AAMC
Tomorrow's Doctors, Tomorrow's Cures®

The Complexities of Physician Supply and Demand: Projections From 2019 to 2034

Learn
Serve
Lead

June 2021

Prepared for the AAMC by IHS Markit Ltd.

Association of
American Medical Colleges

AAMC

The Complexities of Physician Supply and Demand: Projections From 2019 to 2034

June 2021

Prepared for the AAMC by IHS Markit Ltd.

AAMC

Washington, D.C.

This report was prepared for the AAMC by IHS Markit Ltd.:
Tim Dall, Executive Director
Ryan Reynolds, Senior Consultant
Ritashree Chakrabarti, PhD, Senior Consultant
Daria Chylak, Senior Consultant
Kari Jones, PhD, Director
Will Iacobucci, Senior Consultant

IHS Markit Ltd.
1300 Connecticut Ave., NW, Suite 800
Washington, DC 20036

Suggested citation: IHS Markit Ltd. *The Complexities of Physician Supply and Demand: Projections From 2019 to 2034*. Washington, DC: AAMC; 2021.

CONTENTS

EXHIBITS v
EXECUTIVE SUMMARY vii
Key Findings viii
Future Directions in Physician Workforce Research ix
INTRODUCTION 1
UPDATED PROJECTIONS 3
Total Physician Supply and Demand 5
Primary Care Supply and Demand 7
Non-Primary Care Supply and Demand 10
Medical Specialties 10
Surgical Specialties 12
Primary-Care-Trained Hospitalists 14
Other Specialties 17
COVID-19 PHYSICIAN WORKFORCE IMPLICATIONS 19
PROVIDERS REQUIRED IF U.S. ACHIEVED EQUITY IN HEALTH CARE UTILIZATION 24
SUPPLY MODELING 27
Supply Modeling Inputs, Assumptions, and Scenarios 27
Supply Projections 29
DEMAND MODELING 32
Demand Modeling Inputs, Assumptions, and Scenarios 33
Population Characteristics and Projections 33
Demand for Health Care Services 34
Patterns of Care Delivery 34
Advanced Practice Registered Nurses and Physician Assistants 35
Scenarios Modeled 38
Demand Projections 41
National Demand 41
Demand by Population Demographics 44
EVOLVING CARE DELIVERY SYSTEM DEMAND IMPLICATIONS 47
GEOGRAPHIC DISTRIBUTION OF PHYSICIAN DEMAND 53
Physician Demand by Census Region 53
Physician Demand by Urban-Rural Location 56
CONCLUSIONS 58
APPENDIX 1: DATA AND METHODS 61
Synopsis of Study Methods 61

Supply Model Overview and Updates 62
Current Physician Workforce 62
New Entrants 62
Hours-Worked Patterns 62
Retirement Patterns 62
Demand Model Overview and Updates 63
APPENDIX 2: ADDITIONAL TABLES AND CHARTS 65
NOTES 77
REFERENCES 78

EXHIBITS

Exhibit ES-1: Total Projected Physician Shortage Range, 2019-2034 **x**
Exhibit 1: Projected Physician Supply and Demand by Scenario, 2019-2034 **5**
Exhibit 2: Total Projected Physician Shortage Range, 2019-2034 **6**
Exhibit 3: Projected Supply and Demand for Primary Care Physicians, 2019-2034 **8**
Exhibit 4: Projected Primary Care Physician Shortage Range, 2019-2034 **9**
Exhibit 5: Projected Supply and Demand for Medical Specialist Physicians, 2019-2034 **10**
Exhibit 6: Projected Medical Specialist Physician Shortage Range, 2019-2034 **11**
Exhibit 7: Projected Supply and Demand for Surgeons, 2019-2034 **12**
Exhibit 8: Projected Surgeon Shortage Range, 2019-2034 **13**
Exhibit 9: Projected Supply and Demand for Primary-Care-Trained Hospitalists, 2019-2034 **15**
Exhibit 10: Projected Primary-Care-Trained Hospitalists Shortage Range, 2019-2034 **16**
Exhibit 11: Projected Supply and Demand for Other Specialties, 2019-2034 **17**
Exhibit 12: Projected Other Specialist Physician Shortage Range, 2019-2034 **18**
Exhibit 13: Current Use of FTE Physician Services per 100,000 Population by Patient Race and Ethnicity, 2019 **25**
Exhibit 14: Health Care Utilization Equity Scenario 1, 2019 **26**
Exhibit 15: Health Care Utilization Equity Scenario 2, 2019 **26**
Exhibit 16: Projected Supply of Physicians, 2019-2034 **29**
Exhibit 17: Projected Change in Physician Supply: 2021 vs. 2020 Report Projections **30**
Exhibit 18: Projected Change in Physician Supply by Specialty Category, 2019-2034 **31**
Exhibit 19: Percent Change in Projected Population, by Age, 2019-2034 **33**
Exhibit 20: Physician Demand Under Alternative Scenarios of the Degree to Which Advanced Practice Registered Nurses and Physician Assistants Reduce Demand for Physicians, 2019-2034 **38**
Exhibit 21: Projected Demand for Physicians, 2019-2034 **42**
Exhibit 22: Projected Change in Physician Demand: 2021 vs. 2020 Report Projections **43**
Exhibit 23: Proportion of Physician Demand by Population Age 65+, 2019 and 2034 **44**
Exhibit 24: Projected Physician-Demand Growth by Patient Race and Ethnicity, 2019-2034 **46**
Exhibit 25: Physician-Demand Implications of Evolving Care Delivery System Components by 2034 **50**
Exhibit 26: Projected Growth in Physician Demand Under Status Quo and Evolving Care Delivery System Scenarios, 2019-2034 **51**
Exhibit 27: Evolving Care Delivery System Scenario Demand Projections, 2019-2034 **52**
Exhibit 28: Physician Primary Care Demand and Demand Growth by Census Region, 2019-2034 **54**
Exhibit 29: Physician Non-Primary Care Demand and Demand Growth by Census Region, 2019-2034 **55**
Exhibit 30: Physician Primary Care Demand and Demand Growth by Metropolitan Designation, 2019-2034 **56**

Exhibit 31: Physician Non-Primary Care Demand and Demand Growth by Metropolitan Designation, 2019-2034 **57**
Exhibit 32: Summary of Demand Modeling Data Sources **64**
Exhibit 33: Projected Physician Demand by Patient Race and Ethnicity, 2019-2034 **65**
Exhibit 34: Projected Physician Demand by Census Region, 2019-2034 **66**
Exhibit 35: Projected Physician Demand by Urban-Rural Location, 2019-2034 **67**
Exhibit 36: Summary of Projected Gap between Physician Supply and Demand, 2019-2034 **68**
Exhibit 37: Projected Physician Supply, 2019-2034 **69**
Exhibit 38: Physician Supply Projection Summary by Specialty Category, 2019-2034 **70**
Exhibit 39: Projected Physician Demand by Scenarios Modeled, 2019-2034 **71**
Exhibit 40: Additional Physician Demand to Achieve Health Care Utilization Equity in 2019 by Patient Race/Ethnicity **72**
Exhibit 41: Increase in Physician Demand to Achieve Health Care Utilization Equity in 2019 by Region **73**
Exhibit 42: Physician Demand by Health Care Utilization Equity Scenario and Region in 2019 **74**
Exhibit 43: Increase in Physician Demand to Achieve Health Care Utilization Equity in 2019 by Urban/Rural Area **75**
Exhibit 44: Physician Demand by Health Care Utilization Equity Scenario and Urban/Rural Area in 2019 **76**

EXECUTIVE SUMMARY

Assessing the capacity of the nation's future physician workforce to meet expected demand provides critical information to both the public and the private sectors. The pace of change in health care coupled with the lead time required to train new physicians necessitates continuously updating and improving workforce projections. For these reasons, since 2015, the AAMC has commissioned annual reports of national physician workforce projections prepared by independent experts. The purpose of these updates is threefold:

- **Update and improve workforce projections:** The AAMC is committed to supporting ongoing efforts to use the most recent and best-quality data to update projections and to respond to constructive feedback received about previous projections.
- **Present new analyses:** The reports present new and updated research on the physician workforce and the implications of important issues such as the evolving health care system, the changing demographic composition of the workforce, and changing hours-worked and retirement patterns. A new section in this year's report discusses the potential long-term implications of the COVID-19 pandemic for physician supply and demand.
- **Identify future directions for research:** The process of modeling future supply and demand for physicians helps identify areas for future research, data collection, and analysis that will strengthen future projections and support decision-making to help align the nation's physician workforce with its health care needs.

Many of the data used in this study were collected pre-COVID-19. We do know the pandemic has highlighted many of the deepest disparities in health and access to health care services, contributed to a rising physical and emotional toll on physicians and other health workers, and exposed vulnerabilities in the health care system. Some health workers have been furloughed or have faced economic challenges, while others have been pressed to put in long hours to care for surging demand for pandemic-induced health care needs. The Health Care Utilization Equity Scenario included in this report provides a baseline for understanding inequities in access to care in the context of physician supply and demand. Understanding the full impact of COVID-19 on equity in access to care as it relates to the nation's physician workforce, as well as the broader effects of the pandemic, will require further study and analysis in future years' reports.

Moreover, there are still many unknowns about the direct short-term and long-term impacts of COVID-19 on the physician workforce, and it may be several years before those impacts are clearly understood. Differential impacts across specialties, types of workplaces, and geographic locations will also require extensive study.

This report uses a modeling approach and data sources similar to those in previous reports. As in the past, this update projects future physician supply by considering trends in key physician-supply determinants and the sensitivity of supply projections to changes in these determinants. The demand projections reflect changing demographics as the population grows and ages, the rapidly growing supply of advanced practice registered nurses (APRNs) and physician assistants (PAs), and other important trends in health care such as a growing emphasis on achieving population health goals. Because it is impossible to predict with certainty the degree to which any scenario will transpire, the projected shortages are presented as a range under the most likely scenarios rather than as a single number.

