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Commentary

Undergraduate students' involvement in research: Values, benefits, barriers and recommendations

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ABSTRACT

Developing, maintaining, and sustaining undergraduate research initiatives can benefit academic institutions, faculty mentors, and students. As the world evolves, more research is required to advance knowledge and innovation in all fields. This implies that students must be prepared for today's knowledge-driven world. Research in the medical and health sciences has stalled in many developing countries, where a dual burden of communicable and noncommunicable diseases is prevalent. In this article, I discuss the values and benefits of undergraduate healthcare students participating in research and scientific publishing, as well as the challenges they face. I also make recommendations to encourage undergraduates to get involved in research. The potential of undergraduate research has not yet been fully realized. Undergraduate research's main objectives are to teach students how to do research and to help them acquire skills that they can use beyond the academic environment. Undergraduate research will complement rather than conflict with university education and should go beyond the mandatory terminal year thesis and must cover the entire course of their studies. The key to successful undergraduate research participation is for students to see and understand the importance of rigor, academic integrity, and responsible research conduct. This means academic institutions should carefully plan research programs, activities, and courses for students. Building capacity in research has a long-term impact on valuable learning outcomes as undergraduate students prepare for professional service. Stakeholders and educational authorities must invest in strengthening undergraduate involvement in research.

1. Introduction

As the world evolves, the need for research grows, and it remains a factor of key importance in creating a knowledge-driven economy and supporting development initiatives as well as driving innovations across all fields [1]. It is becoming more and more important to increase undergraduate student involvement in research [2]. Academic institutions, faculty mentors, and students can all benefit from developing, maintaining, and sustaining undergraduate research initiatives. By integrating research into their academic courses and giving them a strong academic foundation, students can strengthen their autonomous critical thinking abilities as well as their oral and written communication skills, among others. As students are ready for professional service, the research process affects important learning goals that have a lasting impact. All students should be prepared for the contemporary knowledge-driven world because, today, doing research is not just for academics but also for individuals and institutions interested in knowledge creation and advancement.

The advancement and innovation of all fields, including the health sciences and related areas, depends on research [3]. Society can benefit greatly from health-related research [4], which can provide vital insights into disease trends and risk factors, treatment outcomes or public health interventions, care patterns, costs and usage of healthcare services, and more. By doing research to find solutions to problems that are currently unknown, we can close knowledge gaps and change the way healthcare professionals work as well as how we respond to public health issues. With the increase in health concerns ravaging the world [5–7], it is clear that research is indispensable – whether it be tackling diseases of poverty, performing clinical trials, responding to the rise of chronic diseases, improving access to medicines, increasing vaccines uptake, containing local epidemics, developing innovation in treatment plans, or ensuring that marginalized populations have access to HIV care treatments, among others. This suggests that there is a pressing need to advance knowledge creation and utilization, and that gathering local, grassroots data at all levels of healthcare is important.

Research in the medical and health sciences has seen a downturn in many developing countries [8], where a double burden of communicable and non-communicable diseases is highly prevalent. The development of undergraduate health sciences students' research capacity is a key intervention to address this issue. With the support of faculties, it is possible for undergraduate students to learn about and participate actively in research. In this article, I discuss the values and benefits of undergraduate healthcare students' involvement in research and scientific publishing, as well as the challenges they face. I also provide recommendations to advance undergraduates' involvement in research.

2. Values and benefits of undergraduate research

Involving undergraduate students in research should go beyond the mandatory terminal year thesis and must cover the entire course of their studies. There are myriads of benefits to involving (healthcare) students in research and scientific publishing at the undergraduate level. Research is a methodical process of investigation that includes data collection and analysis, the recording of significant information, and subsequent analysis and interpretation of that information in accordance with the protocols defined by specific academic and professional

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disciplines [9]. This implies that conducting research is an important way to improve students' ability to think critically and solve problems, both of which are essential throughout their career as healthcare professionals. Critical thinking abilities have been linked to better patient outcomes, higher patient care quality, and improved safety outcomes [10]. While problem-solving focuses on identifying and resolving issues, critical thinking entails asking insightful questions and critiquing solutions. Early exposure of healthcare students to the value of research is a critical strategy for increasing their interest in and attitude toward it. Table 1 highlights the achievements of some students that engaged in research as undergraduates.

