ANALYSIS OF METRIC PRODUCTIVITY IN RELATIONSHIP TO FACULTY DEGREES FROM AN ACADEMIC MEDICAL CENTER PERSPECTIVE

A Thesis Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctor of Education

by

Amy S. Wright

May 2016

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Abstract

Dual-degreed MD/PhD physician-scientists bridge the gap between basic science and clinical medicine because they have obtained the tools necessary to move ideas and innovations in a straightforward pathway to benefit patients. Although to receive the dual-degree, it takes almost twice as long to complete than a traditional PhD degree or a basic science MD degree. This study analyzed performance metrics such as RO1 funded grants, peer-reviewed journal publications, honors and awards, and patents issued that were produced by academic medical center faculty. This study compared metric productivity in relationship to the degree the identified faculty held. It was proven that there is a difference in productivity from faculty that have a MD/PhD degree versus a traditional basic science MD degree and a traditional PhD degree. This study concluded that due to the increased productivity of MD/PhD faculty, it would be a benefit for an academic medical center to participate in dual-degreed MD/PhD programs.

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Chapter I

Introduction

Academic research is the process by which scientists in a certain academic field evaluate different aspects of a specific research topic. Dr. Di Fang from the Association of American Medical Colleges (AAMC) introduced academic, clinical, and translational research terms in a 2003 article in *Academic Medicine*, stating that clinical research is the link between advances in basic biomedical research and innovations in medical practice. Translational research is the "bench-to-bedside" enterprise of harnessing knowledge from the basic sciences to produce new drugs, devices, and treatment options for patients (Fang, 2003). The physician-scientist, the product of the dual-degree MD/PhD program, is believed to be the catalyst that bridges those concepts together.

The first MD/PhD program began at Case Western Reserve University School of Medicine in 1956, which introduced the physician-scientist to the world of academic research. The goal of the physician-scientist is to be the interface between basic science and clinical medicine, with the end point being the production of promising new treatments that can be used clinically or be commercialized (i.e., "brought to market"; Woolf, 2008).

Since the initial MD/PhD program began at Case, the National Institutes of Health (NIH) has spent billions of dollars awarding funding to selected dual-degree programs through the Medical Scientist Training Program (MSTP). Currently, the MSTP funds more than 46 institutions across the United States. Albert Einstein College of Medicine, New York University School of Medicine, and Northwestern University were the first three institutions to receive MSTP funding in 1964. The original goal of the MSTP was to produce a bridge between the clinician and the basic scientist by using research produced in the laboratory to translate and assist in resolving questions that are generated in the procedure or operating room by clinicians. A second goal was to move ideas and innovation from bench to bedside in a more straightforward pathway that would enable medical advances and technologies to benefit patients in a more real-time manner.

More than 50 years have passed since the first dual-degree program was initiated, and the underlying question remains: Is it worth providing the eight plus years of training to produce dual-degreed MD/PhD scientists? It is important to look at the metrics that are produced by PhD faculty and basic-science MD faculty and determine whether they differ from those produced by MD/PhD faculty. The metrics that are produced from a PhD or basic science MD faculty member, are the tangible products that are generated upon completion of a graduate program and the laboratory. Those metrics are considered to be: a) the number of publications written and accepted in high-index factored, scientific, peer-reviewed journals; b) the number of RO1 grants or other types of federal funding obtained; d) the patents or other intellectual property generated from laboratory research; and e) the honors, awards, or other accolades received in the chosen research field or discipline. The metrics have the ability to move research forward and show productivity during a research scientist's tenure. For a physician-scientist, the metrics are the same, although the physician-scientist pursues those metrics while adding medical school, clinical rotations, and qualifying boards and exams into the curriculum.

An Academic Medical Center (AMC) is a medical school or degree-granting institution and its associated clinical enterprises, which might include a hospital, research institute, private practice clinic, or anything else that makes up the entire organization in which a medical degree can be earned. An AMC invests critical resources such as time, money, and dedicated laboratory space to train the next generation of physicians, investigators, and physician-scientists. The AMCs commit to investing in the academic success of the trainees when they agree to participate in degree-granting programs. The metrics that are produced by faculty after obtaining a degree are a direct reflection of the AMC and how well the AMC cultivates trainees in the specified degree program. The focus of this study is to look at faculties of AMCs and the metrics that they produce by their obtained degree, to determine whether it is advantageous for the AMCs to participate in a dual-degree program.

Statement of the Problem

An AMC that confers MD/PhD dual degrees invests valuable resources into each of its trainees. The resources such as time, dedicated laboratory space, and money being put into each trainee amount to ~$52K per trainee per year (Jeffe, 2014). A typical MD/PhD trainee will complete four years of traditional medical school with an additional three to four years of PhD research courses and bench work, adding up to a total of seven or eight years for the completion of the dual degree.

Recent research has been performed to determine whether the metrics produced by physician-scientists warrant the investment made by the NIH into the MSTP. Other research has been performed to determine the value of participation in MD/PhD programs for trainees. There is little research, however, on the perspective from the AMCs that invest resources into dual-degree programs. Although this study does not analyze the return on investment for an AMC's participation in MD/PhD programs, it attempts to show the types of metrics produced by AMC faculty members has a direct relationship to what type of degree they hold whether it is a MD/PhD degree, a traditional PhD degree, or a basic science MD degree.

Research Question

Through a comparison of the performance metrics for AMC faculty members that hold either a dual MD/PhD degree, a traditional PhD degree, or a basic-science MD, the following research question is addressed: What is the relationship between the type of degree held and the performance metrics of AMC faculty members (i.e., the number of publications, grants received, patents issued, and awards/honors earned)?

A descriptive statistics research design was used to assess the research question. Descriptive research looks at the metrics reported from various samples and compares the differences between two or more variables without making any attempt to influence the variables. To that end, performance metrics for AMC faculty members were compared to determine whether the metrics changed based on the degree held by the faculty: MD/PhD degree, traditional basic-science MD degree, or traditional PhD degree.

Previous research has focused on the reasons why students are interested in becoming physician-scientists. However, this research study focused on analyzing data from AMCs and the metrics produced by faculty members with either an MD degree in the basic sciences, an MD/PhD degree, or a traditional PhD degree in the basic sciences.

Significance of the Study

This study reports on the metrics produced by faculty members from different levels of previously ranked AMCs. The analyzed metrics showed the performance of the faculty members and whether the faculty members held a basic-science MD degree, a basic-science PhD degree, or an MD/PhD dual degree. The metrics were drawn from the NIH and its reporting mechanism, the Research Portfolio Online Reporting Tools (RePORT), to see how many R01-funded grants were produced over a three-year time frame (2012-2014). This study also used data retrieved from the U.S. News & World Report Top Medical Schools list for the ranking of AMCs so that a grouped representation could be made regarding data from the top, middle, and bottom AMCs in the United States. Finally, this study reviewed whether honorees such as Nobel Laureates and National Academy of Science awardees were employed by these same institutions and whether the faculty who had achieved these honors were more likely to come from the MD/PhD degreed faculty.

It was hypothesized that graduates with an MD/PhD would produce better performance metrics upon receiving a research faculty position than graduates with a traditional basic science MD degree or traditional PhD degree. This would suggest that AMCs' participation in a dual-degree program would be beneficial. This would also suggest that even though a direct return-on-investment was not proven for participating AMCs, a greater production of metrics could be expected when hiring MD/PhD faculty into AMC positions.

