

Evaluation of knowledge, attitude, and practice regarding biostatistics among resident doctors in a tertiary teaching hospital of Odisha: a cross-sectional survey.

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Abstract

Background:

Biostatistics is fundamental to evidence-based medicine, critical appraisal, research design, data analysis, and interpretation of scientific literature. However, postgraduate medical trainees may have inadequate practical competence despite recognizing its importance. This study assessed the knowledge, attitude, and practice (KAP) regarding biostatistics among resident doctors at a tertiary teaching hospital in Odisha.

Methods:

A cross-sectional questionnaire-based survey was conducted among postgraduate resident doctors at MKCG Medical College and Hospital, Berhampur, Odisha, from October 2025 to January 2026. A structured, investigator-designed questionnaire assessed sociodemographic and academic characteristics, knowledge, attitude, and practices regarding biostatistics. Knowledge was assessed using six multiple-choice questions with a maximum score of 30, while attitude was assessed using six Likert-scale statements. Practice-related questions permitted multiple responses. Data were summarized using frequencies and percentages, and associations of knowledge and attitude categories with participant characteristics were assessed using appropriate categorical tests. A p-value <0.05 was considered statistically significant.

Results:

Seventy-four resident doctors participated. Knowledge varied across domains, with correct responses ranging from 32.4% to 79.7%. Most participants (67.6%) demonstrated a moderate attitude toward biostatistics, while 28.4% had a positive attitude and 4.1% a negative attitude. All participants agreed that residents should receive biostatistics training, although 59.5% considered their existing training inadequate. Microsoft Excel (66.2%) and SPSS (55.4%) were the most commonly used software. Previous literature (85.1%) was the predominant basis for sample-size calculation, while convenience sampling (52.7%) was commonly reported. No statistically significant associations were observed between knowledge or attitude categories and the examined sociodemographic, academic, or biostatistics-training characteristics ($p>0.05$).

Conclusion:

Resident doctors showed gaps in biostatistical knowledge despite favourable attitudes, highlighting the need for structured, practical biostatistics training during postgraduate education.

Recommendation:

Structured, longitudinal, competency-based biostatistics training with hands-on application to clinical research should be integrated into postgraduate medical education to improve statistical literacy and independent research competency.

Keywords: Biostatistics; Knowledge; Attitude; Practice; Postgraduate Medical Education; Resident Doctors; Medical Research

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Introduction

Biostatistics plays a fundamental role in medical education and clinical research, equipping healthcare professionals with essential skills to design studies, analyze data, and interpret results critically. It is a cornerstone of evidence-based medicine, facilitating informed decision-making and improving patient outcomes. However, despite its significance, numerous studies indicate that medical students and resident doctors often perceive biostatistics as a complex and challenging subject. Negative attitudes, limited exposure, and inadequate training in statistical methodologies contribute to suboptimal knowledge and application in clinical settings [1,2].

A study conducted in China assessed medical students' attitudes towards biostatistics using a validated instrument, highlighting anxiety and cognitive barriers as major obstacles to effective learning [3]. Similarly, research in Sudan and Nigeria revealed that a lack of familiarity with statistical software and practical exposure hindered students' confidence and competence in biostatistics [4,5]. The scenario is no different in tertiary teaching hospitals in India, where resident doctors are expected to engage in clinical research as part of their competency-based medical education. However, there is limited data assessing their knowledge, attitude, and practice (KAP) regarding biostatistics. Understanding these aspects is crucial for designing targeted interventions, curriculum modifications, and faculty training programs to enhance statistical literacy and research acumen among medical professionals. This cross-sectional survey aims to evaluate the KAP of resident doctors in a tertiary teaching hospital in Odisha regarding biostatistics.

Materials and methods

Study design and setting

The present study was a cross-sectional questionnaire-based survey conducted among postgraduate junior resident doctors at Maharaja Krushna Chandra Gajapati (MKCG) Medical College and Hospital, Berhampur, Odisha, India. The study was conducted over a period of four months, from October 2025 to January 2026.

Sample Size and Sampling:

Approximately 250 postgraduate junior residents constituted the accessible study population during the study period. All eligible residents were approached for participation; therefore, a consecutive invitation approach was adopted rather than selecting a predetermined sample from the eligible population. Of these, 74 residents provided consent and completed the final questionnaire and were included in the analysis.

Development and Validation of the Study Questionnaire

Data were collected using a **structured, investigator-designed questionnaire** developed after reviewing relevant published literature on knowledge, attitudes, and practices related to biostatistics among healthcare professionals and postgraduate medical students.

