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ORIGINAL RESEARCH

Barriers Preventing Medical Trainees from Active Participation in Research Activities

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Background: Research has increasingly become important to career progression and a compulsory component in most medical programs. While medical trainees are consistently urged to undertake research endeavors, they frequently encounter obstacles at both personal and organizational levels that impede the pursuit of high-quality research. This study aims to identify the barriers and recommend successful interventions to increase research productivity amongst medical trainees.

Methods: A descriptive cross-sectional survey was carried out among interns, residents, and fellows within a single hospital located in the emirate of Abu Dhabi, UAE. The survey included inquiries regarding perceived obstacles hindering engagement in research activities, factors driving motivation for research involvement, and the assessment of how research participation relates to their job in terms of relevance.

Results: Fifty-seven medical trainees participated in the survey, reflecting a response rate of 53%. The survey highlighted common obstacles, notably including time constraints, insufficient statistical and methodology training, the weight of other educational commitments, as well as inadequate incentives and rewards. While a majority of participants expressed interest in engaging in research activities, the consensus was that more incentives and increased funding opportunities would significantly encourage their involvement.

Conclusion: Implementing successful interventions such as allocating dedicated time for research, facilitating access to research mentors, and organizing training sessions have the potential to be effective strategies in fostering a thriving research culture and subsequently elevating research productivity of medical trainees.

Keywords: medical research, residents, medical trainees, medical training, future of work, medical education

Introduction

Medical research is the systematic process of developing knowledge to improve patient care practices. Research has substantially promoted scientific output, facilitated access to research-focused jobs, and improved healthcare and quality of life.[1] Moreover, exposure to research stimulates research skills, including literature search, critical thinking, hypothesis testing, data communication, problem-solving, and results interpretation.[2] The future of research will depend on scientific investigation and the critical thinking skills of today's medical trainees, who will become future leaders. Medical trainees refer to individuals who are in the process of acquiring specialized medical skills and knowledge through education and practical experience to reach the level of competence necessary for independent practice.[3] This encompasses a range of roles, including medical students, interns, residents, and fellows, who are engaged in various stages of professional medical training. Earlier studies suggest that exposure to research will prepare medical students for more substantial career options by fulfilling their roles as clinicians, educators, and researchers.[4]

Over time, research has become vital to medical trainees practice and a compulsory component in most medical training.[5] International regulatory bodies, including the Accreditation Council for Graduate Medical Education (ACGME) and the United Kingdom's Royal College of General Practitioners, emphasize the importance of scholarly activity as an essential educational competency.[6,7]

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Nowadays, it has become essential for medical trainees to participate in research to improve clinical performance and keep up with the advances in modern medicine. Medical trainees are motivated and have an interest in undertaking research. Cited motivations include acquiring critical thinking skills, career progression, financial incentives, and, most importantly, personal interest.[8–10] Moreover, medical trainees acknowledge the benefits of involvement in research in improving their knowledge and sharing medical discoveries.[11,12]

Nevertheless, it is uniquely challenging for medical trainees to conduct research because of the barriers inherent to residency training programs. In essence, medical trainees are often faced with personal and organizational challenges to conduct high-quality research. Such challenges include an overwhelming academic workload, personal disinterest, poor research training, unavailability of mentorship, and, most importantly, limited time in a heavy-duty schedule.[8,9,13–15]

Previous research in developed countries has shed light on these challenges. For instance, among medical residents, barriers primarily stem from personal factors such as limited time, diminished interest, and insufficient scholarly skills.[9,13,16–18] Senior medical students often cite the absence of specialized research courses and limited access to expert mentors.[19] Interestingly, while first-year medical students display a favorable attitude towards science, they exhibited limited knowledge about scientific research methods.[11] Moreover, a survey of consultants and junior doctors in Wales revealed similar obstacles including time restrictions, administrative burdens, and lack of research knowledge.[15]

The situation is similar across developing nations and Gulf countries, where research among medical trainees shows a universally positive attitude towards the importance of research in medicine.[20–23] Despite this, there is a notable gap between the enthusiasm for research and actual engagement. Studies have shown that medical trainees in many medical institutions in developing countries publish few articles, a circumstance primarily attributed to systemic issues such as insufficient research training, time constraints, financial barriers, inadequate mentorship, and the lack of a structured research curriculum. Furthermore, these studies also emphasize that research has not yet become an integral part of the medical education curriculum in developing countries.

However, the silver lining remains that many are enthusiastic about future research, indicating that interventions like structured training, allocating dedicated research time, and offering incentives to boost research participation.

Studies worldwide have shown that, for many years, medical trainees' scholarly output has declined.[8] These alarming figures reflect a global concern rather than an isolated issue of one geographical region. As a result, it becomes essential to focus deliberate attention on this issue in the United Arab Emirates (UAE) to identify and overcome such challenges.

