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Assessment of skills development in a residency research track for internal medicine residents

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Abstract

There has been minimal formal evaluation of residency research programs. This study was designed to assess the impact of an internal medicine residency research track on residents' confidence and attitudes about research skills. In 2022, a research track was started within the UMass Chan internal medicine residency. Ten residents (five PGY-2 and five PGY-3) were selected to participate. Pre- and post-program surveys were created distributed electronically at baseline and one year, with 100% response rate. Survey questions, ranked on a Likert scale (1–5), assessed residents' confidence and self-perceived importance of research skills. Change scores were utilized to compare post-survey responses to baseline using paired t-tests. At baseline, residents reported mean (SD) 5.8 (5.7) publications, which increased by 1.4 (1.8) in one year ($p = 0.02$). IRB submission, conducting basic analyses, and grant writing had the lowest baseline scores. After one-year, mean confidence scores significantly increased for writing study protocols (pre-score (SD): 3.0 (1.2), Δ: 0.6), IRB submissions (2.6 (1.1), Δ: 0.9), designing survey questions (2.9 (1.3), Δ: 0.9), writing methods (3.4 (1.0), Δ: 0.5), and designing blank tables (3.4 (1.5), Δ: 0.4, all $p < 0.05$). No significant score reductions were noted. Implementation of research tracks can improve research skills and overcome some barriers to research during residency training. Our study demonstrates improved confidence in research skills through

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completion of research didactics and close mentorship. Future curricula should conduct needs assessments and provide an individualized approach to maintain research scholarship during residency.

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1. Introduction

Individualized learning pathways are essential for medical residents to explore roles beyond patient care, fostering a more comprehensive skill set and love of lifelong learning (Kohlwes et al., 2016). Medical research, as a cornerstone of innovation and academic medicine, plays a crucial role in advancing evidence-based practice and improving patient care. It has been shown that clinical research training during residency promotes scholarship, shapes career trajectories, enhances uptake of evidence-based care, and equips physicians to critically evaluate and apply current literature (Ercan-Fang et al., 2021; Institute of Medicine (US), 2004; Kohlwes et al., 2016; Kohlwes et al., 2006). Early exposure to research and mentorship can help residents to succeed at performing academic clinical research (Ercan-Fang, Rockey, Dine, Chaudhry, & Arayssi, 2017; Leppert & Artal, 2002). Previous studies in both academic and non-academic medical centers have shown that residents who perform scholarly activities during residency training were 50% more satisfied with their training, and 63% of surveyed second-year residents felt that research should be required during residency (Takahashi et al., 2009). Additionally, residents consistently rate completing a research project as one of the most valuable learning experiences in their training (Amrhein et al., 2015; Hamann, 2024; Hayward & Taweel, 1993). Another study found that there was a strong positive correlation between publications during internal medicine (IM) residency and strong clinical performance evaluations (Seaburg et al., 2016).

Despite these promising findings, there are many barriers to performing high-quality clinical outcomes research projects across various specialties during residency. Challenges include limited protected research time, difficulty finding compatible mentors, heavy clinical responsibilities, complex funding applications, and insufficient training in research methodology (Atreya et al., 2018; Potti, Mariani, Saeed, & Smego Jr, 2003; Rivera, Levine, & Wright, 2005; Rothberg, 2012). In 2021, a national survey showed that only 58% of IM programs had a formal research curriculum, although 2/3 of residents were involved in research (Ercan-Fang et al., 2021). Multiple residency program directors designated a formal match between resident and mentor as critical for success in a research program (Ercan-Fang et al., 2021). Implementing a research residency track for motivated and interested postgraduates can address these pitfalls by providing the education, mentorship, and funding required to perform high-quality research. The University of California San Francisco (UCSF) IM residency program was one of the first to demonstrate the effectiveness of a structured residency research program. The Primary Medical Education (PRIME) program, embedded within the IM residency, focused on clinical outcomes research through mentorship to conduct research projects (Kohlwes et al., 2016). Notably, 64% of PRIME alumni published research during residency compared to 40% of non-PRIME residents (p = 0.002). PRIME alumni also reported better access to mentorship. Additionally, longitudinal studies have emphasized the importance of mentorship in broadening career options and enhancing academic productivity (Todd et al., 2013).