The elements required for professional competency in the health fields are covered in healthcare student curricula. This includes understanding of the fundamental theories and literature in the field of study, as well as knowledge of the terminology or technical language specific to health sciences. Incorporating research methodology and the hypothesis-driven scientific process can help to build on this foundation while also stimulating independent critical thinking. By involving undergraduate students in research, they can build trust in the scientific process. Besides that, independent thinking can give an undergraduate student the confidence to draw their own conclusions based on available evidence. No doubt that undergraduate students who took part in research projects will have greater thought independence, a stronger intrinsic motivation to learn, and a more active role in their learning. As a result, as undergraduates prepare for their respective professions, the research process has a very positive impact on their practice.

Students who participate in research may have the chance to develop the advanced writing abilities needed for science publishing and communication [11]. Even though healthcare students write a lot throughout their time in college, many still struggle to write in a way that is considered acceptable. This is due to the fact that students frequently plagiarize in writing assignments since there is usually little to no formal training on academic writing, and some institutions pay less attention to this. It has also become more challenging for students to express themselves in their own words during academic assessments as a result of the encouragement to memorize academic information verbatim by some teachers. Writing is difficult, but it is a skill that can be honed. Improving students' writing skills is much easier if proper attention is paid to strengthening their capacity for and involvement in the academic research process. This will be useful to them throughout their career, whether they choose to be academic or not.

Table 1
Examples of students that got involved in research as undergraduate and their achievements.

Name	Achievement
Adeola Bamisaiye	She contributed to a research effort to advance knowledge on AMR surveillance in Nigeria, as a pharmacy student.
Niel Stensen	He was a medical student when he discovered the parotid duct in sheep.
Joseph Black	He discovered fixed air, now called CO_2, as a medical student.
Alaka Hassan Olayemi	A microbiology student contributing to research effort in the field of antimicrobial resistance and one health.
Jay Mclean	He discovered Heparin, as a medical student.
Adriana Viola Miranda	She is a medical student contributing to research efforts in using digital technology to advance public health, earning her several awards.
Lorenzo Bellini	He was only 19 years when he published his discovery of the kidney tubules.
Melody Okereke	He developed the first framework for Nigerian industrial pharmacists to combat substandard and counterfeit medicine in his third year in pharmacy school.
Aminat Olaitan Adebayo	While still an undergraduate, she is actively contributing to research efforts to advance the field of planetary health.
Yusuff Adebayo Adebisi	He was the first undergraduate healthcare student to publish more than 50 research articles on global public health issues in peer-reviewed journals, while attending pharmacy school, earning him the prestigious Diana Award and many other global accolades.
Isaac Olushola Ogunkola	One of the leading young researchers advancing research and innovation in the field of harm reduction, health justice and drug policy.
Charles Herbert Best	His contribution to medicine nearly won him a Nobel Prize.
Goodness Ogeyi Odey	She was a recipient of the prestigious Diana Award because of her involvement in research geared towards advancing health equity.
Esther Ejiroghene Ajari	She is one of the leading undergraduate students championing research and innovation in the advancement of menstrual health equity.

Investing in academic writing skills among students, particularly in developing countries, is critical for improving scientific outputs on health issues confronting the region. It is not enough to know how to conduct research; academic writing is also important. Additionally, it is crucial for academic institutions to encourage students to present their research work at scientific conferences, which are frequently restricted to postgraduate students. This gives them the chance to collaborate more frequently with faculty members while also giving them another learning opportunity and boosting their confidence and presentation skills. Students who make significant contributions to the intellectual aspect of a research should not be relegated to acknowledgement section of the paper but should be included as co-authors. Furthermore, students should not be denied first authorship because of power dynamics. This will definitely improve students' attitude towards research.