The initial questionnaire was reviewed by faculty members from different medical disciplines to assess its content relevance, clarity, comprehensibility, and appropriateness. Necessary modifications were incorporated based on their suggestions before finalization of the questionnaire.

Pilot study

A pilot study was conducted among 20 postgraduate residents of MKCG Medical College and Hospital to assess the clarity, feasibility, comprehensibility, and practical applicability of the questionnaire. Feedback obtained during the pilot study was used to refine the final questionnaire. The 20 postgraduate residents who participated in the pilot study were excluded from the final study population and analysis.

Measures to Minimize Bias

Several measures were adopted to minimize potential sources of bias. The questionnaire was developed following a review of relevant literature and was reviewed by faculty members from different medical disciplines for content relevance, clarity, and comprehensibility. A pilot study was conducted before final data collection, and the pilot participants were excluded from the final analysis. The questionnaire was administered electronically using a standardized Google Form to ensure uniformity in data collection. Participation was voluntary, and anonymity and confidentiality were maintained to reduce social-desirability bias. Nevertheless, because participation was voluntary and responses were self-reported, selection, non-response, recall, and social-desirability biases could not be completely excluded.

Data collection procedure

The finalized questionnaire was converted into an electronic format using Google Forms. The questionnaire link was circulated to eligible postgraduate junior residents through commonly used social media and electronic communication platforms, including WhatsApp and Facebook.

The study information and informed-consent statement were provided to participants before they proceeded to the questionnaire. Only responses from participants who provided informed consent were included in the study.

Structure of the Questionnaire

The questionnaire consisted of four sections:

Part I – Sociodemographic and Academic Characteristics:

This section collected relevant sociodemographic and academic information about the participants. Questions

were predominantly closed-ended, and participants were instructed to select the most appropriate response from the available options.

Part II – Cognition Regarding Biostatistics:

This section assessed participants' pre-existing knowledge or cognition regarding biostatistical concepts and tools. The cognition section consisted of **six multiple-choice questions**, each containing four response options, of which only one was correct. Each correct response was awarded **5 points**, whereas an incorrect response received **0 points**. Thus, the total cognition score ranged from **0 to 30**, with a higher score indicating better knowledge of biostatistics.

Part III – Attitude Towards Biostatistics:

Participants' attitudes towards biostatistics and the use of biostatistical tools were assessed using statements rated on a **five-point Likert scale**:

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

For quantitative scoring, responses were assigned scores of 1, 2, 3, 4, and 5 for strongly disagree, disagree, neutral, agree, and strongly agree, respectively. For the negatively worded statement, 'Biostatistics is best left to statisticians,' reverse scoring was applied. The cumulative attitude score therefore ranged from 6 to 30, with higher scores indicating a more favourable attitude toward biostatistics.

Part IV – Practice Regarding Biostatistics:

This section assessed participants' practices and behaviours regarding the use of different biostatistical methods, software, and statistical resources. The practice-related questions were presented with **six response options**, and participants were permitted to select **multiple responses wherever applicable**. Therefore, individual response options were analysed as multiple-response variables rather than mutually exclusive categories.

Outcome measures

The principal study outcomes were:

1. **Cognition regarding biostatistics**, assessed using the total cognition score.
2. **Attitude towards biostatistics**, assessed using the cumulative Likert-based attitude score.
3. **Practice regarding biostatistics**, assessed from participants' reported use of statistical methods, software, resources, and related practices.
4. The relationship of cognition, attitude, and practice with relevant sociodemographic and academic characteristics of the postgraduate residents.

Statistical analysis -

The collected data were checked for completeness and consistency before statistical analysis. Data obtained