The United Arab Emirates, a member of the Gulf Cooperation Council, has transformed its medical education infrastructure to meet healthcare needs.[24] To attain sustainable improvement in health research, the development of research capacity is imperative at the individual and institutional levels. Hospitals have shifted from traditional clinical institutions to evidence-based centers.[25] The Accreditation Council for Graduate Medical Education-International (ACGME-I) accredited nearly all teaching hospitals and the majority of residency programs. Research training has been integral to medical school and residency training programs to achieve academic excellence and develop competent physician-scientists. Yet, medical trainees research participation and scholarly activity remain low. Several initiatives have been taken to encourage research involvement; however, many healthcare facilities still need to generate a robust research agenda. Educational leaders cannot target meaningful interventions without accurate information on barriers and facilitators to scholarly research. Therefore, the UAE needs to identify the barriers to research to effectively promote a research-oriented culture, particularly among doctors in training.

There has been increasing interest in exploring trends in resident research and scholarship across the world, yet, limited research has focused specifically on the UAE.[9,26] This study aims to determine the level of knowledge, attitude, practice, and barriers to conducting research among clinical medical trainees in the UAE. This survey is an essential first step toward understanding the contributing factors and barriers to medical trainees' research participation. Responses are intended to help identify perceived barriers faced by medical trainees and assist medical educators and academicians in informing priorities and implementing targeted interventions to mitigate the barriers, promote research among medical trainees, and improve future research success.

Methods

A descriptive cross-sectional survey was conducted on interns, residents, and fellows at Sheikh Shakhbout Medical City (SSMC) in the emirate of Abu Dhabi. Research Ethics Committee at SSMC provided an approval for this study (SSMCREC-309). The

survey was digitized using Google Forms and circulated to all medical trainees across diverse specialties at SSMC between June and November 2022.

An extensive scoping review of the literature, supplemented by consultation with medical experts, informed the design of the survey. The survey was organized into distinct sections to collect data on 1) demographic Information, including gender, training level, and specific training program, 2) previous research experience, covering aspects like past publications – both abstracts and full-length papers, 3) barriers to research, comprising questions on perceived barriers that trainees face in conducting research, 4) attitudes towards research, assessing participants' perspectives on the importance and relevance of research to their careers and 5) awareness of technologies, gathering insights into trainees' familiarity with emerging technologies in healthcare. Each section contained a mix of multiple-choice, Likert-scale, and open-ended questions. For instance, the barriers and attitudes sections used a 5-point Likert Scale ranging from "strongly disagree" to "strongly agree".

Medical trainees were encouraged to express their beliefs and assured that their responses would be kept confidential. Responses were analyzed and summarized using simple descriptive statistical methods.

Results

Medical Trainees Characteristics

Fifty-seven of all one-hundred-and-eight medical trainees responded to the survey (response rate 52.7%). Of these, 64.9% were females. The training program with the highest representation was the internal medicine residency (75.4%). In addition, most medical trainees (52.6%) were in the early stages of specialty training for less than three years. Medical trainees' demographic characteristics are summarized in Table 1. Most medical trainees acknowledged the importance of undertaking research in the medical field, yet, only a few reported any research involvement or submitted their research

Table 1 Demographic Characteristics of Medical Trainees (n=57)

Characteristic	N	(%)
Gender		
Female	37	(65%)
Male	20	(35%)
Medical Training Level		
Residency	35	(61.4%)
Fellowship	22	(38.6%)
Training program		
Internal Medicine	35	(61.4%)
Gastroenterology	5	(8.8%)
Infectious Disease	4	(7%)
Emergency Medicine	3	(5.2%)
Internship	3	(5.2%)
General Practitioner	2	(4%)
Hematology	2	(3.5%)
Cardiology	1	(1.8%)
Family Medicine	1	(1.8%)
Orthopedics	1	(1.8%)
Previous Abstract Publication		
Yes	30	(52.6%)
No	27	(47.4%)
Previous Journal Paper Publication		
Yes	25	(43.9%)
No	32	(56.1%)

for publication (65%). Of these, 51% have published at least one abstract and 45.6% have published journal papers. Scholarly research was more commonly completed by medical trainees at an advanced level of training than at earlier levels and less likely for females than males.

Prior Knowledge of Research

Overall, participants' knowledge of scientific research was good despite existing barriers. 72% of participants were familiar with the literature review, 67% were familiar with research methodology and ethics, and 40% were familiar with statistics. On the other hand, knowledge of academic writing and Institutional Research Board (IRB) initiation was dramatically low; only 2% of medical trainees were familiar with them. Results are summarized in Figure 1.

Barriers to Research

The results show that lack of time to conduct research (77%), lack of statistical skills (72%), the burden of other educational activities (72%), lack of research methodology training (72%), lack of rewards, incentives, or recognition associated with research work (70%) and lack of personal knowledge or research process (70%) were found to be the most significant barriers the study participants faced to conducting research. Other barriers include the unavailability of mentorship and faculty experienced in conducting research, lack of funding to support medical students/medical trainees conducting research, and lack of access to research equipment and facilities. Figure 2 summarizes the perceived barriers toward medical research as identified by medical trainees.