Through research, students can observe how the theories and concepts they have learned are applied. The active learning aspect of research allows students to connect with their own interests, which is not possible in a passive learning setting. If a research culture and thought process are instilled in healthcare students as they progress through the academic institution in a more systematic, logical, and integrated manner, it will be easier for them to understand what they are learning and will promote active participation in class. This is due to the fact that students who conduct research will be able to understand the research process and how scientists think and work on problems; learn about different lab techniques (as needed); develop skills in data analysis and interpretation; and be able to integrate theory and practice. Further, undergraduates should be involved in research as early as possible because it allows them to identify, develop, and nurture their interests while being open-minded to other areas. This will make choosing and transitioning into research area of choice much easier for them as they pursue postgraduate studies. Because of the high-level of interest and fundamental knowledge gained through undergraduate research participation, it will be possible to increase the enthusiasm, completion rates, and quality of academic research at the postgraduate level. Besides that, undergraduate research allows students to decide whether or not they want to pursue a career in research.

Due to the opportunity for students to pursue their individual interests, research experiences have been linked to a boost in students' motivation to learn [12]. This means undergraduates will have the chance to take more control over their own learning experiences and have their intellectual curiosity piqued by research. Student-faculty research mentoring relationships frequently develop over time. In contrast to what is possible in the classroom, students form a distinct type of interaction with their research mentor. Most of the time, the interaction is more intense and lasts longer. It frequently serves as the foundation for lifelong friendships and career guidance. When students are looking for jobs or graduate schools, faculty research mentors are an excellent source of recommendations and advice. Additionally, students gain experience working in a research team, which typically involves group work, stronger relationships with colleagues and faculty members, and the development of communication skills. All of which are qualities that employers are increasingly looking for. The key to successful undergraduate research participation is for students to see and understand the importance of rigor, academic integrity, and responsible research conduct. This means academic institutions should carefully plan research programs, activities, and courses for students.

One of the most significant benefits of student research participation

is the possibility of publishing articles in peer-reviewed journals. This will also give students early exposure to the process and concept of scientific publishing. Students who submit their manuscript to a reputable journal for publication can also benefit from peer review, which allows them to improve their paper and learn more from the reviewers' comments. Also, undergraduate students who are exposed to the scientific publishing process early on will be less likely to become victims of predatory journals. Students with publishing experience may be inspired and motivated to pursue a career in research. Having publication allows students to improve their resumes and graduate school applications. Publishing counts as research experience and demonstrates that undergraduate students who have published are enthusiastic about research. As an active learning process, research requires students to frame questions, devise a strategy for testing their hypotheses, analyze data, and write clearly to report their findings, among other things. The research experiences, skills, and knowledge students acquire at the undergraduate level will better prepare them for many of their future endeavors, including careers and postgraduate study. In addition to exposing students to conducting original/primary research, it is important to engage them in secondary research activities including writing reviews, correspondence, commentary, viewpoints, book chapters, and more. Secondary research improves students' writing abilities and thought processes, enables the construction of intelligent arguments, enhances their capacity to use scientific databases to find evidence, and teaches them how to engage in constructive criticism, among others.

While the benefits of undergraduate research to students have been highlighted in the preceding paragraphs, academic institutions can also benefit from engaging undergraduates in research [13]. Teams conducting research benefit from the enthusiasm and energy of curious undergraduate students. They frequently keep asking for more tasks to complete since they are eager to learn. Undergraduate students often pose inquiries that can be quite perceptive and, perhaps rather unintentionally, alter the way advisors approach research problems and better improve the quality of scientific output from such institutions. In contrast to how faculty research mentors interact with graduate students and other senior team members, undergraduate researchers need responses to inquiries in unique ways, which usually facilitate an opportunity for multidirectional intense learning.

