The attitude of undergraduate medical students towards research: a case study from two medical colleges in Maharashtra, India

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In the present study we evaluate the attitudes, perceptions and perceived barriers towards research among undergraduate medical students in India. The study enrolled 382 students from two medical colleges in Maharashtra, India. The study duration was from January 2016 to March 2016. Each student completed an anonymous on-line survey with 22 closed-ended questions. The survey was designed to assess student attitudes towards research as well as perceived barriers and participation in research. Responses were scored on a five-point Likert scale. The study sample was comprised of 241 (63%) females and 141(37%) males. Among these, 202 (53%) students were enrolled in a government medical college and 178 (46.5%) in a private medical college; 2 students did not identify the type of college and were excluded. Fifth-year medical students comprised the highest number of participants at 105 (27.5%). Thirty-two per cent of the entire study sample indicated that they had participated in a research project, while the rest of the students had not. Over 60% of students indicated that they had access to mentors. A positive attitude towards research was reported by 94.7% students. There was no statistical difference between genders in attitude or perceived barriers to research ($P = 0.06$ and $P = 0.6$ respectively). There was a significantly greater positive attitude towards research in the senior years of medical college (years 1–3 and years 4–5; $P = 0.0006$). The perceived barriers were time constraint (45%) and inadequate training for research (50%). The majority of medical students understood the necessity for research and had a positive attitude towards the same. The perceived barriers to research such as time constraint and inadequate training need to be addressed.

Keywords: Attitudes perceptions, barriers, medical research, undergraduate students.

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THE Republic of India is one of most populous countries. With more than a billion people, there is ample need for research to provide better medical services and breakthrough medical advances. With a marked improvement in the Indian economy, there is greater focus on improving healthcare and healthcare-related research in the country. Hence, numerous new medical colleges have been accredited to improve the capacity of clinical services provided to the general population. Additionally, funding for biomedical research has increased over the recent years.

However, the number of physician–scientists in medical practice is declining[1]. Compared to two decades ago, there are 25% fewer physician–scientists on medical college faculties today. This decline suggests that the environment in medicine is not conducive for research-based careers[2,3]. As a result, many medical colleges have implemented innovative strategies to teach research methodology in the curriculum. However, understanding how medical students respond to these strategies is essential for further enhancing medical education. The majority of data on attitudes and perceptions of medical students towards research are from industrialized countries[4]. There are 49 medical colleges in Maharashtra, western India. Among these, 28 are private colleges with a total student population of 3010 and 21 are government colleges with 2700 students enrolled.

The increased funding presents opportunities for medical graduates to participate in meaningful research that would enhance patient care[5]. However, it is unclear if these new graduates have been adequately trained in research methodology and whether the resources in medical colleges prepare them for a career as a clinician–scientist.

The development of a positive attitude by medical students towards scientific research is a fundamental element of modern undergraduate medical education curricula globally[6]. A recent study reported limitations and barriers perceived by faculty regarding medical student participation in research[3]. To the best of our knowledge, there are no publications in the peer-reviewed literature on the research experience as well as attitudes and perceptions of research among medical students in public and privately funded universities in India.

We believe that the baseline data are important to understand the resources and opportunities available to medical students. This information will help in modifying medical college curricula, if needed, to incorporate instruction in research methodology and teach the importance of research.

The present study investigates the attitudes and perceptions towards research among medical students enrolled at publicly and privately funded medical colleges in Maharashtra.

The prospective cross-sectional study used an anonymous web-based survey tool to evaluate the attitudes towards research among medical students enrolled at

privately funded medical colleges compared to those in publicly funded medical colleges. The study was approved by the Johns Hopkins Institutional Review Board and the Review Boards from the participating institutions in India. The study survey was administered over a period of two months from January to March 2016. The study was coordinated with local investigators at the Rajiv Gandhi Medical College, Mumbai and Mahatma Gandhi Medical College Navi Mumbai. The former is a government-funded medical college and the latter is a private medical college. Study participants were first to fifth year students in either medical college. Students enrolled in postgraduate programmes or fellowship programmes were excluded. The survey was administered via an e-mail invitation by the site administrators to all medical students in both colleges. Consent for participation in the study was obtained electronically prior to completing the questionnaire.