through Google Forms were coded and entered into a Microsoft Excel spreadsheet and subsequently analysed using **IBM SPSS Statistics**. Categorical variables, including sociodemographic characteristics, academic characteristics, previous biostatistics training, research experience, individual knowledge responses, attitude responses, and biostatistical practice patterns, were summarized using **frequency (n) and percentage (%)**. The characteristics of the study participants were therefore presented as descriptive frequency distributions. For assessment of **knowledge regarding biostatistics**, six multiple-choice questions were included. Each correct response was awarded **5 points**, whereas an incorrect response was assigned **0 points**, giving a possible total knowledge score ranging from **0 to 30**. For further analysis, participants were classified into **high knowledge (score 16–30)** and **low knowledge (score 0–15)** groups. The distribution of correct and incorrect responses for each knowledge item was expressed as frequency and percentage. Participants' **attitudes toward biostatistics** were assessed using six statements rated on a five-point Likert scale. For categorical interpretation of the overall attitude score, **Bloom's** criteria were applied. Participants were classified as having a positive attitude (score 24–30), moderate attitude (score 18–23), or negative attitude (score 6–17). The distribution of responses to individual attitude statements and the overall attitude categories were summarized as frequencies and percentages. For the practice component, questions allowing more than one response were treated as multiple-response variables. Consequently, each practice option was analysed independently, and its frequency and percentage were calculated using the total number of participants (**N = 74**) as the denominator. Therefore, the cumulative percentages within individual multiple-response domains were permitted to exceed 100%. Practice domains included statistical software used, approaches to statistical analysis, statistical procedures employed, methods of data presentation, methods of sample-size calculation, and sampling techniques. Associations between categorical variables were assessed using the Chi-square test of independence and Fisher's exact test, as applicable. Similarly, associations between attitude categories and participant characteristics were evaluated using the Chi-square test and Fisher's exact test, as applicable. All statistical tests were **two-tailed**, and a p-value <0.05 was considered statistically significant.

Ethical approval

The study protocol was reviewed and approved by the **Institutional Ethics Committee (IEC), MKCG Medical College and Hospital, Berhampur, Odisha, India**, on **9 April 2025**, with IEC Approval No. 278. The study was

conducted in accordance with applicable institutional ethical principles for research involving human participants.

Informed consent

Written informed consent was obtained from all participants before their enrolment in the study. Participants were informed about the purpose and procedures of the study, the voluntary nature of participation, their right to withdraw at any stage, and the measures adopted to maintain confidentiality and anonymity.

consent for publication of personally identifiable information was not applicable.

Confidentiality and anonymity

Participant anonymity and confidentiality were maintained throughout data collection, analysis, and reporting. The information collected was used exclusively for research purposes, and no personally identifiable information was disclosed in the manuscript

Consent for publication

The manuscript reports aggregated and anonymized study findings and does not contain identifiable personal information of individual participants. Therefore, separate

Results:

Table No. 1: Sociodemographic, Academic, Biostatistics Training, and Research Characteristics of the Study Participants (N = 74)

Variable	Category	Frequency, n (%)
Age (years)	25–30	20 (27.0)
	31–35	29 (39.2)
	36–40	15 (20.3)
	≥41	10 (13.5)
Gender	Female	38 (51.4)
	Male	36 (48.6)
Family status	Married and have a child	17 (23.0)
	Married and have no child	25 (33.7)
	Single	32 (43.3)
Designation	1st-year PGT	15 (20.3)
	2nd-year PGT	17 (23.0)
	3rd-year PGT	26 (35.1)
	Other	16 (21.6)
Department	Allied branches (Anatomy, Physiology, Pharmacology)	34 (46.0)
	Diagnostic	14 (18.9)
	Preventive (Preventive and Social Medicine)	20 (27.0)
	Treatment	5 (6.8)
Previous biostatistics course	VGY	1 (1.4)
	Completed BCBR while in service as Assistant Professor	1 (1.4)
	Completed course before joining PG	3 (4.0)
	Have not completed any course until now	26 (35.2)
	Completed course at the tertiary-care hospital/college where joined PG	33 (44.5)
Research experience	Completed course at another college where PG was not undertaken	11 (14.9)
	Not involved in any study	6 (8.1)
	Submitted an article	20 (27.0)
	Published an article	8 (10.8)
	Started a study but not using biostatistical applications	12 (16.2)
	Started a study and using biostatistics for data analysis	28 (37.8)

Table No. 1 depicted that the largest proportion belonged to the 31–35-year age group (39.2%), with a nearly equal gender distribution (51.4% female and 48.6% male). Most participants were single (43.3%), followed by those married

without children (33.7%). Third-year PGTs constituted the largest designation group (35.1%), while allied branches accounted for the highest departmental representation (46.0%). Regarding biostatistics training, 44.5% had

completed a biostatistics course at the tertiary-care institution where they joined postgraduate training, whereas 35.2% had not completed any such course. In terms of research experience, the largest proportion (37.8%) had

initiated a study and were using biostatistics for data analysis, followed by 27.0% who had submitted an article. Only 8.1% reported no previous involvement in research.