Furthermore, undergraduate students' contributions to peer-reviewed publications and local, regional, national, or international research presentations at conferences and other scientific gatherings will benefit the university or institution's visibility in the scientific community and attract more funding. Students can actively contribute to scientific knowledge provided they are motivated and have the necessary research knowledge and abilities. I serve as a practical example. At the undergraduate level, I published more than 50 articles (including both primary and secondary research) in peer-reviewed journals on a diverse range of public health issues, including the COVID-19 pandemic. While still an undergraduate, I received research and travel grants and presented scientific papers both locally and internationally. This captured the attention of the media, and many undergraduates are now inspired to participate in research more than ever. With the right support systems in place, undergraduates' contributions to scientific literature can be valuable, benefiting not only the student but also the academic institution and society. Imagine a university where students receive the assistance they require to develop their capacity for scientific publishing and research. Such an institution would contribute more to science and knowledge creation, raising their profile in the process. Undergraduate research initiatives are an untapped gold mine if they are nurtured, funded, and supported adequately.

3. Barriers and challenges facing involvement of undergraduate students in research

Healthcare undergraduates interested in research face a number of challenges that have been documented in academic literature. In this section, I conducted a rapid unsystematic review of primary studies and used Table 2 to summarize the challenges and barriers facing undergraduate research identified in randomly selected academic papers.

The rapid review of the fifteen (15) original studies in Table 2 revealed the major barriers and challenges limiting undergraduate student involvement in research across different countries. The findings of the reviewed studies were clearly similar. The key barriers and challenges to undergraduate involvement in research can be divided into three categories: a significant lack of knowledge and skills to participate in research; little to no faculty support, mentorship, funding and motivation for undergraduates to participate in research; and structural barriers limiting student involvement in research such as lack of time due to the loaded curriculum, dearth of research facilities as well as lack of major plans and strategies for undergraduate research.

4. Recommendations

There is an urgent need for stakeholders all over the world to look into the issues and devise tailored strategies to increase the involvement of (healthcare) students in research. Here are my eight (8) recommendations to advance the involvement of undergraduate students in research:

1. Research methods and processes should be taught to students as early as their second year of college. Even though some universities only cover research methodologies in the final year, it is essential to include more content on scientific writing and research methods as a mandatory course throughout the whole academic program. Undergraduate teaching curricula and approaches should promote inquiry-based learning. All professional classes' academic curricula might include regular discussions of new advances in the medical and health sciences, and the academic departments might be tasked with organizing these conversations. Long-term, this practice would foster a research aptitude in undergraduate students since opportunity like these would stimulate their minds.
2. As part of academic program, students should be evaluated for their interest in research and assigned suitable researchers to serve as their research mentors. Faculty research mentors must also be compensated. Lecturers do not receive credit for mentoring students for publications or research projects. Credit points should be awarded for each peer-reviewed publication attributed to such mentorship to encourage faculty-student research collaboration and motivate them to serve as research mentors for undergraduates. Mandatory structured mentorship programs are desperately needed.
3. During the undergraduate program, students should have the opportunity to participate in more research trainings, internships, and placements locally and internationally. This will contribute significantly to students' research skills and experience.
4. Students should be encouraged to publish at least two papers, either primary or secondary research, in peer-reviewed journals before graduation. Besides that, the final year thesis must be published and must be on a topic with the potential to make or drive impact.
5. Encourage undergraduate students to participate in scientific meetings, conferences, and seminars and to present their research, project, ideas or innovation in such gathering. Funding should be provided for undergraduate research conferences so that students can share their work, learn from the experiences of others, and improve institutional collaboration. This is a worthwhile investment towards advancing knowledge creation and utilization.
6. Existing undergraduate journals (e.g., International Journal of Medical Students), student research capacity building initiatives (e.g., Global Health Focus), undergraduate research funding initiatives, and other efforts aimed at promoting student involvement in research should be supported in order to provide more opportunities for students to participate in research.

Table 2
Barriers and challenges facing healthcare students' involvement in research.