To address barriers to research in residency, the UMass Chan Medical School IM residency implemented the Residency Research Track, modeled on prior successful programs (Kohlwes et al., 2016). While existing research tracks across the country have primarily evaluated success based on output metrics, such as number of publications or regional/national poster presentations, few have examined the confidence with and development of specific research skills (Carter et al., 2019; Ercan-Fang et al., 2017). To fill this gap, we conducted this study to evaluate the research track residents over the first year of the program to assess their change in confidence, attitudes, and interests in research skills while enrolled in the program. Our hypothesis is that research track residents would demonstrate increased confidence in several research skills related to early research project development at the end of one year of mentored research and didactics (Hamann, 2024).

2. Materials and Methods

The UMass Chan Medical School IM Residency Research Track was designed to specifically support skill development for our residents who wish to pursue research as part of their future careers. IM residents applied for and were selected to participate in this program. Residents are assigned two mentors (one primary

research mentor and one research track core faculty mentor), with whom they are expected to meet at least monthly. Residents participate in monthly didactics, seminars, and research-in-progress sessions. They are expected to present at least one abstract at a regional or national meeting or publish one manuscript every year. Along with their primary research mentors, they are expected to design research electives with support from their research track core faculty mentor.

Pre- and post-surveys were designed on REDCap (Harris et al., 2019; Harris et al., 2009) and distributed to the IM residents who were a part of the research track via email. Participants' responses were used only for quality improvement and did not affect their standing in the program. Institutional Review Board (IRB) approval was not required for this study after guidance was sought from the UMass Chan Medical School IRB, because no personal information was disclosed. Consent to participate was not required.

The survey questions, ranked on a Likert Scale of 1-5 (with 1 representing No Confidence and 5 representing Very Confident), evaluated residents' confidence with specific research skills and how important certain areas of knowledge are for their career. The survey also asked about the number of hours per week spent on research in the four core IM rotations including inpatient general medicine, inpatient electives, intensive care unit, and ambulatory rotations. One resident's data was removed from the analysis of research hours due to being an extreme outlier, with the reason a likely misinterpretation of the question as asking about time dedicated to clinical hours and not research hours. In both the pre- and post- surveys, the residents were asked about their publication history, including a breakdown of number of publications/abstracts and author position at the time of survey completion. The pre- and post-surveys were collected one year apart, after participation in the research track (100% survey completion).

Likert-scale scores were summarized as mean and standard deviation. Post-survey means were compared to baseline means using a paired t-test. The change in mean scores from pre- to post-survey was calculated for each question. Some questions examined a change in confidence, and others examined a change in the self-rated importance of a skill for their career. All analyses were performed in Microsoft Excel. A p-value of <0.05 was considered statistically significant. The pre- and post-surveys can be visualized in the supplementary material section.

3. Results

Of the ten participants, five were Postgraduate Year (PGY)-2 residents and five were PGY-3. At baseline, residents had a range of experience with publications as abstracts and manuscripts (Table 1). No residents had any publications accepted as senior author, either in the pre- or post-survey. Residents reported up to three publications that they had been involved with that had not been accepted (mean 1.0 (SD 1.4)), with the main reason being previous rejection from a journal. After one year in the program, residents reported a mean of 1.4 (1.8) ($p = 0.02$) new publications accepted and 3.1 (3.6) ($p = 0.03$) new abstracts accepted. In the post-survey, 80% of the residents had at least one first-author paper and all the residents had published new abstracts (90% with at least one first-author abstract). Of these residents, 80% were planning to attend a fellowship, some after a chief resident year. These residents described their future jobs/fellowships as having 36.5% (SD 30%) protected research time.

Table 1. Accepted publications and abstracts among IM residents pre- and post-enrollment in the Residency Research Track at UMass Chan Medical School.

Research output	Measure (Pre)	Total (Pre)	1st author (Pre)	2nd author (Pre)	Middle author (Pre)	Post-survey Δ, all author positions	*p*-value*
Accepted publications	Mean	5.8	1.3	1.4	3.1	1.4	**0.02**
	(SD)	(5.65)	(1.16)	(2.01)	(3.14)	(1.78)	
	Min.	1	0	0	0	0	
	Max.	15	3	5	8	5	
Accepted abstracts	Mean	3.9	2.2	0.5	1.2	3.1	**0.03**
	(SD)	(5.28)	(3.94)	(1.08)	(1.81)	(3.6)	
	Min.	0	0	0	0	1	
	Max.	17	12	3	5	13	

Note: *p-value calculated with paired sample t-test, examining change in total publications from pre- to post-survey.

