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ORIGINAL ARTICLE

IMPACT OF RESEARCH METHODOLOGY WORKSHOPS ON KNOWLEDGE AND SKILLS IN RESEARCH DESIGN, SAMPLING AND STATISTICAL TESTING AMONG CONSULTANTS IN MAJOR CITIES OF PAKISTAN: A QUASI- EXPERIMENTAL STUDY

Muhammad Irfanullah Siddiqui[1], Shakeeb Irfan[2], Asim Awan[3]

[1]Department of Community Medicine and Pilgrims Health careCollege of Medicine, Umm Al-Qura University, Makkah, Saudi Arabia, [2]Ali Habib Medical center, Karachi, Pakistan, [3]Faculty of Eastern Medicine, Hamdard University, Karachi, Pakistan

ABSTRACT

Background: Conducting research involves several challenges, including selecting an appropriate study design, applying proper sampling techniques, data presentation, and choosing appropriate statistical tests. This study aimed to compare participants' pre- and post-workshop knowledge and skills regarding study design, sampling techniques, sample size estimation, use of statistical software, data summarization, data presentation, and data analysis to improve their ability to conduct practical research.

Materials & Methods: This study was multicenter research conducted in various cities of Pakistan from January 01,2025 to February 20, 2025, involving consultants from different medical specialties. A total of 480 consultants were randomly selected from various medical colleges across 12 major cities in Pakistan. All participants completed a pre-test questionnaire before the workshop and the same questionnaire as a post-test after the sessions, prior to receiving their certificates. Data was entered and analyzed using SPSS version 22. Categorical variables were presented as proportions and percentages, with McNemar's test used to compare pre-test and post-test responses. A p-value of ≤ 0.05 was considered significant.

Results: A total of 438 participants completed both the pre- and post-test assessments. A highly significant improvement was observed in the mean scores 5.137 in the pre-test compared to 7.657 in the post-test. Mean scores were compared by applying a paired t-test and a highly significant improvement was observed ($p < 0.001$). Significant improvements were also noted in knowledge of study design, sampling techniques, and data analysis. However, no significant change was observed in data presentation skills.

Conclusion: Research methodology workshops are effective in enhancing participants' knowledge, analytical abilities, and critical thinking skills. Conducting such workshops regularly in teaching institutions can help foster a strong research culture nationwide.

KEY WORDS: Challenges; Clinical Trials; Data analysis; Methodology; Research; study design; Teacher training.

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INTRODUCTION

Globally, healthcare research has seen significant financial investment, rising from approximately US $240 billion in 2010 to around US $2.4 trillion in 2019.[1,2] The important most component of health care research is research methodology. Research methodology is a structured and scientific approach used to collect, organize, present, analyze, and interpret data; whether quantitative, qualitative, or mixed, to answer research questions or test hypotheses. It serves as a blueprint for conducting research, ensuring that the study remains focused and systematically executed.[3-5] The methodology section of a scientific study outlines key decisions, including study design, sampling techniques, sample size determination, inclusion and exclusion criteria, key variables, ethical considerations, statistical software used (e.g., OpenEpi, SPSS), and methods for data analysis and presentation. Justifying these choices is essential to ensure the reliability and

Corresponding Author:

Prof. Dr. Muhammad Irfanullah Siddiqui
Professor, Department of Community Medicine & Pilgrimage Services, Umm Al-Qura University
Hamdard University, Saudi Arabia.
E-mail: irfan7255@yahoo.com

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validity of research findings.