Study	Country of study	Identified barriers and challenges
Kiyimba B et al. (2022) [14]	Uganda	Participants cited a lack of funds, mentorship and guidance, and collaboration opportunities as major barriers to their participation in research. The majority of the study respondents identified design research studies and manuscript writing as the most difficult steps in the research process.
Assar A et al. (2022) [15]	Six Arab Countries (Egypt, Algeria, Sudan, Jordan, Syria and Palestine)	The top ten perceived barriers towards research practice in the entire sample were lack of access to lab equipment for research, priority of education over research, lack of time because of educational tasks, generally poor attention given to researchers, lack of fund, poor collaboration between different academic departments and research centers, Insufficient research skills, lack of suitable research space, lack of faculty input and lack of familiarity with research studies.
Ferdoush J et al. (2022) [16]	Bangladesh	Majority of the respondents reported that inadequate time and priorities, insufficient guidance, inadequate familiarities with research methodology and statistical analysis were the barriers of research.
Mugabo E et al. (2021) [17]	Rwanda	The most significant barrier to research participation was students' belief that they lacked knowledge of research processes. Other significant barriers included a lack of mentors, a lack of funds, and undergraduate students believing they are unqualified to conduct research.
Alsaleem SA et al. (2021) [18]	Kingdom of Saudi Arabia	Lack of time, skills, funding, facilities, and limited access to medical journals and related databases were the significant barriers found.
Kanmounye US et al. (2020) [19]	Cameroon	Barriers to research included lack of funding, obsolete patient information management systems, and limited understanding of biostatistics.
Awofeso OM et al. (2020) [20]	Nigeria	Reported barriers included lack of funding for research, lack of research and biostatistics curriculum, inadequate training in research methodology, insufficient time allocation to undergraduate research, lack of professional supervisors and proper mentoring, and lack of equipped laboratory facilities to conduct research.
El Achi D et al. (2020) [21]	Lebanon	Students found the lack of mentoring and guidance to be the main barrier in conducting medical research.
Kumar J et al. (2019) [22]	Pakistan	Lack of knowledge as a barrier was identified by students. The second most common barrier identified by the students was lack of time, followed by lack of mentoring as the third most common barrier.
Chellaiyan VG et al. (2019) [23]	India	Difficulty in choosing topic, difficulty in collecting data, and allocation of time amidst academic activities were considered as a barrier
Pallamparthy S et al. (2019) [24]	India	Barriers identified were lack of awareness, interest, funds, time, and difficulty in follow-up of patients.
Dadipoor S et al. (2019) [25]	Iran	The two most common personal barriers were a lack of research technique expertise and poor research skills. Access to information sources was the most pervasive organizational barrier, but it was also the least common. The findings revealed that during their studies, research students encountered more personal challenges than organizational constraints.
Kyaw Soe HH et al. (2018) [26]	Malaysia	The majorly cited barriers were the lack of time, lack of knowledge and skills, lack of funding and facilities, and lack of rewards.
Noorelahi MM et al. (2015) [27]	Saudi Arabia	The most important obstacle predictors implicated in not conducting research among all the studied subjects were inadequate facility for research, lack of interest by faculty or guide, and unavailability of the samples or patients.
Memarpour M et al. (2015) [28]	Iran	Inadequate financial support was cited as the main barrier, followed by a preference for academic instruction over research, limited time and lack of research skills and knowledge.

7. A platform should be established to celebrate, provide incentives, and awards to undergraduates who contribute to the advancement of scientific knowledge. More students will be inspired to participate in research as a result of this. Funding (e.g., travel grant, research grant, etc.) should be made more accessible to students that have demonstrated remarkable passion for knowledge creation.
8. More research should be conducted across academic institutions to better understand the local barriers that prevent undergraduates from participating in research.

5. Conclusion

Undergraduate research is a treasure trove that has yet to be fully tapped. The primary goal of undergraduate research is to teach students how to conduct research and to develop necessary skills that can be applied outside of the academic setting. Bolstering undergraduate research will complement, rather than conflict with, university education. There is an urgent need to develop global and local initiatives as well as strengthen current initiatives to further encourage undergraduate students to participate in research and scientific publishing.

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I conceptualized, wrote and revised the paper. I agreed to and approved the final publication of this article.

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None

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