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Title: 2015 American College of Rheumatology Workforce Study: Supply and Demand Projections of Adult Rheumatology Workforce (2015-2030)

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Abstract (239 words)

Objective: Describe the character and composition of the 2015 U.S. adult rheumatology workforce; evaluate workforce trends; and project supply and demand for clinical rheumatology care 2015-2030.

Methods: The 2015 Workforce Study of Rheumatology Specialists in the U.S. used primary and secondary data sources to estimate the baseline adult rheumatology workforce and determine demographic and geographic factors relevant to workforce modeling. Supply and demand was projected through 2030, utilizing data-driven estimations regarding the proportion and clinical full-time equivalent (FTE) of academic vs. non-academic practitioners.

Results: The 2015 adult workforce (physicians, NPs, and PAs) was estimated to be 6,013

providers (5,415 clinical FTE). At baseline, the estimated demand exceeded the supply of clinical FTE by 700 (12.9%). By 2030, the supply of rheumatology clinical providers is projected to fall to 4,882 providers or 4,051 clinical FTE (a 25.2% decrease in supply from 2015 baseline levels). Demand in 2030 is projected to exceed supply by 4,133 clinical FTE (102%).

Conclusion: The adult rheumatology workforce projections reflect a major demographic and geographic shift that will significantly impact the supply of the future workforce by 2030. These shifts include baby boomer retirements, a millennial predominance, and an increase of female and part-time providers, in parallel with an increased demand for adult rheumatology care due to the growing and aging U.S. population. Regional and innovative strategies will be necessary to manage access to care and reduce barriers to care for rheumatology patients.

Significance and Innovations:

- The projected demand for adult rheumatology services greatly exceeds the projected growth of the rheumatology workforce.
- There is a geographic maldistribution of adult rheumatologists across the U.S. that will worsen over the next 15 years.
- Effective strategies to recruit fellows, nurse practitioners and physician assistants to support the adult rheumatology workforce will be necessary to address the anticipated workforce gap.
- Processes to retain rheumatology providers in the workforce and to facilitate access to quality care must be explored.

INTRODUCTION

In 2005, the American College of Rheumatology (ACR) conducted the last formal workforce study of U.S. rheumatologists.[1-2] At that time, the demand for adult rheumatologists was projected to exceed the supply by over 2,500 rheumatologists by 2025. The demand for adult rheumatology services was projected to significantly increase by approximately 46% due to the aging of the U.S. population, while the supply was only predicted to increase by about 1.2%. In response to the projected need, there was a 4.6% increase in adult fellowship programs from 108 to 113, with a 17.6% increase in fellowship positions from 398 to 468.[3-4] In addition, the Association of Rheumatology Health Professionals (ARHP) expanded educational opportunities for nurse practitioners (NPs) and physician assistants (PAs) interested in rheumatology.

Since 2006, despite an increase in the number of graduating physicians from U.S. medical schools by over 20%, there are still significant anticipated physician shortages far beyond primary care.[5-6] In 2013, the majority (90%) of adult rheumatologists practiced in urban metropolitan areas, resulting in a maldistribution of rheumatology care with underserved micropolitan and rural areas of the U.S.[7] Additionally, a large portion of the adult rheumatology workforce is nearing retirement, and the workforce is projected to grow at a much slower rate than in past decades.[8] This coincides with an anticipated 28% increase in doctor-diagnosed arthritis in adults 18 years of age and older (52.5M to 67M) by 2030.[9-10]. For these reasons, the ACR established a workforce study group (WSG) in 2015 in order to: 1) describe the character and composition of the current clinical rheumatology workforce; 2) identify demographic and employment trends; 3) assess workforce and succession (retirement) planning and the potential to ensure access to care for patients with rheumatic diseases; 4) develop assumptions regarding the key factors affecting the supply of and demand for rheumatologists; 5) identify potential paths for the evolution of workforce supply and demand and their associated implications; 6) conduct a comprehensive patient-centered, integrative approach that attempts to capture both a more realistic clinical effort estimation and a better picture of access-to-care issues; and 7)

conduct sensitivity analyses on the workforce model to determine holistic 'best' case and 'worst' case scenarios.[11]

METHODS

Workforce Study Group (WSG)

The WSG included a small core leadership advisory group and a diverse membership group of volunteer rheumatology specialists to ensure wide-ranging experience and perspectives relative to rheumatology workforce issues. [11] The ACR conducted this workforce study with the expertise from the Academy for Academic Leadership consultants in Atlanta, GA. The WSG determined data collection procedures, provided guidance in the design of the workforce survey of ACR/ARHP members, identified critical factors affecting supply and demand for rheumatology services, decided on the workforce study modeling process, and accepted the final workforce study findings. The University of Michigan Institutional Review Board (IRB) reviewed the study and determined it to be exempt from ongoing review (Exemption #2, 45 CFR 46.101.(b); HUM00104523).

Data Collection

A mixed methods approach was used, including both primary and secondary data, to identify and evaluate workforce issues that would help in the development of the workforce model for predicting the future rheumatology workforce. Data were collected from many secondary sources including the American Medical Association, American Board of Internal Medicine, Rheumatology Nurses Society, National Commission Certification of Physician Assistants, as well as other published data. Primary data were also collected through electronic surveys of ACR/ARHP members, current rheumatology fellows in training (FITs), and a group of rheumatology patients identified by the Arthritis Foundation. These data were supplemented by data collected through focus groups and personal interviews.

Workforce Study Modeling

The WSG began with a review of the methodology used in the 2005 workforce study. The challenge was to develop a workforce model that would include the complexity of the population and their needs, and could translate those needs into clinical care requirements. The WSG determined the most appropriate model to use as the basis of the workforce study was an

integrated workforce framework model that combined socio-economic factors that drive economic demand, epidemiological factors that drive need, and utilization rates that incorporate the current use of healthcare services. The first step was to characterize the current adult rheumatology workforce who provides direct patient care, which in this study included physicians, NPs, and PAs. Next, the WSG identified the critical modeling factors. Both the characterization of the workforce and the critical factors were determined from the secondary data sources and the primary survey results. These generated the supply and demand assumptions that were used in the workforce study model (Table 1).[7,11-22]

Demand Factors. The focus of the workforce model was on the expressed patient demand, a market-based approach that emphasizes the person as the unit of analysis. Factors influencing demand included health care utilization patterns, prevalence of disease, changes in patient demographics, examination of contemporary geographic domestic patterns of population distribution and density, cost of rheumatology care, and per capita income impact. Metro and micro areas were used as the unit of analysis of future population trends, in consideration of the projected aging U.S population, as states are often too large of a unit to provide meaningful subnational analysis, and in that way, resulting in obscured patterns worthy of attention from either a regional or national perspective.[23-24] In 2015, unlike the 2005 workforce study, patients were queried to determine their perceived needs. This added another dimension that allowed the WSG to assess the difference in perceived demand between rheumatologists and patients. Multivariate and logistic regression with backward stepwise analysis was used to determine factors that contributed significantly to the model for adult rheumatology services ($F=39.06$, $p<0.001$; $R2=0.37$). Goodness-of-fit tests were used to determine model fit.

