

THE ORTHOPAEDIC FORUM

A Research Year for Medical Students

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A research year during medical school can be a worthwhile excursion from the typical 4-year path for medical students. The number of medical students who elect to take a research year prior to residency has been increasing over time¹. Currently, 11% to 17% of applicants to U.S. orthopaedic surgery residencies participated in a research year^{1,2}. For comparison, 25% of applicants in integrated plastic surgery, a similarly competitive specialty, participated in a research year³.

As research years become more prevalent, it is important for both medical students and orthopaedic surgeons to be conscious of the benefits, pitfalls, logistics, and factors that determine the success of these endeavors. Thus, we present a discussion of these topics based on our experience as an orthopaedic surgeon who has mentored students in his role as Director of Cleveland Clinic Adult Reconstruction Research (CCARR) and a medical student who completed his own research year.

Benefits to the Medical Student and Orthopaedic Surgeon

While the motivations for pursuing a research year may vary, students benefit from an increase in their competitiveness when applying for an orthopaedic surgery residency. One study found that students who participated in a research year had a higher match rate compared with the mean in U.S. orthopaedic surgery, despite lower United States Medical Licensing Examination (USMLE) Step 1 scores⁴. With the move of Step 1 to pass or fail, research is playing an increasingly important role in residency applications, especially as the number of publications of prospective applicants increases⁵. Additionally, medical students who publish research match at higher-ranked residency programs⁶.

An aptitude for research will continue to pay dividends during residency. Residents who completed a research year while in medical school produce more peer-reviewed journal publications during residency than those who did not⁷. The ability to publish high-quality research in residency will subsequently empower residents when applying to fellowships and as they advance in their careers. However, the number of publications of residency applicants does not appear to correlate with American Board of Orthopaedic Surgery (ABOS) Part I scores, Orthopaedics In-Training Examination (OITE) scores, or overall residency evaluation scores⁸. Regardless, a resident's ability to perform research is certainly a valuable skill to develop and may not necessarily be reflected in general measures of resident performance. Indeed, learning how to conduct and interpret research can prove useful as surgeons attempt to stay up to date on recent advancements. Furthermore, a year of research may have career choice implications since graduates of orthopaedic residency programs who decide to enter a career in academics have more first-author publications, more total publications, and higher Hirsch (H)-indices⁹.

Research mentors provide a myriad of benefits, including access to career advice, personal and professional development, acquisition of new knowledge and skills, and the support of an advocate as the student advances in their career. A research year also provides students an opportunity to experience the field first-hand and build other relationships in orthopaedics. We typically encourage participation in departmental research meetings, orthopaedic grand rounds, and other opportunities where students can network with faculty and professionals throughout the department. These connections appear to pay off. Approximately 20% of students who match following a

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research year match at the same institution^{1,10}. Finally, the deeper understanding of and aptitude for conducting research obtained during a research year will benefit the field, in which there is a need to implement evidence-based changes in clinical practice³.

The advantages of a research year extend to the orthopaedic surgeon who volunteers to mentor a student. Medical students who dedicate a year to research often are highly motivated and committed to the field, offer new ideas for investigation, and have greater time and flexibility to dedicate to pushing projects forward to publication. They provide a fresh pair of eyes, a unique perspective, and opportunities for self-reflection and personal growth. Similar to how teaching trainees in the clinical setting encourages a surgeon to stay abreast of best practices, the questions and ideas of medical students help a mentor advance their research. Additionally, there can be great satisfaction in developing the young minds that will be responsible for driving the advancement of the field in the future. Furthermore, orthopaedic surgery residencies may encourage faculty to mentor students in research to help build relationships with and improve the skills of prospective applicants.

While there are many benefits of participating in a research year during medical school, notable drawbacks also exist. A research year adds time to the already lengthy process of a medical student's education. Students may also have opportunity costs associated with a year of lost income. This adds to the costs of applying to orthopaedic surgery, which are already higher than in many other specialties¹¹. Furthermore, despite participating in a research year, a student may fail to match into an orthopaedic surgery residency. Students must carefully evaluate their own unique application strengths and weaknesses and seek feedback from mentors when deciding to take a year off from medical school for research. Additionally, despite the rising participation in and focus on research years, to our knowledge, no residency requires a research year to be completed during undergraduate medical education. Moreover, many students can accumulate adequate research experience throughout the standard 4-year medical education, and thus may find a full year dedicated to research to be unnecessary.