When describing the time dedicated to research activities on various residency rotations, there was no significant change over the year of the study (Table 2). For both survey time periods, the most time was spent during ambulatory rotations (pre-survey: 7.4 (5.6) hours; post-survey: 8.1 (5.3) hours, $p = 0.80$), and the least time during intensive care unit (ICU) (pre-survey: 1.4 (1.7) hours; post-survey: 1.1 (1.8) hours, $p = 0.71$).

Table 2. Resident time spent performing research activities by clinical rotation, among residents enrolled in the IM Residency Research Track at UMass Chan Medical School.

Rotation	Research time (hours/week) (Pre) * (N = 9) **	Research time (hours/week) (Post) * (N = 9)	Δ Score	*p*-value
Inpatient internal medicine	1.55 (1.81)	2.33 (2.06)	+ 0.78	0.49
Elective inpatient	6.67 (3.28)	8.11 (5.37)	+ 1.44	0.47
Intensive care unit	1.44 (1.74)	1.11 (1.83)	-0.33	0.71
Ambulatory	7.44 (5.55)	8.11 (5.33)	+ 0.67	0.80

Note: *Scores are presented as mean (SD).
**One resident's answers removed because of incorrect interpretation of the survey questions.

High mean baseline scores (mean > 4.0 on the Likert scale) were observed for confidence in writing a manuscript background or discussion, performing literature review for discussion, writing/submitting abstracts, and creating oral presentations. Confidence in IRB submission, conducting basic analysis, designing survey questions, and grant writing had the lowest baseline scores, all with mean scores < 3.0 (Table 3). Mean scores increased significantly after one year in the program for IRB submissions (pre-score (SD): 2.6 (1.1), Δ: 0.9), writing study protocols (3.0 (1.2), Δ: 0.6), designing blank tables (3.4 (1.5), Δ: 0.4), designing survey questions (2.9 (1.3), Δ: 0.9), and writing methods (3.4 (1.0), Δ: 0.5) on post-survey responses (all $p < 0.05$) (Table 4, Figure 1). No significant negative change scores were noted. No significant changes in self-rated importance of research skills were noted.

Table 3. Research skills with high and low baseline confidence reported by IM residents in the Residency Research Track at UMass Chan Medical School.

Baseline high scores (Mean > 4.0) *	Baseline low scores (Mean < 3.0) *
Write a manuscript background or discussion	Create an institutional review board submission
Perform a literature review for discussion	Conduct basic analysis
Write/submit abstracts	Write a research grant/search for funding
Create/present oral presentations	Design survey questions
	Use software programs for figure creation
	Apply for access to data
	Write a cover letter for journal submission

Note: *A score of 1 = No confidence, a score of 5 = Very confident.

Skills early in the research project development or "study prep" category of skills improved the most. Creating an IRB, writing a study protocol, designing blank tables, and designing survey questions all had significant improvement after one year of didactics and mentorship (Table 4, Figure 1). For "manuscript writing and revision", with generally higher baseline scores, only "writing a methods section" had a significant increase in confidence score (Table 4, Figure 1). There were no significant increases in confidence in the "dissemination/funding" category of research skills, which included writing and submitting an abstract, creating an oral presentation, and writing a research grant (Table 4).

Table 4. Confidence in research skills, pre- and post-one year in the Residency Research Track at UMass Chan Medical School.

Category	Research skill	All residents (N = 10)		Δ Score	*p*-value
		Pre-survey scores *	Post-survey scores *		
Study Prep	Create an IRB submission	2.6 (1.1)	3.5 (1.1)	+ 0.9	**<0.01**
	Create an analysis plan	3.1 (1.2)	3.2 (1.2)	+ 0.1	0.68
	Write a study protocol	3.0 (1.2)	3.6 (0.8)	+ 0.6	**0.02**
	Design blank tables	3.4 (1.5)	3.8 (1.2)	+ 0.4	**0.04**
	Design survey questions	2.9 (1.3)	3.8 (0.9)	+ 0.9	**0.02**
Manuscript writing/ Revision	Write a background	4.1 (1.3)	4.6 (0.5)	+ 0.5	0.18
	Write a methods section	3.4 (1.0)	3.9 (0.7)	+ 0.5	**0.02**
	Interpret/Write results	3.6 (1.3)	4.1 (0.7)	+ 0.5	0.14
	Design figures/Tables	3.4 (1.4)	3.6 (1.2)	+ 0.2	0.64
	Conduct basic analysis	2.3 (1.2)	2.9 (1.4)	+ 0.6	0.22
	Perform a literature review for discussion	4.0 (0.8)	4.4 (0.7)	+ 0.4	0.68
	Write a discussion	4.2 (0.9)	4.2 (0.8)	-	1.0
	Write a case report	3.4 (1.2)	3.9 (1.1)	+ 0.5	0.32
	Draft a reviewer reply	3.5 (1.1)	3.6 (1.2)	+ 0.1	0.81
Dissemination/ Funding	Write/Submit abstract	4.6 (0.5)	4.5 (0.7)	- 0.1	0.68
	Create oral presentation	4.2 (1.0)	4.3 (0.5)	+ 0.1	0.81
	Write a research grant	2.0 (1.0)	2.4 (1.0)	+ 0.4	0.34