Table 2: Knowledge regarding biostatistics among study participants (n= 74)

Question No.	Knowledge Question	Correct Answer	Participants Answering Correctly, n (%)	Participants Answering Incorrectly, n (%)
Q1	Which of the following is an ordinal variable? (a) Age (b) Gender (c) Blood group (d) Socioeconomic status	Socioeconomic status	48(64.9)	26(35.1)
Q2	Rejecting the null hypothesis when it is actually true leads to: (a) Type I error (b) Standard error (c) Type II error (d) Correct decision	Type I error	43(58.1)	31(41.9)
Q3	All are used to test the normality of data except: (a) Shapiro–Wilk test (b) Histogram (c) Bar chart (d) P–P plot	Bar chart	33(44.6)	41(55.4)
Q4	Which of the following is a non-parametric test? (a) Unpaired t-test (b) Paired t-test (c) One-way ANOVA (d) McNemar test	McNemar test	59(79.7)	15(20.3)
Q5	If both the exposure and outcome variables are quantitative and normally distributed, which statistical test is used? (a) Pearson correlation (b) Spearman correlation (c) Kruskal–Wallis test (d) Binomial regression	Pearson correlation	51(68.9)	23(31.1)
Q6	A study compares BMI among individuals with and without a history of CVD. BMI is normally distributed. Which statistical test should be used? (a) Paired t-test (b) Two-way ANOVA (c) Unpaired t-test (d) Chi-square test	Unpaired t-test	24(32.4)	50(67.6)

Table No. 2 shows that among the 74 participants, the highest proportion of correct responses was observed for

identifying McNemar test as a non-parametric test (79.7%), followed by selecting Pearson correlation for normally

distributed quantitative variables (68.9%) and recognizing socioeconomic status as an ordinal variable (64.9%). More than half (58.1%) correctly identified Type I error as rejection of a true null hypothesis. Knowledge was comparatively lower regarding assessment of normality,

with only 44.6% correctly identifying that a bar chart is not used for testing normality. The poorest performance was observed in selecting the appropriate test for comparing normally distributed BMI between two independent groups, where only 32.4% correctly chose the unpaired t-test.

Table 3: Attitude regarding biostatistics among resident doctors (n=74)

Statement	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly Agree n (%)
All resident doctors must have training in biostatistics	0 (0.0)	0 (0.0)	0 (0.0)	31 (41.9)	43 (58.1)
Biostatistics is interesting to me	0 (0.0)	11 (14.9)	29 (39.2)	20 (27.0)	14 (18.9)
My training in biostatistics is adequate for my needs	15 (20.3)	29 (39.2)	15 (20.3)	15 (20.3)	0 (0.0)
I must be able to analyze my own research projects	7 (9.5)	11 (14.9)	11 (14.9)	28 (37.8)	17 (23.0)
Knowledge of biostatistics is necessary for literature review	2 (2.7)	9 (12.2)	8 (10.8)	28 (37.8)	27 (36.5)
Biostatistics is best left to statisticians*	27 (36.5)	23 (31.1)	17 (23.0)	5 (6.8)	2 (2.7)

Table No. 3 displayed that all participants expressed a favourable attitude toward formal biostatistics training, with **58.1% strongly agreeing and 41.9% agreeing** that all resident doctors should receive such training. Similarly, **74.3% agreed or strongly agreed** that knowledge of biostatistics is necessary for literature review, while **60.8%** believed that they should be able to analyze their own

research projects. However, perceived adequacy of existing training was relatively poor, with **59.5% disagreeing or strongly disagreeing** that their biostatistics training was adequate for their needs. Only **45.9%** considered biostatistics interesting, while 39.2% remained neutral. Notably, **67.6% disagreed or strongly disagreed** with the statement that biostatistics should be left to statisticians.

Table 4: Overall attitude score classification using bloom's criteria

Attitude category	Score	N	%
Positive	24-30	21	28.4
Moderate	18-23	50	67.6
Negative	6-17	3	4.1

Table No. 4 shows that among the 74 participants, the majority (**67.6%**) had a **moderate attitude** toward biostatistics, while **28.4%** demonstrated a **positive attitude**. Only **4.1%** were classified as having a negative attitude.

Table 5: Practice patterns related to biostatistical analysis, data presentation, sample size calculation, and sampling techniques among study participants (n = 74)