Mentor and Mentee: Choosing One Another

Selecting a Mentor

Careful selection of a research mentor is the most important task for a medical student planning a research year, and we recommend a proactive approach. Many surgeons do not have the time, resources, or interest to create the optimal experience for a medical student who is dedicated to full-time research. Additionally, residency programs want to see that an applicant's research year produced a sufficient number of high-quality publications, which was a median of 4.5 in a study surveying orthopaedic surgery residency program directors¹². Suitable research mentors should, at a minimum, have (1) dedicated or sufficient research time, (2) a proven history of regular publication of quality research, and (3) sincere enthusiasm to serve as an advisor (Table I).

Students should seek out other medical students and residents who have worked with mentors in a research capacity

TABLE I Important Characteristics to Seek in a Research Mentor

Dedicated or sufficient research time*
Proven history of regular publication of quality research*
Sincere enthusiasm to serve as an advisor*
Previously mentored medical students with successful research years
Great communicator
Organized
Access to funding
Research support staff, including statistical analysis
Clear expectations
Projects related to student areas of interest
Variety of research project types

*Minimum required characteristics.

and are willing to give an honest evaluation of the experience. These individuals can point the student toward promising mentors for a research year as well as alert them regarding suboptimal mentorship arrangements⁸—e.g., tell them if the researcher has a history of behaviors such as failing to give students credit for contributing work to published materials, being very difficult to contact, or excessively delaying projects. Another option is searching the internet for research fellowships. A recent article by Carr et al.⁹ identifies 30 established research-year fellowships and the average number of publications produced from each. Fellowships may be more structured and have clearly outlined expectations; however, in practice, they can be similar to research years that medical students set up with a mentor themselves. When applying to fellowships, students should still ask previous fellows about their experiences.

Students can contact a prospective mentor through an email that includes their curriculum vitae and prior research experience, and describes their interest in working with the mentor for a research year. The student can also show initiative by proposing an idea for a research project. If the faculty member is interested in working with the student, it is wise for them to meet to confirm that they are a suitable fit. Students should ask questions about the kinds of projects in which they can get involved, time commitments, if they can work remotely, how productive other students have been when working with the researcher, and the researcher's expectations of students who work with them. Inquiring about the support staff and resources, including statistical staff, clinical research coordinators, and funding, may also be useful.

Selecting a Mentee

Similarly, research mentors should carefully select medical students with whom they will work and in whom they will invest their time. Although a medical student's previous research experience may increase their chance of being highly

productive, other skills and motivation may be far more important. In general, medical students who are most productive will be passionate about orthopaedics, self-driven, hardworking, and inquisitive. Additionally, interpersonal communication skills and a willingness to work together with other medical students, residents, fellows, and members of the research team are imperative. As stated above, we encourage an in-person meeting prior to working together in order to facilitate identification of productive and counterproductive personality traits, to start building a relationship, and to allow the student and surgeon to ask each other questions. To identify characteristics suggesting that a student may or may not be the best candidate for a research year, we ask them why they are interested in orthopaedics, why they want to do research, how they work as part of a team, and what challenges they have overcome. The exact answers to these questions are not necessarily important. More so, answers should demonstrate a genuine interest in orthopaedics, a hardworking attitude, and a collegial demeanor. We also remain alert for aspects of their background that may allow for optimal alignment of personal and research interests. Asking students to supply recommendations from professors or other researchers can be helpful as well. Finally, we suggest that students start on a research project with us before beginning their research year, to decrease the learning curve at the start of the year and so that we can directly observe their work ethic and ability to work with the team.