Supply Factors. Supply factors included geographic distribution, productivity, succession trends, gender and generational breakdown, workload trends, practice settings, and demographic breakdown of new graduate entrants into rheumatology. Based on the information collected, the WSG identified shifts in the demographic breakdown (e.g., gender and generational differences), geographic distribution trends, and practice patterns that indicated a much larger decline in the supply of rheumatology effort than projected in the 2005 workforce study.[1-2,11] This decline in supply was due to three major factors. First, the workforce survey identified an increase in the number of retiring rheumatology specialists, both physician and non-physician providers. This crucial component was used to help define the capacity for patient access to care, now and in the

future. Secondly, the anticipated percentage of females entering the workforce was expected to surpass the percentage of males by 2020. With this shift to a more female predominant workforce comes a projected reduction of approximately 7 working hours each week and approximately 30% fewer patient visits annually, based on survey responses and other published literature.[5] Lastly, the number of rheumatology graduates seeking part-time employment is anticipated to grow.

Clinical Full-Time Equivalent (FTE). Because of the changing demographics and pattern trends identified, the WSG realized the importance of defining not only the actual number of practitioners entering the workforce, but also defining the clinical FTE. The clinical FTE is the ratio of units that equate to the number of practitioners seeing patients full-time (e.g., 2 providers spending 0.5FTE each seeing patients would equate to 1.0 clinical FTE). This factor was used to provide a clear picture of effort devoted to direct patient care, and thereby a more realistic patient care treatment model. The shift to a more female predominant workforce and the anticipated part-time workforce contributed to the calculations of clinical FTE. The WSG also reached a consensus after careful deliberation regarding clinical FTE relative to practice setting for the purposes of this study, which was corroborated by information from the environmental scan conducted prior to the WFS and primary data collected through survey data of the workforce and several focus groups, the latter consisting of private practitioners, Division Directors, and academic rheumatology professionals.[23,25-31] A 1.0 clinical FTE was assigned to adult rheumatology physicians working in non-academic settings (~80%), 0.5FTE for those working in academic settings (~20%), and 0.9FTE for NPs/PAs working with adult rheumatologists. Identifying specific trends in clinical FTE of rheumatology practitioners (both physician and non-physician) is sensitive to assumptions about productivity.

Sensitivity testing (ST) To address the range in possible productivity for these assumptions, sensitivity analyses were conducted to cover the feasible range of these assumptions. ST is an analytic methodology used to build confidence in results. It allows for alternate models to be used in conjunction with a "base-case" model that incorporates "best-estimated" values of all selected parameters. ST is used to evaluate potential changes due to unexpected conditions in the estimated economic, geographic, and demographic variables.[11] ST was used was used to ascertain a “best-case” and “worst-case” scenario providing an estimated

range of supply for and demand of services through 2030.

The workforce model provided projections on the supply of and demand for rheumatology services for the U.S. between 2015 and through 2030 using: 1) retrospective data collected from various sources published since 2005 on projected provider and patient demographic changes, trends in rheumatic diseases, changes in funding sources, growing demand for non-physician providers, compensation models, and reported job satisfaction; and 2) primary data collected from rheumatology providers (physician and non-physician), current fellows-in-training, and patients (adult, young adult and pediatric). Because of the anticipated excess demand, including non-physician providers in the baseline provided the ability to evaluate their effect on the workforce. Additional details of the robust workforce study methodology and assumptions can be found in the 2015 workforce study document (Table 1).[7,11-22]

RESULTS

Baseline Rheumatology Workforce

Adult rheumatology providers were defined as rheumatologists, NPs and PAs. The estimated number of adult rheumatologists practicing in the U.S. in 2015 was 5,595; the corresponding clinical FTE was estimated to be 4,997 (computed based on the Clinical FTE equivalent described in the methods section). The total number of NPs practicing in adult rheumatology was estimated at 248, with a corresponding clinical FTE of 228. The total number of PAs was estimated at 207, with a corresponding clinical FTE of 190. Thus, the overall total number of adult rheumatology patient care providers in 2015 was just over 6,000 (N=6,013), with a corresponding clinical FTE of 5,415.

Demand Factors

Of the factors used to assess future demand for rheumatology services, one major driver of demand was the aging population of the U.S. Based on data reported by the U.S. Census Bureau, the percentage of adults over the age of 65 will increase by over 100% from 2014 through 2060.[18] Demand was also complicated by the number of patients treated, and the amount of services provided, for osteoarthritis (OA). In addition, based on per capita income compound growth from 2010 to 2015 and the forecasted value for 2020, an estimated compound growth for 2015-2030 will be approximately 2.5%, up 1.5% from the 2005.[19-22] Lastly, demand also included a close examination of metro and micro area population changes which affect where the

demand will be the greatest.[23-24]

Supply Factors

Of the factors used to assess future supply for rheumatology specialists, three major drivers included workforce practice trends, geographic distribution of rheumatology services, and changes in the demographic breakdown of the new graduates entering the workforce (Table 1).[7,11-22]

Current Workforce Practice Trends. Given the aging adult rheumatology workforce and taking into consideration the potential increases in demand for services, succession patterns (e.g., retirement, anticipated changes in workload, etc.) were critical. Labor workforce participation rates for physicians of a given age, sex, and international medical graduate (IMG) status from year to year were reflected in the projections. There was also a growing portion of the provider workforce (both males and females) who anticipated working fewer hours per week and treating fewer patients per year. This resulted in approximately a 14% (for male physicians) to 19% (for female physicians) decrease in patient visits per week by physicians since 2005.[5]

Geographic Distribution of Rheumatology Workforce. In 2015, there was a maldistribution of adult rheumatologists practicing in the U.S.[9-14] For example, 21% of rheumatologists were in the Northeast, compared with only 3.9% in the Southwest (Table 2).[11] In 2015, the ratio of provider per 100,000 patients by region ranged from 3.07 in the Northeast to 1.28 in the Southwest. By 2025, there is an anticipated decrease in all regions ranging from 1.61 in the Northeast to 0.50 in the Northwest (Figure 1).

New Graduates Entering the Workforce. When considering the future supply of adult rheumatologists, graduating fellows who enter the workforce were an important factor in the model. The calculated number depended on available fellowship positions, the fill-rate of those positions, graduation rates, and number of IMGs who anticipate remaining in the U.S. Other factors that contributed to the entering workforce calculations included the projected gender shifts from 2015-2030 and those seeking part-time vs. full-time employment (Table 1).[7,11-22] At 2015 baseline, there are a total of 5,595 rheumatologists; 2,294 are female and 3,301 are male. It is projected that there 5,385 (3,069 female/2,316 male) rheumatologists in 2020, 4,515 (2,574 female/1,941 male) rheumatologists in 2025 and 4,346 (2,477 female/1,869 male) rheumatologists in 2030.

Supply-Demand Projections

The supply and demand projections of adult rheumatology services included NPs and PAs. Figure 2 compares the total number of rheumatology providers (physician and non-physician) to the projected clinical FTE of all providers from 2015 to 2030. The assumptions for each factor (Table 1) were included in the workforce model. In 2015, demand exceeded supply by 700 clinical FTE (12.9%). By 2030, the demand is projected to exceed supply by 4,133 clinical FTE (102%) (Table 3).

Sensitivity Testing. In the best-case scenario, the supply of the adult rheumatology workforce by 2030 increased to 5,989 and demand decreased to 6,692 clinical FTE. This reduced the excess demand from over 100% to 11.7%. In contrast, the worst-case scenario decreased the supply to 3,592 and increased demand to 8,666. This increased the excess demand to approximately 140% (Figure 3). The assumptions used in the based workforce model reflected the best estimates given the economic, social, and political climates in 2015. Table 1 provides the assumptions used in the base model, best-case model, and worst-case model.