Chapter II

Literature Review

The terms MD/PhD, physician-investigator, clinician-scientist, medical scientist, and physician-scientist all describe a graduate with a dual degree in medicine and research. The study reviewed reports related to MD/PhD programs in the areas of historical background, funding mechanisms, outcomes and metrics, and careers for physician-scientists. The intention of the review was to analyze and determine whether there was a significant difference in faculty metrics between faculty who participate in dual-degree programs and those who participate in traditional basic-science MD or PhD programs.

Historical Background of MD/PhD Programs

The purpose of an AMC is not only to create new knowledge but also to generate new physicians and a new supply of investigators for the advancement of medical knowledge. Additionally, MD/PhD programs aim to produce graduates who will serve the wider medical community (Bryne, 2010). The fundamental basis of an MD/PhD program is to "provide rigorous integrated training for physician-scientists, enabling them to frame scientific questions in unique ways and apply clinical insight to fundamental science…apply a clinical medicine perspective to the broad spectrum of biomedical research" (Bonham, 2014, 1). The expectation for the physician-scientist that is dually trained and degreed in research and medicine is that he or she will be a significant contributor toward advances in clinical translation. Typically, the standard format for the dual MD/PhD degree is:

- Years 1 and 2 are used to complete the first two years of medical school.

- Years 3–6 are used to fulfill research requirements and to complete the PhD degree.
- Years 7 and 8 are used to return to a medical school to finish the last two years of clinical rotations.

Alternatively, another model for producing physician-scientists was demonstrated at the University of Miami with conflicting results. The PhD-to-MD model was used in 1971, where the University Of Miami School Of Medicine enrolled 508 students who already had a PhD in the sciences, mathematics, or engineering in an accelerated MD program, which was completed in just 24 months. The intent was to condense the curriculum by reducing the time spent on coursework that had been previously covered and that coincided with the medical school curriculum. The accelerated program was a response to a predicted national shortage of physicians caused by the long training time required to become a physician (Koniaris, 2010). The program also seemed to answer the concerns of medical school deans and the AAMC about the debt incurred over the long clinical-training time required to produce physicians who could lead in cutting-edge research and innovation in medicine. State medical licensing boards began, however, to question the short duration of the actual medical training received in the accelerated program and eventually pressured the program to close. Hence, the last graduating class ended in 1989. An analysis of the program's 18 years of operation showed, however, that the compressed medical training was sufficient for the trainees to become successful in their medical careers and academic research (Koniaris, 2010). The success of the program also suggested that shortening the medical-education portion of the combined MD/PhD program would "speed the completion of the degree without sacrificing achievement on objective measures of knowledge" (Koniaris, 2010, 691). To date, however, the state licensing boards as well as AAMCs have not elected to reinstate the PhD-to-MD model.

While not all MD/PhD program models have been successful, numerous programs have been developed since the inception of the dual MD/PhD degree in 1956. There are currently 88 programs in the Unites States, along with seven DO/PhD training programs. In addition, there are 34 international institutions that provide MD/PhD training (NIH). With the abundance of dual MD/PhD degree-granting institutions, the goal of physician-scientists remains constant: to be the translators between research and medicine, and therefore to move clinical translation forward.

MD/PhD Program Funding and Support

Currently, of the 88 national MD/PhD dual-degree programs, 46 receive financial support through the government-funded MSTP. The MSTP is funded through the National Institute of General Medical Sciences (NIGMS), a branch of the NIH. The first three programs to receive MSTP in 1964 were the New York University School of Medicine, the Albert Einstein College of Medicine, and the Northwestern University Feinberg School of Medicine. In fiscal year 2007, the NIH reported more than 42 million dollars in assistance to the MSTP-funded AMCs. The goal of the MSTP training is to produce physician-scientists who have the unique ability to translate laboratory discoveries into effective treatments for patients. Not only has the NIGMS been able to subsidize the costs of the dual-degree programs, it has set the standards for the training approaches and provided a regular source of external review to the participating AMCs. With the celebration of the MSTP's 50^{th} year anniversary in June 2014, the Director of the NIH called for a robust, public report indicating the outcomes that have been met since the inception of the program as well as to show justification for the money invested in the program to date.

There are an additional 75 MD/PhD training programs offered in medical schools in the United States that are not part of the MSTP and are therefore not funded through the NIGMS, which means that the students receive financial support through internal mechanisms or other support mechanisms. In a national cohort study published in *Academic Medicine*, Jeffe reported that institutions without MSTP funding were less likely to have research-grant support and academic appointments and were more likely to be engaged in clinical practice rather than doing research (Jeffe, 2014). However, the fact that the majority of the MD/PhD programs are not a part of the MSTP does not seem to hinder the number of programs that are effectively granting the dual MD/PhD degree.

Career Success as an Outcome of MD/PhD Programs

How do we measure the productivity of students in an MD/PhD program? A bibliometric analysis, a set of methods to quantitatively analyze aspects of academic literature such as authorship and content, can provide data by illustrating the interdisciplinary nature and level of collaboration that might evolve as individuals participate in training programs that emphasize translational science (Rubio, 2011). In addition, career success is one of many outcomes that can be evaluated as a metric for MD/PhD programs. Even though leadership is usually identified in a business framework, leadership competencies are becoming more known in public health professionals, nurses, and medical professionals. Satisfaction of customers and maintaining a competitive advantage would be two areas for a successful leadership competency for research success. Customers being identified as students, staff, faculty, or research participants in the academic or research environment (Lee, 2012).

While leadership is important, another aspect of the personal factors in career success is professionalism. While there is a great deal of literature on professionalism for medical students and residents, research on how to measure professionalism among clinical and translational scientists is limited (Lee, 2012). Career success can also be influenced by organizational factors, which should also be considered. The availability and accessibility of research infrastructure and resources that facilitate translational research should also be considered when evaluating the success of developing researchers (Lee, 2012).

The fundamental question after the completion of an MD/PhD degree would naturally be: What next? The translation of basic-science discoveries into clinical practice is the goal; however, the question remains: How is it achieved once the education is obtained? How will these physicians face the challenge of juggling the demands of clinical care with the time required to perform research? How will they obtain the "protected time" they need to begin and maintain a research program and deal with the lag time between beginning and funding a research career? To that end, most physician-scientists hope to receive an R01, The Research Project Grant, which is the original and historically oldest grant mechanism used by the NIH. The R01 provides support for health-related research and development based on the mission of the NIH (www.nih.gov).

Gibbs and Griffin (2013) wrote an article entitled, "What do I want to be with my PhD?" They stated that 40 years ago, the majority of PhD scientists progressed into a faculty position upon completion of graduate school. Currently, only 14% of PhDs in the life sciences hold a tenured or tenure-track faculty position within five to six years of graduation. Additionally, the average age at which new PhD investigators receive their first R01 grant is 42 years (Gibbs, 2013). Gibbs and Griffin stated that the interest of most graduate students in research careers decreases as the students' training progresses, and newly trained PhD scientists pursue careers in policy, communication, law, and other nonacademic fields. In concluding their research, Gibbs and Griffin found that PhD biomedical scientists shaped career interests by aligning personal values with career opportunities, and that the structural dynamics of the workforce (e.g., the high number of PhDs relative to the available academic jobs, the pay, the availability of grant funding, and the extremely high faculty workload) played the most central roles in shaping the career interests (Gibbs, 2013).