Study sample size calculation were performed as follows. To achieve 95% confidence interval and 7% margin of error with study design effect of two among a population of 5710 medical students per year in Maharashtra, at least 350 students were needed for the survey. One senior researcher and one medical student from each medical college were the field investigators for this study.

The questionnaire used in this study was previously-validated[1]. The logistics of web-based survey and language content of the survey were previously tested and considered acceptable in a previous publication[1]. No changes were made to the survey for this study.

The survey was administered with Lime Survey software[7]. The data collected in the survey included basic demographic information, gender, private or public medical college, location of medical college and current year of medical college training. The survey consisted of 22 questions addressing the attitude and research resources available to medical students. Each question was graded with a five-point Likert response scale as follows: +2, I completely agree; +1, I agree; 0, I do not know; –1, I disagree, and –2, I completely disagree. Table 1 presents a copy of the survey.

Only completed survey responses were included in the analyses for this study. Descriptive and correlative statistics were used to review the students' responses and analyse the study outcomes; $P < 0.05$ was considered statistically significant. The program OpenEpi was used for comparison of mean score between male and female students and calculated difference of mean, its 95% confidence interval and two-sided P values.

A total of 382 students participated in the survey; 2 students were excluded from the study since they did not respond to the question on the type of college they were enrolled; therefore, total number of students included in analysis was 380; of these, 202 (53%) were from a government medical college and 178 (46.5%) were from a private medical college. Also, 241 (63%) were females and 141 (37%) were males. Thirty-seven students (9.7%) from the first year, 90 (23.6%) from the second year, 49 (12.8%) from the third year, 101 (26.4%) from the fourth year and 105 (27.5%) from the fifth year responded to the survey. It may be noted that the proportion of female and male medical students that responded to the survey was reflective of the percentage of female and male medical students admitted to the respective medical colleges. Table 2 summarizes the responses of the medical students participating in the survey. There was no statistically significant difference in the response rate between students from either college ($P = 0.5$). There was no difference in the attitude, perception of barriers and practice of research between the two colleges ($P = 0.8$). Table 3 provides a comparison of responses based on gender. There was no statistical difference in attitude, perception of barriers and practice of research between the two genders.

Fifth year medical students comprised the greatest proportion of participants (27.5%) and 9.7% of the participants were first-year medical students. A total of 32% of the entire study sample indicated that they had participated in a research project during medical college and 260 (68%) had not participated (Table 2). Most research did not result in a peer-reviewed publication with only 9 (2.4%) responding that the project was published.

Approximately 50% of participants felt that research helped in obtaining a good residency programme and in achieving their career goals. Approximately 20% were unsure of the role of research in career development.

Over 80% of the students agreed that research would personally interest them and 70% of respondents felt that research was relevant to medical care in India. Over 60% of the students responded that research should be a mandatory part of their curriculum. Approximately 45% of students responded that time was a barrier to participate in research. Furthermore, approximately 50% of the participants indicated that training in research methods was inadequate and they were poorly trained in performing literature searches. Over 60% of the students felt that they had easy access to research mentors, but were unsure of the rewards/recognition that they may receive for performing research. About half of the students felt that they had an opportunity to share their outcomes and if the research was published, 45% responded that they were given co-authorship. The responses to the latter questions must be taken in balance, since most of the respondents did not participate in research in the survey.

A positive attitude towards research was reported by 94.7% of participants. The attitude ($P = 0.06$) and perceived barriers ($P = 0.6$) were not significantly different in male and female participants. There was a statistical difference in attitude towards research by the number of years in medical college, between years 1–3 and years 4–5 ($P = 0.0006$). Fourth and fifth year students, i.e. senior students had a more positive attitude to research. The perceived barriers were time constraint (45%) and inadequate training for research (50%).