This update extrapolates a 2019 level of care delivery to 2034 to project future demand under the Status Quo Scenario, whereas the previous report extrapolated a 2018 level of care delivery to 2033. The update also reflects the federal Health Resources and Services Administration's downward revision of the number of additional physicians required to remove Health Professional Shortage Area (HPSA) designations for primary care and mental health specialties; this information is used as a conservative proxy for national gaps between supply and demand in 2019. The supply projections include the anticipated increase in

graduate medical education slots due to the Consolidated Appropriations Act of 2021, which will fund an increase of 200 slots in each of the five years from 2023 to 2027.

Study findings offer stakeholders insights into changes expected in the physician workforce by 2034. All supply and demand projections are reported as full-time-equivalent (FTE) physicians, where an FTE is defined for each specialty category as the average weekly patient-care hours for that specialty category. The projections include all active physicians who have completed their graduate medical education.

Key Findings

- We continue to project that physician demand will grow faster than supply, leading to a projected total physician shortage of between 37,800 and 124,000 physicians by 2034 (Exhibit ES-1). This projected shortage range reflects updates to model inputs including (1) a larger estimate of the annual number of physicians being trained, which is associated with higher numbers estimated from the single Graduate Medical Education Accreditation System and a slight increase in funding for training slots under the Consolidated Appropriations Act of 2021, and (2) smaller starting-year shortage estimates based on recently revised federal HPSA designations for primary care and mental health.
    - A primary care physician shortage of between 17,800 and 48,000 is projected by 2034.
    - A shortage of non-primary care specialty physicians of between 21,000 and 77,100 is projected by 2034, including:
        - Between 15,800 and 30,200 for Surgical Specialties.
        - Between 3,800 and 13,400 for Medical Specialties.
        - Between 10,300 and 35,600 for the Other Specialties category.

By 2034, we project:

- ✓ A shortage of primary care physicians of between 17,800 and 48,000.
- ✓ A shortage across the non-primary care specialties of between 21,000 and 77,100 physicians.

- Demographics — specifically, population growth and aging — continue to be the primary driver of increasing demand from 2019 to 2034. During this period, the U.S. population is projected to grow by 10.6%, from about 328.2 million to 363.0 million. The population under age 18 is projected to grow by 5.6%, which portends low growth in demand for pediatric specialties. The population aged 65 and older is projected to grow by 42.4% — primarily due to the 74.0% growth in size of the population age 75 and older. This trend portends high growth in demand for physician specialties that predominantly care for older Americans.
- A large portion of the physician workforce is nearing traditional retirement age, and supply projections are sensitive to workforce decisions of older physicians. More than two of five currently active physicians will be 65 or older within the next decade. Shifts in retirement patterns over that time could have large implications for physician supply. Growing concerns about physician burnout, documented in the literature and exacerbated by COVID-19, suggest physicians will be more likely to accelerate than delay retirement. On the other hand, economic uncertainty and any detrimental effect on physician wealth could contribute to delaying retirement.

COVID-19 has raised awareness of the disparities in health and access to care by minority populations, people living in rural communities, and people without medical insurance. If underserved populations had health care use patterns like populations with fewer access barriers, demand would rise such that the nation would be short by about 102,400 (13%) to 180,400 (22%) physicians relative to the current supply.

- COVID-19 has raised awareness of the disparities in health and access to care by minority populations, people living in rural communities, and people without medical insurance. We updated two hypothetical Health Care Utilization Equity Scenarios around the effects of removing access barriers. These estimates, which are excluded from the shortage-projection ranges, help illuminate the magnitude of current barriers to care and provide an additional reference point when gauging the adequacy of the nation's physician workforce supply to achieve national goals. If underserved populations had health care use patterns like populations with fewer access barriers, demand would rise such that the nation would be short by about 102,400 (13%) to 180,400 (22%) physicians relative to the current supply. Improving access to care is a national imperative.
- While there are still many unknowns about the long-term implications of COVID-19 for the physician workforce, by 2034, any overall supply or demand effect of COVID-19 likely will be small despite the disruptive short-term impact. The impact on physicians themselves, including how they practice, will be more profound. The disruptions caused by COVID-19 have laid bare many problems and significant disparities in the health care system, including disparities in access, the growing shortage of physicians, insufficient numbers of health care workers to respond to the surge in need, and a lack of pandemic planning. In this report, we discuss COVID-related factors that likely will affect physician supply, including physician mortality from COVID-19; physicians leaving the field temporarily or permanently due to stress, risk, and frustrations from COVID-19; trainees having their training times delayed or extended, or their choices of specialties affected; and changes in physicians' retirement plans due to health risks or adverse financial impacts of COVID-19. We discuss COVID-19-related factors affecting demand for physician-provided health care services, including excess deaths (i.e., a higher-than-usual number of deaths) due to the pandemic and the related recession; the declining birth rate; the mental and emotional toll of COVID-19 on the public; new demand by patients who do not fully recover from the disease after a few weeks ("long-COVID" patients); and changes in expected kinds of demand because of the screening and preventive appointments missed during the pandemic. We discuss how COVID-19 might change how care is delivered, including the types of places where physicians work and how much of their care is provided via telemedicine. Because of the lag between events and when data are available to researchers, it will be several years before the physician workforce implications are fully understood. We will continue to focus on this issue in the coming years.

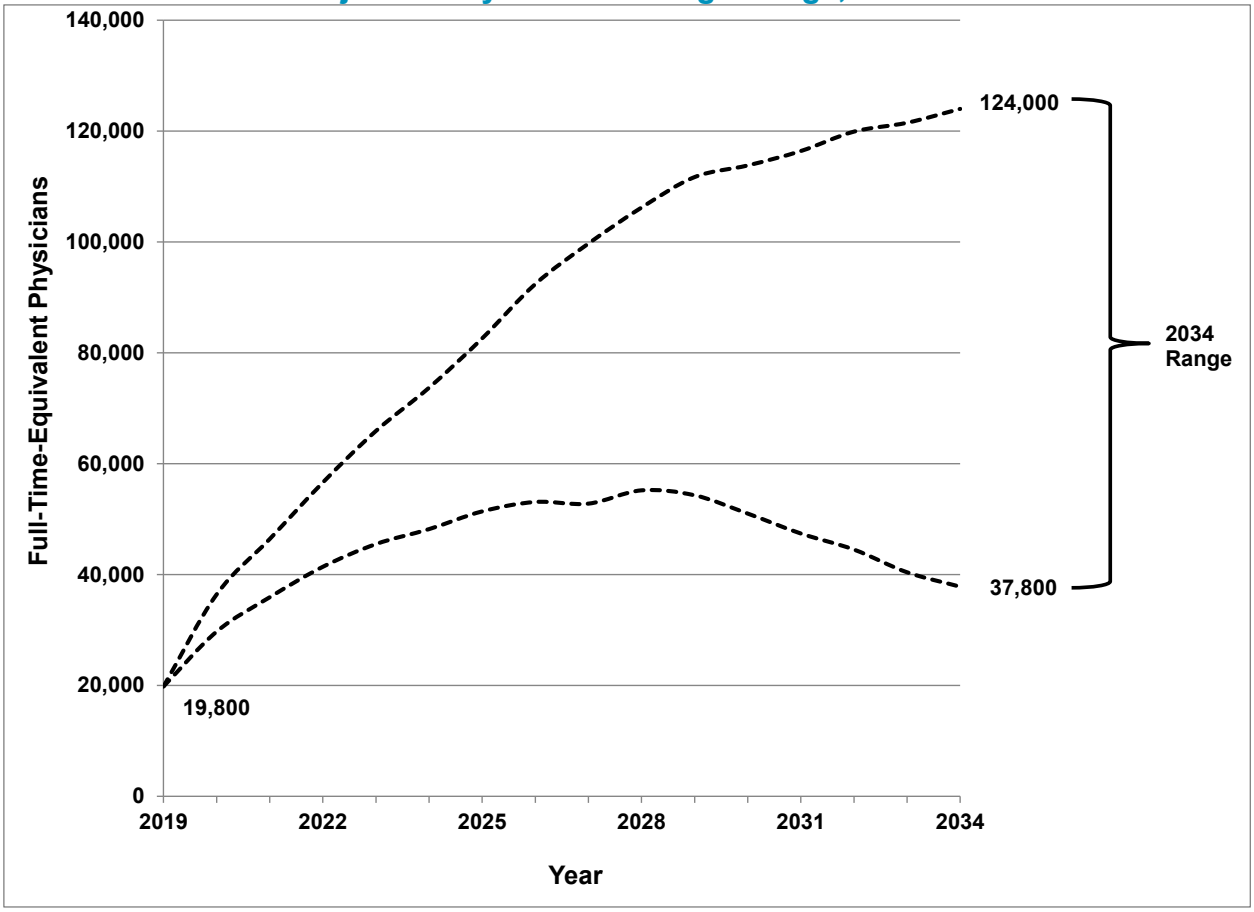
Future Directions in Physician Workforce Research

An ever-present challenge in making these workforce projections is the rapid pace of change in the health care system and the dearth of data available to quantify these changes. We have identified seven areas where additional data and research could improve health care workforce projections:

- **COVID-19 impact:** The COVID-19 pandemic is likely to have short- and long-term consequences for the nation's physician workforce, including for:
    - Training (e.g., interruption of education, cancellation of clinical rotations, changes in curriculum, the potential need to cross-train physicians in preparation for future pandemics).
    - Regulation (e.g., changes in licensure and reimbursement).
    - Practice (e.g., uptake of telehealth, many private practices being hit hard economically).
    - Workforce exits (due to death from COVID-19, early burnout-induced retirement, or postponed retirement due to the economy).
    - Well-being (e.g., short- and long-term burnout and trauma).
    - Specialty mix (interest in some specialties, like infectious disease, may increase while interest in others may decrease).

- Demand (e.g., scope-of-practice changes for other professions, changes in demand due to delayed care, sudden need for critical care for COVID-19 cases, longer-term demand decreases due to COVID-19 deaths).
- Deployment of technology (e.g., acceleration in the use of telehealth and its attendant underscoring of inequitable broadband access).
- Equity (e.g., women physicians bearing a greater share of childcare).