Career success can be characterized and divided into two domains based on a variety of characteristics: objective versus subjective, extrinsic versus intrinsic, or material versus psychological elements of success (Rubio, 2011). In theory, therefore, the concrete or tangible markers of success would be financial reward and hierarchical status, and the psychological elements would include abstract or intangible markers such as personal and social fulfillment. In order for physician-scientists to achieve career success, AMCs have to play an important role by creating a supportive environment, infrastructure, policies, mentors, and other factors that are needed to maximize the chances of success for individuals who begin investigative careers (Rubio, 2011).

A study performed in 2002 at the University Of Pennsylvania School Of Medicine indicated that the MSTP graduates reached academic success after completion of the program because they "[are] well published, occupy academic and research positions, and are well funded. … these graduates not only help bridge the gap between the basic sciences and clinical activities, but they are also important sources of leadership in biomedicine, become role models for future students, and help to fill the pool of young physician-scientists" (Watt, 2005, 193). Because physician-scientists have important long-term influences on the future of academic medicine, in addition to the potential to significantly affect the quality, quantity, and direction of research in fields that are currently underrepresented, the career goals of MD/PhDs are important and should be assessed when looking at what happens to students after graduation.

Traditionally, MD/PhD students showed an interest in going into more "traditional" clinical areas such as internal medicine or family practice. A new trend is showing a greater influx of MD/PhD graduates into "underrepresented" fields such as dermatology, radiation oncology, and surgical specialties, however, (Watt, 2005). When measuring the career success of physician-scientists, it is important to remember the conflicting demands on clinical scientists, because it is not uncommon for translational scientists to have multiple responsibilities that are juggled on a daily basis (Lee, 2012).

In an effort to promote the valuable but challenging career path of academic medicine, the Medical Student Research Fellowship (MSRF) program was initiated by the NIH in the late 1950s and then reinstated in 1980 to present. It was developed to support a critical "turn-on" period for medical students by allowing them to seriously consider careers in academic medicine and research early in their professional training. In the *Journal of Investigative Medicine* in 2003, an article entitled: "Impact of Medical Student Research in the Development of Physician-Scientists" was written by Solomon et al. from the University of Tennessee College of Medicine (UTCOM) and Vanderbilt University School of Medicine (VUSM). In that work, the authors examined the impact and outcomes of the MSRF program at both institutions. Although the AAMC reported that the percentage of medical students interested in a career involving research had declined from 14% to 10% from 1989 to 1996, the majority of the students surveyed at UTCOM and VUSM expressed an interest in conducting research after completing the MSRF program (Solomon, 2003). The study showed that:

> Early exposure to research: 1) allowed students to test their "fit" in conducting biomedical research; 2) taught them to appreciate the effort it takes to create new information; 3) increased their attractiveness and acceptability as house staff to university residency programs; 4) made them more likely to pursue careers in research and/or academic medicine; and 5) seemed to maintain a lasting positive influence on their professional activities and attitudes throughout their careers. (p. 153)

By providing lectures, seminars, visiting professors, and a forum for student presentation, the infrastructure of the MSRF programs provided a supplement to the students' research experience, which helped the students better understand the opportunities and strategies for becoming a physician-scientist. Solomon et al. (2003) felt that early research exposure in medical training was effective because the time constraints of a medical education typically leave little time for demonstrating to students the importance of biomedical research in improving health care or for encouraging students to participate in biomedical research. Hence, any exposure could have a positive influence.

The Education Evaluation Working Group of the Clinical and Translational Science Award Consortium wrote a manuscript for NIH Public Access entitled "Clinical and Translational Scientist Career Success: Metrics for Evaluation." That article discussed ways to successfully evaluate the career success of physician-scientists. It identified two components of career success: extrinsic success (e.g., promotions and funded grants) and intrinsic success (e.g., career satisfaction). Within career success, the article delineated two types of higher-order contextual factors. The first type included personal factors, such as demographic characteristics (e.g., gender, race, ethnicity, and age), educational history (e.g., degrees and research experience), psychosocial factors (e.g., life events, family dependent care, and stress), and personality factors (e.g., motivation, passion, and leadership). The second type included organizational factors, such as institutional resources (e.g., infrastructure and financial resources), training (e.g., didactics and research experience), conflicting demands (e.g., clinical and service responsibilities), and relational factors (e.g., mentoring and networking; Lee, 2012).

Two of the most common metrics used to measure career success in academia and research are the numbers of grants and publications. Approaches that measure career success include citation analysis, return-on-investment analysis, social network analysis, and curriculum vitae (CV) analysis. Data abstracted from CVs provide indicators of the productivity of individual trainees over time, including current appointment, degrees received, presentations, publications, funding proposals, and awards receipts. The article concluded by expressing that its goal was to encourage consistent data collection, to foster more systematic factors associated with career success, and to help address previously identified difficulties in program evaluation (Lee, 2012).

Conclusions from the Literature

The investment that AMCs make into each trainee within an MD/PhD program is significant. Based on the literature review, current research is lacking in terms of showing participation in MD/PhD programs from the AMCs' perspective. Being able to analyze the metrics produced by faculty from an MD/PhD program as well as from a single MD basic-science program or a single PhD program helped to show the intent of this study. Through a comparison of the performance metrics for AMC faculty members that hold a dual MD/PhD degree, a traditional PhD degree, or a basic-science MD, the following research question is addressed: What is the relationship between the type of degree held and the performance metrics (i.e., the number of publications, grants received, patents issued, and awards/honors earned)?

Chapter III

Methodology

Large and small AMCs offer MD/PhD programs with or without participation in the NIH-funded MSTP. To offer an MD/PhD program, institutions must provide resources including time, money, and lab space, the cost of which easily exceeds $52K per year per student (Jeffe, 2014). Although the cost per year is comparable for an MD student, the cost per year for a PhD student is less at approximately $40K per student (Jeffe, 2014). The duration of the MD program (four years) is much shorter than that of the MD/PhD program (eight years). Students in MD programs typically pay their own tuition, whereas students in MD/PhD programs typically have their tuition paid by the AMC. Is there a way to see a return on the investment of those resources for the AMCs? Are there any differences between the AMCs that participate in MD/PhD programs and those that participate only in traditional PhD or basic-science MD programs? Is there a relationship between the type of degree received and the metrics of career success (i.e., number of publications, grants received, patents issued, and awards/honors granted)? This study addressed those questions.

The data collected for this study included metrics that were produced by faculty with either an MD/PhD degree, an MD degree in the basic sciences, or a PhD degree in the basic sciences. The hypothesis was that there would be a difference in the metrics associated with the type of degree received and there would be a higher production of metrics by MD/PhD faculty.

Variables

The research question for this study was: What is the relationship between the type of degree held and the performance metrics of AMC faculty members (i.e., the number of publications, grants received, and awards/honors earned)? The independent variable for the research question was the type of degree. The dependent variable was the relationship that type of degree has on the performance metrics of AMC faculty. Thus, this research was inspired by the need to tie the performance metrics to the type of degree that AMCs hire as faculty with the assumption that there was more production from MD/PhD faculty making it a benefit to produce MD/PhD potential faculty.

Conceptual/Operational Definitions

The conceptual definition of an AMC was a medical school or degree-granting institution and its clinical enterprises, which could include a hospital, research institute, private practice, or anything else that makes up part of the organization through which a medical degree could be granted. Operationally, AMCs were measured by identifying the various components of the medical degree-granting institutions that offer MD/PhD degree programs, traditional MD basic-science degree programs, or traditional PhD basic-science degree programs. The physical organization could be a research institute, a hospital or clinic, or anything else that in collaboration with the medical school helped to provide the training necessary to obtain the degree.