Table 1. Survey questions

Your completion of this survey or questionnaire will serve as your consent to be in this research study						
	Gender	Male	Female			
	Student of	M1(Ist Year)	M2(2nd Year)	M3(3rd Year)	M4(4th Year)	M5 (5th Year)
Question		**Yes**			**No**	**I don't know**
Have you participated in any research project?						
Have you performed/participated in research project in medical school?						
Have you published a research paper as a 1st author in a peer review journal?						
Have you published a research paper as a co-author in a peer review journal?						
Do you agree that the medical education at your school provides you with adequate training tools to conduct research?						

Question	**I completely Agree**	**I Agree**	**I don't know**	**I disagree**	**I completely disagree.**
Research will help me enter a good residency postgraduate training program of my choice.					
Research will help me with my long-term career goals.					
I am/would like to be involved in research because of personal interest.					
Research is relevant to medical education in my country					
Research should be mandatory requirement in the medical school curriculum.					
Medical students in my school have sufficient time to perform research.					
Medical students in my school are provided sufficient training in research methodology.					
My medical school provides me sufficient training to perform literature searches independently.					
Medical students in my school have easy access to mentors/advisors to conduct research.					
My mentor/advisor (If I have one) provides students adequate opportunities for participating in research					
Medical students in my school are provided an opportunity to share their research outcomes through local, regional, national or international presentations.					
Medical students in my school are provided an opportunity to participate as authors in research publication.					
The contributions of medical students are acknowledged by research faculty principal investigators.					

Historically, medical students have made some fundamental discoveries by research. For example, in 1869, a 22-year-old German medical student, Paul Langerhans discovered the Islets of Langerhans. Charles H. Best played a pivotal role in the discovery of insulin when he was a student[8]. Hence research by medical students can result in potentially ground-breaking advances.

In the present study, a large majority, i.e. over 80% of medical students agreed that research would personally interest them and 70% felt that research was relevant to medical care in India. This is similar to another study in India, where 81.7% of the responders felt research was essential for medical students to change their perceptions regarding medicine[9]. It has been shown that research has actually helped understand medicine better. It helps medical students to develop core clinical skills, especially in the areas of diagnostic reasoning, communication and physical examination[9]. Similar outcomes were present in a Canadian study of three medical colleges which reported that majority (83%) of students felt participation in research was valuable for medical education[1]. Over 60% students felt that research should be a mandatory component of the curriculum in medical colleges in India. The two medical colleges surveyed had no research curriculum. This indicates that some reforms in the medical curriculum would be beneficial to improving research output from India. There is a need for medical educators to focus on the integration of specific training in research skills in all branches of undergraduate medical curriculum, so that these skills are perceived by undergraduates to be relevant to the routine practice of all doctors, and not just those engaged in full-time research[10].

Table 2. Survey responses to attitudes to research among medical students enrolled in a government-funded medical school compared those enrolled in a privately funded medical school

		Private medical college (n = 179)		Government-medical college (n = 203)		
Parameter	Response	Number	Percentage	Number	Percentage	Validation
Attitude	Strongly negative	2	1.1	1	0.5	$\chi^2 = 0.08$
	Negative	12	6.7	11	5.4	df = 3
	Positive	108	60.3	128	63.1	P = 0.8
	Strongly positive	56	31.3	62	30.5	
	Missing	1	0.6	1	0.5	
Perception of barriers	Strongly negative	11	6.1	7	3.4	$\chi^2 = 0.4$
	Negative	97	54.2	122	60.1	df = 4
	Positive	60	33.5	70	34.5	P = 0.5
	Strongly positive	10	5.6	3	1.5	
	Missing	1	0.6	1	0.5	
Practice of research	Negative	44	15.8	49	24.1	$\chi^2 = 0.2$
	Equivocal	35	12.5	35	17.2	df = 3
	Positive	98	35.1	118	58.1	P = 0.6

χ^2, Chi square value; df, Degrees of freedom; $P < 0.05$ is statistically significant.