A considerable number of medical trainees (68.4%) felt that the research opportunities are prioritized by program leadership. However, believe that their training needs to undergo a significant transformation to encourage meaningful research by medical trainees. The majority considered increasing the time available for research and allocating research mentors are the most successful interventions to improve scholarly research. Other interventions that were considered helpful include giving research opportunities to the medical trainees, offering training sessions, making research participation mandatory, and providing incentives.

Attitude to Research

The attitude toward research undertaking and interest was positive. Most medical trainees responded that research would improve their critical thinking, widen their medical knowledge, allow exploring different areas of medicine, and apply

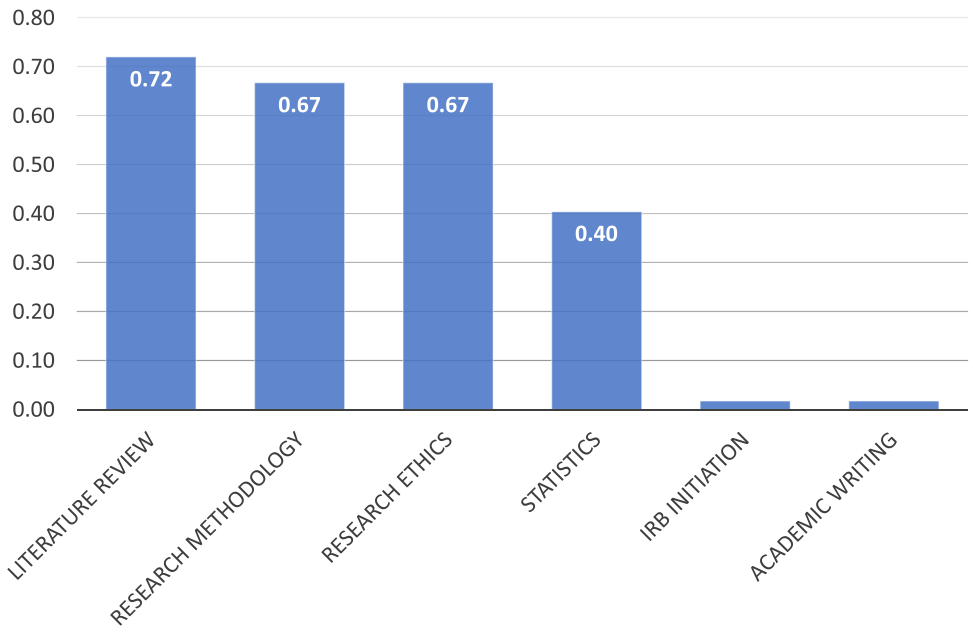

Figure 1 Prior Research Skills and Knowledge.