The conceptual definition of an MD/PhD program was a program in which a dual degree is obtained through the concurrent completion of an MD and a PhD. The MD/PhD program was identified operationally by whether the MD-granting institution granted both degrees to students who completed the requirements for an MD and for a PhD.

The conceptual definition of a traditional basic-science MD program was a program in which the MD was granted after the completion of medical school. Operationally, basic-science MD programs were identified by determining that the degree-granting institution conferred MDs to students who completed the requirements for the MD program.

The conceptual definition of a traditional PhD basic-science program was a program that granted a PhD after the completion of all requirements. Operationally, traditional PhD basic-science programs were identified by determining that the degree-granting institution conferred PhDs.

The independent variable was defined as the type of degree earned by faculty. The dependent variable included all metrics that measure success in an academic organization. Operationally, the dependent variable included: the number of publications faculty members completed after joining the faculty, whether the faculty members were able to obtain federally funded R01 grants, whether the faculty members received any national honors, and whether the faculty members produced any patents issued to the AMC.

Reliability and Validity

Internal validity was not an issue, because no causal inferences were made. In terms of external validity, only 15 AMCs were surveyed, but they came from three different groups of the 88 medical schools granting MD/PhDs, basic science PhDs, and basic science MDs in the United States. Five were selected from the top of the News and

World Report's Top Medical College list and five were selected from the middle of the Report, and five were then selected from the bottom of the Report. The distribution of the AMCs among geographic regions or types of communities were also varied between rural and metropolitan areas. Thus, the results have some measure of external validity.

Research Design

The purpose of this study was to determine whether a relationship existed between the degrees obtained by faculty members and the metrics they produced while in their tenure at an AMC. A descriptive statistical analysis was used, because it provided a summary and observation of the data collected. The 15 AMCs that were selected, grant degrees in all three programs (MD/PhD, a traditional MD in the basic sciences, and a traditional PhD in the basic sciences). Data regarding federally funded RO1 grants, publications in peer-reviewed journals, patents issued, and honors and awards received by faculty from each AMC were analyzed and compared to determine whether there was a relationship between the metrics faculty produced and the type of degree they obtained. The patents issued data had to be dropped from the data analysis because the data was not available by degree type, only by AMC. This would not allow for inferences to be made regarding the metric productivity by AMC faculty.

Participants

The participants in the study were faculty who completed an MD/PhD program, a traditional MD basic science program, or a traditional PhD basic science program at an AMC who were subsequently hired as faculty members at one of the AMCs included in the study. The 15 out of 88 AMCs selected for this study were from the top, middle, and bottom of the list produced from the News World and Report of Best Medical Schools in

Research. Faculty from the Basic Science departments (Neurobiology and Anatomy; Biochemistry; Microbiology, Immunobiology, and Cell Biology; and Physiology and Pharmacology) were listed from each of the 15 AMCs. The type of degree that each listed faculty member held was then identified. The number of peer-reviewed publications, R01 grants funded, and any honors and awards such as being named a Nobel Laureate or member of the National Academy of Sciences during the 2012–2014 time period were then recorded.

Characteristics of the Participants

Each participant had either an MD/PhD, a traditional basic-science MD, or a traditional basic-science PhD. The other characteristics of the participants also varied. The hypothesis was made that the participants varied in gender, age, ethnicity, place of birth and came from a wide range of undergraduate degrees. The participants also varied in the time taken to complete their MD/PhD, MD, or PhD program based on whether they completed a single-degree program or a dual-degree program. Each AMC produced varying metrics such as the number of peer-reviewed publications, funded R01 grants, Nobel Laureates, and National Academy of Sciences members. The faculty participants were used only to compare the above metrics among the three types of degrees and not for other analyses.

Data Collection Procedures

Data were collected from various databases including the NIH RePORT, Scopus, the AAMC, and the National Academy of Inventors. The Nobel Laureate awards and the National Academy of Sciences awards were searched for the period 2012–2014 to see if there were any awardees from the included AMCs during the study period. Institutional

Review Board approval was obtained, and data were collected for each AMC faculty member who was identified.

Data Analysis Procedures

Once the data were compiled, the SPSS Statistics software was used to analyze the data using descriptive statistics. The identified AMCs were labeled as Group 1 for the top 5, Group 2 for the middle 5, or Group 3 for the bottom 5. In addition, a bar graph was used to illustrate the differences in the variables for each metric in each year by AMC group.

Summary

The purpose of this chapter was to describe the important aspects of the research methodology associated with this study and to conceptualize the variables, research design, participants, and data procedures. The next chapter will provide the results of the data analysis.

Chapter IV

Results

The data analysis was performed with SPSS software by using the data collected from the three groups of AMCs (top 5, middle 5, and bottom 5). From each group, data were collected for: the number of peer-reviewed publications, the number of NIH-funded R01 grants, the number of Nobel Laureates named, and the number of National Academy of Sciences awardees. The data were grouped separately based on whether the faculty members held an MD, a dual MD/PhD, or a PhD during the academic years spanning 2012–2014. Faculty of the Basic Science departments from the 15 AMCs were selected based on their school ranking by U.S. News and World Report Best Medical Schools (U.S News Rankings and Reviews).

Findings

Various Public Databases. To ensure that all critical data points were collected, public databases were used to gather production metrics for the included faculty members. The U.S. News and World Report Best Medical Schools ranked 88 medical schools in the United States. Those rankings were used to formulate three groups among the AMCs included in the study.

Table 1

Selected Medical Schools by Group

Group 1	Group 2	Group 3
Harvard	Indiana University	University of Missouri
Stanford	University of Utah	Texas A&M Health Science Center
Johns Hopkins	Georgetown University	Texas Tech University Health Science Center
University of Pennsylvania	Medical College of Wisconsin	University of Hawaii
Washington University in St. Louis	University of Texas Health Science Center- San Antonio	West Virginia University

Group 1 consisted of the top five medical schools in the United States according to the U.S. News and World Report. Group 2 consisted of the middle five medical schools according to the U.S. News and World Report). Group 3 consisted of the bottom five medical schools on the list by the U.S. News and World Report. According to the AAMC, the basic sciences consist of seven departments which include: Neurobiology and Anatomy, Biochemistry, Microbiology, Immunobiology, Cell Biology, Physiology, and Pharmacology. For this study, faculty members from each department from each of the included AMCs were listed to track the metrics consisting of: peer-reviewed publications, R01 grants funded, and patents issued for 2012–2014. The largest database of peer-reviewed literature, Scopus, was used to tally the number of publications authored by the listed faculty members, concentrating on whether the faculty members held MDs, MD/PhDs, or PhDs. The NIH RePORT was used to determine which faculty members had received an R01 independent research project grant. The number of Nobel Laureates and National Academy of Sciences award recipients were gathered from each institution's website to tally how many faculty members from the AMCs in each group won awards in 2012–2014.

Listed in Table 2 are the selected medical schools with the number of faculty by degree that were used to retrieve the data for this study.

Table 2

Number of Faculty from each Medical School by Degree Type

Medical School	MD	MD/PhD	PhD
Group 1			
Harvard	8	18	83
Stanford	14	13	64
Johns Hopkins	3	10	62
University of Pennsylvania	7	7	79
Washington University in St. Louis	1	10	80
Group 2			
Indiana University	1	2	79
University of Utah	1	0	37
Georgetown University	5	1	72
Medical College of Wisconsin	7	16	111
University of Texas- Health Science Center- San Antonio	7	8	119
Group 3			
University of Missouri	15	3	125

Texas A&M Health Science Center	2	8	78
Texas Tech University Health Science Center	1	5	35
University of Hawaii	0	1	48
West Virginia University	0	1	51

2012 Data

The AAMC 2012 Faculty Roster in the Basic Sciences from 88 medical schools in the United States included 1,793 individuals with MDs, 14,037 individuals with PhDs, and 1,414 individuals with MD/PhDs. The average number of R01 grants awarded in 2012 by each faculty member at the AMCs in each group according to the NIH RePORT are shown in Table 3.