Musculoskeletal Funding and Stipends

Although musculoskeletal conditions impact more than one-third of the U.S. population, with a cost of approximately \$381 billion dollars in 2016¹³, National Institutes of Health (NIH) funding for musculoskeletal research is much lower than that for other diseases¹⁴. These effects trickle down to funding for medical student and resident researchers. Consequentially, stipends available to medical students pursuing an orthopaedic surgery research year vary widely⁹. One well-known research fellowship (not specific to orthopaedics) is the NIH Medical Research Scholars Program, which provides a \$41,000 stipend¹⁵. However, many students participate in an unpaid research year¹, which increases the costs associated with medical school and can prevent students with less advantaged backgrounds from applying for such positions. Additionally, there are concerns regarding unpaid research years. Students must evaluate unpaid positions individually, specifically focusing on what they are obtaining in return for their time. Overall, unpaid research may be a worthwhile arrangement for some students if the mentor is willing to commit their time and energy to teaching skills and guiding the medical student in a long-lasting relationship that may ultimately result in a substantial improvement of their application for residency. Nevertheless, every research position is different, and students should gather data from past students to better understand if the research year resulted in a true mentorship relationship, and increased their odds of interviewing or matching at the institution. Some research programs may not be interested in mentoring students and focus only on using students to increase publications, which may not provide an optimal experience for students. Our research group tries to provide an approximately

\$15,000 stipend, drawn from our internal funds, for medical students who commit for 1 year. This stipend, while modest, is meant to partially address problems with access to research for medical students who cannot afford to take an unpaid year.

Funding for a medical student stipend can come from a variety of sources, including the orthopaedic department, grants, and philanthropy. One option for researchers who cannot secure internal funding for a stipend is to work together with the student to apply for outside grants. In this way, the student can not only potentially obtain a stipend, but also benefit from learning how to apply for and write grants. George Washington University provides a calendar listing deadlines for many grants to which researchers, residents, and medical students may wish to apply¹⁶. However, none of these strategies change the fact that research funding needs to increase for orthopaedics, one of the highest disease burden- and quality of life-impacting specialties in medicine¹⁴.

Timing of the Research Year

Over 80% of orthopaedic surgery residency applicants who completed a research year did so after their third medical school year, and approximately 10% did so after their fourth year¹. The timing of the research year provides different advantages and disadvantages. Students who elect for the research experience between their first and second years have the opportunity to form a longitudinal relationship, although they may not have yet cemented their interests in the field. Again, starting on a project before committing to research full-time can help students maximize their research year. In contrast, it can be helpful to work with students in the later years of medical school as they have more substantial medical knowledge and clinical experience. Nevertheless, the timing of the research year does not seem to affect the number of publications resulting from that year or the ability to successfully match¹.

Students who participate in a research year later in medical school also face increased pressure to publish research in time for residency applications. Residency directors are aware of this issue, yet they expect students to have documented manuscript submissions. Students who elect to take a research year between the third and fourth years of medical school face the tightest timeline and should work diligently with their research mentor to create a plan that will allow for projects to, at a minimum, reach submission by the culmination of the year. Students should be cautious of joining a research team that does not anticipate publication or submission of at least some projects in time for their Electronic Residency Application Service (ERAS) submission. Nevertheless, only approximately one-half of submissions listed on the application typically reach publication, and one-third fall to a journal with a lower impact factor¹⁷. Thus, residency programs typically find acceptance more valuable than submission.

Setting Parameters, Expectations, and Goals

Setting the parameters for the research year and defining both the mentee's and mentor's goals early in the relationship allow for mutual understanding and a focus on activities that will be

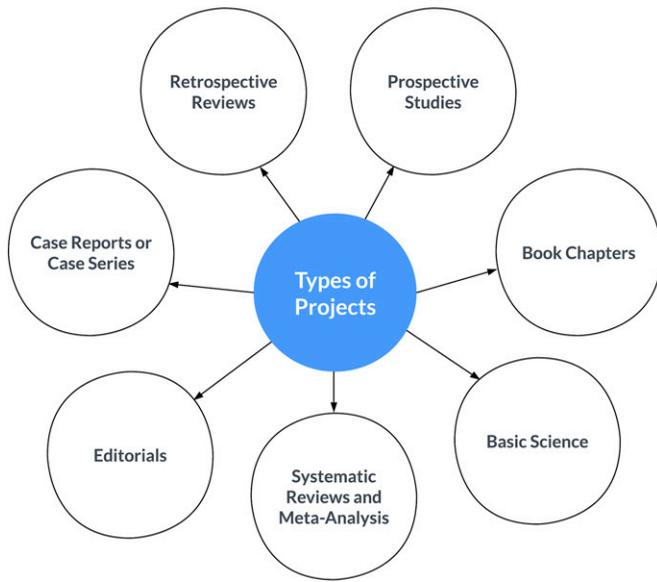


Fig. 1
Non-exhaustive list of the types of research projects that medical students typically work on during a research year.