Exhibit ES-1: Total Projected Physician Shortage Range, 2019-2034



Note: Because complex systems have internal checks and balances to avoid extremes, the upper and lower bounds of the shortage projections reflect the range of most likely outcomes. The divergence over time represents increasing uncertainty.

All those issues require in-depth research to help us better understand their scope and to inform future workforce policy.

- **Workforce diversity, equity, and inclusion (DEI):** The physician workforce lacks sufficient diversity and inclusion (i.e., it lacks diversity overall and in positions of leadership and influence). The AAMC has identified addressing this lack as a core strategic priority. Extensive, long-term data-collection work is needed, as is extensive and nuanced research about physician workforce diversity and the anti-racist policies that can combat the endemic structural and systemic racism that harms the current physician workforce, damages the nation's ability to create a more diverse and inclusive physician workforce, and impedes a diverse population from receiving equitable health care.

- **APRNs and PAs:** This report explores the potential implications of continued rapid growth in the APRN and PA supply, and more information is needed. How will the health care system continue to deploy this growing supply of health care professionals? What are the implications of this supply on the demand for physicians? To what extent have APRNs and PAs reduced demand for physicians in some specialties, and to what extent are APRNs and PAs providing previously unfilled services and expanding access to care?

  To help inform the modeling of the interprofessional effects of future workforce supply and the demand for other professions, a panel of physicians, APRNs, and PAs should be convened to compile an inventory of the data and research still needed to estimate the necessary model parameters and test the modeling assumptions currently in use. Such a panel should produce guidance on the specific research and data collection needed to answer these questions: (1) What proportion of APRN and PA time is for performing activities that physicians also provide, and how does that proportion vary (e.g., by specialty and setting)? (2) What proportion of APRN and PA time is spent in activities that complement physician efforts and expand the comprehensiveness of services provided to patients (e.g., conducting follow-up visits or providing care that otherwise would not have been provided to patients)? (3) What proportion of APRN and PA time is spent providing care to people who otherwise would not have received services (e.g., services provided in retail clinics or health clinics for patients who otherwise would not have sought physician services)?
- **Current shortages:** The demand projections start with the assumption that physician national supply and demand were in equilibrium in 2019 — except for primary care and psychiatry, where federal government estimates for Health Professional Shortage Areas are used as a conservative proxy for the current shortage of physicians. How might we better measure current shortages in other specialties? To the extent that current national shortages or surpluses exist for other specialties, the projections underestimate or overestimate the shortage from 2019 to 2034. The pandemic has highlighted the enormous extent of inequitable access to care at a time when the need for health care has been acutely high. This raises questions about how best to quantify — through an equity lens — current imbalances between supply and demand across specialties. Work is needed to develop methods for estimating shortages across specialties.
- **Care becoming increasingly specialized:** While the demand projections reflect the more specialized care an aging population requires, the general trend in medical care has been toward increased specialization. Research is needed to better understand how these factors might combine to drive up demand for some specialties at an even faster rate than current utilization patterns might suggest.
- **Changes in the graduate medication education (GME) pipeline:** With the transition to a single GME accreditation system; emergent state-level efforts to shore up GME capacity; the passage of legislation that includes new, federally funded GME slots; and the approval of Teaching Hospital Center GME (THCGME) supplemental COVID-19 funding, a comprehensive analysis of the aggregate effect of these changes on future physician supply is warranted.
- **Stagnant growth in surgeon supply:** The projections indicate little growth in the supply of surgeons across many surgical specialties. Future research should explore why surgeon supply numbers are stagnant.

INTRODUCTION

Since 2015, the AAMC has commissioned annual reports by independent experts to project future supply and demand for physicians. The primary purpose of these studies is to inform policies and strategies that help ensure the United States trains a sufficient number and specialty mix of physicians to further national goals of increased access to high-quality and affordable care. These studies also further discussion of unequal access to health care services and advance the field of health workforce research.

The title of this report, "The Complexities of Physician Supply and Demand: Projections From 2019 to 2034," reflects the data challenges and uncertainties of projecting future workforce supply and demand. Unforeseen events such as the COVID-19 pandemic can create substantial disruptions to the health care system with potential long-term implications for physician supply and demand. The pandemic has raised awareness of disparities in health and access to health care services,[1] contributed to a rising physical and emotional toll on physicians and other health workers,[2] and exposed vulnerabilities in the health care system. These vulnerabilities have led to some health workers being furloughed or having to face economic challenges, while at the same time, other health workers have been in high demand to care for surging demands for pandemic-induced health care needs. Many of the data used in this study were collected pre-COVID-19. Although there are still many unknowns about the short- and long-term impacts of COVID-19 on the physician workforce, a chapter in this report summarizes published information that begins to outline some of the long-term implications for physician supply and demand.

Other trends and factors contribute to the complexities of physician workforce modeling. The results of national and state elections over the past decade have shown that health-related policy and priorities at the federal and state levels can change quickly. The supply of advanced practice registered nurses (APRNs) and physician assistants (PAs) continues to grow rapidly, along with improved understanding of their value in care delivery and in helping improve access to care for underserved populations.[3-5] The health workforce continues to age, and concern about provider burnout has been growing since before the pandemic exacerbated it.[2,6-12] Efforts continue to improve health care delivery and control rising medical costs through alternative payment models such as accountable care organizations (ACOs) and value-based reimbursement; alternative ways to deliver care such as team-based care, integrated care, patient-centered care, and telemedicine; and efforts to encourage preventive care and improve population health.[13-17] Advances in medicine, medical equipment, and information technology continue to expand and improve prevention and treatment options, allow for faster and more accurate clinical diagnosis, and provide patients and clinicians with more data to inform their decisions.[18] The effect of these advances on physician supply and demand is complex and unclear. Against this backdrop is a U.S. population that is growing, aging, and becoming more racially and ethnically diverse.

Mindful of the magnitude and speed of these changes, the AAMC contracted with IHS Markit to update physician workforce projections by incorporating the latest available data on trends and factors affecting physician supply and demand. Projecting future adequacy of physician supply is essential to determining whether adjustments are needed in the nation's training capacity. Given the lead time required to adjust training capacity and train new physicians, this study models a 15-year time horizon, 2019 to 2034.

This report is part of the AAMC's commitment to regularly updating projections and to refining scenarios that reflect the best available evidence of trends in health care delivery and the physician workforce. Key trends likely to affect the supply of and demand for health care services were identified and modeled under multiple supply and demand scenarios. Projections for individual specialties were aggregated into five broad categories for reporting, consistent with specialty groupings designated by the American Medical Association (AMA): Primary Care, Medical Specialties, Surgical Specialties, and Other Specialties — with Primary-Care-Trained Hospitalists reported as a fifth category to avoid confounding the Primary Care projections.[a]

Each year, the updated demand projections shift to reflect new levels of care use. For example, data inputs and demand projections in the 2020 report extrapolated a "2018 national-average" level of care, while this 2021 report extrapolates a "2019 national-average" level of care.[19] The latest available data at the time this study was conducted were from 2019. The Status Quo Scenarios for demand and supply extrapolate current care-use and care-delivery patterns to future populations, while alternative scenarios model different assumptions about ongoing and future trends in care delivery. The alternative supply and demand scenarios form the basis of the projection ranges for supply and demand.

The remainder of this update is organized slightly differently from past reports. The next section presents the updated physician supply and demand projections and implications for future adequacy of supply. Following that is a summary of information about the possible long-term implications of COVID-19 for physician supply and demand and a discussion of the updates to the Health Care Utilization Equity Scenarios. Additional information is then provided on the supply and demand scenarios and results. The final section highlights conclusions and key findings. Appendix 1 presents details about the data and modeling methods, and Appendix 2 contains additional tables and charts.

UPDATED PROJECTIONS

Projected demand continues to exceed projected supply under the scenarios considered, leading to a projected shortage of between 37,800 and 124,000 physicians by 2034 — lower than the previous projected shortage range for 2033, between 54,100 and 139,000 (2020 report).[19] The update reflects the following:

1. The demand projections were recalibrated to reflect a 2019 level of care (rather than a 2018 level of care) using updated data on population demographics, disease prevalence, and health risk factors, as well as newer data on health care use and delivery patterns. The result is a projection for 2034 of total physician demand that is about 14,840 FTEs (1.5%) lower than the 2020 report's projected demand for 2033.
2. The federal government estimated that an additional 13,758 primary care physicians and 6,100 psychiatrists (19,858 total physicians) would have been needed in 2019 to provide a level of care that would have removed the Health Professional Shortage Area (HPSA) designation for areas with primary care and mental health shortages.[20] The designation is used as a conservative proxy for the current national shortage of physicians. That shortage estimate is 1,936 physicians lower than the estimate for 2018 used in the 2020 report (21,794 total physicians).
3. Our estimates of the number of new physicians completing graduate medical education (GME) and entering the workforce (29,627) is higher than last year's estimate (28,980). This difference might be due in part to GME now being reported under a single GME accreditation system whereas in previous years, estimates needed to be combined from multiple accreditation systems and adjusted for duplication from dually accredited programs. In addition, the projections of new graduates include the anticipated increase in GME slots due to the Consolidated Appropriations Act of 2021, which will fund an increase of 200 slots in each of the five years from 2023 to 2027, resulting in an increase of about 250 additional physicians per year after the phase in (the fifth year of slots overlaps with the first, yielding 1,000 new physicians every four years).
4. Supply projections for physicians, APRNs, and PAs have been updated using more recent data on the demographics and specialty mix of the current supply, hours-worked patterns, and the characteristics and specialty mix of new graduates. By 2034 projected physician supply is about 4,000 FTEs (0.5%) higher than estimated for 2033.

The modeled scenarios used to calculate the shortage range remain the same as in last year's report.