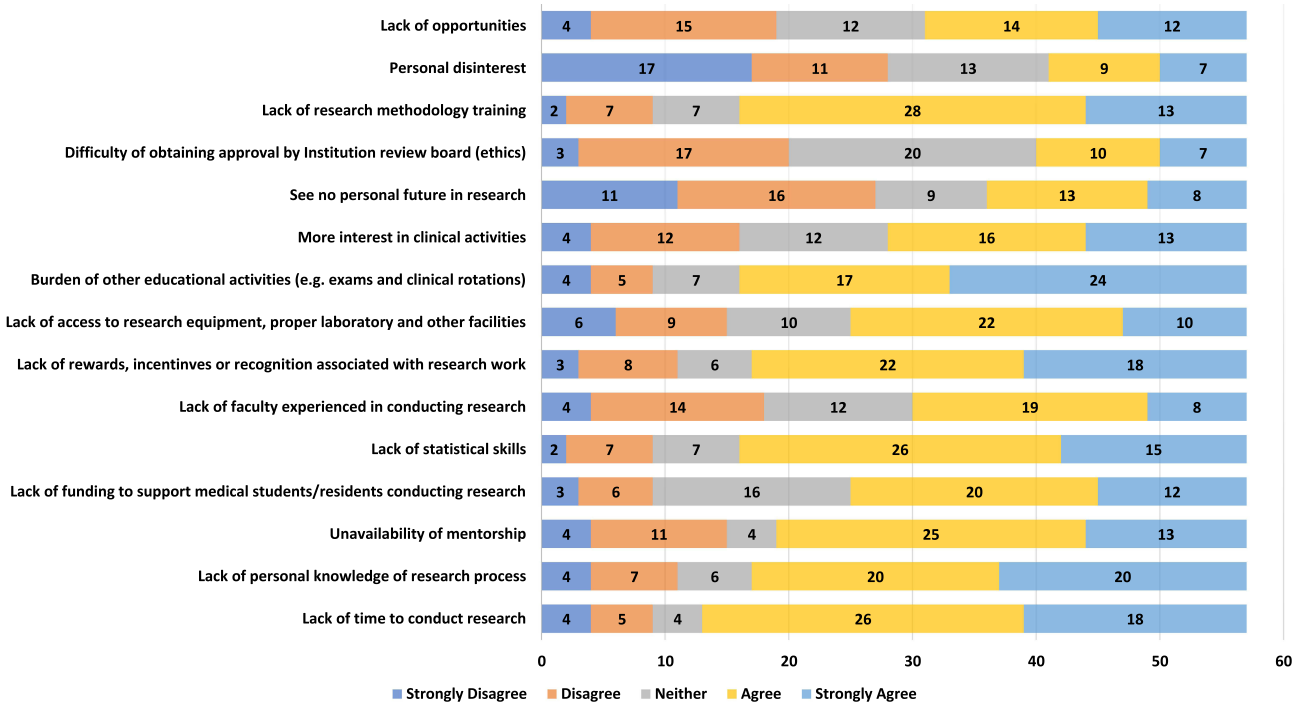

Figure 2 Perceived Barriers to Conducting Research.

the evidence-based practice. Moreover, a majority believe that research will increase their research output, improve the chance for collaborative research work, stay in touch with up-to-date literature, and build future career opportunities. Most recognize the relevance of research to their career and training. The majority responded that they are open to trying new technologies in the healthcare industry.

When asked about how the COVID-19 pandemic changed their attitude toward research; almost half of the participants believed the pandemic had no impact on their interest toward research. Conversely, the other half believed that the pandemic has increased the chance of research and made it more accessible, mainly because of the increased collaboration between external partners. Moreover, they claimed that the pandemic has significantly increased their motivation to engage in research and utilize emerging technologies in the medical field.

Awareness of Technologies

When awareness of emerging technologies in healthcare was questioned, as summarized in Figure 3, respondents (43%) were aware of Artificial Intelligence (AI) and Telehealth technologies. However, knowledge of other technologies, like the Internet of Things, Blockchain and Cloud Computing, were rare among medical trainees. Additionally, when questioned about the impact of AI on future clinical research; the majority (77%) believe the impact will be positive, AI will make data collection and statistical analysis more accessible, minimize medical errors, increase patient safety and healthcare efficacy, provide accurate diagnoses, and lessen the burden on the medical staff.

Discussion and Findings

Our study details the current research environment in a large hospital in UAE, emphasizing the barriers that medical trainees face in pursuing research. Although several global studies have explored barriers encountered by medical professionals in research,[13–15,17] the existing body of literature focusing specifically on trainees in the UAE is relatively scant.[9,26]

The main finding of our study is the disparity between trainees' positive attitude toward engaging in research activities and their tangible research output (measured by their research paper or abstract publications). Despite the robust understanding of scientific research, the knowledge did not reflect the reported attitude in their publication records: 51% published abstracts, while 46% published journal papers. This disparity between attitudes and engagement in

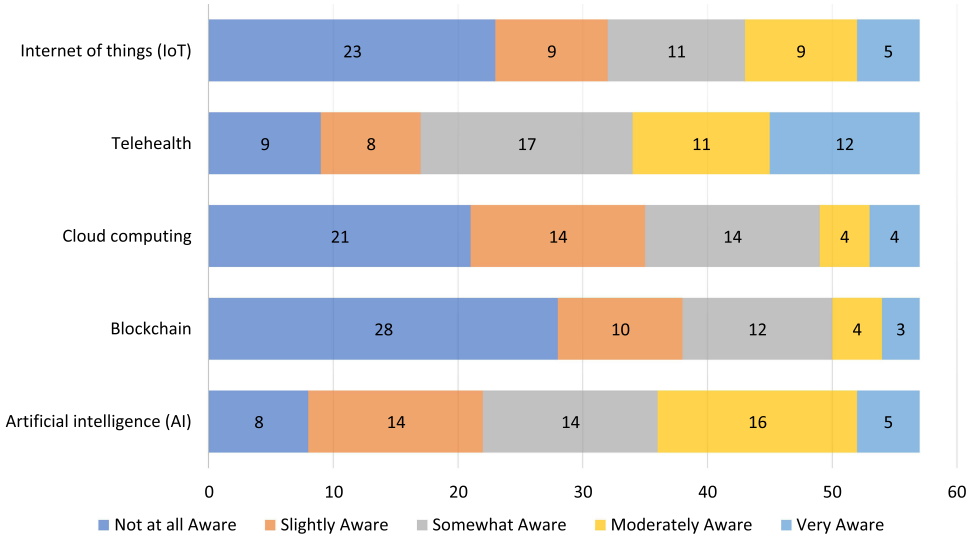

Figure 3 Awareness of Emerging Technologies in Healthcare.

research mirrors global trends. Predominantly, time constraints emerged as common barrier.[9,13,16,17,27]. It is hypothesized worldwide that the structure of many medical training programs may unintentionally impose this barrier. The demanding nature of medical training, paired with exhaustive post-graduate examinations, often leaves trainees with minimal room for research. Addressing this requires a pivotal shift in medical training structures. Some disciplines, like radiology, have endorsed dedicated research durations to improve engagement,[28–31] suggesting that allocating specific periods for research could uplift research productivity.[32,33]

Besides time constraints, our study resonated with other global challenges in residency programs.[12,22,34–36] These include the burden of other educational activities, statistical skills deficits, inadequate mentorship, and lack of rewards, incentives, or recognition for research efforts. Lack of time and mentorship, trainees workload, and limited funding were particularly emphasized in studies from developing countries.[12,22,23,36,37] Systematic adjustments in the academic ecosystem of residency programs, emphasizing research as an integral component might offer a resolution.