Practice domain	Category/Method	Frequency, n (%)
Statistical software used for data analysis	SPSS	41 (55.4)
	Microsoft Excel	49 (66.2)
	GraphPad Prism	17 (23.0)
	R	8 (10.8)
Approach used for statistical analysis	Solved by own	37 (50.0)
	Took help from guide	44 (59.5)
	Took help from seniors	27 (36.5)
	Left to statistician	10 (13.5)
	Chi-square/Fisher's exact/McNemar test	38 (51.4)
Statistical procedures used	Student's t-test/Mann–Whitney/Wilcoxon test	38 (51.4)
	ANOVA/Kruskal–Wallis/Friedman test	26 (35.1)
	Correlation tests	3 (4.1)
	Regression analysis	6 (8.1)
Methods used for data presentation	Tables	45 (60.8)
	Histogram/Bar chart/Frequency curve	50 (67.6)
	Line chart/graph	24 (32.5)
	Scatter/dot diagram	8 (10.8)
	Pie chart	21 (28.4)
Sample size calculation methods	Previous literature	63 (85.1)
	Pilot study	20 (27.0)
	OpenEpi	24 (32.4)
	G*Power	13 (17.6)
Sampling techniques commonly used	Convenience sampling	39 (52.7)
	Random sampling	27 (36.5)
	Systematic sampling	12 (16.2)
	Stratified sampling	10 (13.5)
	Cluster sampling	5 (6.8)

Table No. 5 shows that Microsoft Excel (66.2%) and SPSS (55.4%) were the most commonly used software. For statistical analysis, 59.5% sought help from their guide, while 50.0% performed the analysis independently. Chi-square/Fisher's exact/McNemar tests and t-test/Mann–Whitney/Wilcoxon tests were the most frequently used statistical procedures (51.4% each), whereas correlation (4.1%) and regression analyses (8.1%) were infrequently

used. For data presentation, histograms/bar charts/frequency curves (67.6%) and tables (60.8%) were most commonly used. Previous literature was the predominant method for determining sample size (85.1%), while dedicated software such as OpenEpi (32.4%) and G*Power (17.6%) was less frequently used. Convenience sampling (52.7%) was the most commonly reported sampling technique, followed by random sampling (36.5%).

Table 6: Association of knowledge score regarding biostatistics with sociodemographic, academic and biostatistics training characteristics (n = 74)

Variable	Category	High Knowledge Score (16-30) n (%)	Low Knowledge Score n (%)	p-value
Gender	Female	22 (57.9)	16 (44.4)	0.247
	Male	16 (42.1)	20 (55.6)	
Family status	Married & have child	9 (23.7)	7 (19.4)	0.875
	Married & no child	12 (31.6)	13 (36.1)	
	Single	17 (44.7)	16 (44.4)	
Designation	1st-year PGT	10 (26.3)	5 (13.9)	0.136
	2nd-year PGT	11 (28.9)	6 (16.7)	
	3rd-year PGT	9 (23.7)	17 (47.2)	
	Others	8 (21.1)	8 (22.2)	
Department	Allied branches (Anatomy, Physiology, Pharmacology)	19 (50.0)	15 (41.7)	0.389
	Diagnostic	9 (23.7)	6 (16.7)	
	Preventive (Preventive & Social Medicine)	7 (18.4)	13 (36.1)	
	Treatment	3 (7.9)	2 (5.6)	
Previous biostatistics course completion	Completed at college/tertiary hospital where joined PG	21 (55.3)	24 (66.7)	0.554
	Not completed any biostatistics course	7 (18.4)	4 (11.1)	
	Completed course before joining PG	5 (13.2)	3 (8.3)	
	Completed course at another college	5 (13.2)	3 (8.3)	
	Completed BCBR while serving as Assistant Professor	0 (0.0)	1 (2.8)	
	Completed physical/online course (unspecified location)	0 (0.0)	1 (2.8)	

Table No. 6 shows that of the 74 participants, 38 had high knowledge scores, and 36 had low knowledge scores. A greater proportion of participants with high knowledge scores were female (57.9%), single (44.7%), from allied branches (50.0%), and had completed a biostatistics course at their postgraduate institution (55.3%). However, none of

the examined characteristics showed a statistically significant association with knowledge score. The p-values were 0.247 for gender, 0.875 for family status, 0.136 for designation, 0.389 for department, and 0.554 for previous biostatistics course completion (all $p > 0.05$).