DISCUSSION

The U.S. is facing a significant deficit of physicians across all specialties. The Council on Graduate Medical Education (COGME) projects a shortage of 85,000 physicians in 2020, which is approximately 10% of today's physician workforce.[32] The current U.S. primary care physician workforce is in jeopardy of accelerated decline because of decreased production and accelerated attrition.[24] The Association of American Medical Colleges (AAMC) projects a shortage of 124,000 full-time physicians by 2025.[33] The 2015 rheumatology WFS identifies current and future shortages that mirror the national projections.

The primary purpose of the 2015 ACR study was to assess for significant trends in the projected workforce, in order to anticipate strategic planning and/or identify potential strategies to explore workforce challenges. The 2015 study used a patient-centered, integrated, access-to-care focused approach. Estimating the clinical FTE was a fundamental step in the design of the 2015 study, to better understand the clinical productivity of the workforce and its effect on access to care. Based on available data, the current study differentiated between those working in

non-academic (~80%) and academic settings (~20%), resulting in a 1.0FTE for those in non-academic settings and 0.5FTE for those in academic settings.[11]

The 2005 workforce study projected a shortage of 2,576 rheumatologists by 2025, which included applying clinical productivity factors based on gender and age.[1-2] The 2015 workforce study included many additional factors for clinical productivity, including retirements and succession planning (Table 1), which resulted in an estimated shortage of 3,269 clinical FTE, including NPs and PAs by 2025. Additionally, the current study did not assume equilibrium between supply and demand at baseline. Table 3 reflects the differences between supply and demand starting with a 2015 clinical FTE baseline of 5,415 to the projected clinical FTE of 4,051 by 2030 for adult rheumatology providers. At the 2015 baseline, the demand exceeded the supply by 700 clinical FTE (12.9); and by 2030 the projected demand will exceed the supply by 4,133 clinical FTE (102%).

These results represent a dramatic decline in the rheumatology workforce from 2015 to 2030. The workforce shift is due to many coinciding demographic changes. However, there are potential strategies that may be considered to address some of these workforce challenges. These include recruitment of non-physician providers, encouraging changes in the regional distribution of the workforce, expansion of telemedicine programs, retention of IMGs who train in rheumatology, and improved practice efficiencies.

In response to the 2005 workforce study, the number of first-year adult fellow training positions increased from 156 to 210 with over 95% fill-rate each year.[2,4,34] Early medical student and internal medicine resident exposure to rheumatology should enhance recruitment of internal medicine residents to the field.[35] Unfortunately, based on the WFS model, the projected loss of clinical FTE due to retirees over the next 10 years greatly exceeds the capacity of rheumatology training programs to replace them with new graduates. While early exposure to rheumatologists and mentorship prior to the selection of specialty training is important,[11,35] other mechanisms that potentiate re-distribution of the workforce are also advantageous. Current fellows in training are comprised by greater than 50% IMGs and the FIT survey (11 WFS document) delineated that nearly 20% of IMGs would choose to leave the US after training.[11,36] Thus retention strategies for this important sector of new entrants into our workforce are warranted. [37] Moreover strategies are needed to direct a segment of the workforce to underserved regions of the U.S.; this

may include incentives to address the maldistribution of rheumatologists. [38,39] Initiatives to improve reimbursement rates for cognitive subspecialties is ongoing with advocacy from the AMA/Specialty Society Relative Value Scale Update Committee (RUC)) and could potentially increase the pool of trainees considering rheumatology as a career. [40]

Financial incentive programs offer scholarships, loans with service requirements and loan repayment or forgiveness programs but typically focus on primary care practitioners. [37,40] There is evidence that financial incentive programs increase the number of health care providers in underserved areas. [38,42] Participants in financial incentive program are more likely to serve in underserved areas and remain in these areas longer than nonparticipating peers. [43,44] Expanding financial incentives with service requirements may increase access to care in rural and underserved communities. [45] Surveys suggest that competitive salaries, professional development, knowledgeable support staff, and professional support increase the likelihood of provider retention in rural or underserved areas after completion of service commitments. [46]

Hooker et al have discussed approaches to expanding the rheumatology workforce utilizing NPs and PAs .[47-48] A web-based rheumatology curriculum for NPs and PAs was created after the 2005 ACR Workforce study to help transition primary care NPs/PAs into a rheumatology practice. NPs and PAs have been shown to be quite effective in managing treat-to-target goals in a rheumatology practice.[49] As a result there is an ACR/ARHP initiative to consider formal NP/PA rheumatology training programs at selected sites. Recruitment and training strategies for NPs/PAs into the adult rheumatology workforce to improve access to care should be explored further.

The current distribution of adult rheumatologists is concentrated in the Northeast, Mid-Atlantic, Great Lakes and West regions. These 4 regions currently exceed 2 adult rheumatologists per 100,000 adults. This correlates closely with popular metropolitan and suburban areas of the U.S. However, regions like South Central, Southeast and Southwest have significantly lower ratios of 1.52, 1.41, and 1.28, respectively. By 2025, the vast majority of U.S. regions will only have 0.5-1.0 rheumatologists per 100,000 adults, despite a growing aged population. The projected workforce deficit and the maldistribution of rheumatologists are not unique to the U.S.[50-52] Addressing the maldistribution in access to rheumatologic care needs to be a priority; one potential strategy is loan repayment initiatives to incentivize new workforce

entrants to work in underserved areas. Other considerations could include part-time locum tenens or volunteer services by rheumatologist retirees in underserved communities. Local and intrastate disease management models may enhance rheumatology support in some communities and regions of the U.S.

Telemedicine also has the potential to facilitate timely care and improve access to care for underserved communities.[53] Increased or delayed time to rheumatology care is correlated with more severe disease, worse outcomes, and increased health care cost.[54] Tele-rheumatology/telehealth modalities can include screening patient referrals for new onset connective tissue disease, electronic (asynchronous) consultation or synchronous video teleconference (VTC) for diagnosis and treatment.[55] This may work best where areas with excess supply (e.g. metropolitan areas) could expand care to underserved areas. Currently a VTC is often necessary for reimbursement at the intrastate level; interstate VTC presently poses legislative, regulatory and malpractice challenges.[56-58]

The projected shortage of adult rheumatologists and the significant patient demand for rheumatologists will require innovative and multifaceted strategies to effectively provide rheumatology care. A dynamic ACR/ARHP website for patient education, practice models, business practices, collaboration, etc., could provide a centralized and effective resource for education and quality care. Research funding for studies investigating new practice models is needed. A rheumatology cognitive payment model, not based on volume, may help focus rheumatology care for patients who require it the most. [40] Building rheumatology specific tools within electronic health records that facilitate quality care and office practices without prohibitive administrative burden could have a huge impact on provider satisfaction and retention. Multidisciplinary disease management approaches and shared appointments could maximize efficiency while enhancing patient-centeredness in the management of chronic rheumatic disease.[59-60] Integrating fundamental musculoskeletal and rheumatology curricula into primary care residencies is very valuable for quality patient care and timely diagnosis and could reduce the demand for rheumatology consultations.[61-63] Shortages in underserved areas may lead to creative community solutions leveraging technology and using various providers, teams and even unconventional physician extenders to facilitate patient care.[64-66]

The strength of this study is that it utilized a comprehensive, patient-centered, integrative

approach which included numbers of required adult rheumatology providers while applying service utilization rates for various populations. This modeling approach allows socio-economic factors to drive demand, epidemiologic factors to drive need, and utilization rates to incorporate health care services. Analyzing the primary survey, the FIT survey and patient surveys allowed for input from multiple primary sources, strengthening assumptions for the integrated model. Estimated clinical FTE is likely to project more accurate trends in the adult clinical rheumatology workforce than estimating total numbers of providers alone. Many data sources were referenced and cross-referenced to determine the 2015 baseline estimation of adult rheumatology practitioners. A robust approach towards integrating changing demographics and trends in practice was applied to the workforce model.[5,7,23,24,33] Finally, sensitivity testing was used to ascertain the best-case and worst-case scenario to estimate the range of supply and demand for services from 2015-2030 (Figure 3).