Such research plays a critical role in shaping healthcare policies, optimizing patient outcomes, and ensuring efficient use of limited healthcare resources to support sustainable service delivery. In order to contribute and benefit from the healthcare research the physicians are required to be well trained for research methods. There are three primary types of research methodology; quantitative, qualitative, and mixed-method, which can be chosen based on the research objectives. Having a good research methodology in place has many advantages.[6-8] Data collection methods vary depending on the research type: Qualitative research: "It often employs methods such as content analysis, narrative analysis,

discourse analysis, grounded theory, and thematic analysis".[9]

Quantitative research: "It relies on statistical applications for data analysis, which can be

categorized into": Descriptive analysis which summarizes data using measures such as frequency, central tendency (mean, median, mode), dispersion (variance, standard deviation), and percentiles and Inferential analysis which draws conclusions from a sample to a larger population using methods like correlation analysis, cross-tabulation, regression analysis, and ANOVA.[9] Training the teaching faculty followed by assessing the impact of research methodology workshops on faculty members is essential, as they play a key role in cultivating a research-oriented culture and improving community health outcomes. Various models have been developed to evaluate the effectiveness of methodological training programs. Given the importance of a robust research methodology in conducting scientifically sound research,[10] this study was designed to train medical consultants on key research components, including study design, sampling techniques, sample size estimation, risk measurement, data summarization, presentation, and statistical analysis followed by evaluation to measure the change in knowledge and application of the research tools in practical settings. This study aimed to evaluate participants' knowledge before and after attending a research methodology workshop, focusing on study designs, sampling techniques, sample size estimation, risk calculation, data summarization, presentation, and statistical analysis for application in future research.

MATERIALS & METHODS

This study is multicenter research conducted in various cities of Pakistan from January 01,2025 to February 20, 2025, involving consultants from different medical specialties. It follows a quasi-experimental design.[11,12], where participants were assessed for their pre-training knowledge, underwent intensive training in research methodology, and were then reassessed immediately after the two days training to evaluate the impact.[13] All those medical graduates (MBBS recognized by PMDC), with postgraduate qualifications such as PhD, FCPS, MD, or M.Phil., and registered with PMDC as Assistant Professor or above were included in the study.

All those who had attended any research methodology course during the last five years were excluded from the study. Anyone who did not give consent for the study was also excluded. This quantitative study measured knowledge and skills related to summarization, presentation, analysis, sampling techniques, study design, and sample size. Ideally, a control group would have been included to better assess the true impact, but no participants consented to be in the control group. Each correct response was given a score of one, while incorrect responses were marked as zero.

A 15 item, questionnaire was developed and validated to ensure clarity before its implementation. No major modifications were required as participants found it comprehensible. Stratified random sampling was used to ensure adequate female representation. The sample size was calculated using OpenEpi software,[14] considering a 95% confidence interval, 50% prevalence, and 5% alpha, resulting in a required sample of 384 participants. This was increased to 480 to account for potential dropouts and non-responses for either pre-test or post-test. Data collection involved administering a pre-test questionnaire at the outset of the workshop, followed by structured sessions covering research topics such as study design selection, sampling methods, data summarization, and presentation. Hands-on training was incorporated to enhance learning. A post-test was conducted at the end to assess improvements in knowledge and skills.

Data was entered and analyzed using SPSS version 22. Categorical variables were presented as proportions and percentages, with McNemar's test used to compare pre-test and post-test responses. A p-value of ≤ 0.05 was considered significant. Quantitative variables were presented as mean and standard deviation, and paired t-tests were used to compare pre-test and post-test performance. Ethical approval was obtained from the ethics committee of Hamdard Medical College (letter no. CMHCMD0005/2008), and informed consent was taken from all participants. Confidentiality and anonymity were strictly maintained, and all procedures adhered to the principles of the Declaration of Helsinki.

RESULTS

Demographic Characteristics: A total of 460 participants attended the workshops out of a total of 480 randomly selected. 460 participants filled the form, but 22 were excluded due to incomplete pre-test or post-test responses. Ultimately, data from 438 participants were analyzed. The response rate was 91.3% (438/480). The sample included 275 males (62.8%)%), with 228 Assistant Professors (52.1%), 139 Associate Professors (31.7%), and 71 Professors (16.2%). The participants' ages ranged from 30 to 60 years, with a mean age of 40.66 ± 5.23 years. Most of the participants were in the

age group 40-49 (47.7%) and there were only 6.6% in 50 and above age group There was no significant association between gender and age groups with any of the knowledge and skill variables. However, there was a significant association between designation and knowledge about presentation of data, measures of dispersion, and screening tests. For skills, the significant association was found between designation and application of concepts of confidence limit, measures of central tendency and calculations for relative risk. There was no significant association found between gender and pre and post test total scores.