The updated Primary Care physician shortage range for 2034 is between 17,800 and 48,000, which is lower than the range in last year's report (between 21,400 and 55,200). The projected 2034 shortage ranges for non-primary care physicians are also lower than in last year's report: between 15,800 and 30,200 for Surgical Specialties; between 10,300 and 35,600 for Other Specialties; and between 3,800 and 13,400 for Medical Specialties.[a] If the annual number of primary-care-trained physicians becoming hospitalists (Primary-Care-Trained Hospitalists) remains similar over time, then by 2034, general hospitalist supply will be between about 2,700 and 7,000 higher than the estimated demand. If the nation reaches saturation in the supply of hospitalists, physicians who might otherwise have chosen to become hospitalists might choose other specialties. The overall physician shortage projections assume all primary-care-trained physicians find practice opportunities, whether as a primary care provider, a hospitalist, or other specialty provider.

The supply and demand scenarios used to calculate the shortage ranges reflect the uncertainty, complexity, and evolving nature of the environment within which physicians practice. One scenario alone is inadequate to convey the associated uncertainty. We examined four scenarios with different assumptions about key physician-supply determinants and six scenarios with different assumptions about

key physician-demand determinants. We compared each supply scenario with each demand scenario to generate 24 sets of projections of future adequacy of supply for physicians overall and for each specialty category. The extreme high and low scenarios are least likely to occur since multiple factors tend to mitigate highs and lows. For example, if physicians were to begin retiring earlier, the growing systemic stresses this could cause due to the growing shortage of physicians (including rising wages) might eventually lead some physicians to delay retirement. Given the propensity of such systems-level "checks and balances" to avoid extremes, we exclude the highest and lowest supply-adequacy projection quartiles and use the middle two quartiles to indicate a likely range. The ranges presented throughout this report thus represent the middle-most combinations of the supply and demand scenarios described in the "Supply Modeling" and "Demand Modeling" sections of the report. The growing divergence over time of the highest and lowest projections we present can, then, be interpreted as an increase in uncertainty as we project further and further out into the future.

The updated projections model 29,627 newly trained physicians entering the workforce each year plus anticipated growth due to the Consolidated Appropriations Act of 2021 and continued growth in the number of APRNs and PAs entering the workforce. The starting supply of physicians comes from analysis of the 2019 AMA Physician Masterfile. The updated demand projections reflect new data from the 2018 Medical Expenditure Panel Survey on health care use patterns (using 2014-2018 data) and updated data on population characteristics and prevalence of health risk factors from the 2019 American Community Survey and the 2019 Behavioral Risk Factor Surveillance System. The most recent state and national population projections are used. The U.S. Census Bureau estimates the U.S. population was 328.2 million in 2019 and will grow to 363.0 million by 2034.[21] Of the estimated 34.8 million growth in the population, 22.9 million (66%) is growth in the number of people age 65 or older.

Total Physician Supply and Demand

Under most scenarios projected, the total projected demand for physicians exceeds the total projected supply (Exhibit 1). Looking at the 25th-to-75th-percentile projections for total physicians, demand will continue to grow faster than supply, leading to a projected shortage of between 37,800 and 124,000 physicians by 2034 (Exhibit 2).

Exhibit 1: Projected Physician Supply and Demand by Scenario, 2019-2034

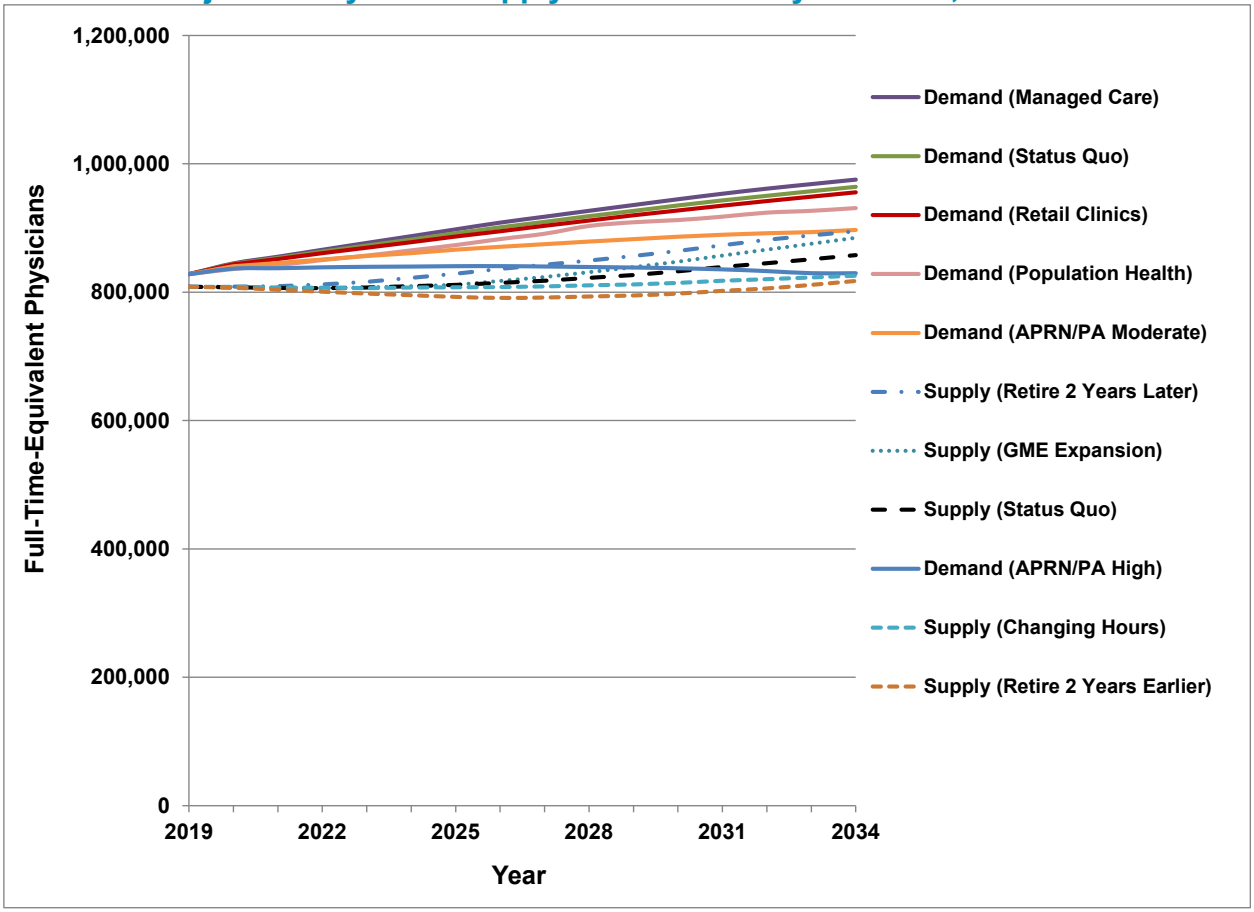
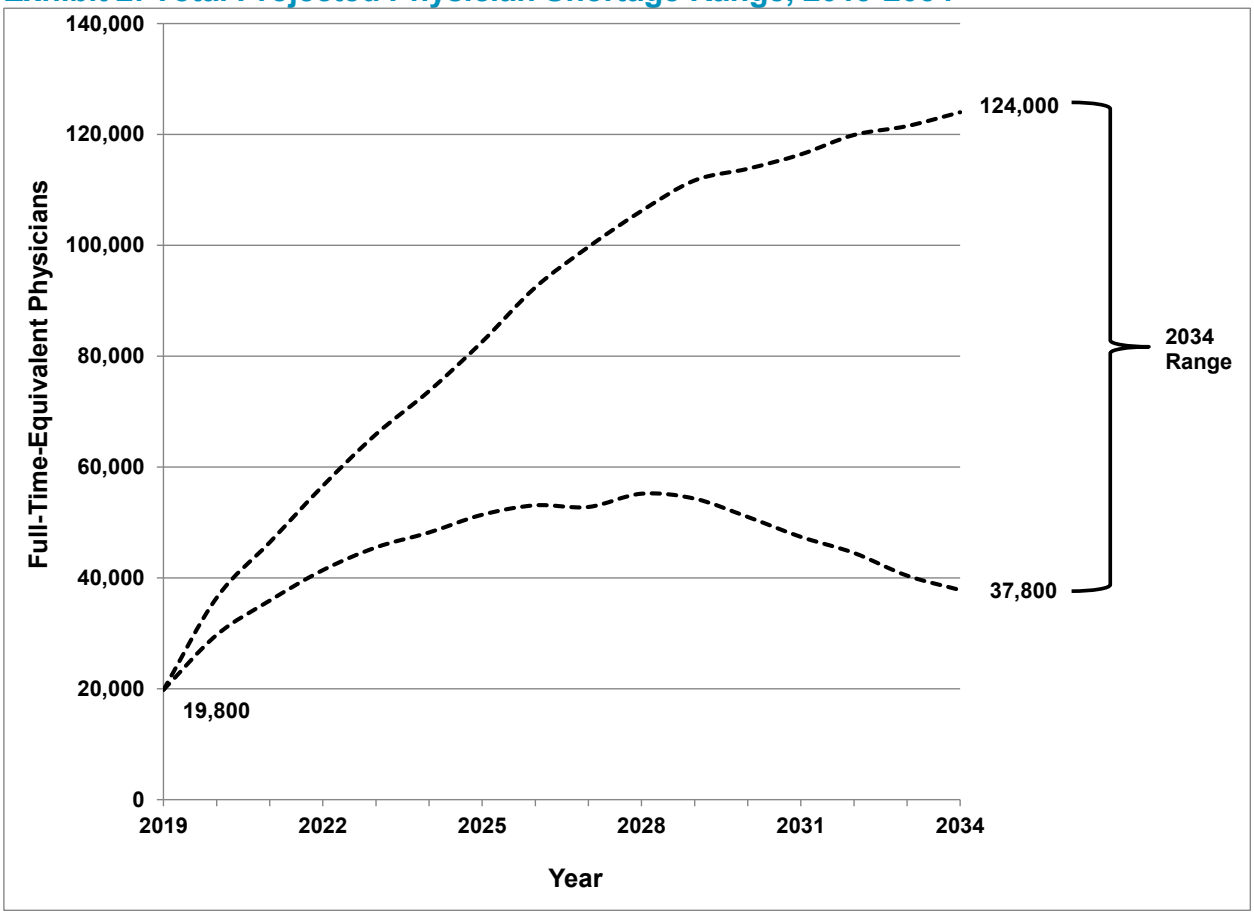