Table 3

Average Number of R01 Grants Awarded in 2012 by Terminal Degree at the AMCs in Each Group

Degree	Group 1	Group 2	Group3
MD/PhD	1.9	2.3	1.5
PhD	1.5	1.3	1.2
MD	1.5	1	1

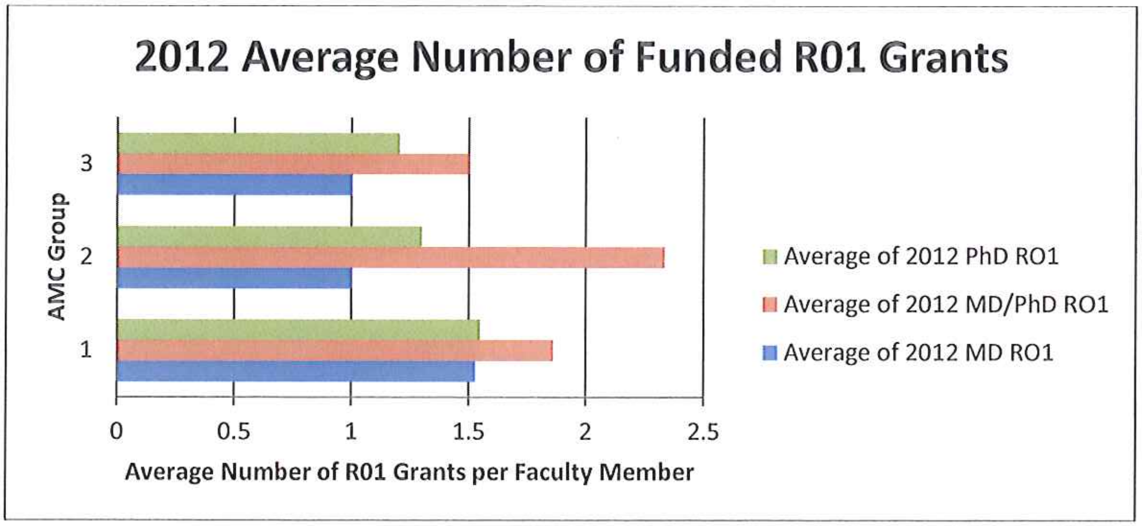

Figure 1. Average number of R01 grants awarded in 2012 by terminal degree at the AMCs in each group

Table 4 shows the average number of papers published in 2012 in peer-reviewed journals by each faculty member who published at the AMCs in each group according to Scopus.

Table 4

Average Number of Papers Published in 2012 in Peer-Reviewed Journals by Terminal Degree Who Published at the AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	3.7	3.8	3.1
PhD	3.8	3.1	3
MD	3.3	6.1	2.7

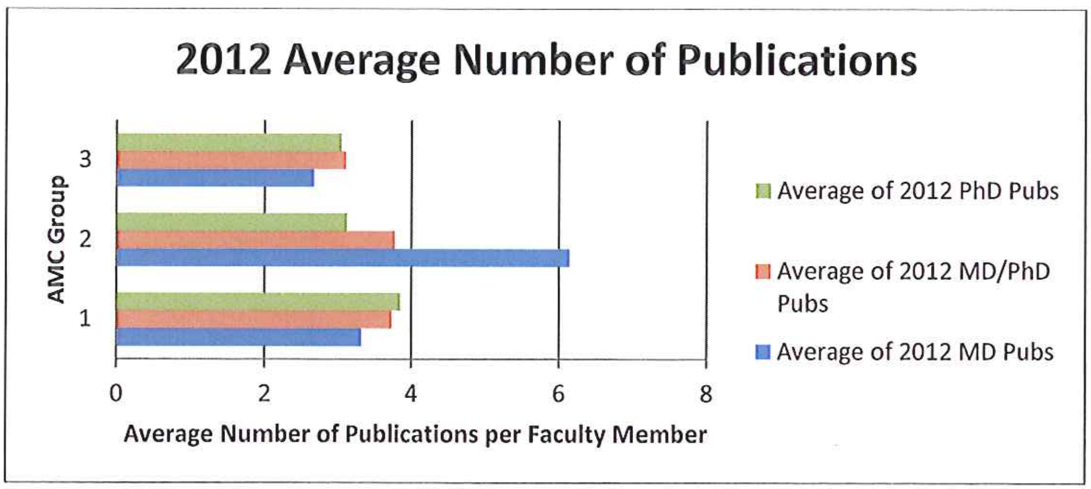

Figure 2. Average number of papers published in 2012 in peer-reviewed journals by terminal degree who published at the AMCs in each group

In 2012, none of the AMCs produced any Noble Laureates. Harvard and Stanford (both group 1) each had one PhD faculty member inducted into the National Academy of Sciences.

2013 Data

The AAMC 2013 Faculty Roster in the Basic Sciences from 88 medical schools in the United States included a total of 1,822 individuals with MDs, 14, 232 individuals with PhDs, and 1,462 individuals with MD/PhDs. The average number of R01 grants awarded in 2013 by each faculty member at the included AMCs in each group according to the NIH RePORT are shown in Table 5.

Table 5

Average Number of R01 Grants Awarded in 2013 by Terminal Degree at the Included AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	1.7	1.5	2
PhD	1.6	1.3	1.2
MD	1.4	1.3	1

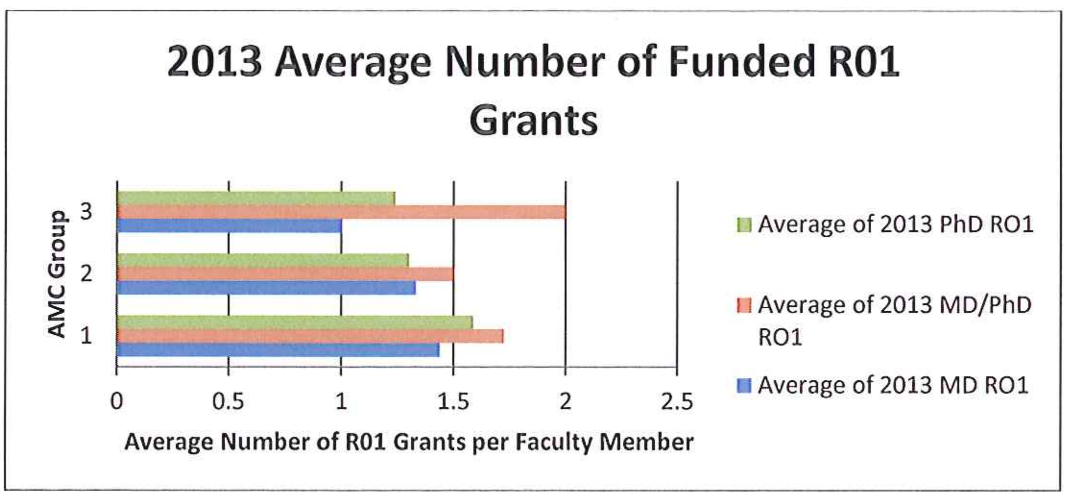

Figure 3 Average number of R01 grants awarded in 2013 by terminal degree at the included AMCs in each group

Table 6 shows the average number of papers published in 2013 in peer-reviewed journals by each faculty member who published at the AMCs in each group according to Scopus.