Knowledge about research variables: In terms of knowledge, 58.9% of participants demonstrated correct understanding of the normal distribution, while only 30.1% correctly identified cross-sectional study concepts. A total of 60.3% correctly understood data presentation techniques, while knowledge about the application of range and measures of dispersions was notably poor. Encouragingly, 51.4% of participants demonstrated correct knowledge of OpenEpi software. However, knowledge regarding screening tests, and cohort/case-control studies remained below 50%. (Table 1)

Table 1: Distribution of the sample studied according to knowledge about research variables (Pre-test) n= 438

"Knowledge about"	No	%
Normal curve		
Correct	258	58.9
Incorrect	180	41.1
Cross sectional studies		
Correct	132	30.1
Incorrect	306	69.9
Presentation of data		
Correct	264	60.3
Incorrect	174	39.7
Application of range		
Correct	140	32.0
Incorrect	298	68.0
Measures of dispersion		
Correct	202	46.1
Incorrect	236	53.9
Epi-info software		
Correct	225	51.4
Incorrect	213	48.6
Screening tests		
Correct	160	36.5
Incorrect	278	63.5
Cohort/case control studies		
Correct	117	26.7
Incorrect	321	73.3

Skills about research variables: Regarding research skills, 64.4% of participants correctly applied study design concepts in a given scenario, and 50.9% successfully applied confidence limits. However, a significant proportion struggled with differentiating data types, using appropriate central tendency measures, calculating relative risk and odds ratios, applying standard error concepts, and identifying cohort/case-control studies. (Table 2)

Table 2: Distribution of study samples according to ability to apply the concepts (skills) of research variables (Pre-test) n=438

"Skill to"	No	%
Select appropriate study design		
Correct	282	64.4
Incorrect	156	35.6
Apply concept of confidence limit		
Correct	223	50.9
Incorrect	215	49.1
Differentiate types of data		
Correct	50	11.4
Incorrect	388	88.6
Apply appropriate measures of central tendency		
Correct	159	36.3
Incorrect	279	63.7
Calculate relative risk for cohort studies		
Correct	64	14.6
Incorrect	374	85.4
Calculate odd ratio		
Correct	155	35.4
Incorrect	283	64.6
Use concept of standard error		
Correct	31	07.1
Incorrect	407	92.9

Comparison of pre-test and post-test results showed substantial improvement. Correct answers regarding normal distribution increased from 58.9% to 81.5% ($p<0.001$). Similarly, knowledge of cross-sectional studies improved from 30.1% to 85.4% ($p<0.001$), and understanding of data presentation enhanced from 60.3% to 94.3% ($p<0.001$). The application of range knowledge increased from 32% to 46.6% ($p<0.001$), while knowledge of measures of dispersion exhibited borderline significance ($p=0.048$). Moreover, correct responses regarding OpenEpi software increased from 51.4% to 65.3% ($p=0.006$). Knowledge of screening tests improved significantly from 36.5% to 65.8% ($p<0.001$), but knowledge regarding cohort/case-control studies did not exhibit significant improvement ($p= 0.1798$). (Table 3)

In terms of skills, the ability to select the correct study design improved from 64.4% to 72.8% ($p < 0.001$), while the application of confidence limits increased from 50.9% to 79.5% ($p < 0.024$). Though the ability to differentiate types of data improved from 11.4% to 17.8% but did not reach to significant level ($p = 0.432$), hence further training is needed in this area. No significant change was observed in applying central tendency measures ($p = 0.675$). However, skills in calculating relative risk, odds ratio, standard error, and identifying cohort/case-control studies improved significantly ($p < 0.001$). (Table 4)