Note: *Scores are presented as mean (SD).

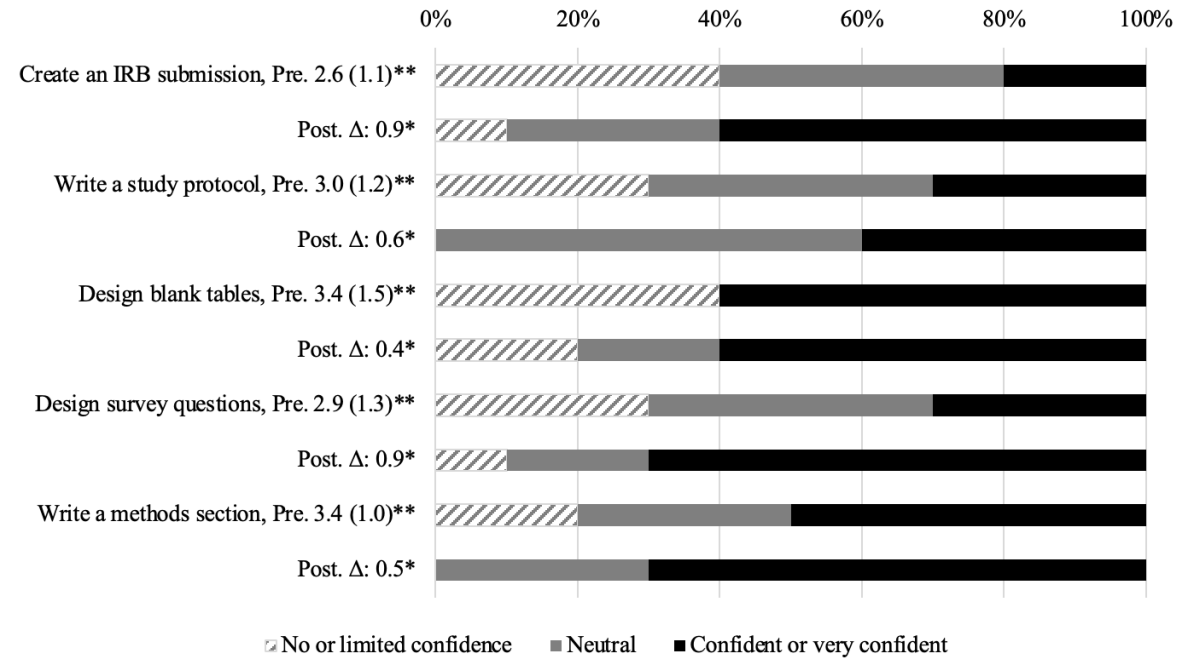

Figure 1. Pre- and post-research track research skills with significant improvement in confidence among IM residents enrolled in the Residency Research Track at UMass Chan Medical School.

Note: *p-value <0.05
**Scores presented as mean (SD).

4. Discussion

This study was conducted to evaluate a new IM research track over the first year of the program. While several research skills had high baseline levels of confidence among residents, the creation and implementation of this research track led to an increase in scholarly output and improvement in several areas of study preparation and manuscript writing. This adds to the growing literature showing that creation and implementation of research tracks in IM residency programs can improve research skills and overcome some of the many barriers to conducting research during residency training (Ercan-Fang et al., 2017; Institute of Medicine (US), 2004; Kohlwes et al., 2016; Kohlwes et al., 2006; Leppert & Artal, 2002) . Important early skills, such as creating an IRB, writing a study protocol and methods section, and designing blank tables/

survey questions, all improved after one year of research didactics and mentorship. Importantly, there was no significant change in perceived importance of research skills over one year in the program.