Table 6

Average Number of Papers Published in 2013 in Peer-Reviewed Journals by Terminal Degree Who Published at the AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	5.6	4.2	4.8
PhD	4.1	3.9	3.1
MD	5.9	6	2.8

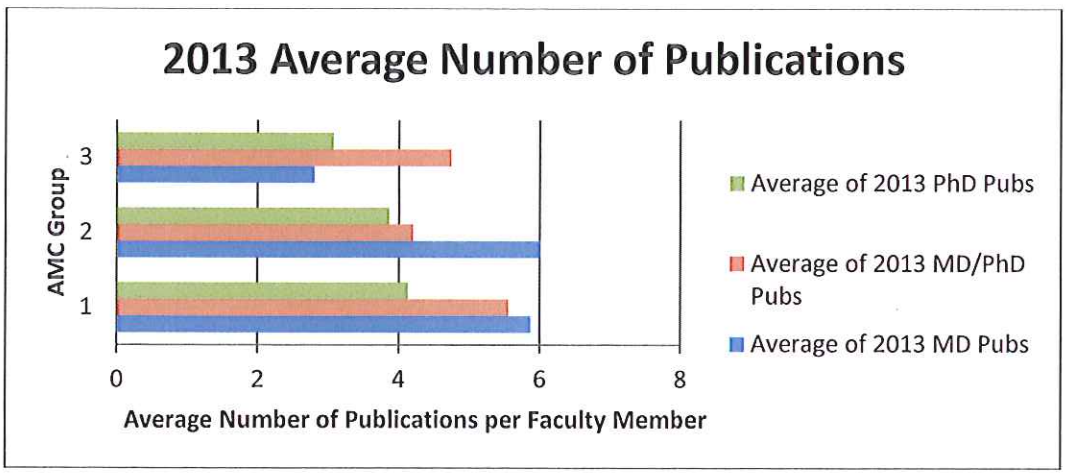

Figure 4 Average number of papers published in 2013 in peer-reviewed journals by terminal degree who published at the AMCs in each group

In 2013, Harvard and Stanford each had a Nobel Laureate named. Harvard, Stanford, and Johns Hopkins together had a total of four PhD faculty inducted into the National Academy of Sciences.

2014 Data

The AAMC 2014 Faculty Roster in the Basic Sciences from 88 medical schools in the United States included a total of 1,955 individuals with MDs, 14,204 individuals with PhDs, and 1,649 individuals with MD/PhDs. The average number of R01 grants awarded in 2014 by each faculty member at the included AMCs in each group according to the NIH RePORT is shown in Table 7.

Table 7

Average Number of R01 Grants Awarded in 2014 by Terminal Degree at the Included AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	1.8	1.5	1.5
PhD	1.6	1.3	1.2
MD	1.5	1.3	1

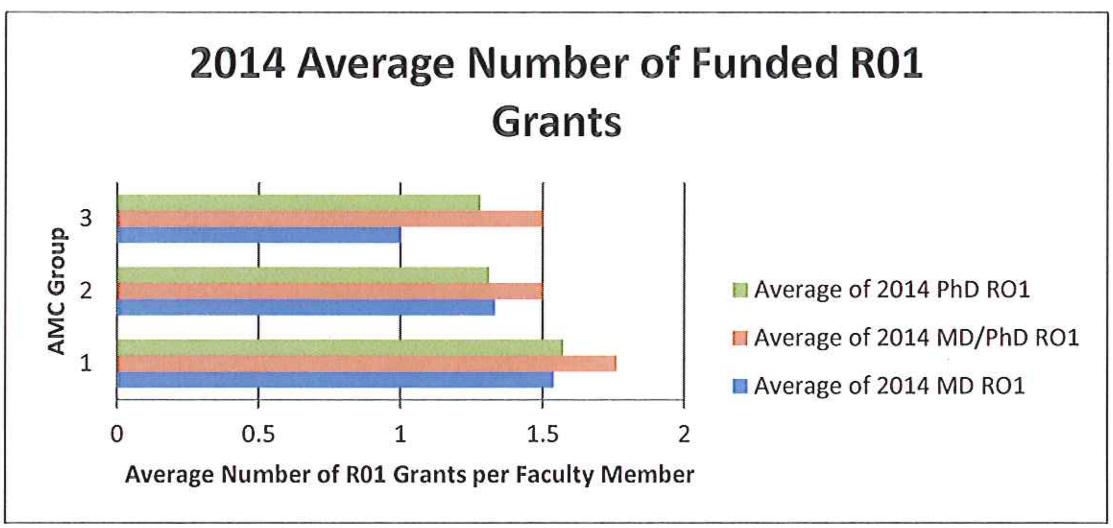

Figure 5 Average number of R01 grants awarded in 2014 by terminal degree at the included AMCs in each group

Table 8 shows the average number of papers published in 2014 in peer-reviewed journals by each faculty member who published at the AMCs in each group according to Scopus.

Table 8

Average Number of Papers Published in 2014 in Peer-Reviewed Journals by Terminal Degree Who Published at the AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	4.8	3.7	5.5
PhD	4.3	3.6	3.2
MD	4	6.1	2.6

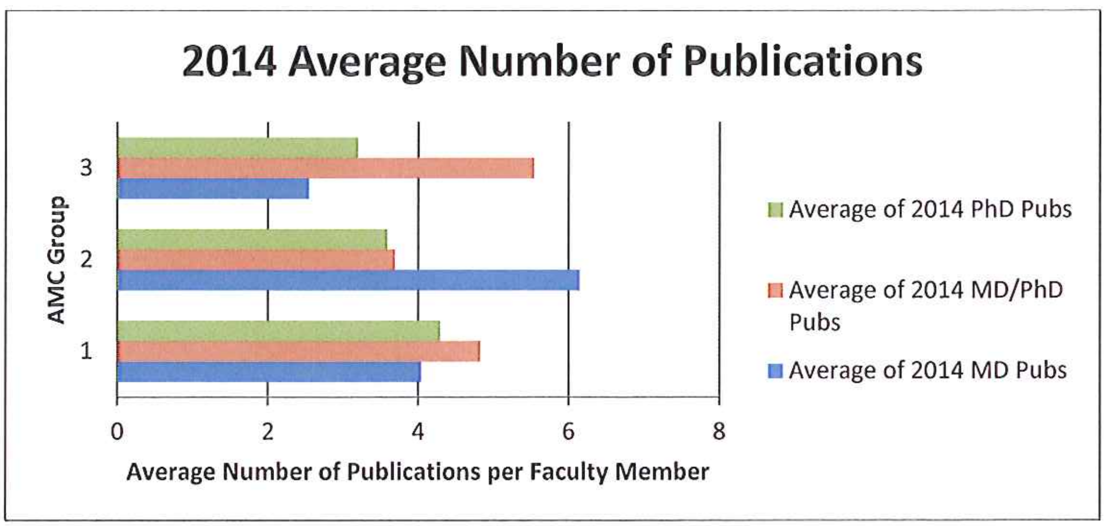

Figure 6. Average number of papers published in 2014 in peer-reviewed journals by terminal degree who published at the AMCs in each group

In 2014, none of the included medical schools produced any Noble Laureates. Harvard and Stanford together had a total of three PhD faculty members inducted into the National Academy of Sciences.

