondents, 12.7% (n=83) acknowledged using their previously published work without giving it credit, and 11.5% (n=75) reported resubmitting their own work in another class without permission.

Table 6: Respondents' Undergraduate research Practice

Questions	No	Maybe	Yes
Have you ever copied and pasted from someone else's work into your research project	425 (65.1%) CI = 60.5 – 69.6%	98 (15%) CI = 7.9 – 22.1%	130 (19.9%) CI = 13.1 – 26.8%

or assignment without crediting or citing them?			
Have you ever used something that was previously published without giving adequate credit in another publication?	512 (78.4%) CI = 74.8 – 81.9%	58 (8.9%) CI = 1.6 – 16.2%	83 (12.7%) CI = 5.5 – 19.9%
Have you ever submitted your work to another class and then reused it without permission?	532 (81.5%) CI = 78.1 – 84.8%	46 (7%) CI = -0.35 – 14.4%	75 (11.5%) CI = 4.3 – 18.7%

DISCUSSION

The current findings revealed Karachi-based undergraduate pharmacy students' perceptions of research ethics and plagiarism. The rising prevalence of plagiarism has become a growing concern for higher education institutions. However, the literature review showed that, so far, there is a scarcity of research available to understand pharmacy students' views on this major topic. Studies indicated that more than two-thirds of college students were engaged in cheating or plagiarism at least once during their academic period [16, 17]. The current study reported a majority of female students. A Malaysian study revealed that a higher percentage of undergraduate pharmacy students were female [18]. Likewise, a study conducted in Jordan by Jarab et al., showed that the number of female respondents was five times more than the number of male respondents[19]. Contrary to this, a Saudi study reported that the percentage of female students who responded to the survey was lower than that of male students[20]. It was not unexpected to note that only 26.2% of the students have actively participated in publication process or have published research article. However, a little more than half considered themselves knowledgeable about plagiarism, likely because this understanding comes from classroom discussions, online tools, or workshops, rather than formal research or publication. Another possible reason could be that many students may not have access to platforms that guide them in publishing their work, even if they understand plagiarism[21]. Nevertheless, the knowledge of research ethics and understanding of plagiarism play important roles in predicting research

behavior. Ababneh et al., reported that out of 800 respondents, 79.12% had limited knowledge of research ethics and misconduct, 20.88% had substantial knowledge, 36.5% had received prior training in research ethics, and only 9% had received training in research conduct/misconduct[22].

Phogat et al., studied the nature and frequency of misconduct in scientific research and reported that research misconduct was notably higher in non–self-reported studies [23]. Similar to this, the responses in the present study showed a general lack of thorough understanding of specific research ethical terms, which could be a factor in the continuation of such violations. Furthermore, the distribution of responses to concepts regarding data falsification and authorship misconduct was more balanced, with many respondents indicating either full awareness or a basic knowledge. Students' views on plagiarism and its behaviors have reportedly been impacted by the university's initiatives through courses related to ethical norms of conducting research [24]. According to the results of the current study, the majority of respondents had no formal training and had not taken any courses on ethics, research misconduct, or methodology. Misconduct behaviors such as plagiarism and data falsification may be the result of ignorance, which is most likely caused by a lack of information or establishing unrealistic goals based only on achievement or higher grades[25]. Another study reported a general lack of knowledge regarding plagiarism and proper referencing expertise among students [26].

A significant proportion of respondents (60.6%) admitted that it can occasionally be difficult to refrain from repeating someone else's words without giving credit, and 50.9% felt that using prior method descriptions was acceptable, indicating some acceptability of uncredited reuse in scientific writing. A study conducted in Jordan, reported that 69.9% students admitted to plagiarizing during their studies[27]. A Saudi study revealed that a large number of respondents thought that plagiarism meant completing research assignments without properly citing sources

[28]. Likewise, a Chinese study showed that academic dishonesty engagement rates were high among students [29]. Fifty-four percent of respondents thought that self-plagiarism should not be penalized or should be punished with fewer consequences than regular plagiarism. Students' opinions demonstrated a lack of knowledge about scientific methods; they thought that plagiarism was acceptable if an article had scientific value. Babelghaith, S.D., et al. reported similar results, pointing out that the majority of pharmacy students shared comparable opinions [30].

Although 67% were categorized as having good practice based on overall composite scoring, a proportion of respondents admitted isolated misconduct behaviors. This indicates that the dichotomous ≥70% threshold may not fully capture nuanced practice patterns. The current findings showed that only (19.9%) of respondents admitted copying and pasting material from others' work without citation and 11.5% reported resubmitting their own work in another class without permission. Notably, half of respondents felt that copying with a colleague's permission was not wrong. Notably, while these unethical practices were admitted by a minority, a much larger share (62%) of respondents r**e**ported using plagiarism detection software, suggesting some awareness and effort toward maintaining academic integrity. Alua et al., reported that the respondents agreed that using Turnitin software improves academic writing, though there was a lack of awareness among students regarding its use and many had trouble comprehending the originality reports produced by the software[24]. The majority of respondents in the current study favored the adoption of a combined strategy including paraphrasing guidance, plagiarism detection tools, workshops, and clear guidelines to effectively reduce student plagiarism. Similar findings were reported by another study [31]. A study from Iran suggested that enhancing researchers' self-esteem and self-efficacy, prioritizing the quality over the quantity of published work, discouraging boastful attitudes among practitioners, reducing excessive competition among researchers, and establishing clear regulations with strict penalties for plagiarism are the strategies that could reduce plagiarism[32].