Limitations include that primary survey data were collected predominantly from ACR/ARHP members. While a power analysis was conducted to ensure appropriate sample size of primary data collected, caution should be placed on generalizability of these results. Surveys collect data at a single point in time, and it is difficult to predict changes over time. Self-reported data are not always accurate and web-based surveys may have some coverage bias. Published literature influenced some of the assumptions for estimates of supply and demand which were applied to this study. Unanticipated factors could not be easily predicted and therefore the assumptions were based on equilibrium of the market in 2015. Furthermore, workforce modeling is multi-faceted, and the influence of multiple factors on the future supply of health care providers and demand for services could not be easily predicted or modeled. The political climate and health system changes may affect the efficiency (either positively or negatively) and adequacy of providers' supply as well as patients' access to care. System-level changes cannot be accurately anticipated or predicted, despite a good faith effort to determine variations by conducting a best-case and worst-case scenario. Therefore, modeling projections for supply and demand can reflect workforce trends but cannot accurately reflect adult workforce total numbers or clinical FTE.

In summary, the 2015 ACR/ARHP workforce study projects a significant adult rheumatology workforce shortage over the next 15 years; this is in parallel with the projections

for a national physician shortage and shortages in other subspecialties. The ACR/ARHP is committed to optimizing quality rheumatology care and facilitating access to rheumatology care. This will require a passionate vision and innovative strategies by the ACR/ARHP, as well as at the state and federal levels, to both manage patients with rheumatic diseases and support our underserved communities. Decreasing insurance barriers and health care regulations, may allow more rapid, timely and creative solutions to offset the projected rheumatologist shortage and the maldistribution of rheumatologists in the U.S.

References

1. American College of Rheumatology. 2005 Workforce Study of Rheumatologists: Final Report. Prepared by Lewin Group, 2006, May. Accessed May 19, 2017 from https://www.rheumatology.org/Portals/0/Files/LewinReport.pdf
2. Deal CL, Hooker R, Harrington T, Birnbaum N, Hogan P, Bouchery E, et al. The United States rheumatology workforce: Supply and demand, 2005–2025. Arthritis Rheum. 2007;56:722-729.
3. Accreditation Council for Graduate Medical Education (ACGME). *Rheumatology Programs Academic Year 2017*. United States. https://apps.acgme.org/ads/Public/Reports/ReportRun?ReportId=1&CurrentYear=2015&SpecialtyId=28&IncludePreAccreditation=false. January 13, 2017. Accessed April 24, 2017.
4. Accreditation Council for Graduate Medical Education (ACGME). Data Resource Book. *Academic Year 2014-2015*. http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book/GraduateMedicalEducation/GraduateMedicalEducationDataResourceBook. 2016. Accessed April 24, 2017
5. Association of American Medical Colleges (AAMC). The complexities of physician supply and demand projections from 2014 to 2025; 2016 update, Final Report April 2016.
6. Gallegos A. Medical experts say physician shortage goes beyond primary care. *AAMC*, 2014. Retrieved April 8, 2015 from https://www.aamc.org/newsroom/reporter/february2014/370350/physician-shortage.html.

7. FitzGerald JD, Battistone M, Brown CR Jr, Cannella AC, Chakravarty E, Gelber AC, et al. Regional distribution of adult rheumatologists: American College of Rheumatology Committee on Rheumatology Training and Workforce Issues., Arthritis Rheum. 2013 Dec;65(12):3017-25.
8. Tossi M. Employment outlook: 2010-2020 Labor Force projections to 2020: a more slowly growing workforce. Monthly Labor Review, 2012: January, 43-64. Accessed May 19, 2017 from https://www.bls.gov/opub/mlr/2012/01/art3full.pdf
9. Myasoedova E, Crowson CS, Kremers HM, Therneau TM, Gabriel SE. Is the incidence of rheumatoid arthritis rising: Results from Olmsted County, Minnesota, 1955-2007. *Arthritis Rheum*, 2010;62(6):1576-1582.
10. Barbour KE, Helmick CG, Theis KA, Murphy LB, Hootman JM, Brady TJ, et al. Prevalence of Doctor-Diagnosed Arthritis and Arthritis-Attributable Activity Limitation — United States, 2010–2012. *Morb Mortal Wkly Rep.* 2013;62(44):869-873. PubMed PMID: 24196662.
11. American College of Rheumatology (ACR). 2015 Workforce Study of Rheumatology Specialists in the United States. 2016. Accessed May 19, 2017 from https://www.rheumatology.org/portals/0/files/ACR-Workforce-Study-2015.pdf
12. U.S. Census Bureau. Population by Age and Sex. Retrieved January 23, 2016 from: https://www.census.gov/population/age/data/2012comp.html
13. U.S. Census Bureau. State and Metropolitan Area Data Book: 2010, 7th Ed. U.S. Government Printing Office. ISBN:0-16-084189-7. 2010, April.
14. Health Resources and Services Administration. Shortage Designation: Health Professional Areas & Medically Underserved Areas/Populations. Retrieved January 23, 2016 from: http://www.hrsa.gov/shortage/
15. American Medical Association. *The Medicare Physician Payment Schedule*. Retrieved February 8, 2016 from http://www.ama-assn.org/ama/pub/physician-resources/solutions-managing-your-practice/coding-billing-insurance/medicare/the-medicare-physician-payment-schedule.page
16. Association of the American Medical Colleges. (2015). *2015 State Physician Workforce Data Book, Centers for Workforce Studies*. Retrieved January 20, 2015 from:

http://members.aamc.org/eweb/upload/2015StateDataBook%20(revised).pdf

17. Colby SL, Ortman JM. *Projections of the Size and Composition of the U.S. Population, 2014-2060*. U.S. Census Bureau. 2015. Retrieved February 3, 2016 from: https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-1143.pdf
18. U.S. Census. Population Projections. Retrieved January 23, 2015 from: http://www.census.gov/
19. Centers for Disease Control and Prevention. Prevalence of doctor-diagnosed arthritis and arthritis-attributable activity limitation—United States, 2003–2005. *MMWR*, 2006;55:1089–1092. Available from: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5540a2.htm 17
20. Myasoedova E, Crowson CS, Kremers HM, Therneau TM, Gabriel SE. Is the incidence of rheumatoid arthritis rising: Results from Olmsted County, Minnesota, 1955-2007. *Arthritis Rheum*, 2010;62(6):1576-1582. doi:10.1002/art.27425. PubMed PMID: 20191579; PubMed Central PMCID: PMC2929692
21. Helmick CG et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part I. *Arthritis Rheum*. 2008 Jan;58(1):15-25. doi:10.1002/art.23177.
22. Lawrence RC et al. Estimates of the Prevalence of Arthritis and Other Rheumatic Conditions in the United States, Part II. *Arthritis Rheum*, 2008 Jan; 58(1): 26–35. doi:10.1002/art.23176
23. U.S. Census Bureau. Migration/Geographic Mobility. Available from https://www.census.gov/topics/population/migration/guidance/metro-to-metro-migration-flows.html. Accessed December 8, 2017
24. U.S. Census Bureau. Migration/Geographic Mobility. Metropolitan and Micropolitan. Available from https://www.census.gov/programs-surveys/metro-micro.html. Accessed December 8, 2017
25. Stewart, F. Marc et al. "Benchmarks in Clinical Productivity: A National Comprehensive Cancer Network Survey." *Journal of Oncology Practice* 3.1 (2007): 2–8. *PMC*. Web. 10 Dec. 2017.
26. Reich DL, Galati M, Krol M, Bodian CA, Kahn RA. A mission-based productivity compensation model for an academic anesthesiology department. Economics, Education, and policy, 2008, 107(6):1981-1988.
27. Wilson MS, Joiner KA, Inzucchi SE, Mulligan GJ, Mechem MF, Gross CP, Coleman DL.

Improving clinical productivity in the academic setting: A novel incentive plan based on utility theory. Academic Medicine, 2006, 81(4):306-316.

28. Scoggins CR, Crockett T, Wafford L, Cannon RM, McMasters KM. Improving clinical productivity in an academic surgical practice through transparency. American College of Surgeons, 2013, 217(1):46-51.
29. Canadian Medical Association (CMA): Rheumatology profile. Available from https://www.cma.ca/Assets/assets-library/document/en/advocacy/Rheumatology-e.pdf. Accessed December 8, 2017.
30. Hanly JG; Canadian Council of Academic rheumatologists. Manpower in Canadian academic rheumatology units: current status and future trends. Canadian Council of Academic Rheumatologists. J Rheumatol 2001: 28:1944-51.
31. Monrad S, Battafarano D, Ditmyer M. Academic and Non-Academic Rheumatology: Practice Trends and Common Barriers to Practice from the 2015 ACR/ARHP Workforce Study Survey. *Arthritis Rheum* October 2016; 68(S10): 127-129.
32. Council on Graduate Medical Education. Twentieth Report. Retrieved May 26, 2016 from http://www.hrsa.gov/advisorycommittees/bhpradvisory/cogme/reports/twentiethreport.pdf
33. Association of American Medical Colleges. (2008). *The complexities of physician supply and demand: Projections through 2025*. Retrieved April 19, 2016 from: https://members.aamc.org/eweb/upload/The%20Complexities%20of%20Physician%20Supply.pdf
34. National Resident Matching Program, Results and Data: 2015 Main Residency Match®. National Resident. Matching Program, Washington, DC. 2015.www.nrmp.org/wp-content/.../2015/05/Main-Match-Results-and-Data-2015_final.pdf
35. Kolasinski, S. L., Bass, A. R., Kane-Wanger, G. F., Libman, B. S., Sandorfi, N., & Utset, T. (2007). Subspecialty choice: why did you become a rheumatologist? *Arthritis Care & Research*, *57*(8), 1546-1551.
36. Hausmann JS, Monrad S, Ditmyer M, Bolster MB, Imundo LF, Battafarano D. "The Future of Rheumatology: Pediatric and Adult Fellows-in-Training Results from the 2015 ACR/ARHP Workforce Study" *Arthritis Rheum* October 2016: 68(S10): 1467-1468.
37. Higher education financial incentives for health professionals serving underserved areas. Available from http://www.countyhealthrankings.org/take-action-improve-health/what-

works-health/higher-education-financial-incentives-for-health-professionals-serving-underserved-areas. Accessed December 30, 2017.

38. Opoku DT, Apenteng BA, Lin G, Chen L-W, Palm D, Rauner T. A comparison of the J1-Visa waiver and loan repayment programs in the recruitment and retention in rural Nebraska. The Journal of Rural Health 2015, 31:300-309 doi:10.1111/jrh.12108
39. Thompson, M. J., Hagopian, A., Fordyce, M. and Hart, L. G. (2009), Do International Medical Graduates (IMGs) "Fill the Gap" in Rural Primary Care in the United States? A National Study. The Journal of Rural Health, 25: 124–134. doi:10.1111/j.1748-0361.2009.00208.x
40. RVS update committee/RUC/AMA-American Medical Association. www.ama-assn.org/rvs-update-committee-ruc/. Accessed December 30, 2017.
41. Grischkan J, George BP, Chaiyachati K, Friedman AB, Dorsey ER, Asch DA. Distribution of Medical Education Debt by Specialty, 2010-2016. *JAMA Intern Med.* 2017;177(10):1532–1535.
42. Goodfellow A, Ulloa JG, Dowling PT, Talamantes E, Chheda S, Bone C, Moreno G. Predictors of primary care physician practice location in underserves urban and rural areas in the United States: a systematic literature review. Acad Med 2016:91:1313-1321.
43. Grobler L, Marais BJ, Mabunda S. Interventions for increasing the proportions of health professionals practicing in rural and other underserved areas. Cochrane Database Syst Rev 2015Jun 30;(6):CD005314. doi:10.1002/14651858
44. Barnighausen T, Bloom DE. Financial incentives for return of service in underserved areas: a systematic review. BMC Health Serv Res 2009 May 29;9:86. doi: 10.1186/1472-6963-9-86.
45. Tierney J, Terhune K. Expanding the national health service scholarship program to general surgery. A proposal to address the national shortage of general surgeons in the United States. JAMA Surg 2017;152:315-316.
46. Scarbrough AW, Moore M, Shelton SR, Knox RJ. Improving primary care retention in the medically underserved areas: What's a clinic to do? The Health Care Manager Oct/Dec 2016, 35:368-372.
47. Hooker RS. The extension of rheumatology services with physician assistants and nurse practitioners. *Best Pract Res Clin Rheumatol*. 2008 Jun;22(3):523-33.