Our study also reported the willingness and personal interest of medical trainees to participate in research training, especially related to statistical analysis, as they believe it is key to enabling research productivity. Most agree that research would improve their critical thinking, widen their medical knowledge, allow exploring different areas of medicine, and apply evidence-based practice. A growing body of evidence suggests that research activity in hospitals is associated with improved patient outcomes. Studies report that continued medical research improves health and care for future generations. Thus, there is a need to build a culture that reinforces the relationship between quality of care and research.

Strategically, integrating research curricula and introducing specialized training can be transformational, as validated by published results from other surveys of trainees. Merani et al (2014) demonstrated that research training positively affects research outcomes.[37] Moreover, a positive association between research training in medical schools and more publications has been found.[38,39] Numerous studies have consistently determined that effective research training is a significant determinant of the success of scholarly research.[40] As such, it is interesting to note that implementing a research training program to optimize medical trainees' research skills will positively impact research productivity[40]. Hence stressing that research training and exposure should take place early in residency and even during undergraduate education. It is also imperative to dedicate more protected time to research training with focused skills in research methodology and statistics.[41]

Notably, more than half of the medical trainees (70%) believe that lack of rewards and incentives is strongly linked to research output. Several studies have documented increased research productivity with the implementation of reward systems.[42] Such a system is a feasible method of encouraging medical trainees to collaborate and increase their exposure to research.

Furthermore, this study provides valuable information on promoting a research environment among medical trainees from various specialties in the UAE. Establishing an academic environment that promotes research and acknowledges personal interests is the most efficient strategy for motivating medical trainees to engage in research.[43] While personal disinterest in research is a recognized barrier worldwide, it was relatively minor in our context. Only 28% of trainees exhibited research disinterest, aligning with most surveys mentioned in the literature.[13,14,44,45]

Medical trainees may have an appetite for research. However, they need more time or statistical skills to practice research or are unaware of the available opportunities. According to (72%) of medical trainees, lack of methodology training is a significant barrier. Without research training, medical trainees find it challenging to develop meaningful research questions, identify metrics, collect data, submit successful Institutional Research Ethics Board applications, conduct accurate statistical analysis, and publish their research in journals. An example of a successful research training program in the United States revealed that a specialized 2-week research training course has led to each trainee completing, on average, four papers, posters, abstracts, and presentations by the end of their residency.[46]

Further, most medical trainees expressed their desire for more accessible faculty mentorship. There is no doubt that good mentorship results in more extraordinary research achievements. Mentors help encourage medical trainees' interest, inspire intellectual curiosity, and significantly impact their future academic and career choices.[13]

The framework presented in Figure 4 summarizes the potential barriers medical trainees face when undertaking research, which are broadly consistent with global observations.[13–15,21] The challenges are categorized into internal, organizational, and external challenges. Internally, targeted educational initiatives such as specialized training workshops can address skill gaps. Organizational strategies like formal mentorship programs and the allocation of protected research time are vital in overcoming mentorship scarcity and time constraints.[9,13,20,21,27] These strategies are reflective of successful worldwide practices.[28–33] Externally, establishing research forums can foster collaborative environments, while streamlining administrative processes may reduce barriers to entry, facilitating smoother transitions into research for trainees. Thus, while this framework is contextualized within our institution, its principles are applicable to other residency programs aiming to enhance research exposure among medical trainees. We would advise program leaders to