Table 3: Comparison of pre-test and posttest knowledge of the participants (n=438)

"Knowledge about" Pre-test	Post-test				No	%	p
	Incorrect		Correct				
	No	%	No	%			
Normal distribution							
Incorrect	48	26.7	132	73.3	180	41.1	<0.001**
Correct	33	12.8	225	87.2	258	58.9	
Total	81	18.5	357	81.5	438		
Cross sectional studies							
Incorrect	40	13.1%	266	86.9%	306	69.9	<0.001**
Correct	24	18.2%	108	81.8%	132	30.1	
Total	64	18.5%	374	85.4%	438		
Presentation of data							
Incorrect	25	14.4%	149	85.6%	174	39.7	<0.001**
Correct	0	0%	264	100%	264	60.3	
Total	25	5.7%	413	94.3%	438		
Application of range							
Incorrect	198	66.4%	100	33.6%	298	68.0	<0.001**
Correct	36	25.7%	104	74.3%	140	32.0	
Total	234	53.4%	204	46.6%	438		
Measures of dispersion							
Incorrect	105	44.5%	131	55.5%	236	53.9	<0.048*
Correct	100	49.5%	102	50.5%	202	46.1	
Total	205	46.8%	233	53.2%	438		
OpenEpi-info							
Incorrect	124	58.2%	89	41.8%	213	63.5	<0.006**
Correct	28	12.4%	197	87.6%	225	51.4	
Total	152	34.7%	286	65.3%	438		
Screening test							
Incorrect	113	40.6%	165	59.4%	278	63.5	<0.001**
Correct	37	23.1%	123	76.9%	160	36.5	
Total	150	34.2%	288	65.8%	438		
Cohort/case control studies							
Incorrect	203	63.2%	118	36.8%	321	73.3	=0.1798
Correct	99	84.6%	18	15.4%	117	26.7	
Total	302	68.9%	136	31.1%	438		

Test: McNamara *: Statistically significant at $p \leq 0.05$

Table 4: Comparison of pre-test and post-test skills of the participants (n=438)

"Skill to" Pre-test	Post-test				Total	p
	Incorrect		Correct			
	No	%	No	%		
Select appropriate study design						
Incorrect	77	49.4%	79	50.6%	156 35.6	<0.001**
Correct	42	14.9%	240	85.1%	282 64.4	
Total	119	27.2%	319	72.8%	438	
Apply concept of confidence limit						
Incorrect	54	25.1%	161	74.9%	215 49.1	=0.024*
Correct	36	16.1%	187	83.9%	223 50.9	
Total	90	20.5%	348	79.5%	438	
Differentiate types of data						
Incorrect	321	82.7%	67	17.3%	388 88.6	=0.432
Correct	39	78%	11	22.0%	50 11.4	
Total	360	82.2%	78	17.8%	438	
Apply appropriate measures of central tendency						
Incorrect	181	64.9%	98	35.1%	279 63.7	=0.576
Correct	107	67.3%	52	32.7%	159 36.3	
Total	288	65.8%	150	34.2%	438	
Calculate relative risk for cohort studies						
Incorrect	271	72.5%	103	27.5%	374 85.4	<0.001**
Correct	58	90.6%	6	9.4%	64 14.6	
Total	329	75.1%	109	24.9%	438	
Calculate odd ratio						
Incorrect	104	36.7%	179	63.3%	283 64.6	<0.001**
Correct	71	45.8%	84	54.2%	155 35.4	
Total	175	40.0%	263	60.0%	438	
Concept of standard error						
Incorrect	285	70.0%	122	30.0%	407 92.9	<0.001**
Correct	25	80.6%	6	19.4%	31 07.1	
Total	310	70.8%	128	29.2%	438	
Cohort/case control studies						
Incorrect	199	62.8%	118	37.2%	317 72.4	<0.001**
Correct	103	85.1%	18	14.9%	121 27.6	
Total	302	68.9%	136	31.1%	438	