574 doi:10.1016/j.berh.2007.12.006
575 48. Dill MJ, Pankow S, Erikson C, Shipman S. Survey shows consumers open to greater role for
576 physician assistants and nurse practitioners. **Health** Aff (Millwood). 2013 Jun;32(6):1135-
577 42.
578 49. Solomon DH, Bitton A, Fraenkel L, Brown E, Tsao P, Katz JN. Roles of nurse practitioners
579 and physician assistants in rheumatology practices in the US. *Arthritis Care Res (Hoboken*).
580 2014 Jul;66(7):1108-13. doi:10.1002/acr.22255.
581 50. Barber CE, Jewett L, Badley EM, Lacaille D, Cividino A, Ahluwalia V, Averns H, Baillie C,
582 Ellsworth J, Pope J, Levy D, Charnock C, McGowan C, Thorne JC, Barnabe C, Zummer M,
583 Lundon K, McDougall RS, Thomson JG, Yacyshyn EA, Mosher D, Brophy J, Ruban TN,
584 Marshall DA. Stand up and be counted: measuring and mapping the rheumatology workforce
585 in Canada. J Rheumatol. 2017 Feb;44(2):248-257
586 51. Harrison MJ, Lee J, Deighton C, Symmons DP. UK rheumatology consultant workforce
587 provision 2007-9: results from the BSR/Arthritis Research UK Consultant. Clin Med 2011;
588 11:119-24. Workforce Registrar
589 52. Zhang F. The china rheumatology workforce: a status report. Int J Rheum Dis 2009; 12:279-
590 82.
591 53. Ward JM, Schmidt TW, Lappan C, Battafarano DF. How critical is telemedicine to the
592 rheumatology workforce? Arthritis Care Res 2016 Oct; 68(10):1387-9.
593 54. Molina E, del Rincon I, Restrepo JF, Battafarano DF, Escalante A. Association of
594 socioeconomic status with treatment delays, disease activity, joint damage, and disability in
595 rheumatoid arthritis. Arthritis Care Res (Hoboken) 2015; 67:940–6.
596 55. US Department of Health & Human Services. Telehealth. www.hrsa.gov/healthit/telehealth/.
597 Accessed October 28, 2017.
598 56. American Telemedicine Association. Telemedicine and telehealth services. 2013. URL:
599 http://www.americantelemed.org/ docs/default-source/policy/medicare-payment-of-
600 telemedicineand-telehealth-services.pdf
601 57. Thomas L, Capistrant G. State telemedicine gaps analysis: physician practice standards and
602 licensure. American Telemedicine Association. 2015. URL:
603 http://www.americantelemed.org/docs/ default-source/policy/50-state-telemedicine-gaps-
604 analysis– physician-practice-standards-licensure.pdf?sfvrsn56.

605 58. Hildebrand P. Telemedicine risk management.
606 URL:http://ihcrme.com/docs/Research/White-Paper-Telemedicine. pdf.
607 59. Stults CD, McCuistion MH, Frosch DL, Hung DY, Chang PH, Tai Seale M. Shared medical
608 appointments: a promising innovation to improve patient engagement and ease the primary
609 care shortage. Popul Health Manag 2016;19(1):11-6.
610 60. Ng G, Tan N, Bahadin J, Shum E, Tan SW. Development of an automated healthcare kiosk
611 for management of chronic disease patients in the primary care setting. J Med Syst. 2016;
612 40(7):169.
613 61. Kroop SF, Chung CP, Davidson MA, Horn L, Damp JB, Dewey C. Rheumatologic skills
614 development: what are the needs of internal medicine residents? Clin Rheumatol 2016
615 Aug;35(8):2109-15.
616 62. Parisek RA, Battafarano DF, Marple RL, Carpenter M, Kroenke. How well do internists
617 diagnose common musculoskeletal complaints? J Clin Rheumatol 1997 Feb;3(1):16-23.
618 63. Katz SJ, Oswald AE (2011) How confident are internal medicine residents in rheumatology
619 versus other common internal medicine skills: an issue of training time or exposure? Clin
620 Rheumatol 30:1081-1093.
621 64. Green LV, Savin S, Lu Y. Primary care physician shortages could be eliminated through use
622 of teams, non-physicians and electronic communication. Health Aff(Millwood). 2013
623 Jan;32(1):11-9.
624 65. Eisenman A. How do retired paramedics fit into remote, rural emergency departments? Rural
625 Remote Health. 2013 Apr-Jun;13(2);2057.
626 66. Anthony D, El Rayess F, Esquibel AY, George P, Taylor J. Building a workforce of
627 physicians to care for underserved patients. R I Med J (2013). 2014 Sep 2;97(9):31-5.

Table 1. 2015 ACR Workforce Study Supply and Demand Model Assumptions
(Base Model, Best-Case Model, and Worst-Case Model)

Supply Factors	Base-Model Assumptions	Best-Case Model Assumptions	Worst-Case Model Assumptions
Geographic	✓ No changes in the geographic distribution through 2030. ✓ Physicians practicing in MSAs* worked on average 15% fewer hours per week ✓ Mean hours=53	✓ No geographic changes in the model	✓ No geographic changes in the model
Productivity (RVUs)	✓ No factor applied for adults due to low growth rate	✓ No factor applied for adults due to low growth rate	✓ No factor applied for adults due to low growth rate
Succession Planning	✓ ~50% will retire through 2030. ✓ 25% patient load reduction for those planning to retire (0.75 FTE)	✓ Reduced the percentage for retirement to 40% for 2020, 2025, and 2030	✓ Increased the percentage for retirement to 60% for 2020, 2025, and 2030
Gender	✓ In 2015, ratio 59.2% male: 40.8% female. ✓ Expected 14% increase females by 2030. ✓ Females work 7 fewer hours/week and treat 30% less patients	✓ Decreased percentage of females by 10% for 2020, 2025, and 2030	✓ Increased percentage of females by 10% for 2020, 2025, and 2030
Full-time vs. Part-time (PT) Employment	✓ ~18% workforce work PT (0.5FTE). ✓ 90% PTs female.	✓ Decreased the number PT to 10% for 2020, 2025, and 2030	✓ Increased the number PT to 25% for 2020, 2025, and 2030

Table 1. (Cont.)

Supply Factors	Base-Model Assumptions	Best-Case Model Assumptions	Worst-Case Model Assumptions
Practice Setting	✓ 80% non-academic settings (1.0FTE) ✓ 20% academic settings (0.5FTE)	✓ Decreased the number working in non-academic settings to 75% for 2020, 2025, and 2030	✓ Increased the number working in non-academic setting to 90% for 2020, 2025, and 2030
New Graduate Entrants	✓ 215 graduates annually ✓ ~1.4% will not graduate. ✓ ~83% of the IMGs stay in U.S. ✓ ~18.3% work PT (0.05FTE)	✓ 100% fill-rate, 25% increase in new graduates	✓ 50% fill-rate, no new graduates
Non-Physician Providers (NPs/PAs)	✓ ~2% to 5% increase into Rheumatology	✓ Increase by 30% into Rheumatology	✓ Decrease by only 10% into Rheumatology
Demand Factors	**Base-Model Assumptions**	**Best-Case Model Assumptions**	**Worst-Case Model Assumptions**
Patients with Osteoarthritis (OA)	✓ ~25% patient load	✓ Decrease the patient load to 0%	✓ Increase the patient load to 50%
Aging Population	✓ ~18% patients ≥65 years of age ✓ ~25% patients ≥65 years of age	✓ No change in the aging population rates	✓ No change in the aging population rates
Prevalence of Disease	✓ ~23% adults females ✓ ~18.6% adult males ✓ ~25% of all adults doctor-diagnosed arthritis by 2030	✓ No change in the aging population rates	✓ No change in the aging population rates

Note: American College of Rheumatology (ACR). 2015;[11] FitzGerald et al, 2013,[9] U.S. Census Bureau, 2016;[12] U.S. Census Bureau, 2010;[13] Health Resources and Services Administration, 2016;[14] American Medical Association. 2016;[15] AAMC, 2015;[5,16] Colby & Ortman, 2015;[17] U.S. Census Bureau, 2015;[18] Centers for Disease Control and prevention (CDC), 2016;[19] Myasoedova et al., 2010;[20] Helmick et al., 2008;[21] Lawrence et al, 2008.[22] *MSAs= Metropolitan Statistical Areas; **IMGs= International Medical Graduates