Averages

The average number of R01 grants awarded in 2012–2014 by each faculty member at the included AMCs in each group according to the NIH RePORT is shown in Table 9.

Table 9

Average Number of R01 Grants Awarded in 2012–2014 by Terminal Degree at the Included AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	4.6	3.2	2.7
PhD	3.8	3.2	2.6
MD	3.6	3	2.6

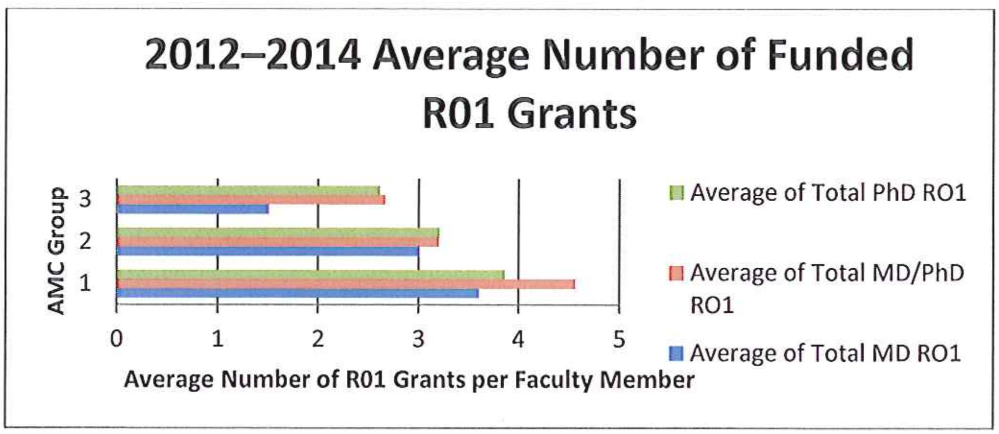

Figure 7. Average number of R01 grants awarded in 2012–2014 by terminal degree at the included AMCs in each group

Table 10 shows the average number of papers published in 2012–2014 in peer-reviewed journals by each faculty member that published at the AMCs in each group according to Scopus.

Table 10

Average Number of Papers Published in 2012–2014 in Peer-Reviewed Journals by Terminal Degree That Published at the AMCs in Each Group

Degree	Group 1	Group 2	Group 3
MD/PhD	11.92	10.1	10
PhD	10.5	8.6	7.8
MD	11.25	16	6.6

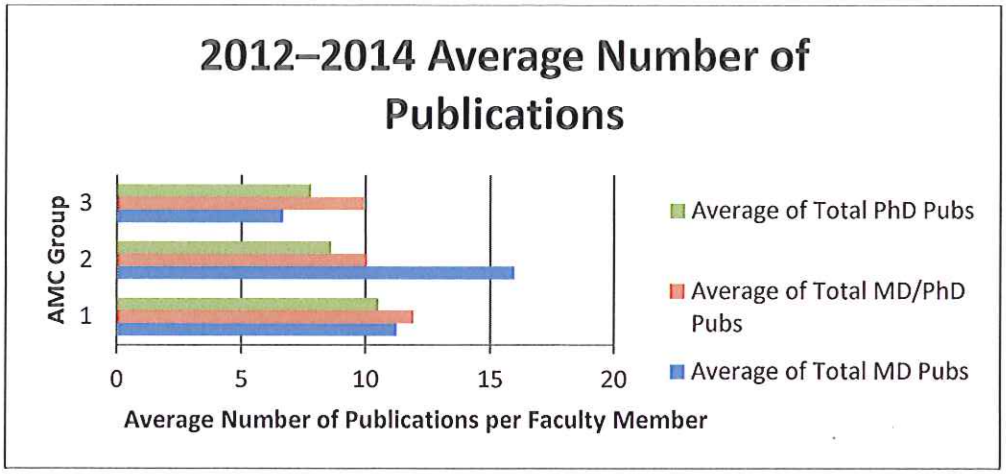

Figure 8. Average number of papers published in 2012–2014 in peer-reviewed journals by terminal degree that published at the AMCs in each group

Research Question

Through the comparison of the performance metrics for AMC faculty members who hold either a dual MD/PhD degree, a traditional PhD degree, or a basic-science MD, the following research question was addressed: What is the relationship between the type of degree held and the performance metrics (i.e., the number of publications, grants received, patents issued, and awards/honors earned)? The descriptive analysis of the data showed that there is a relationship between the type of degree held and the metrics that are produced by AMC faculty. The data showed that there is a greater productivity for faculty that have obtained a MD/PhD degree versus faculty that just have a traditional PhD degree. However, the data also showed that there is a greater productivity in basic science MDs than MD/PhD or PhDs. Therefore, these data indicate that there is a benefit for AMCs to participate in MD/PhD programs based on the metrics produced by faculty. These results will be further analyzed and discussed in the concluding chapter.

Chapter V

Discussion

This study investigated the academic success, estimated by various production metrics, after earning a dual MD/PhD degree, a traditional basic science MD degree, or a traditional PhD degree. The metrics were found to vary based on the type of degree earned, although other factors, such as the resources available to the faculty members at their respective institutions, also likely impacted the results as well. The results are intended to provide AMCs some insight into whether there are any benefits to providing certain types of degree programs, particularly, MD/PhD programs. Based on this research study, there appear to be notable differences between the metrics produced and the degree of the faculty member.

In almost all cases, MD/PhD faculty out produced both basic science MDs and basic science PhDs. Even though some of the differences were in tenths of points, it is still concluded that on an average, MD/PhD faculty did outperform the other degreed faculty. One observation that is notable, however, is the difference that basic science MDs have in Group 2 AMCs on average for publications. MDs produced on average 16 publications to MD/PhDs' ten publications and PhDs' eight publications. Based on the data, MDs almost doubled the productivity in years 2012-2104 over the other degreed faculty. The AMCs that are reflected in Group 2 were: Indiana University, University of Utah, Georgetown University, Medical College of Wisconsin, and University of Texas-Health Science Center-San Antonio. The reason for this spike in productivity in MD faculty could range from greater protected time for their research, to a greater volume of research personnel dedicated to moving forward their research (i.e. graduate students, postdocs, etc.), or even additional incentives or resources granted to basic science MDs than in Group 1 or Group 3 AMCs. The greater volume in metrics in this particular area for these identified schools could skew the hypothesis generated. However, further research with a larger sample size would be warranted to determine the factors that could cause such a difference in metric productivity before generalized statements could be made affecting the entire study.

For this study, the number of patents issued was to be a part of the metrics analyzed. However, it must be noted that the data that was available for issued patents by year was listed by AMC and not per faculty. Thus, the presentation of patents would have been tabled by group and it would not have been noted whether the patents were issued to faculty according to type of degree. The number of patents issued by tier could still be considered as significant because it reinforced the productivity of AMCs which could be used as a recruitment tool in attracting MD/PhD faculty to a particular AMC. However, for consistency in data reporting, the patents issued were eliminated from the study.

Limitations

The following limitations described in this section highlight the restrictions that have been identified for this research study. This study had a limited sample size, so the results should be interpreted with caution. Although faculty members from the top, middle, and bottom ranked AMCs were included, there are still hundreds of AMC faculty members with an MD, PhD, or MD/PhD whose metrics were not analyzed. More data from a larger sample might show a different range of metrics produced by faculty with the identified types of degrees.

The study included only data from 2012–2014. It is possible that a longer period of time would show different trends in production metrics. There was an increase in the total number of faculty members with each type of degree in each year beginning with 2012. It is unclear what effect the growing overall number of faculty members might have on the performance metrics for individual faculty members.