Students in the current study most frequently reported academic pressure (n=119, 18.2%), lack of time (n=103, 15.7%), and lack of knowledge (n=89, 13.6%) as the primary causes of academic plagiarism. According to Lima et al., students who have struggled academically and know peers who plagiarize are more likely to do plagiarism themselves. They also emphasized that perceiving plagiarism as a serious offense could reduce its likelihood *[16]*. According to another investigation, the standards of a highly competitive, performance-based research environment have led to accusations of "unethical behavior indicative of poor research integrity" against academics *[14]*. Overall, the findings show that students' tendency for plagiarism is significantly influenced by both internal and external factors. A similar attitude of plagiarism among students was noted in another Pakistani research *[33]*. Likewise, the students are usually expected to rely on academic texts written in English even though it is not their first language, language hurdles may be a contributing factor to inadvertent plagiarism[34]. Furthermore, the collectivist academic culture might normalize group projects and collaborative education, which could make it harder to distinguish between legitimate teamwork and individual authorship. Furthermore, even when ethical issues are raised, students may be deterred from challenging the approaches of senior authors or supervisors due to high power-distance values. The integration of plagiarism and research ethics modules in Urdu or bilingual formats, faculty-led mentorship programs that emphasize ethical authorship, and institutional training that encourages transparent interaction between students and supervisors are some culturally sensitive interventions that are advised in context with these findings. Moreover, the academic integrity and ethics modules should be included in undergraduate curricula as well as there should be the routine integration of plagiarism detection software (like SafeAssign) into institutional learning management systems[35].

Plagiarism among students is undoubtedly a prevalent issue that compromises their academic integrity and learning. The findings revealed a concerning acceptance for plagiarism and self-plagiarism, underscoring

the need for stronger institutional norms and focused strategies to reduce the prevalence of plagiarism among undergraduates. In the esteemed field of pharmacy, students acquire training to become ethical healthcare professionals. Students' behavior and attitude during their academic journey have significant impacts on how they will act in their future career *[25]*. Therefore, it is essential to establish specific protocols to more effectively track and identify dishonest behavior and to inform students of institutional actions intended to curb this growing trend.

Limitation of study:

The study was designed to detect small-to-medium effects. The observed effect size was smaller than expected, resulting in limited statistical power to detect very small associations. Nevertheless, the questionnaire showed good validity and reliability, supporting the credibility of the measured constructs. Test–retest reliability was not assessed because participants could not be re-contacted for a second administration of the questionnaire. As a result, temporal stability could not be evaluated within this cross-sectional framework. Future studies using the same instrument in a follow-up design will incorporate test-retest assessment to confirm the stability of responses over time.

Another limitation is that we did not include a measure of social-desirability bias. Since plagiarism is a sensitive topic, some students may have softened or underreported their actual behaviors to appear more responsible. Without a tool to assess this tendency, we cannot estimate the extent to which such bias may have influenced the self-reported data. Despite these limitations, this study provides novel perspectives on the attitude–behavior gap in students' awareness and practice of plagiarism. Future research can be further explored by adding more contextual factors and examining how well these models work in various educational contexts.

Students were sampled from multiple universities; however, institutional identifiers were anonymized in the dataset to preserve confidentiality. As a result, clustering effects could not be formally assessed using multilevel

modeling or intraclass correlation coefficients. Future studies retaining institutional identifiers may better evaluate potential hierarchical effects.

The post-hoc power analysis indicated limited achieved statistical power (0.32), primarily due to the very small observed effect size (Cohen's f^2 = 0.0043). This suggests that the detected associations were weak and that the study may have been underpowered to detect small effects reliably. Consequently, non-significant findings should be interpreted with caution, as the probability of Type II error is increased. Future studies with larger sample sizes or stronger underlying effect structures are warranted to confirm these associations.

The ≥70% threshold used to categorize "good" KAP was based on conventional practice in similar survey-based studies; however, it was not externally validated against objective behavioral criteria. Therefore, classification should be interpreted cautiously.

Lastly, the findings may not be generalizable beyond Karachi's urban academic context to rural or other regional universities and future studies should include students from rural areas and diverse regions to provide a more comprehensive understanding of the topic.

Conclusions:

The current study showed that the developed PRE-Q was successfully validated and had good reliability and construct validity. The outcomes provide a baseline understanding of students' knowledge, attitudes, and practices regarding research ethics and plagiarism and highlighted the key predictors that may guide the development of targeted educational or policy interventions.

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List of Abbreviations

PRE-Q: Plagiarism and Research Ethics Questionnaire

KMO: Kaiser-Meyer-Olkin

CHAID: Chi-squared automatic interaction detection

SDG: Sustainable Development Goal

COPE: Committee on Publication Ethics

LMS: Learning Management Systems

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

PCA: Principal Component Analysis

Declarations

Ethics approval and consent to participate:

The study was approved by the Ethical Review Committee of Hamdard University, Karachi, Pakistan (Reference No: ERC-FOP-2024-019). All methods were performed in accordance with the relevant guidelines and regulations. The study was conducted in accordance with the principles of the Declaration of Helsinki. The students were explained about the scope of study and their written consent was obtained. The questionnaire included a consent statement, and respondents were able to proceed only after clicking the “I Agree” button.

Consent for publication

Not applicable.

Availability of data and materials:

The datasets used during the study are available from the corresponding author upon reasonable request.

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The authors declare that they have no competing interests.

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Authors' contributions

SS, HI, TM, HR: Conception, Study design, Data collection, Data interpretation, Manuscript writing. MA, AA, SA: Data analysis, interpretation. SN, HS: Data collection, interpretation. SA, SJ: Supervision, Validation, Project administration. All authors reviewed the manuscript.

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