Table 2. Regional Distribution of Physician per Population Data Breakdown

	Region	Adult Rheumatologists			
		N	% by Region	Adult Population/Region	Adult/ Physician Ratio
1	Northeast	1264	21.1	33,719,386	26,676.7
2	Mid-Atlantic	1028	17.1	35,555,292	34,586.9
3	Southeast	698	11.6	41,940,692	60,087.0
4	Great Lakes	957	16.0	39,642,918	41,424.2
5	North Central	255	4.3	12,026,980	47,164.6
6	South Central	493	8.2	25,975,519	52,688.7
7	Southwest	233	3.9	15,415,990	66,163.0
8	West	742	12.4	30,763,180	41,459.8
9	Northwest	262	4.4	11,947,352	45,600.6
10	Puerto Rico	64	1.1	2,750,008	42,968.9
Totals		**5995**		**249,737,317**	**41,657.6**

Source: 2015 ACR Workforce Study.[11]

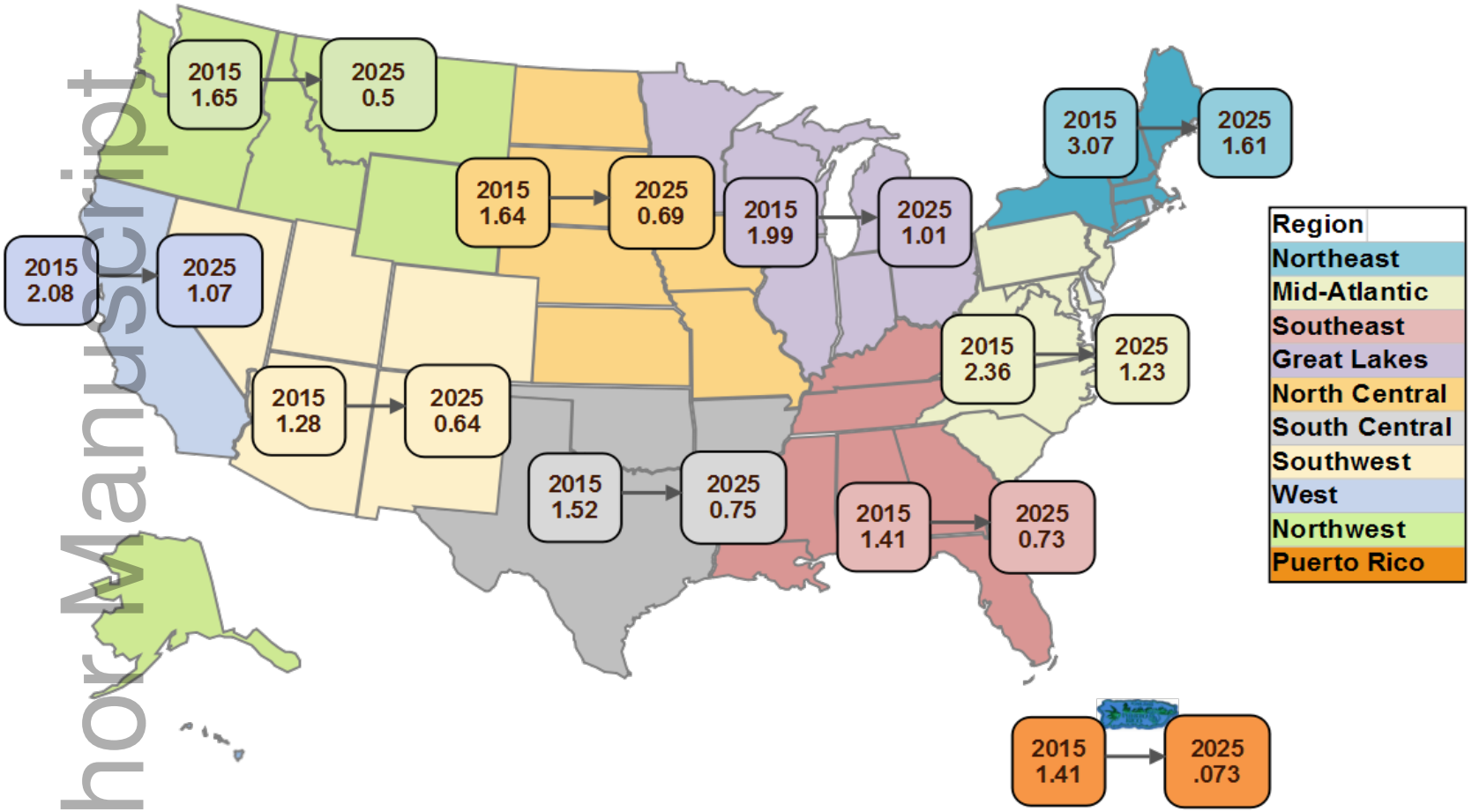

Figure 1. Adult Rheumatology Provider Distribution Rate per 100,000 Patients in 2015 compared to projections for 2025