Our results show that residents had low baseline confidence scores in submitting an IRB/study plan, conducting basic analysis, and grant writing. These skills are the ones often needed in the initial stages of research development or later in their careers (grant writing) and may not have been experienced in their previous research endeavors. These initial project development skills improved more significantly than those needed in the later stages of research. This suggests that our residents may have initiated a new study within this one-year time frame but might not have progressed to the later stages of research, such as manuscript writing/revision. The high baseline skills related to performing literature reviews and writing introductions and discussions also suggests that residents may be more likely drawn to projects in various stages of completion such as completed analysis plans/analyses given the low baseline analysis confidence scores.

The UCSF PRIME program is one example of a long-standing IM research track program (Kohlwes et al., 2016) while Lincoln Hospital (affiliated with Weill Cornell Medicine) and the University of South Dakota Sanford School of Medicine are additional examples (Fanciullo, Hsu, & Stevens, 2018; Kanna et al., 2006). These programs have demonstrated that residents involved in the research program developed a greater interest in research, gained new learning experiences, and exhibited increased research productivity than non-research track counterparts (Fanciullo et al., 2018; Kanna et al., 2006). While past studies have also shown the success of their research programs through increased numbers of publications (Carter et al., 2019; Ercan-Fang et al., 2017) our study adds to the literature by demonstrating how research programs can increase residents' confidence in important research skills. These skills are more specific measures of success. Other training programs such as family medicine, radiology, and undergraduate medical schools have also benefited from incorporating research into training (Amrhein et al., 2015; Arora, Bell, & Hagberg, 2020; Karthik, Greenfield, & Otteson, 2023; Smith, 2005). Residents in these non-IM research track programs have also reported higher levels of satisfaction with training, productivity, and appreciation for research (Amrhein et al., 2015; Arora et al., 2020; Smith, 2005). Medical students reported that research and shadowing had the highest impact on their specialty choice (Karthik et al., 2023).

Our study shows that residents planning on incorporating research in future careers dedicated consistent time each week to research after one year in the program except when on rotation in the ICU. In general, these residents fulfilled their manuscript and abstract publication goal with an average increase of ~1.5 manuscripts published and ~3 abstracts published per resident.

The strengths of this study are that we displayed objective increases in confidence in research skills, a different approach than used by other studies, which have tended to measure the effectiveness of a research track through the number of publications only. However, while this measure is objective, the report of confidence by each participant was subjective, and we did not directly observe the increase in these skills objectively or track our residents to look at the sustainability of these improved research skills. While this is a limitation to our study, this could be considered for future investigation.

As the program continues to train residents, we have used these survey results to tailor the didactics, workshops, and support towards skills that have low confidence. This tailored approach will help each individual cohort improve research skill proficiency while remaining academically productive. Additionally, we plan to develop follow-up surveys to examine how our graduates are using research in fellowship and beyond. It has been demonstrated previously that residents aiming for fellowship after IM residency produce more publications (Fanciullo et al., 2018). We noticed a similar rate of IM residents nationally pursued specialties (87.6% in 2024) (Sanjula, 2024) as our first Research Track cohort.

Our work suggests that future IM research tracks should measure their success using a comprehensive approach assessing residents' confidence in skills rather than solely focusing on research outputs. While not all programs may have implemented pre-research track surveys, we found that the pre-surveys helped to elucidate research knowledge gaps in our cohort. Additionally, implementing a residency research track for motivated and interested postgraduates can address common barriers such as access to mentorship, foundational knowledge in study design/statistics, and access to resources (Atreya et al., 2018; Potti et al., 2003; Rivera et al., 2005; Rothberg, 2012). Enhancing residents' abilities to formulate research questions and follow projects from design to manuscript completion is likely to contribute to not only sustained interest and involvement in research but also better educated physician-scientists.

5. Conclusion

Internal medicine serves as a critical foundation for many medical subspecialties—especially those addressing unmet clinical needs and policy-related challenges. Establishing research tracks within residency programs equips future physician-scientists with skills to conduct quality research that can shape their career trajectories after residency. By providing dedicated education, mentorship, and funding opportunities or alternative support such as access to shared statisticians, research track residency programs can enhance residents' skills, improve research quality and boost confidence in exploring new areas of research. Our findings demonstrate a significant increase in participants' confidence in key research skills along with an increase in research output. These findings offer valuable insights for structuring future research track

programs and address knowledge gaps regarding their effectiveness. We encourage future studies to explore the impact of dedicated research tracks across all residency specialties and the long-term effect on physicians.

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