Table 3. Comparison of attitude of medical students towards research by gender

		Male (n = 141)		Female (n = 241)		
Parameter	Response	Number	Percentage	Number	Percentage	Validation
Attitude	Strongly negative	2	1.4	1	0.4	$\chi^2 = 7.4$
	Negative	12	8.5	11	4.6	df = 3
	Positive	93	66	144	59.8	P = 0.06
	Strongly positive	34	24.1	84	34.9	
	Missing	0	0	1	0.4	
Perception of barriers	Strongly negative	8	5.7	10	4.1	$\chi^2 = 0.2$
	Negative	82	58.2	137	56.8	df = 4
	Positive	45	31.9	85	35.3	P = 0.6
	Strongly positive	6	4.3	7	2.9	
	Missing	0	0	2	0.8	
Practice of research	Negative	40	28.4	53	22	$\chi^2 = 0.6$
	Equivocal	21	14.9	49	20.3	df = 3
	Positive	80	56.7	136	56.4	P = 0.4
	Missing	0	0	2	0.8	

$P < 0.05$ is statistically significant.

There have been several studies indicating that including a research curriculum, whether short term or a standardized curriculum, makes the medical student more confident about a research carrier[2,11]. Infectious diseases still constitute the major disease burden in India; non-communicable diseases like diabetes are on the rise and research is necessary for developing action plans for their control by future generations of medical professionals[8]. Thus we need to increase interest and change perceptions towards medical research in India.

We found that a greater number of students from the fourth and fifth years participated in the survey. This may be because two investigators for this study were enrolled in the fifth year and hence there was a better rapport with students in the fourth and fifth years. A study from Brazil found that the number of students involved in research increased from the first year, superseding those not involved from year four onward, when involvement peaked. European studies confirm that most undergraduate research initiation takes years during two or three place[12]. However, there were statistical differences in attitude towards research between the senior classes (fourth and fifth years) versus the first–third year students ($P = 0.0006$). This may be due to improved attitudes towards health research with increasing number of years at the medical college, an observation that has been made in other studies as well[1,13]. There was a difference in the number of female respondents in the present study. This is likely due to the higher number of female medical students enrolled at both the medical colleges, with a female-to-male ratio of approximately 60.

Only 32% of students participated in research, of which 2.4% had a publication based on the project. This was in contrast to a similar study from Saudi Arabia,

Table 4. Comparison of attitude of medical students towards research by the number of years in medical school

Response	Response	Number	Percentage	Number	Percentage	
Attitude	Strongly negative	1	0.6	2	1	$\chi^2 = 16$
	Negative	3	1.7	20	9.8	$df = 3$
	Positive	103	58.5	134	65.4	$P = 0.0006$
	Strongly positive	69	39.2	49	23.9	
	Missing	0	0	1	0.5	
Perception of barriers	Strongly negative	7	4	11	5.4	$\chi^2 = 5.2$
	Negative	90	51.1	129	62.9	$df = 3$
	Positive	71	40.3	59	28.8	$P = 0.02$
	Strongly positive	7	4	6	2.9	
	Missing	1	0.6	0	0	
Practice of research	Negative	40	22.7	53	25.9	$\chi^2 = 0.5$
	Equivocal	31	17.6	39	19	$df = 3$
	Positive	103	58.5	113	55.1	$P = 0.5$
	Missing	1	0.6	0	0	

$P < 0.05$ is statistically significant.

where 62.3% participated in research and 3.2% published their results[14]. A previous study from Canada reported that the majority of research-related activities were retrospective chart reviews or case reports, and not basic science projects[1]. However, we did not query the type of research activities in our survey. The low research output by medical students parallels analysis of the data in Index Medicus in 1998. Globally 416,561 papers were published, of which India's share was only 0.714% (2974 articles)[15]. Of the 5500-plus journals covered in PubMed, just 39 (0.71%) are from India. Similarly, in the EMBASE, there are 128 (1.71%) Indian journals. Global databases present similar numbers[9].

Low rates of research participation are worrisome, since a decline in research can result in a lack of progress in medical advancements. For example, some specialties have expressed concern over the lack of basic science projects in medicine[1,15,16].