The length of time that a faculty member has held his or her position might also play an important role in metric production but was not included in this study. If a faculty member had just received tenure at the AMC, it would be hard to realistically compare that faculty member to others who had been tenured for five years or longer. The more senior a faculty member, the more likely it is that he or she will be able to produce a higher level of metrics. That is in large part because more senior faculty members usually have more funding for graduate students or postdocs to run experiments and further research initiatives. Senior faculty members are also more likely to be awarded prestigious awards and accolades such as the Nobel Prize or induction into the National Academy of Sciences. They have had more time to establish their research than junior faculty members. A junior faculty member also has the added complexity of setting up the research lab and obtaining the necessary equipment and personnel to further his or her research endeavors, often on a limited budget.

It is common for faculty members to move from one AMC to another, whether for personal or professional reasons. This study did not consider whether the faculty members produced metrics at another medical school or AMC before joining the faculty roster of one of the AMCs included in the study. This study focused on the selected AMCs and not on the individual faculty members, so any metrics produced at a previous institution would not have been considered in the analysis. Although independent funding awarded through R01 grants usually follows a researcher if the researcher moves to another institution, this study only included data that were submitted through the selected institutions.

At some AMCs, the faculty members teach as part of their contractual agreement, which could hinder their productivity in comparison with faculty members who have more "protected time" for research. When researchers have protected time for research, they are not expected or required to teach a certain number of hours to fulfill their contractual agreement. Basic-science MDs with protected time are not required to see a certain number of patients or perform a certain number of procedures to fulfill their contractual agreement with their employer. When faculty members are granted protected time, they can use more of their time to move their research forward, spending more time in the laboratory to make sure papers and grants are being submitted. Faculty members that do not have protected time are required to spend more time teaching classes and attending to student issues, which leaves less time for research initiatives.

The medical school's reputation and ranking could be a factor in recruitment of highly metric producing faculty. However, to prove that recruitment and reputation are linked would be difficult to show because, reputation is a subjective metric that cannot be easily quantified.

In order to get a better understanding of how AMCs are able to recruit new faculty, it would be helpful to have a measurement of prestige and perception. However, prestige and perception are subjective, making it impossible to conclude that if an individuals who graduated from any of the three programs (MD, PhD, or MD/PhD) had a choice to work at the best AMC in the country, he or she would likely do so. That does not mean, however, that some of the smaller and lower-ranked medical schools are not recruiting and cultivating great faculty members who produce strong metrics. In this study, the tier 2 schools actually produced stronger metrics than the group 1 schools in some cases.

The resources that AMCs spend on MD/PhD dual-degree programs are considerable. Approximately $52K is spent per student per year (Jeffe, 2014). It is nearly impossible to measure the return on that investment, however, because the return is largely based on the prestige and reputation gained by participating in the MD/PhD dual-degree program. AMCs do not necessarily hire their own graduates to serve as faculty members, nor is there any other contractually binding agreement or service obligation that links the graduate to the degree-granting AMC. The armed forces are an example of an organization that put a service obligation into place. A recipient of tuition paid by the military is required to give back a certain number of years of service to the armed forces. The NURSE Corps Scholarship Program is another organization in which there is funding by ways of a granted scholarship for nursing students who in exchange must work a minimum of two years at an eligible health care facility with a critical shortage of nurses. Graduates of MD/PhD programs, however, are able to pursue their professional interests in any manner they choose and at any institution that they choose. There is no service obligation to the institution from which they obtained their degree. If a service obligation were required upon completion of the dual degree, it might be easier for the degree-granting institution to justify spending $52K per year on the student, and there might be a more clear return on the investment made by the AMC.

Conclusions and Future Research

This study was undertaken to see if there was a difference in performance metrics for faculty members based on the type of degree that the faculty member obtained. It was hypothesized that graduates with an MD/PhD would produce better performance metrics upon receiving a research faculty position than graduates with a traditional MD or PhD. This would suggest that AMCs' participation in the dual-degree programs is beneficial, albeit more expensive than the traditional MD or PhD programs. The data, however, indicated that there was no real difference in performance based on the degree earned. Consequently, even if faculty members with MD/PhDs are more productive than faculty members with traditional MDs or PhDs in some instances, is the difference great enough for the degree-granting AMCs to recoup their investment in participation in the dual-degree program? Based on this study, it seems probable that the resources invested into the dual-degree programs are considered a cost of doing business, meaning that whether or not the investment is recouped, the AMCs will still participate in the dual-degree programs, because a lack of participation in the dual-degree programs would have a negative impact on the AMCs. All of the AMCs grant PhD and MD degrees in the basic sciences, so offering the MD/PhD program ensures that each AMC is able to offer what 88 other AMCs offer. Because the NIH only funds 42 AMCs through the prestigious MSTP grants, the other 46 AMCs must find another way to support the dual-degree program. The AMCs use the dual-degree programs to attract faculty members with MD/PhD degrees, who are expected to produce strong metrics in order to pay for the dual-degree programs. It is a cycle that will continue until more evidence shows that faculty members with traditional MDs or PhDs can produce metrics comparable to those produced by faculty members with MD/PhDs.

An interesting avenue for future study would be to follow individual graduates from traditional-degree or dual-degree programs to investigate how quickly they are recruited for faculty positions. It would also be interesting to examine if there is a relationship between an AMC's rank and its recruitment of faculty. For example, do the top AMCs recruit MD/PhD faculty members first, before they recruit faculty members with traditional degrees? Furthermore, are graduates of certain MD/PhD programs more highly sought after based on the relative quality of the MD/PhD program? A related question is whether the perceived quality of the MD/PhD program is based mainly on the prestige of the AMC or on other factors. Another avenue for future research would be to investigate the careers that MD/PhD graduates pursue outside of academia, and whether MD/PhDs outside of academia produce the same type of metrics that those within academia produce.

Because the main goal of MD/PhD programs is to train individuals who will eventually focus on translational research it would be interesting to determine whether MD/PhD graduates who become independent researchers are actually able to spend a large amount of their time doing research in the laboratory. It is possible that MD/PhD graduates spend a substantial amount of time in the clinic or in the classroom. Are graduates with traditional MDs or PhDs actually able to spend more time than graduates with MD/PhDs in the same field doing translatable research in the laboratory? Such a comparison would contribute to our understanding of the performance of translatable products by scientists with different types of degrees.

Summary

MD/PhD programs require an investment of resources by AMCs. The benefit of providing MD/PhD programs is expected to be the production of graduates that become successful faculty members at prestigious medical schools and produce strong academic metrics such as peer-reviewed publications, R01 research grants, issued patents on translatable research, and accolades and awards from societies such as the National Academy of Sciences. The question remains, however: Do researchers with MD/PhDs produce stronger metrics; such as publications, grants, and awards/honors; than researchers with traditional MDs or PhDs? The results of this study suggest that researchers with MD/PhDs do produce stronger metrics than those with traditional MDs or PhDs, but the difference is small. There are currently 88 MD/PhD dual-degree programs across the United States and even more in other countries.

By addressing the original question about the relative performance of MD/PhD graduates, this study has raised many additional questions. It is clear, however, that MD/PhD dual-degree programs are a part of the curriculum at most AMCs, and they offer a perception of prestige to the AMCs. For now, physician-scientists are bridging the gap between research in the basic sciences and the clinical needs of patients, making the investment of resources in MD/PhD programs worthwhile and beneficial for AMCs to participate.

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