most beneficial to both parties. Important issues for discussion include anticipated research topics, publication goals, compensation, duties, time commitments for the research, and other

commitments outside of the research. It is also important to provide an overview of the types of projects a student may be involved with (Fig. 1) and tasks that students are typically responsible for (Fig. 2). As in so many other work situations, the COVID-19 pandemic has led to changes in the balance of remote and in-office work for student researchers. Our program typically expects full-time work for the committed year but is flexible. We understand that medical students are on a journey and, even though they committed to a research year, they often have other important obligations. The achievement of objectives is more important than the assessment of time spent working.

One year is a short period of time; therefore, it is of utmost importance that both medical students and leaders of research programs establish realistic and well-thought-out plans to accomplish the tasks and objectives, so that both parties can finish the year with measurable metrics of success. It is beneficial for the mentor and student to meet on a regular basis and be accessible outside of these meetings. We have found a 15 to 30-minute weekly meeting to be successful. Regular meetings allow for both the student and mentor to remain up to date on the progress of each project and ensure that the mentor is available to provide insight and advice. These meetings include progress reports on all of the projects that a student is currently working on. Furthermore, key submission deadlines should be communicated early.

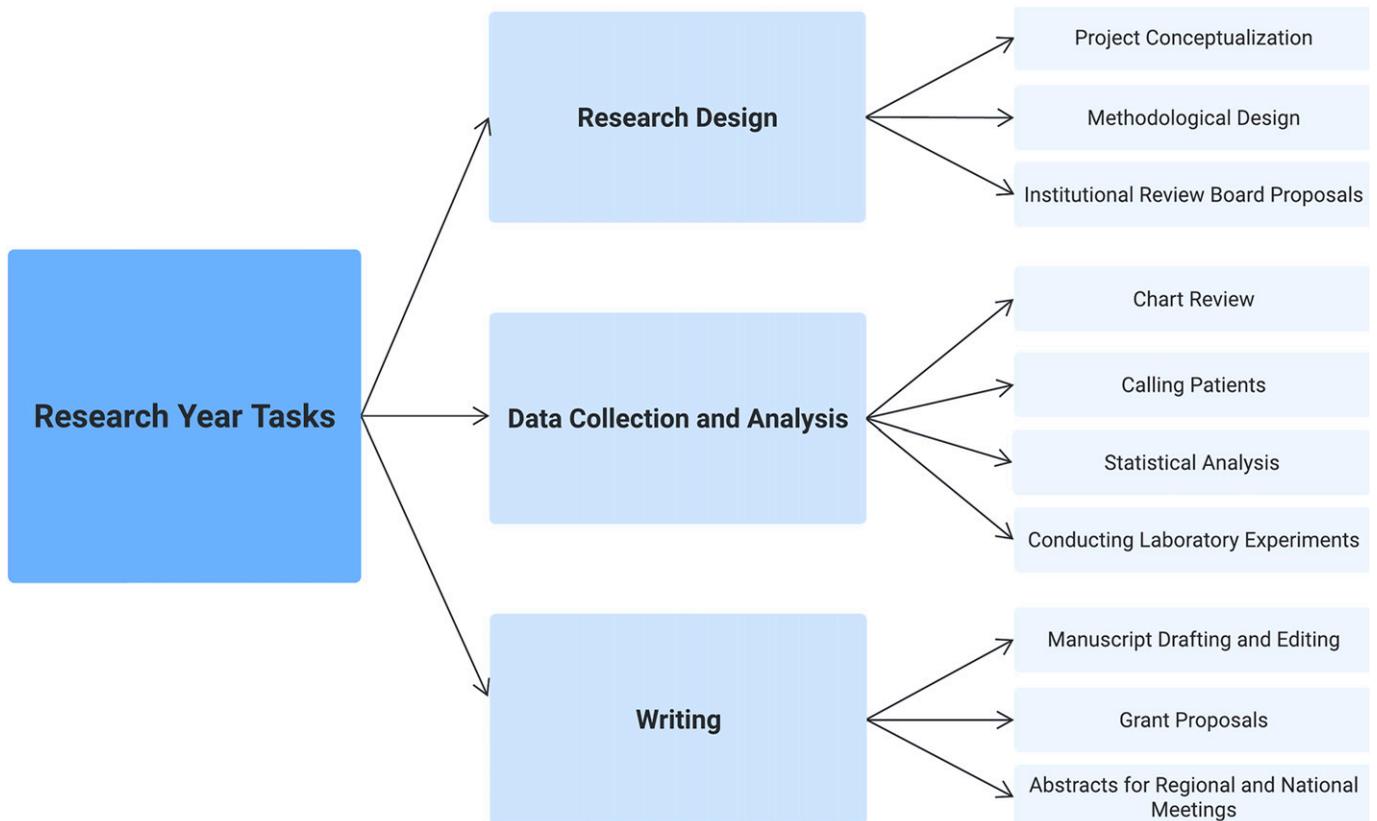


Fig. 2
Overview of common tasks assigned to medical students during a research year.

Outlining several conference deadlines and goal project deadlines is recommended.

Planning and Orchestration of Projects

The research process from inception of a worthwhile idea to publication typically takes several months if not years, depending on the nature of the project. Thus, it is often best if students can participate in multiple projects at different stages (e.g., project design, institutional review board [IRB] approval, data extraction, analysis, and writing) simultaneously, so that downtime is limited and they can contribute to projects that will be published before the end of the year. When there are many projects proceeding at various stages, ample communication is imperative. Research is a team sport, requiring people of various backgrounds and skills to work in concert¹⁸, and together this team should set a timeline, establish which tasks and projects should be prioritized, and identify “next steps” and bottlenecks. This may be especially relevant when it comes to requests for data, IRB