Participants in the present study responded that barriers to research included time constraint (45% participants), inadequate training for research and literature searches (50% participants), and college support (40% participants). Students from Canadian medical colleges reported similar barriers[1]. Whether these concerns are endemic to medical curricula remains unknown and should be investigated. Our survey outcomes concur with those of Unnikrishanan *et al.*[17], who reported that time was the main barrier to research for medical students in India. Time was also a significant barrier to research among Canadian medical students[1]. Time constraints to perform research in medical colleges seem to be a universal issue and solutions may have to be individually tailored after careful examination of the college curriculum.

There are some limitations to this study. The analyses are based on two medical colleges in only one province, which may not be indicative of the entire country. Additionally, the colleges were not randomly selected. However, this study provides data on the attitudes and perceptions towards research that can be used as a baseline by public health policy experts and instructors at medical colleges. Additionally, data from this study provide a baseline for comparison in future studies.

This study was undertaken to evaluate the attitudes of undergraduate medical students towards research in India. Majority of the medical students indicated that research would interest them and it was relevant to medical care in India. They also felt that research should be a mandatory component of the curriculum in medical colleges. There have been several studies demonstrating that including a research curriculum, whether short term or a standardized one, makes the medical student more interested in research. Only 2.4% of students published from India and 32% participated in research. The barriers such as time constraint, limited training and college support inhibited their ability to perform research.

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Dual polarization lidar for remote sensing of aerosols and clouds in the atmosphere

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We describe an indigenously developed dual polarization lidar (DPL) system for remote sensing of the range-resolved properties of non-spherical nature of airborne and cloud particles. The DPL system probes the atmosphere using a linearly polarized second harmonic Nd : YAG laser. The design of receiver optics is such that it separates the collected backscattered light into parallel and perpendicular polarization components. The ratio of intensity of perpendicular to parallel signals is known as the depolarization ratio (DR), which is a gauge for non-spherical particle content in the atmosphere. The DPL employs an external irradiance standard to calibrate the depolarization measurements. Comparison of simultaneous measurements between DPL and a similar instrument validates the utility of the system for cloud and aerosol studies. The altitude profiles of DR derived from lidar signals potentially indicate the type of major particle layers in the atmosphere.

Keywords: Aerosols, clouds, laser, polarization lidar, remote sensing.

ATMOSPHERIC aerosols, clouds and water vapour play a crucial role in climate change. The altitude of suspended aerosols in the atmosphere is an important issue for human health as well as the global environment. At lower altitudes aerosol particles are washed out from the atmosphere due to rain, and will not have a long-term effect on the climate. In the upper altitudes, aerosol particles are injected into the atmosphere from desert storms and biomass burning, and are frequently transported for more than thousands of kilometres and affecting remote areas[1].

The climate effects of atmospheric aerosols and clouds remain highly uncertain because of the lack of detailed data for the optical properties as well as the scarcity of information about the vertical distribution and spatial homogeneity of the particle layers. In addition to the optical properties, altitude information on particle non-sphericity is a vital parameter to understand aerosol and cloud microphysics. The particle shape critically controls its optical properties[2], and hence affects the earth's radiative process[3] as well as the vertical distribution of the particles[4].

Since the depolarization ratio (DR) is a measure of non-sphericity of the particles, it can also be considered as an indicator of the particle phase. Liquid droplet particles are mostly spherical in nature and indicate near-zero or low depolarization values, whereas solid crystals are non-spherical and indicate values substantially larger than zero. Moreover, hygroscopic nature of aerosol particles significantly affects the direct radiative forcing[5]. Hygroscopic particles contain water-soluble compounds and can change the shape of aerosol particles. Hence, the simultaneous altitude information of water vapour is essential to understand the hygroscopic behaviour of aerosol particles.

Recently, a cost-effective polarization-sensitive lidar was successfully developed and demonstrated for atmospheric studies at the National Atmospheric Research Laboratory (NARL), a unit of the Government of India under the Department of Space, located at Gadanki (13.5°N, 79.2°E, ~375 m above ground level (agl)) near Tirupati, Andhra Pradesh. Preliminary measurements of

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