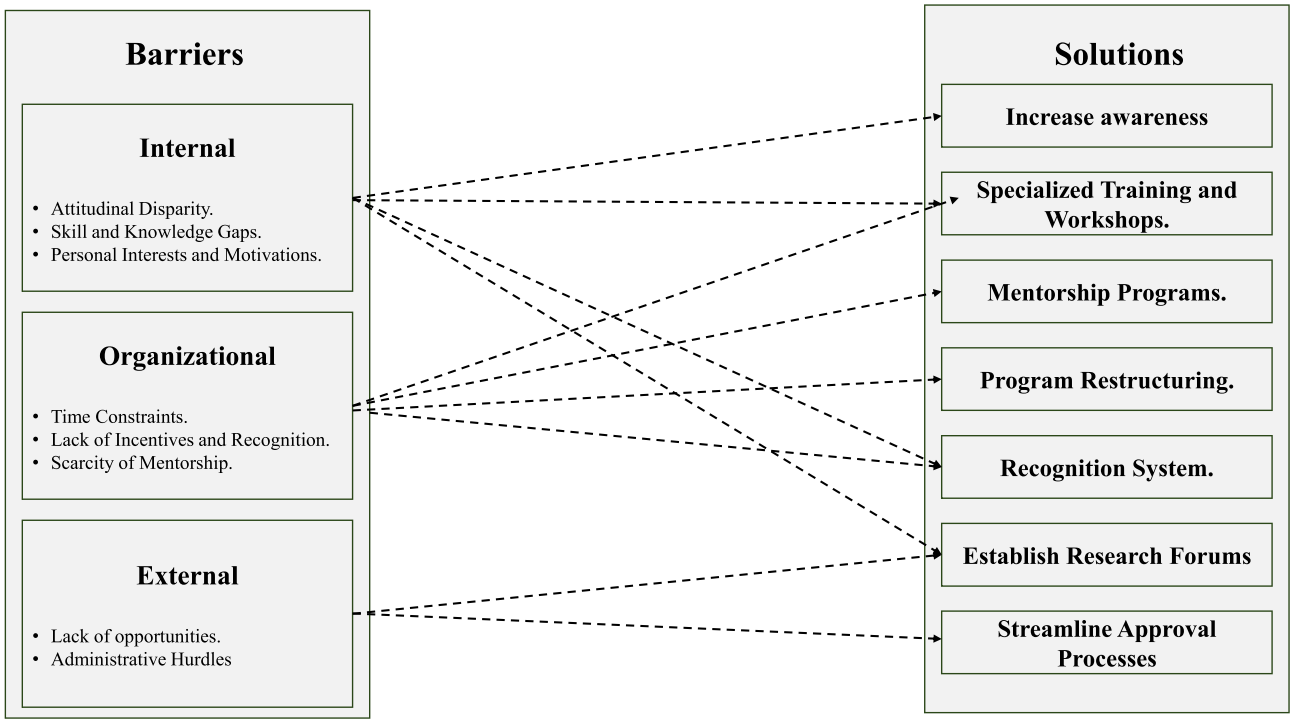

Figure 4 Research Barriers and Solutions Framework.

adopt a collaborative approach, engaging trainees in identifying research barriers and tailoring interventions to promote research activities within their respective program structures.

Limitations and Future Research

Our study, conducted at a single hospital in the UAE, involved a relatively small sample size (n=57). While this sample is reflective of the scale of many residency programs in the UAE, its scope limits the broader generalizability of our findings. To truly comprehend the barriers to research participation among medical trainees, future studies would benefit from a broader sample, incorporating multiple hospitals and addressing other potentially influential factors cultural influences and the diverse personalities of medical trainees. Notably, the voluntary nature of our survey, combined with its decent response rate (52.7%), might suggest a bias toward those with a more positive research attitude. In the context of the UAE, this research represents an initial attempt to identify and address the barriers medical trainees face in engaging with research activities. We emphasize the need for ongoing research in this area to provide a more robust foundation for interventions to improve scholarly research among medical trainees. While the challenges and unmet needs identified are specific to a UAE hospital context, they echo broader themes prevalent in medical training programs globally. Therefore, our findings, while regionally specific, may offer valuable insights into universal educational challenges. Our results herein provide a framework to identify potential barriers and proposed interventions for institutions seeking to increase research output.

Conclusion

The future of the medical field relies significantly on the current cohort of medical trainees and their active involvement in ongoing research endeavors. The findings revealed that only a small percentage of medical trainees successfully complete research projects for publication, primarily due to the considerable constraint of insufficient time dedicated to research activities. Additionally, barriers such as inadequate statistical skills, the heavy workload of other educational commitments, lack of adequate training in research methodology, absence of rewards, incentives, or recognition, and a lack of personal understanding of the research process were identified as significant hurdles for medical trainees engaging in research.

To address these primary obstacles, successful interventions have been identified, including the dedication of specific time slots for research, the provision of research mentors, and the facilitation of training sessions. These interventions have demonstrated efficacy in fostering a culture encouraging to fruitful research and have the potential to significantly increase research productivity among medical trainees.

Abbreviations

ACGME, Accreditation Council for Graduate Medical Education; UAE, United Arab Emirates.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the institutional review board of Sheikh Shakhbout Medical City (SSMCREC-309), and the requirement for informed consent was waived due to the deidentified nature of the survey. All methods were carried out in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically

reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests.