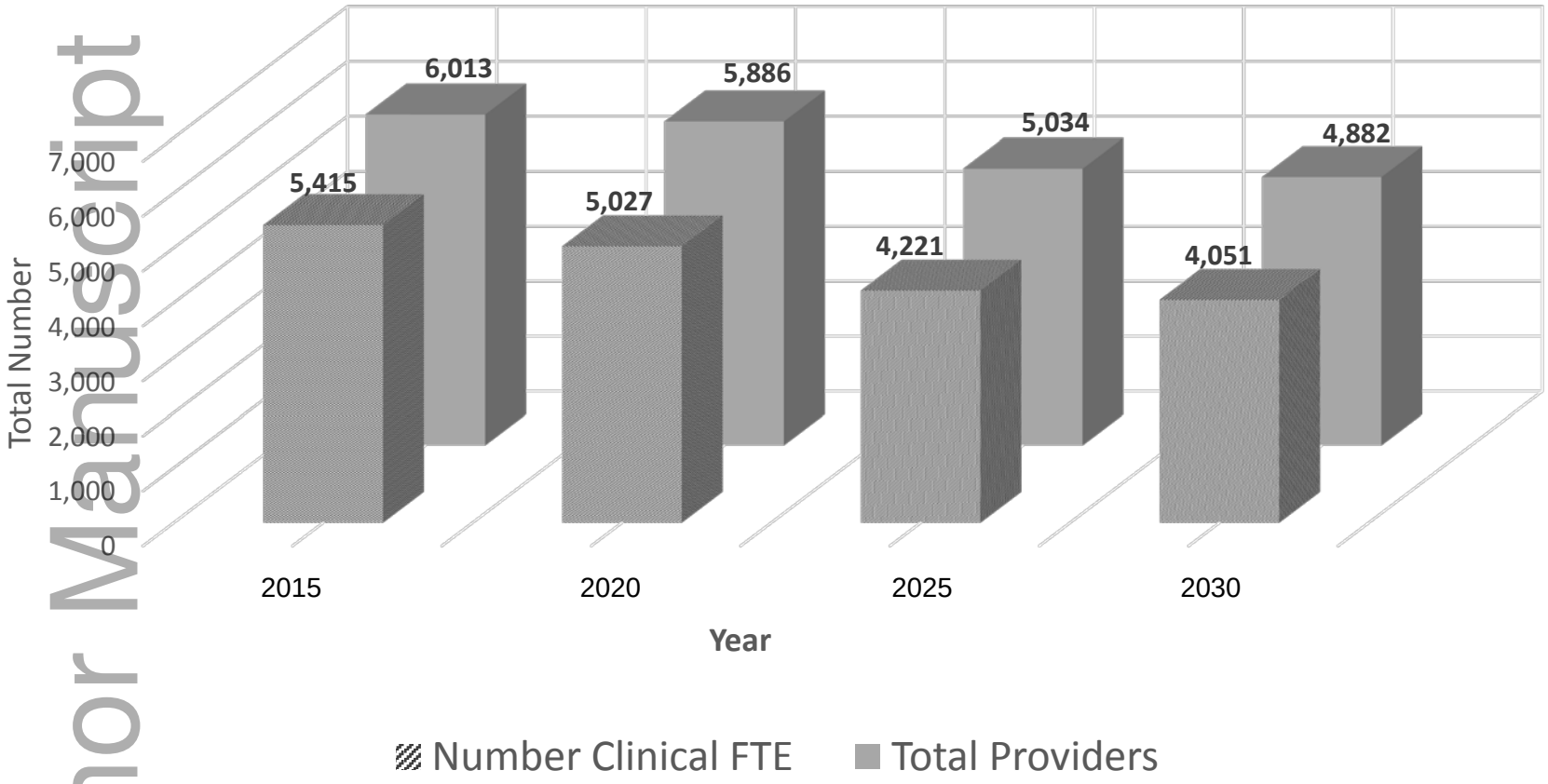

Figure 2. Projected Total Number Providers including NPs/PAs, Compared to Projected Clinical FTE (2015-2030)

Table 3. Total Adult Rheumatology Workforce Supply and Demand Projections (Clinical FTE)

Supply	2015 Base (FTE)	2020 Projections		2025 Projections			2030 Projections		
		Total	% Diff. 2015-20	Total	% Diff. 2020-25	% Diff. 2015-25	Total	% Diff. 2025-30	% Diff. 2015-30
Adult^	4,997	4,470	**-10.5**	3,645	**-18.6**	**-27.1**	3,455	**-5.2**	**-30.9**
NP	228	306	+34.2	313	+2.3	+37.3	320	+2.2	+40.4
PA	190	251	+32.1	263	+4.8	+38.4	276	+4.9	+45.3
Total	**5,415**	**5,027**	**-7.8**	**4,221**	**-16.0**	**-22.6**	**4,051**	**-4.2**	**-25.2**

Demand	Baseline	2020	2025	2030
Projected Workforce Supply**	5,415	5,027	4,221	4,051
Projected Need	6,115	6,796	7,490	8,184
Difference (Excess Demand)[≠]	700	1,769	3,269	4,133
Percent Change Excess Demand	+12.9	+35.2	+77.5	+102.0
Number projected with Disease[±]	22,500,000	25,421,467	28,571,024	36,361,586
Adults with Disease/Provider (Supply) [£]	4,155.1	5,057.0	6,768.8	8,976.0
Adults with Disease/Provider (Need)[€]	3,679.5	3,740.7	3,814.6	4,443.0

Note: *Numbers include new graduating fellows entering the workforce annually; Assumes 1.0FTE for adult rheumatologists working in non-academic settings (~80% workforce); Assumes 0.5FTE for adult rheumatologists working in academic settings (~20% of workforce); Assumes 0.9FTE for all NPs/PAs. **Supply numbers include both physician and non-physician providers; ≠Number of excess demand compared to same year supply projections; ±Number of projected patients with rheumatic diseases plus 25% OA patient load; [£]Number of adult with disease per provider based on current projections; [€]Number adults with disease per provider if projected need is met.

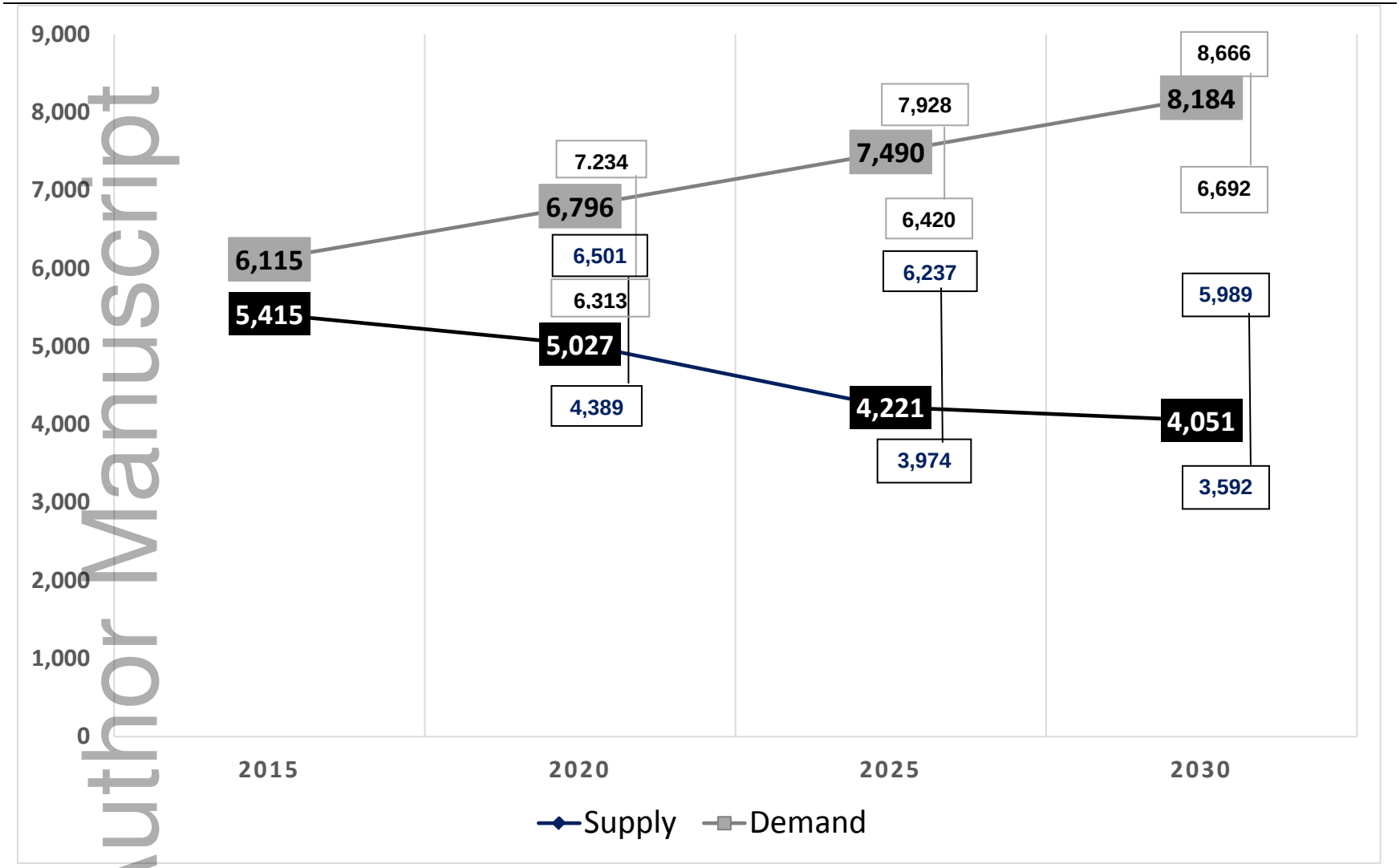

Figure 3. Projected Supply and Demand Adult Providers (Clinical FTE), 2015 – 2030; Includes NPs and PAs in the totals.