Table 7: Association of attitude regarding biostatistics with sociodemographic, academic and biostatistics training characteristics (n = 74)

Variable	Category	Moderate n (%)	Negative n (%)	Positive n (%)	p- value
Gender	Female	26 (52.0)	2 (66.7)	10 (47.6)	0.816
	Male	24 (48.0)	1 (33.3)	11 (52.4)	
Family status	Married & have child	10 (20.0)	0 (0.0)	6 (28.6)	0.785
	Married & no child	17 (34.0)	1 (33.3)	7 (33.3)	
	Single	23 (46.0)	2 (66.7)	8 (38.1)	
Designation	1st-year PGT	11 (22.0)	0 (0.0)	4 (19.0)	0.227
	2nd-year PGT	14 (28.0)	0 (0.0)	3 (14.3)	
	3rd-year PGT	18 (36.0)	1 (33.3)	7 (33.3)	
	Other	7 (14.0)	2 (66.7)	7 (33.3)	
Department	Allied branches (Anatomy, Physiology, Pharmacology)	21 (42.0)	0 (0.0)	13 (61.9)	0.154
	Diagnostic	12 (24.0)	2 (66.7)	1 (4.8)	
	Preventive (Preventive & Social Medicine)	14 (28.0)	1 (33.3)	5 (23.8)	
	Treatment	3 (6.0)	0 (0.0)	2 (9.5)	
Previous biostatistics course completion	Completed at college/tertiary hospital where joined PG	23 (46.0)	1 (33.3)	9 (42.9)	0.071
	Not completed any biostatistics course	17 (34.0)	1 (33.3)	8 (38.1)	
	Completed course before joining PG	1 (2.0)	1 (33.3)	0 (0.0)	
	Completed course at another college	9 (18.0)	0 (0.0)	3 (14.3)	
	Completed BCBR while serving as Assistant Professor	0 (0.0)	0 (0.0)	1 (4.8)	

Table No. 7 showed that a moderate attitude was predominant across most participant subgroups, while relatively few participants demonstrated a negative attitude. No statistically significant association was observed between attitude category and gender ($p = 0.816$), family status ($p = 0.785$), designation ($p = 0.227$), department ($p = 0.154$), or previous biostatistics course completion ($p = 0.071$). Although previous biostatistics training showed the lowest p-value and suggested some variation in attitude across training categories, it did not reach statistical significance at the 5% level.

Discussion

Sociodemographic and academic characteristics

The present study included postgraduate resident doctors from different age groups, academic years, and disciplines, providing insight into biostatistical knowledge, attitudes, and practices across a heterogeneous resident population. The largest proportion of participants belonged to the 31–35-year age group, were single, and were third-year postgraduate trainees (Table 1). Previous studies by Bharti et al. and Laxman Kumar et al. reported a predominance of male participants [6,7], whereas Turk et al. observed a relatively comparable gender distribution, similar to the

nearly equal representation of male and female participants in the present study [8]. Younger participants also predominated in the study reported by Tomak et al. [9]. Hasabo et al. similarly reported that a substantial proportion of participants were single and were in the third year of medical study [10]. These demographic variations across studies may reflect differences in the populations studied, institutional settings, and stages of medical training.

Knowledge regarding biostatistics

The findings demonstrate variability in residents' understanding and application of fundamental biostatistical concepts (Table 2). While relatively high proportions correctly identified McNemar's test as a non-parametric test and Pearson correlation as appropriate for normally distributed quantitative variables, considerably fewer participants correctly selected the unpaired t-test for comparing normally distributed continuous data between two independent groups. This pattern suggests that residents may be familiar with individual statistical concepts but experience greater difficulty when required to apply those concepts to specific research scenarios.

No statistically significant association was observed between the categorized knowledge score and the sociodemographic, academic, or previous biostatistics-

training characteristics examined in the present study (Table 6). Sami H. et al. reported significantly higher mean knowledge scores among males than females (25.0 vs. 19.8; $p=0.008$), whereas specialty ($p=0.12$), duration of postgraduate residency ($p=0.72$), years after graduation ($p=0.06$), and previous epidemiology training ($p=0.06$) were not significantly associated with knowledge scores [11]. Tomak et al., in contrast, reported a significant association between previous biostatistics training and knowledge scores ($p<0.001$) [9,12]. The absence of a similar association in the present study may reflect differences in sample characteristics, sample size, course content, intensity of previous training, or the extent to which theoretical training was translated into practical statistical competency.

Attitude towards biostatistics

Despite the observed knowledge gaps, participants generally demonstrated favourable perceptions regarding the importance of biostatistics. Most had a moderate or positive overall attitude; all agreed that resident doctors should receive biostatistics training, and a substantial proportion recognized its importance for literature review and independent research (Tables 3 and 4). At the same time, 59.5% considered their existing training inadequate. Collectively, these findings indicate that the principal challenge may not be unwillingness to learn biostatistics, but rather insufficient practical and competency-oriented exposure during postgraduate training.

Attitudes toward statistics have previously been evaluated using instruments such as the Survey of Attitudes Toward Statistics described by Schau et al. [13]. Hasabo et al. similarly found above-average attitude scores among approximately two-thirds of participants [10], whereas Sujatha et al. reported a predominantly negative attitude toward biostatistics [14]. Kiekkas et al. demonstrated the potential value of formal biostatistics education in improving attitudes toward statistics [15]. These observations support the importance of incorporating structured biostatistics training into medical education.