Exhibit 2: Total Projected Physician Shortage Range, 2019-2034



Primary Care Supply and Demand

Comparing projected supply and demand for Primary Care physicians (Exhibit 3) predicts a shortage by 2034 of between 17,800 and 48,000 physicians (Exhibit 4). This range for 2034 is lower than the 2020 report shortage projection of between 21,400 and 55,200 Primary Care physicians by 2033.[19]

The updated projections use higher estimates of the annual number of new Primary Care physicians entering the workforce than were used last year: 8,584 compared with 8,366, plus a portion of new GME slots funded through Consolidated Appropriations Act of 2021. It is unclear how much of this increase in the number of graduates is due to a real increase in physicians entering primary care and how much is due to improved estimates of physicians completing GME now that a single accreditation system is in place.[22] The annual estimate of new Primary Care physicians adjusts for an estimated 1,221 physicians annually who will leave primary care to become hospitalists and 306 who will pursue other non-primary care specialties (in addition to the estimated 5,655 physicians annually who leave primary care to pursue internal medicine and pediatric subspecialties). The estimated shortage of about 13,758 Primary Care physicians in 2019 was based on the calculation from the Health Resources and Services Administration (HRSA) that about this number of Primary Care providers are needed to remove the primary-care-shortage designation in currently designated shortage areas (down from 14,900 physicians in 2018).[20]

Each modeled supply and demand scenario is based on assumptions about the continuation of current trends or changes in care delivery that might happen at a future date, so each scenario has a degree of uncertainty. The projected shortage range widens over time, reflecting (1) that some trends have a compounding effect (such as annually training more APRNs and PAs) and (2) greater uncertainty in supply and demand determinants as we move further into the future. As illustrated in Exhibit 3, projected demand exceeds supply under all scenarios modeled except the one that assumed the highest impact of APRNs and PAs on primary care. This APRN/PA High Use demand scenario assumes (1) the number of new APRNs and PAs trained each year will continue growing at high rates and the proportion of new entrants choosing primary care will remain at recent levels and (2) APRNs and PAs will offset demand for physicians at the rates discussed later in this report. Despite large increases over the past decade in the number of APRNs and PAs entering primary care, as well as a large number of primary care physicians trained annually, the demand for primary care providers remains strong. The rate of growth in training APRNs and PAs cannot be sustained indefinitely, but at what level the nation will reach market saturation is unknown.[23-26]

Exhibit 3: Projected Supply and Demand for Primary Care Physicians, 2019-2034

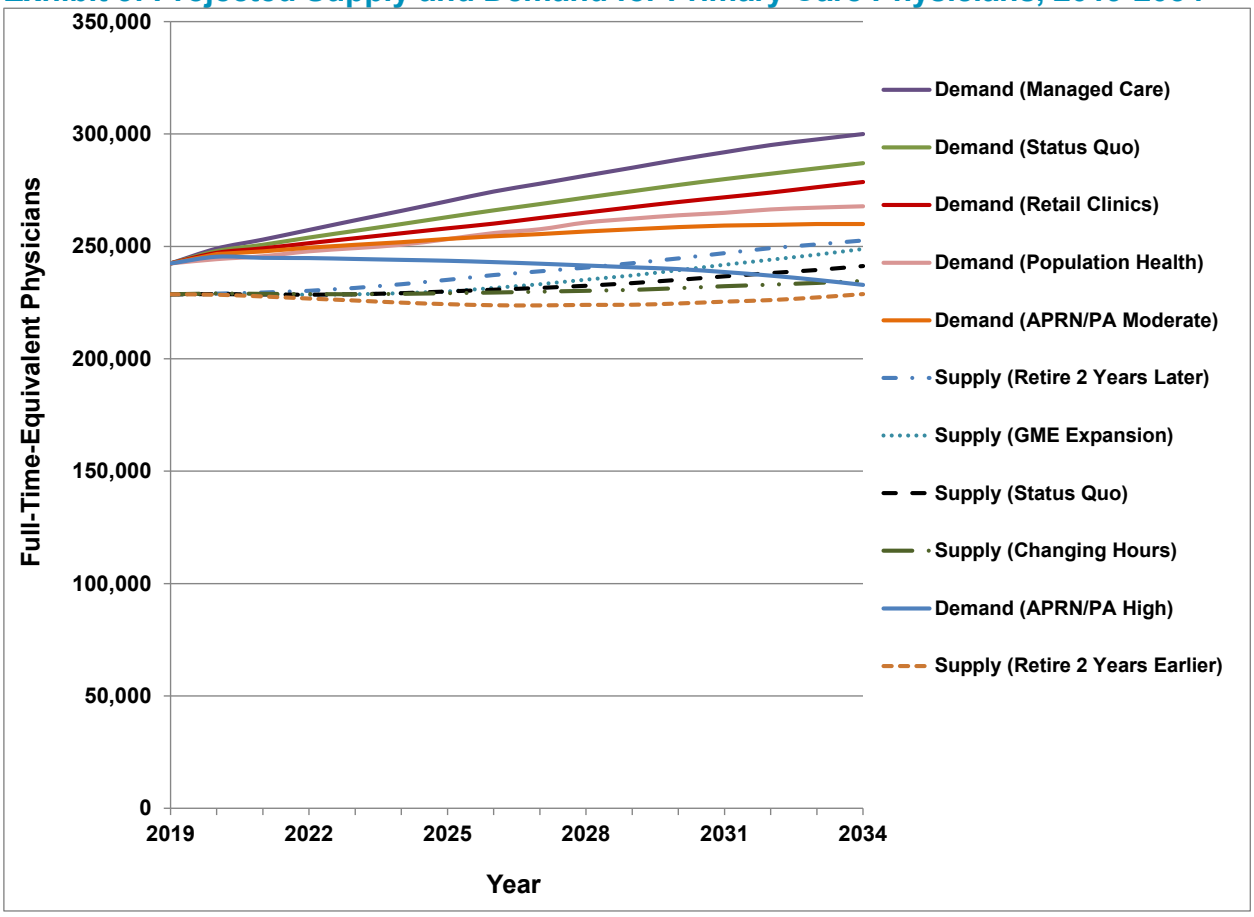
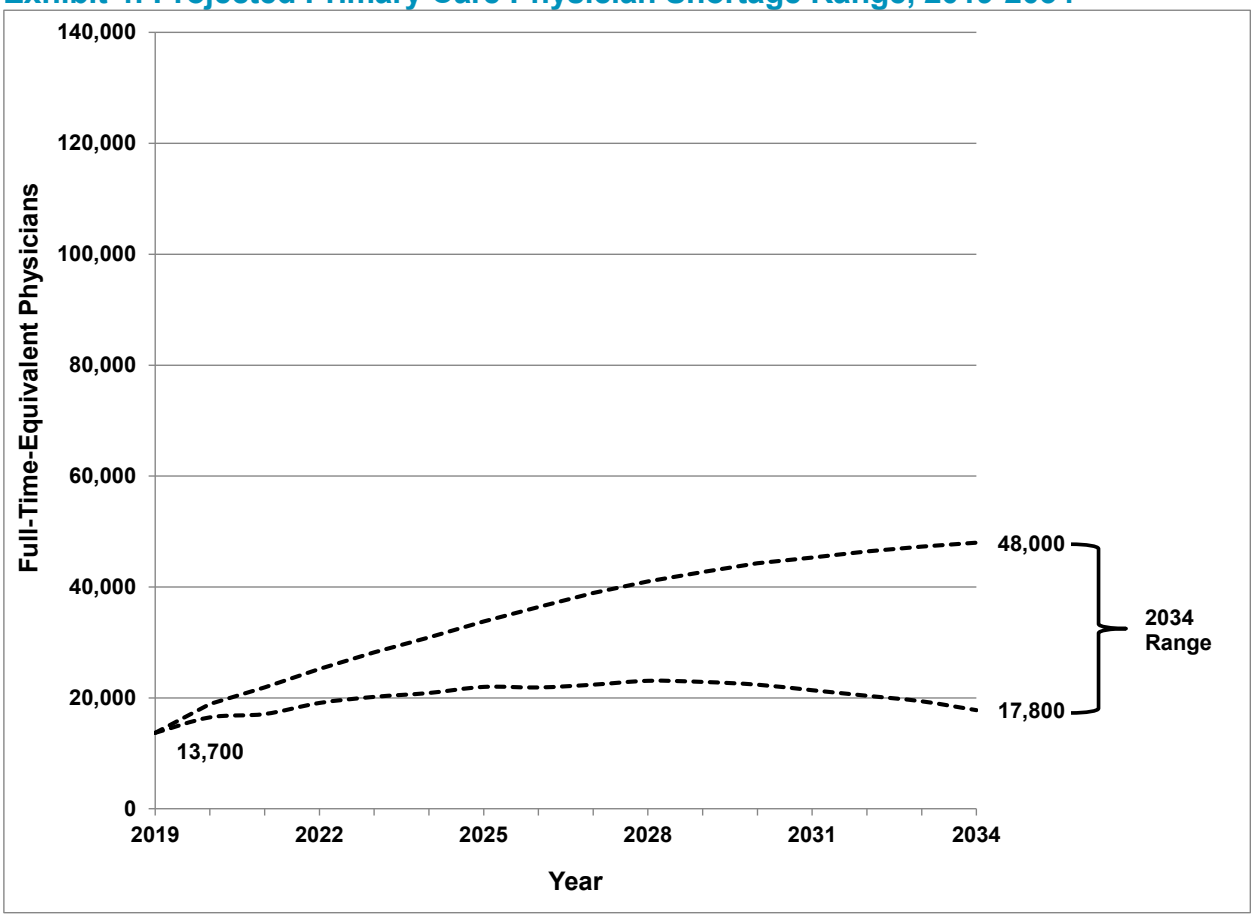


Exhibit 4: Projected Primary Care Physician Shortage Range, 2019-2034



Non-Primary Care Supply and Demand

Exhibits 5 through 12 depict the overall range of supply and demand growth and projected shortage ranges for non-primary care physicians by specialty category. Under the scenarios modeled, we project a shortage of between 21,000 and 77,100 non-primary care physicians by 2034. Non-primary care specialties are grouped into four categories: Medical Specialties, Surgical Specialties, Primary-Care-Trained Hospitalists, and Other Specialties.