submissions, and conducting edits or revisions. The plan for a student’s specific contribution to a project must take into consideration their past research experience, current abilities, and desire to develop various skills. In addition, medical students will gain knowledge and skills that can be used to teach other medical students and new members of the team. Pairing students with research fellows and/or residents can also help students quickly acclimate to the team, and learn how to organize and prioritize projects.

Medical students can achieve a variety of high-quality publications. One study of students who matched into orthopaedic surgery from 2013 to 2017 noted that most of their publications were related to clinical projects (53%)¹⁹. Other common types of publications included basic science research articles (19%), reviews (14%), short reports (8%), editorials (3%), and book chapters (2%)¹⁹. The average journal impact factor for medical student publications was 1.5²⁰. Students also contribute substantially to projects, as demonstrated by a 28% rate of first authorship¹⁹. However, these numbers are not specific to those who participated in a research year, and they may change as a result of the change of Step 1 to pass or fail¹². In addition, there has been a trend in medical student publica-

tions away from basic science to clinical topics¹⁹. While there is merit to pursuing both, it may be more difficult to achieve publication of basic science research during the restricted timeline of a research year. If basic science research is pursued, it may be wise to supplement it with clinical research, which can be more flexible in terms of timing and commitment. Additionally, we recommend that students focus on orthopaedic surgery-related research because it demonstrates commitment to the field.

Conclusions

Medicine has historically operated under an apprenticeship model, and mentorship continues to drive the field of orthopaedics forward. Mentorship in research is no exception. A research year provides tangible benefits—including an increase in publications and thus competitiveness for residency matching, fellowships, and beyond—and intangible benefits in terms of personal and professional growth for both the student and the researcher. A successful research year depends on careful selection of both mentor and mentee as well as planning and communication throughout the process. This manuscript has focused primarily on students interested in completing a research year, yet many of these concepts are also applicable to students seeking to maximize their experience within the normal 4-year course of medical school. Finally, the field as a whole needs to support these valuable activities through an increase in musculoskeletal funding. ■

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