In the present study, attitude categories were not significantly associated with gender, family status, designation, department, or previous biostatistics training (Table 7). This differs from the findings of Sami H. et al., who reported significant relationships between attitude and gender, age, and previous biostatistics training, while specialty was not significantly associated with attitude [11]. Such differences may arise from variations in study populations, educational exposure, institutional curricula, and sample size. Importantly, the absence of statistically significant associations in the present study suggests that the need for improved biostatistical training may extend across resident subgroups rather than being confined to particular demographic or academic categories.

Practice regarding biostatistics

The practice findings provide further evidence of a gap between favourable attitudes toward biostatistics and its practical application in research (Table 5). Microsoft Excel was the most commonly reported software, followed by SPSS. In contrast, Hasabo et al. reported SPSS as the most commonly used statistical software [10], while Stata and SAS have been reported in health-services research in the United States [16]. These differences may reflect variations in software accessibility, institutional resources, familiarity, and the level of statistical training available to researchers.

Basic statistical procedures were used more frequently than advanced analytical methods. Chi-square/Fisher's exact/McNemar tests and t-test/Mann-Whitney/Wilcoxon tests were commonly reported, whereas correlation and regression analyses were used relatively infrequently. Similarly, histograms, bar charts, frequency curves, and tables were the predominant approaches to data presentation. Hasabo et al., in contrast, reported tables as the most frequently used method of data presentation and linear regression as a commonly used statistical procedure [10]. The predominance of relatively basic analytical methods in the present study may indicate greater familiarity with conventional statistical procedures and comparatively limited practical exposure to advanced statistical analysis.

The practice findings also identified potential methodological training needs. Previous literature was the most frequently reported basis for sample-size determination, while convenience sampling was the most commonly reported sampling method. These findings suggest that postgraduate training should place greater emphasis on independent sample-size estimation, appropriate selection of sampling strategies, and the methodological rationale underlying statistical analysis rather than relying primarily on previously published studies or easily accessible sampling methods.

Half of the participants reported performing statistical analyses independently, while many also sought assistance from their guides or seniors. Bharti et al. reported that none of their participants used or paid professionals for biostatistical assistance [6]. Gore et al. identified the non-availability of statisticians as an important difficulty encountered during research analysis [17]. Access to appropriate statistical mentorship may therefore be important; however, such support should complement rather than replace the development of fundamental statistical competency among postgraduate residents.

Generalizability

The findings should be interpreted within the context of a single tertiary teaching hospital in Odisha. Although participants represented different postgraduate years and

medical disciplines, the relatively small sample size and voluntary participation may limit external validity. Differences in postgraduate curricula, availability of formal biostatistics training, research infrastructure, and access to statistical support across institutions may influence residents' knowledge, attitudes, and practices. Consequently, the findings should not be assumed to represent all postgraduate resident doctors in Odisha or India. Larger multicentre studies involving diverse specialties and institutions would provide more robust evidence regarding the generalizability of these observations.

Conclusion

This study highlights an important knowledge–attitude–practice gap in biostatistics among postgraduate resident doctors at a tertiary teaching hospital. Although the participants demonstrated variable knowledge of fundamental biostatistical concepts, important deficiencies were evident in the practical selection of appropriate statistical tests, particularly for normality assessment and comparison of continuous variables between independent groups.

Despite these knowledge gaps, the residents demonstrated a strong willingness to learn and apply biostatistics. All participants agreed that resident doctors should receive formal training in biostatistics; 74.3% recognized its importance for literature review, and 60.8% believed that they should be capable of analysing their own research. Importantly, however, 59.5% considered their existing training inadequate for their needs. Thus, the principal challenge appears to be not a lack of perceived importance of biostatistics, but insufficient translation of favourable attitudes into statistical competence and independent research practice.

The practice findings further reinforce this gap. Participants predominantly relied on readily accessible tools such as Microsoft Excel and SPSS, basic statistical procedures, previous literature for sample-size estimation, and convenience sampling; advanced analytical approaches such as correlation and regression were relatively infrequently reported. Moreover, neither knowledge nor attitude showed statistically significant associations with the examined sociodemographic, academic, or previous biostatistics-training characteristics, suggesting that the observed deficiencies may be broadly distributed across resident subgroups rather than confined to a particular demographic or academic category.