Medical Specialties

The demand for physicians in internal medicine subspecialties is growing rapidly due to population growth and aging, with slower growth in demand for pediatric subspecialties. The demand projections reflect that an aging population requires more complex care and thus greater reliance on specialized care. The degree to which more care might be provided in the future by specialists that historically was provided by generalists is unclear. The supply of specialists is also growing rapidly (Exhibit 5). Under the scenarios modeled, this update projects a shortage range of between 3,800 and 13,400 FTEs by 2034 (Exhibit 6), lower than the range of between 9,300 and 17,800 projected in the 2020 report. Included in the lower shortage range is the updated estimate of new physicians entering medical specialties.

Exhibit 5: Projected Supply and Demand for Medical Specialist Physicians, 2019-2034

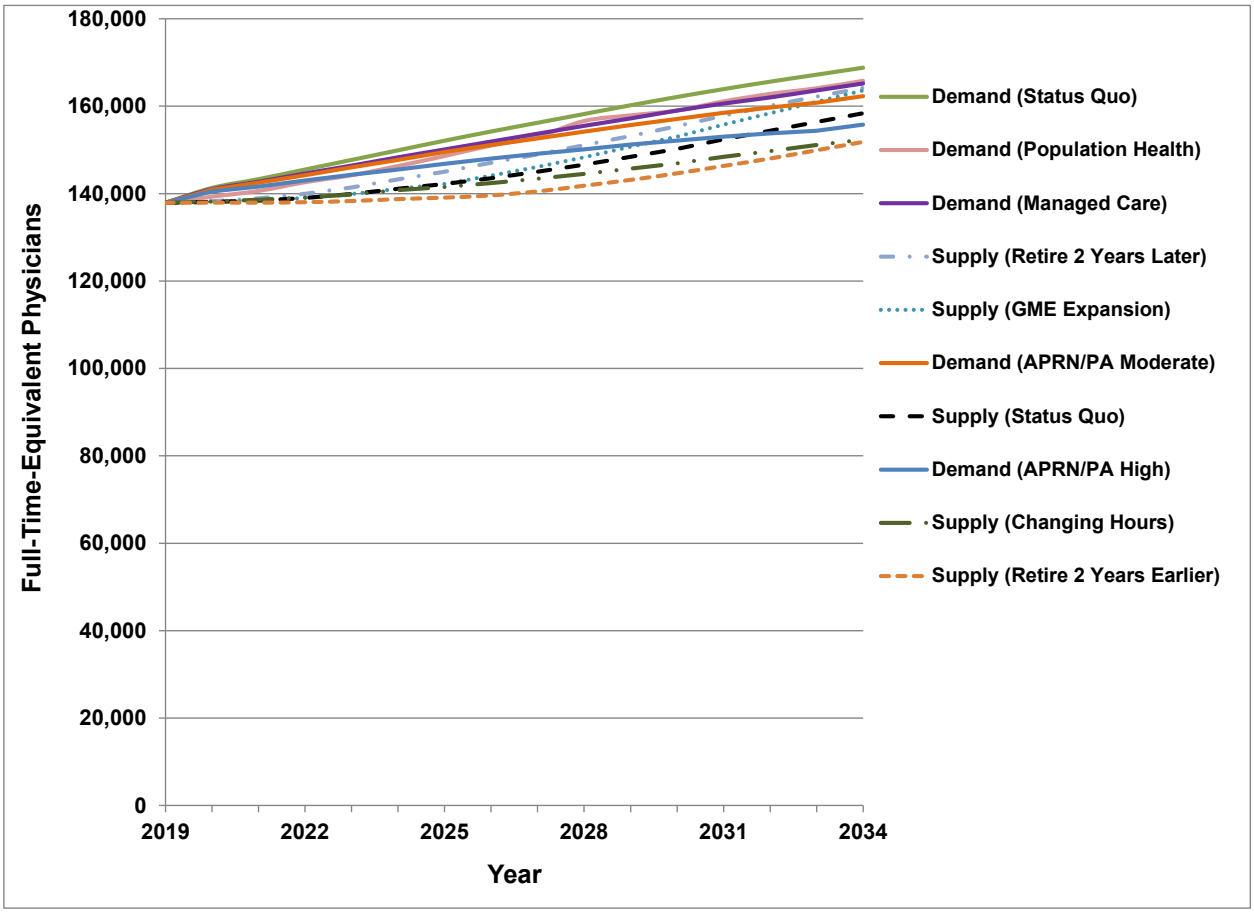
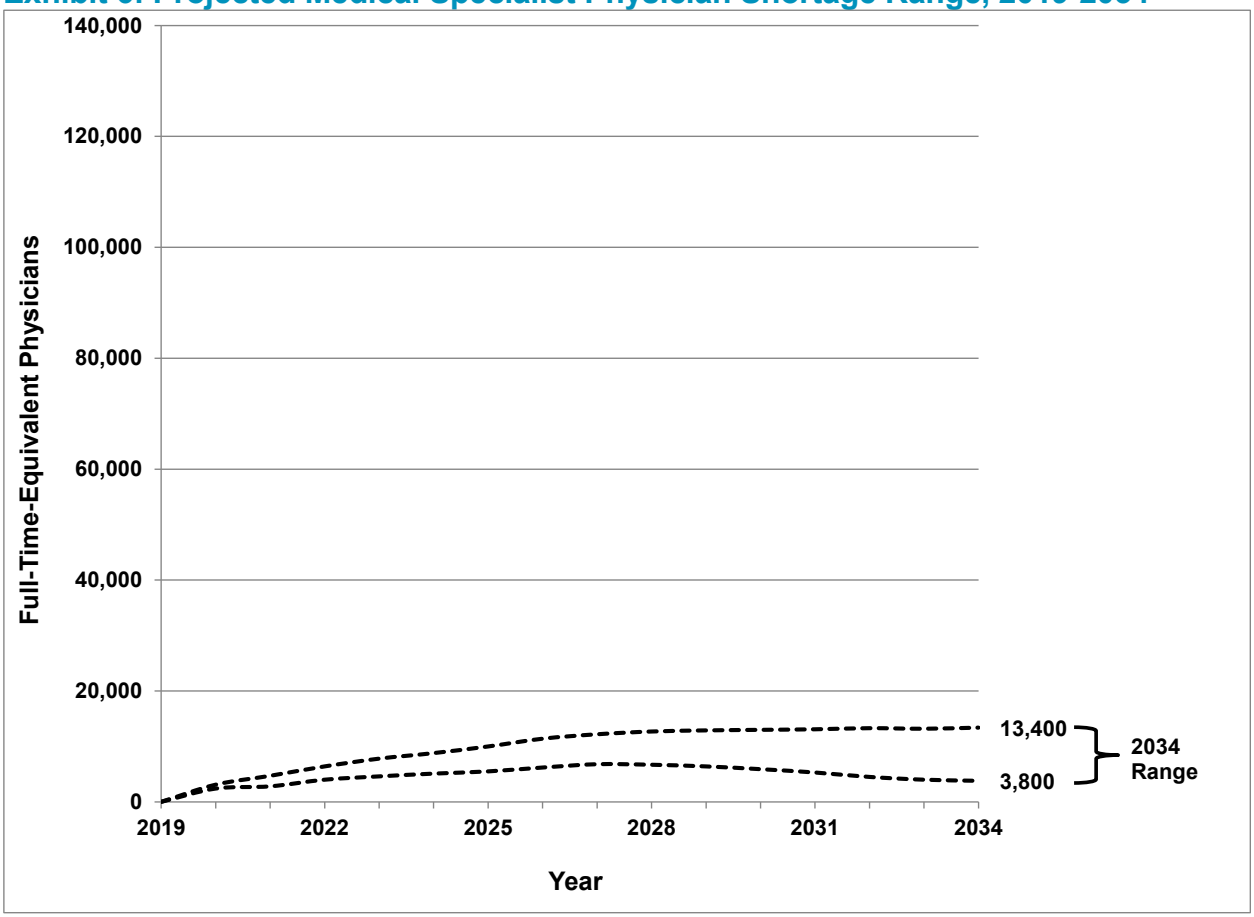


Exhibit 6: Projected Medical Specialist Physician Shortage Range, 2019-2034



Surgical Specialties

Based on current trends, the supply of surgeons is not projected to change substantially over the next 15 years and might decline as future attrition offsets or exceeds the number of newly trained surgeons. Demand continues to grow, with projected demand exceeding projected supply under all scenarios modeled (Exhibit 7). The projected shortage for 2034 is between 15,800 and 30,200 surgeons (Exhibit 8), which is a slightly larger range than the 17,100 to 28,700 surgeon shortage for 2033 in our 2020 report.