References

1. Greenhalgh T, Raftery J, Hanney S, Glover M. Research impact: a narrative review. *BMC Med*. 2016;14(1):78. doi:10.1186/s12916-016-0620-8
2. Rivera JA, Levine RB, Wright SM. Completing a scholarly project during residency training. Perspectives of residents who have been successful. *J Gen Intern Med*. 2005;20(4):366–369. doi:10.1111/j.1525-1497.2005.04157.x
3. Derse AR. Medical training and errors: competence, culture, caring, and character. *Acad Med*. 2020;95(8):1155. doi:10.1097/ACM.0000000000003118
4. DeFranco DB, Sowa G. The importance of basic science and research training for the next generation of physicians and physician scientists. *Mol Endocrinol*. 2014;28(12):1919–1921. doi:10.1210/me.2014-1343
5. Abu-Zaid A, Alkattan K. Integration of scientific research training into undergraduate medical education: a reminder call. *Med Educ Online*. 2013;18(1):22832. doi:10.3402/meo.v18i0.22832
6. Accreditation Council for Graduate Medical Education. Program requirements for graduate medical education in internal medicine. Available from: https://www.acgme.org/. Accessed March 26, 2024.
7. RCGP. Royal College of General Practitioners (RCGP) - Home. Available from: https://www.rcgp.org.uk/. Accessed February 9, 2023.
8. Stone C, Dogbey GY, Klenzak S, Van Fossen K, Tan B, Brannan GD. Contemporary global perspectives of medical students on research during undergraduate medical education: a systematic literature review. *Med Educ Online*. 2018;23(1):1537430. doi:10.1080/10872981.2018.1537430
9. Nair SC, Ibrahim H, Almarzoqi F, Alkhemeiri A, Sreedharan J. Addressing research barriers and facilitators in medical residency. *J Fam Med Prim Care*. 2019;8(3):1145–1150. doi:10.4103/jfmpc.jfmpc_38_19
10. Moges T, Deribew M, Mariam DH. Knowledge, attitude, and practice of residents in medical research and barriers: a cross-sectional survey at tikur anbessa specialized hospital. *Ethiop J Health Dev*. 2017;31(4):259–265.
11. Vodopivec I, Vujaklija A, Hrabak M, Lukić IK, Marusić A, Marusić M. Knowledge about and attitude towards science of first year medical students. *Croat Med J*. 2002;43(1):58–62.
12. Khan H, Khan S, Iqbal A. Knowledge, attitudes and practices around health research: the perspective of physicians-in-training in Pakistan. *BMC Med Educ*. 2009;9(1):46. doi:10.1186/1472-6920-9-46
13. Hames K, Patlas M, Duszak R. Barriers to resident research in radiology: a Canadian perspective. *Can Assoc Radiol J*. 2018;69(3):260–265. doi:10.1016/j.carj.2018.03.006
14. Olaussen A, Jennings PA, O'Reilly G, Mitra B, Cameron PA. Barriers to conducting research: a survey of trainees in emergency medicine. *Emerg Med Australas*. 2017;29(2):204–209. doi:10.1111/1742-6723.12734
15. Vas A, D'sa P, Daud H, et al. Perceived barriers to participation in clinical research amongst trauma and orthopaedic community: a survey of 148 consultants and junior doctors in wales. *Cureus*. 2021;13(11). doi:10.7759/cureus.19694
16. Levine RB, Hebert RS, Wright SM. Resident research and scholarly activity in internal medicine residency training programs. *J Gen Intern Med*. 2005;20(2):155–159. doi:10.1111/j.1525-1497.2005.40270.x
17. Gill S, Levin A, Djurdjev O, Yoshida EM. Obstacles to residents' conducting research and predictors of publication. *Acad Med J Assoc Am Med Coll*. 2001;76(5):477. doi:10.1097/00001888-200105000-00021
18. Tamirat M, Deribew M, Mariam D. Knowledge, attitude, and practice of residents in medical research and barriers: a cross-sectional survey at tikur anbessa specialized hospital. *Ethiop J Dev Res*. 2018;31(4):259–265. doi:10.13140/RG.2.2.21576.83202
19. Valentino AL, Juanico JF. Overcoming barriers to applied research: a guide for practitioners. *Behav Anal Pract*. 2020;13(4):894–904. doi:10.1007/s40617-020-00479-y
20. Pawar DB, Gawde SR, Marathe PA. Awareness about medical research among resident doctors in a tertiary care hospital: a cross-sectional survey. *Perspect Clin Res*. 2012;3(2):57–61. doi:10.4103/2229-3485.96446
21. Habineza H, Nsanzabaganwa C, Nyirimanzi N, et al. Perceived attitudes of the importance and barriers to research amongst Rwandan interns and pediatric residents - a cross-sectional study. *BMC Med Educ*. 2019;19(1):4. doi:10.1186/s12909-018-1425-6
22. Mitwalli HA, Al Ghamdi KM, Moussa NA. Perceptions, attitudes, and practices towards research among resident physicians in training in Saudi Arabia. *East Mediterr Health J Rev*. 2014;20(2):99–104.
23. AlGhamdi KM, Moussa NA, AlEssa DS, AlOthimeen N, Al-Saud AS. Perceptions, attitudes and practices toward research among senior medical students. *Saudi Pharm J*. 2014;22(2):113–117. doi:10.1016/j.jsps.2013.02.006
24. Abdel-Razig S, Alameri H. Restructuring graduate medical education to meet the health care needs of Emirati citizens. *J Grad Med Educ*. 2013;5(2):195–200. doi:10.4300/JGME-05-03-41
25. Koornneef EJ, Robben PBM, Al Seiari MB, Al Siksek Z. Health system reform in the Emirate of Abu Dhabi, United Arab Emirates. *Health Policy Amst Neth*. 2012;108(2–3):115–121. doi:10.1016/j.healthpol.2012.08.026
26. Abdulrahman M, Ahmed A, Carrick FR. Implementing resident research program to enhance physicians research in the United Arab Emirates. *Int J Appl Basic Med Res*. 2019;9(2):75. doi:10.4103/ijabmr.IJABMR_183_18
27. Hamann KL, Fancher TL, Saint S, Henderson MC. Clinical research during internal medicine residency: a practical guide. *Am J Med*. 2006;119(3):277–283. doi:10.1016/j.amjmed.2005.12.001
28. Gay SB, Hillman BJ. Evaluation of a mandatory radiology resident research rotation. *Acad Radiol*. 2000;7(3):172–175. doi:10.1016/S1076-6332(00)80119-1
29. Chithriki M. Research during radiology residency: challenges for the future. *J Am Coll Radiol*. 2004;1(5):361–363. doi:10.1016/j.jacr.2003.12.045
30. Collins J. Resident research. *Acad Radiol*. 2003;10(1):S24–S30. doi:10.1016/S1076-6332(03)80146-0