Strengths and Limitations

This study provides institution-specific evidence regarding knowledge, attitudes, and practices related to biostatistics among postgraduate resident doctors in South Odisha and

additionally examines their associations with selected sociodemographic, academic, and training characteristics. However, several limitations should be considered. First, the cross-sectional design precludes assessment of temporal or causal relationships. Second, the relatively small sample from a single tertiary teaching institution limits generalizability. Third, voluntary participation may have introduced selection and non-response bias, as residents with greater interest in research or biostatistics may have been more likely to participate. Fourth, practice-related information was self-reported and may therefore be subject to recall and social-desirability bias. Finally, the predominantly closed-ended questionnaire did not permit detailed qualitative exploration of participants' perceived barriers, educational needs, or suggestions for improving biostatistics training.

Recommendations

Based on the findings of the present study, there is a need to strengthen practical and competency-oriented biostatistics training during postgraduate medical education. Although resident doctors demonstrated predominantly moderate-to-positive attitudes toward biostatistics, substantial gaps were observed in the application of fundamental statistical concepts. Furthermore, 59.5% of participants perceived their existing biostatistics training as inadequate, despite universal agreement regarding the need for biostatistics training among residents.

The following measures are recommended:

1. **Structured biostatistics training should be integrated throughout postgraduate residency**, rather than being restricted to isolated lectures or short-term courses. Training should progress from fundamental concepts to their practical application in clinical research.
2. Greater emphasis should be placed on **hands-on, problem-based learning using real clinical datasets**, particularly on choosing the appropriate statistical test, assessing data distribution and normality, interpreting p-values and confidence intervals, and differentiating parametric from non-parametric methods. This is particularly relevant because important knowledge gaps were observed in normality assessment and selection of the appropriate test for comparing two independent groups.
3. Postgraduate residents should receive practical training in **statistical software beyond basic data handling**, including SPSS, R, GraphPad Prism, and other appropriate statistical packages. The emphasis should be on understanding the statistical principles underlying an analysis rather than merely generating software output. The

current findings indicate predominant use of Microsoft Excel and SPSS, with comparatively limited use of advanced analytical procedures.

4. Training should specifically address **research methodology, sample-size calculation, sampling techniques, and advanced statistical methods**. The high reliance on previous literature for sample-size determination (85.1%) and convenience sampling (52.7%) indicates areas where greater methodological competency may be beneficial.
5. **Biostatistical consultation or mentorship services** should be readily available within teaching institutions. Residents should be encouraged to consult trained faculty or biostatisticians from the protocol-development stage rather than seeking statistical assistance only after data collection.
6. Competency in biostatistics should be assessed periodically through **formative assessments, research-protocol exercises, critical appraisal of published articles, interpretation of statistical outputs, and analysis of clinical datasets**. Such assessments would help identify individual learning gaps and reinforce the practical application of statistical concepts.
7. Since no significant association was demonstrated between knowledge or attitude and the sociodemographic and academic characteristics examined, educational interventions should preferably be offered **across postgraduate batches and disciplines rather than being restricted to selected resident subgroups**.
8. Finally, **larger multicentre studies** involving postgraduate residents from different specialties, institutions, and geographical regions should be undertaken using validated assessment instruments. Longitudinal or pre-post interventional studies would be particularly valuable to determine whether structured biostatistics training produces measurable and sustained improvements in statistical knowledge, attitudes, research practices, and independent analytical competency.

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Conflict of interest

The authors declare that they have no financial or non-financial conflicts of interest relevant to this study.

Data availability statement

The data generated and analysed during the present study are not publicly deposited because they were collected from resident doctors under conditions of confidentiality. De-identified data may be made available by the corresponding author upon reasonable request, subject to applicable institutional and ethical requirements.

List of abbreviations

- ANOVA – Analysis of Variance
- BCBR – Basic Course in Biomedical Research
- CVD – Cardiovascular Disease
- IEC – Institutional Ethics Committee
- KAP – Knowledge, Attitude and Practice
- MKCG – Maharaja Krushna Chandra Gajapati
- PG – Postgraduate
- PGT – Postgraduate Trainee
- SPSS – Statistical Package for the Social Sciences

Author contributions

Srikanta Panigrahy (First Author): Conceptualization; Methodology; Investigation; Data curation; Writing – original draft.

Adyasha Anindita Panda (Second Author): Investigation; Data curation; Methodology; Writing – review and editing.

Suvendu Kumar Panda (Third Author and Corresponding Author): Conceptualization; Methodology; Formal analysis; Supervision; Writing – review and editing.

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Original Article

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