Exhibit 7: Projected Supply and Demand for Surgeons, 2019-2034

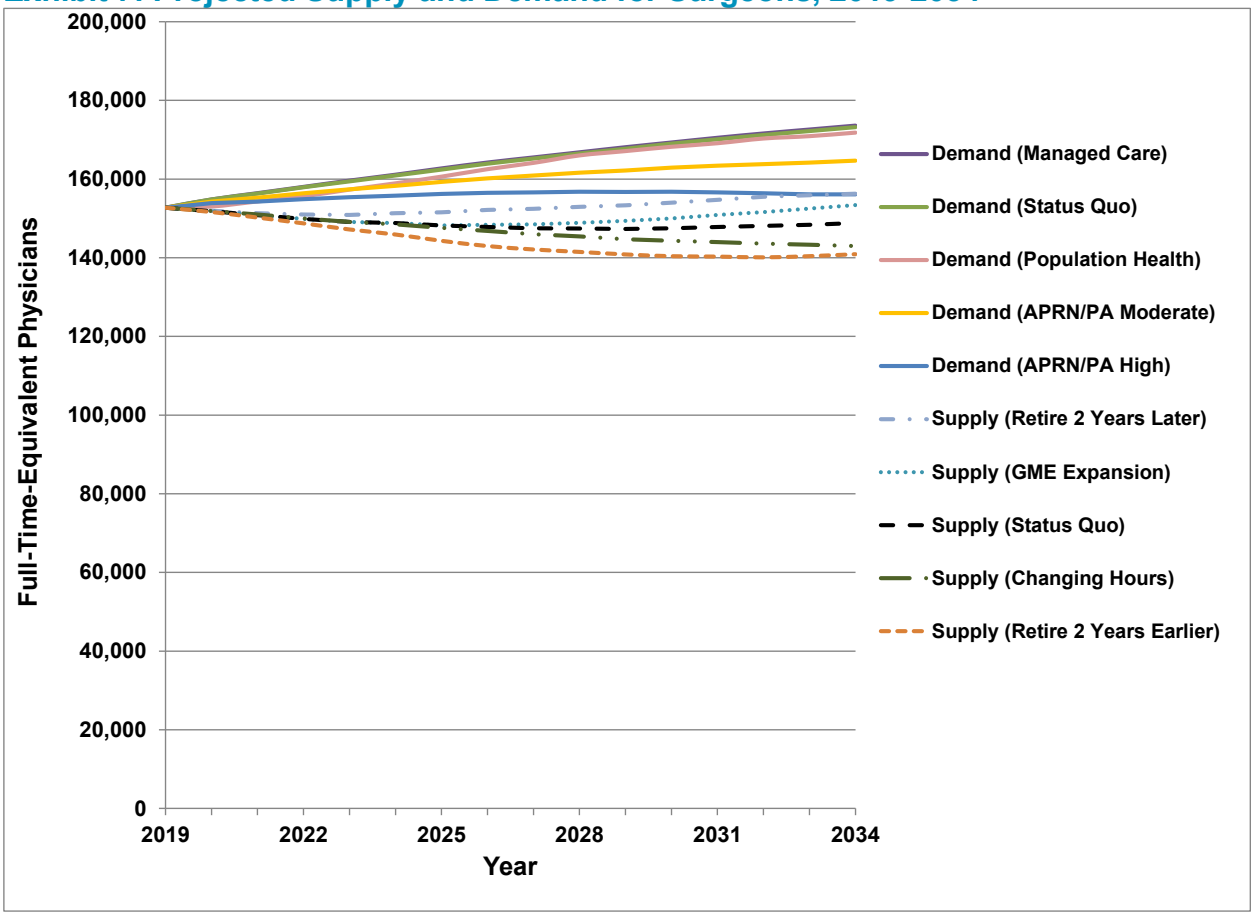
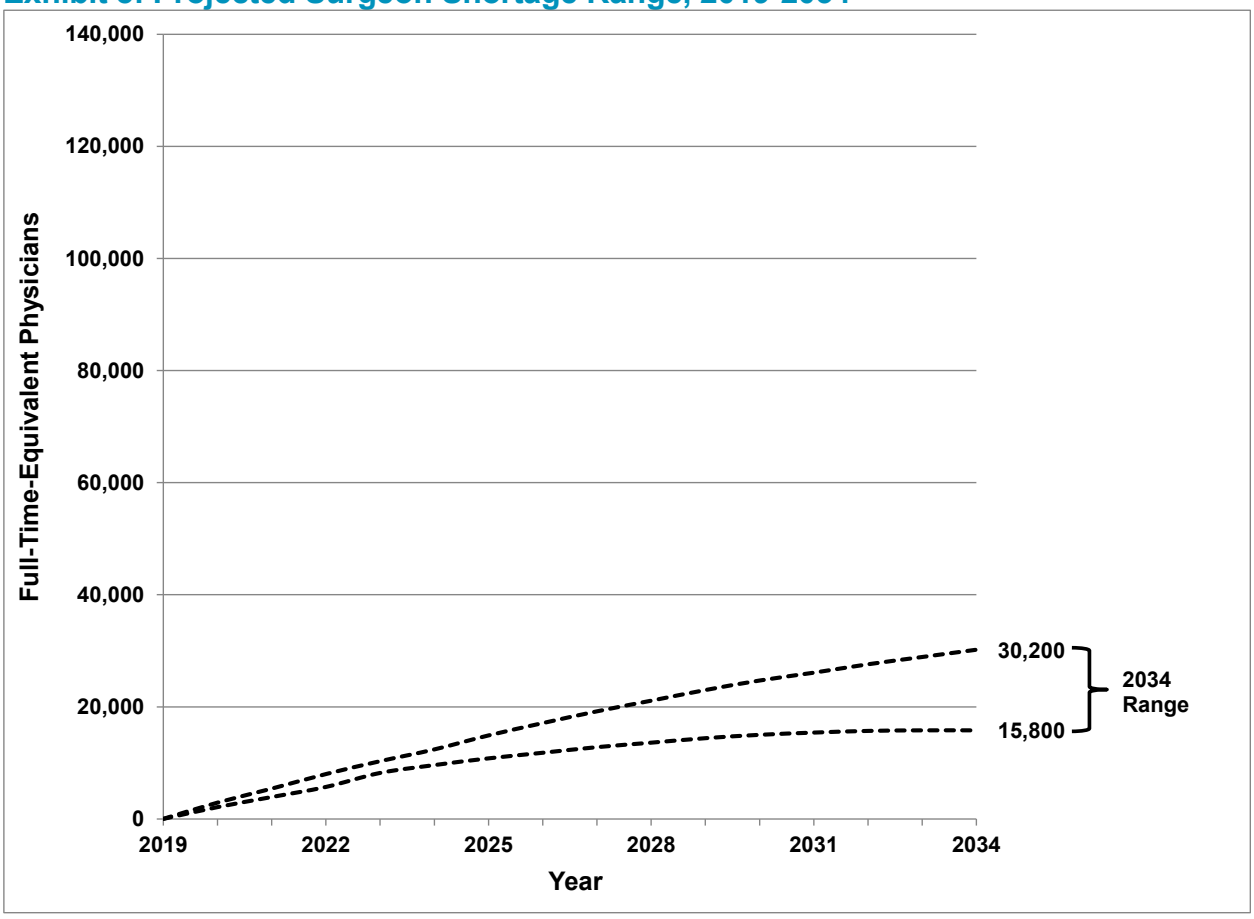


Exhibit 8: Projected Surgeon Shortage Range, 2019-2034



Primary-Care-Trained Hospitalists

Primary-Care-Trained Hospitalists are analyzed separately from the Primary Care category. The number of physicians working as hospitalists over the past decade has grown rapidly,[27] reflecting a shift in how care is provided rather than in a growing demand for hospital inpatient services (demand has declined over this same period[28]). Analysis by the AAMC of billing records identified physicians with at least 90% of their revenue billed through hospitals as physicians likely practicing as hospitalists, and this analysis is updated each year to estimate the trend in the number of Primary-Care-Trained Hospitalists. However, because of delays in the Centers for Medicare and Medicaid Services (CMS) publishing the 2019 billing records, for this analysis, we used the 2018 billing records analysis, so our estimate of the annual number of primary-care-trained physicians becoming hospitalists (1,221) remained unchanged from last year's report. Supply projections suggest that at current rates of physicians becoming hospitalists, there would be more than required to meet projected demand for services (Exhibit 9), with supply by 2034 between 2,700 and 7,000 higher than the level required to meet the demand for Hospitalist services (Exhibit 10).

Having more hospitalists reduces the amount of time required for primary care physicians to do hospital rounds, freeing them up to see more patients in ambulatory settings. The increase in the productivity of primary care physicians might not offset the loss to the hospitalist workforce of primary care providers, however.[29,30] Hospitals will not hire more hospitalists than are needed, so, as with many relatively young professions, a shift has been taking place that is not being captured by the assumptions in our model. The rapid growth in hospitalist supply over the past two decades has been facilitated by (1) financial considerations that increased the willingness of primary care physicians to turn inpatient care over to hospitalists, (2) the widespread implementation of electronic health records and hospitals' focus on quality and patient safety, and (3) the availability of newly trained generalists trained in hospital settings.[27] It is unclear whether this surge in the growth of hospitalist employment will continue or the nation will reach saturation — at which point, hospitalist demand will change at roughly the same rate as demand for inpatient services. Likewise, if saturation is reached, physicians who would otherwise choose to become hospitalists will, presumably, choose other specialties or other settings.

Exhibit 9: Projected Supply and Demand for Primary-Care-Trained Hospitalists, 2019-2034