31. Linaker KL. Radiology undergraduate and resident curricula: a narrative review of the literature. *J Chiropr Humanit*. 2015;22(1):1–8. doi:10.1016/j.echu.2015.09.004
32. Rothberg MB, Kleppel R, Friderici JL, Hinchey K. Implementing a resident research program to overcome barriers to resident research. *Acad Med J Assoc Am Med Coll*. 2014;89(8):1133–1139. doi:10.1097/ACM.0000000000000281
33. Md KJ, Dmam M, Md SH. Scholarly success among internal medicine residents in Canada. *Can J Gen Intern Med*. 2015;10(3). doi:10.22374/cjgim.v10i3.54
34. Abramson EL, Naifeh MM, Stevenson MD, et al. Research training among pediatric residency programs: a national assessment. *Acad Med J Assoc Am Med Coll*. 2014;89(12):1674–1680. doi:10.1097/ACM.0000000000000404
35. Bammeke F, Liddy C, Hogel M, Archibald D, Chaar Z, MacLaren R. Family medicine residents' barriers to conducting scholarly work. *Can Fam Physician Med Fam Can*. 2015;61(9):780–787.
36. Azhar GS, Azhar AZ, Azhar AS. Overwork among residents in India: a medical resident's perspective. *J Fam Med Prim Care*. 2012;1(2):141–143. doi:10.4103/2249-4863.104986
37. Merani S, Switzer N, Kayssi A, Blitz M, Ahmed N, Shapiro AMJ. Research productivity of residents and surgeons with formal research training. *J Surg Educ*. 2014;71(6):865–870. doi:10.1016/j.jsurg.2014.05.007
38. Brancati FL, Mead LA, Levine DM, Martin D, Margolis S, Klag MJ. Early predictors of career achievement in academic medicine. *JAMA*. 1992;267(10):1372–1376. doi:10.1001/jama.1992.03480100078035
39. Solomon SS, Tom SC, Pichert J, Wasserman D, Powers AC. Impact of medical student research in the development of physician-scientists. *J Investig Med off Publ Am Fed Clin Res*. 2003;51(3):149–156. doi:10.1136/jim-51-03-17
40. Smith M. Research in residency: do research curricula impact post-residency practice? *Fam Med*. 2005;37(5):322–327.
41. Lennon RP, Oberhofer AL, McNair V, Keck JW. Curriculum changes to increase research in a family medicine residency program. *Fam Med*. 2014;46(4):294–298.
42. Jessani NS, Valmeekanathan A, Babcock CM, Ling B. Academic incentives for enhancing faculty engagement with decision-makers—considerations and recommendations from one school of public health. *Humanit Soc Sci Commun*. 2020;7(1):1–13. doi:10.1057/s41599-020-00629-1
43. Mustafa K, Murray CC, Nicklin E, Glaser A, Andrews J. Understanding barriers for research involvement among paediatric trainees: a mixed methods study. *BMC Med Educ*. 2018;18(1):165. doi:10.1186/s12909-018-1263-6
44. Myint PK, MacLullich AMJ, Witham MD. The role of research training during higher medical education in the promotion of academic medicine in the UK. *Postgrad Med J*. 2006;82(973):767–770. doi:10.1136/pgmj.2006.046227
45. Al-Taha M, Al Youha S, Al-halabi B, Canadian Plastic Surgery Research Collaborative (CPSRC). Barriers and attitudes to research among residents in plastic and reconstructive surgery: a national multicenter cross-sectional study. *J Surg Educ*. 2017;74(6):1094–1104. doi:10.1016/j.jsurg.2017.04.004
46. Dinglasan LAV, Scanlon MH. The high-performing radiology residency: a case study. *Curr Probl Diagn Radiol*. 2017;46(5):373–376. doi:10.1067/j.cpradiol.2017.01.002