Test: McNamara *: Statistically significant at $p \leq 0.05$ ** Highly significant <0.01

Table 5: Relation between total pre score and total post score of respondents (n=438)

Type of test	Mean	95% confidence interval		Standard deviation	Standard error	Test of significance Paired t test	P values
		lower	upper				
Pretest	5.137	4.911	5.356	2.280	0.1097	-18.437*	<0.001**
Post test	7.657	7.422	7.897	2.610	01210		

* Paired sample t-test

**: Statistically significant at $p \leq 0.05$

A paired t-test comparing pre-test and post-test mean scores showed a significant difference (-2.521), with pre-test scores at 5.137±2.28 and post-test scores at 7.657±2.61 ($t = -18.437$, $p < 0.001$). (Table5)

DISCUSSION

Demographic factors such as gender and age did not significantly predict knowledge and skills related to research tools, though male participants scored slightly higher than females, albeit not at a significant level. The substantial improvement in post-test scores confirms that structured training enhances participants' research knowledge and skills, which is crucial for fostering a research culture in the country. The pre-test and post-test comparisons indicate significant progress, particularly in areas like normal distribution, cross-sectional study knowledge, and data presentation. However, concepts like analytical studies and the application of range require further reinforcement through more extensive training.

The overall response rate of 91.3% was slightly lower than a similar study by Piryani,[13] which had a response rate of 96.67%. This discrepancy may be attributed to Piryani's study being conducted in a single institute, reducing dropout chances. The pre-test scores in this study (34.25% ±15.2) were like those reported by Khan[15] whereas Giri [16] found participant knowledge below 20%. Post-test scores in this study rose to 51.04% ±14.4, aligning with Dhodi[17], which reported similar post-training mean scores of 7.9 ±2.4. Normal distribution is the most widely known and used of all distributions and a basis of applying the test of significance.[18] Hence, it was encouraging to note that most of the participants' concepts were clear after the structured training about this important variable among the research variables.

Although knowledge and skills in several areas improved, gaps remain, particularly in analytical concepts, standard error application, and study designs. This could be because these important concepts were not well supported by sufficient exercises during the workshops. More time should be devoted for discussing these concepts with a variety of examples and case based/problem based exercises to clarify the analytical aspects of study design.

A two-day workshop appears insufficient to address all research training needs, and a structured four-to-five-day program with problem-based learning exercises would be more effective. Future efforts should focus on expanding training duration and incorporating mandatory research assignments to cultivate a stronger research culture in medical education in Pakistan.[19,20]

Limitation: This study was conducted in major cities of the country, and participants from smaller cities were not included. The knowledge and skills of individuals in smaller cities could differ due to fewer educational and training opportunities, which may affect the generalizability of the study. Additionally, only faculty members with the designation of assistant professor or above were included, while lecturers and demonstrators were excluded. As a result, the study findings may not be fully representative of all faculty members across the country. Being quasi-experimental, the study does not allow causal conclusions and limits the ability to quantify errors when extrapolating results to the entire faculty population.

As there was no control group, and participants' pre-test scores were considered as the control for post-test comparisons, which further limits the generalization. We recommend future national-level research to evaluate faculty members' challenges, including barriers and promoters, in gaining research knowledge and skills.

CONCLUSION

This study reports inadequate research knowledge and skills among faculty members (assistant professors and above), which significantly improved after structured workshop training. However, some areas of knowledge and skills did not improve or remained inadequate, raising concerns about gaps in medical curricula regarding research training. Future workshops should be extended in duration and emphasize variables with insufficient improvement through additional examples and exercises. Health policy planners should address this crucial issue and implement strategies to equip 21st-century physicians with essential research skills to enhance community health outcomes. Further studies should be conducted to identify barriers preventing faculty members from acquiring research competencies.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	MIS, SI
Acquisition, Analysis or Interpretation of Data:	MIS, SI, AA
Manuscript Writing & Approval:	MIS, SI, AA

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.