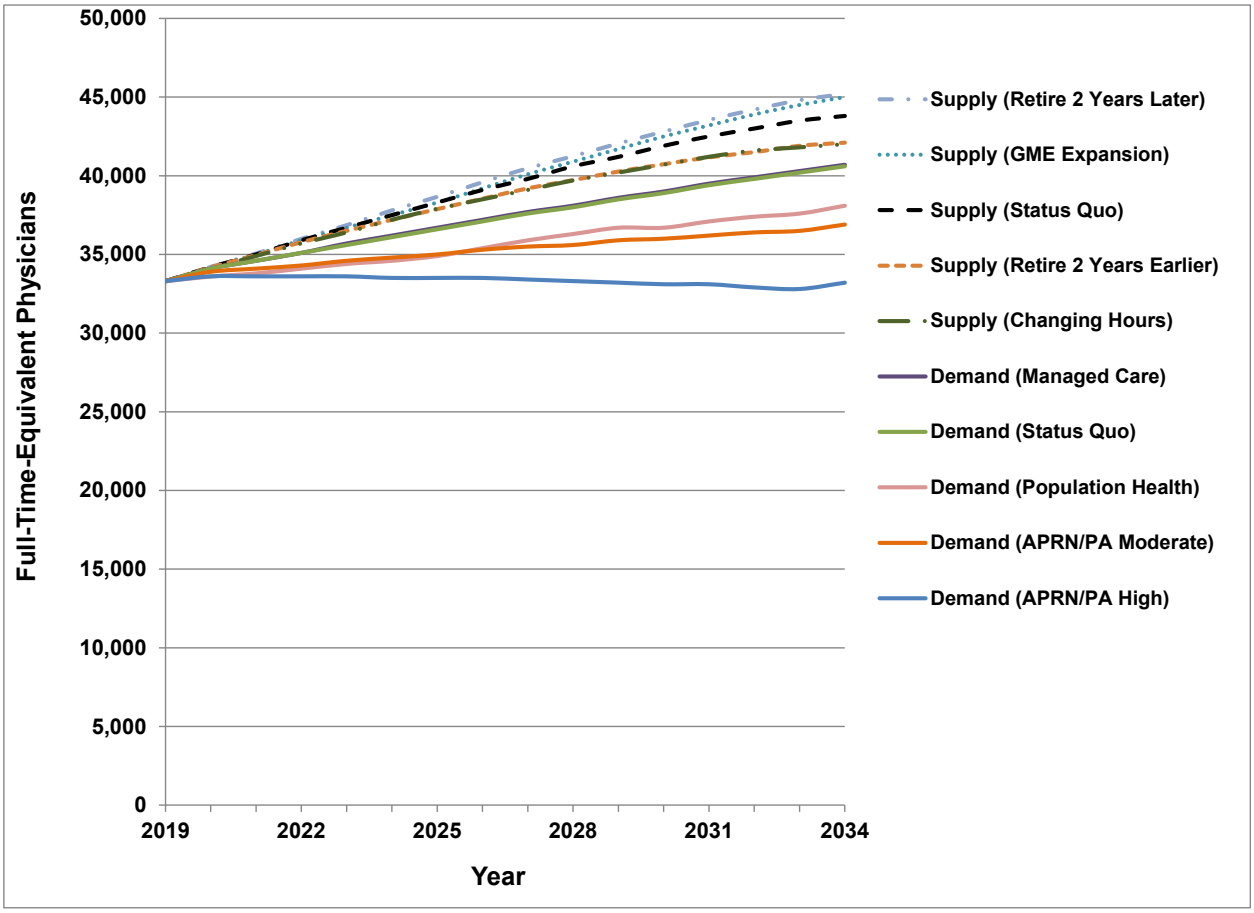
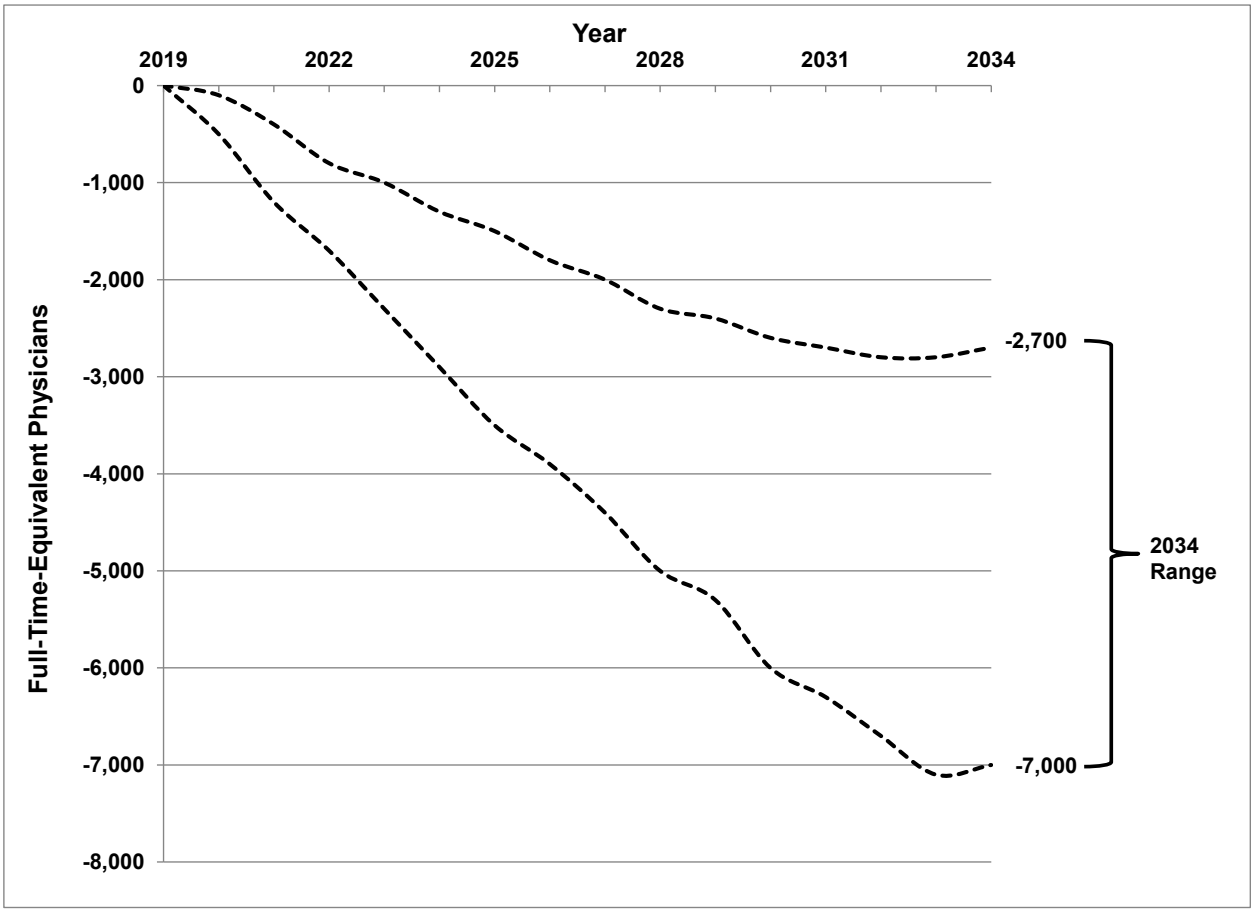


Exhibit 10: Projected Primary-Care-Trained Hospitalists Shortage Range, 2019-2034



Other Specialties

For the Other Specialties category, projected demand meets or exceeds supply for all but one scenario (Exhibit 11). The projected shortage range for 2034 is between 10,300 and 35,600 (Exhibit 12), which is lower than last year's projected shortage range by 2033 of between 17,100 and 41,900 physicians. Part of the lowering of the shortage range is the higher estimate of the number of physicians entering specialties in this category (especially emergency medicine), as well as the continued rapid growth in the supply of PAs and nurse practitioners (NPs), nurse anesthetists, and psychiatric NPs.

Exhibit 11: Projected Supply and Demand for Other Specialties, 2019-2034

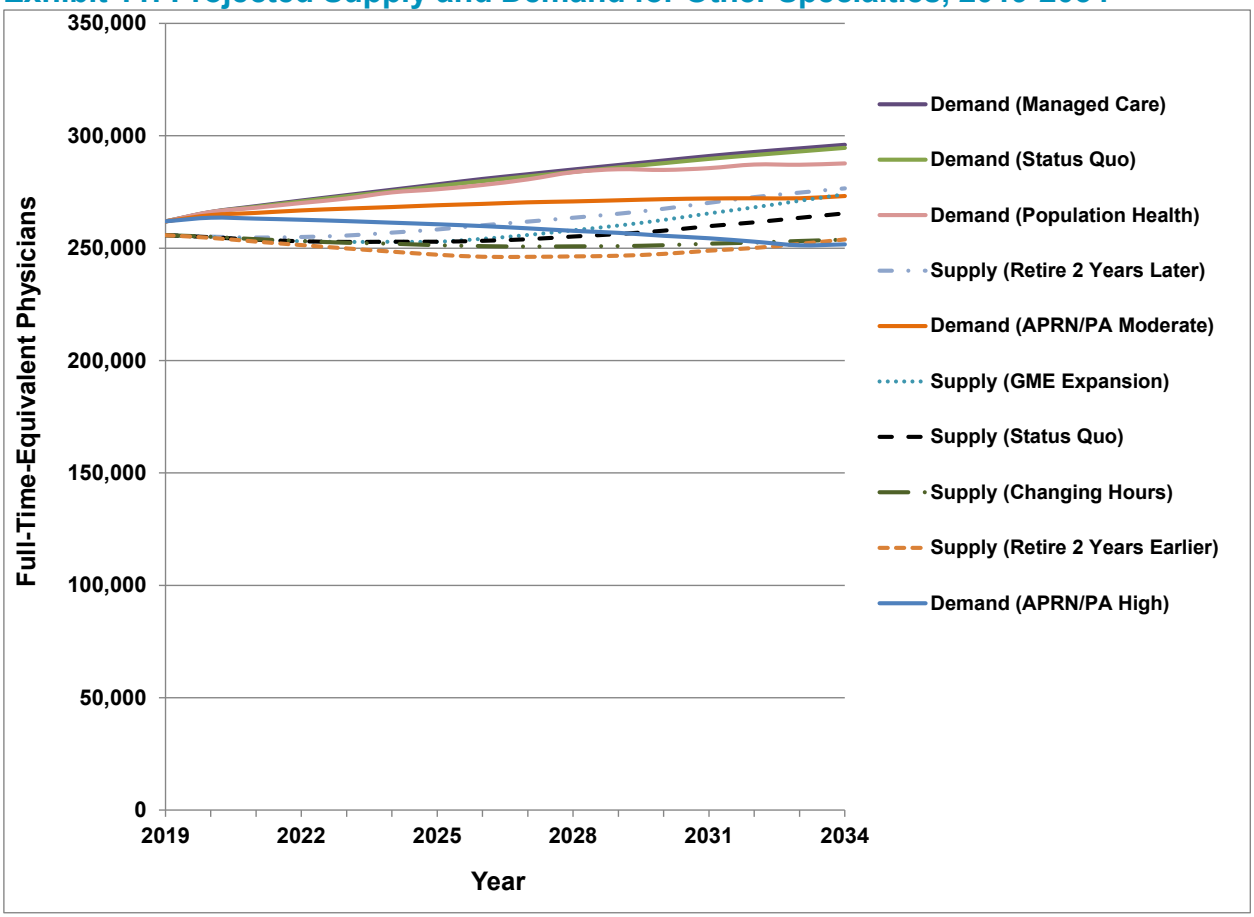
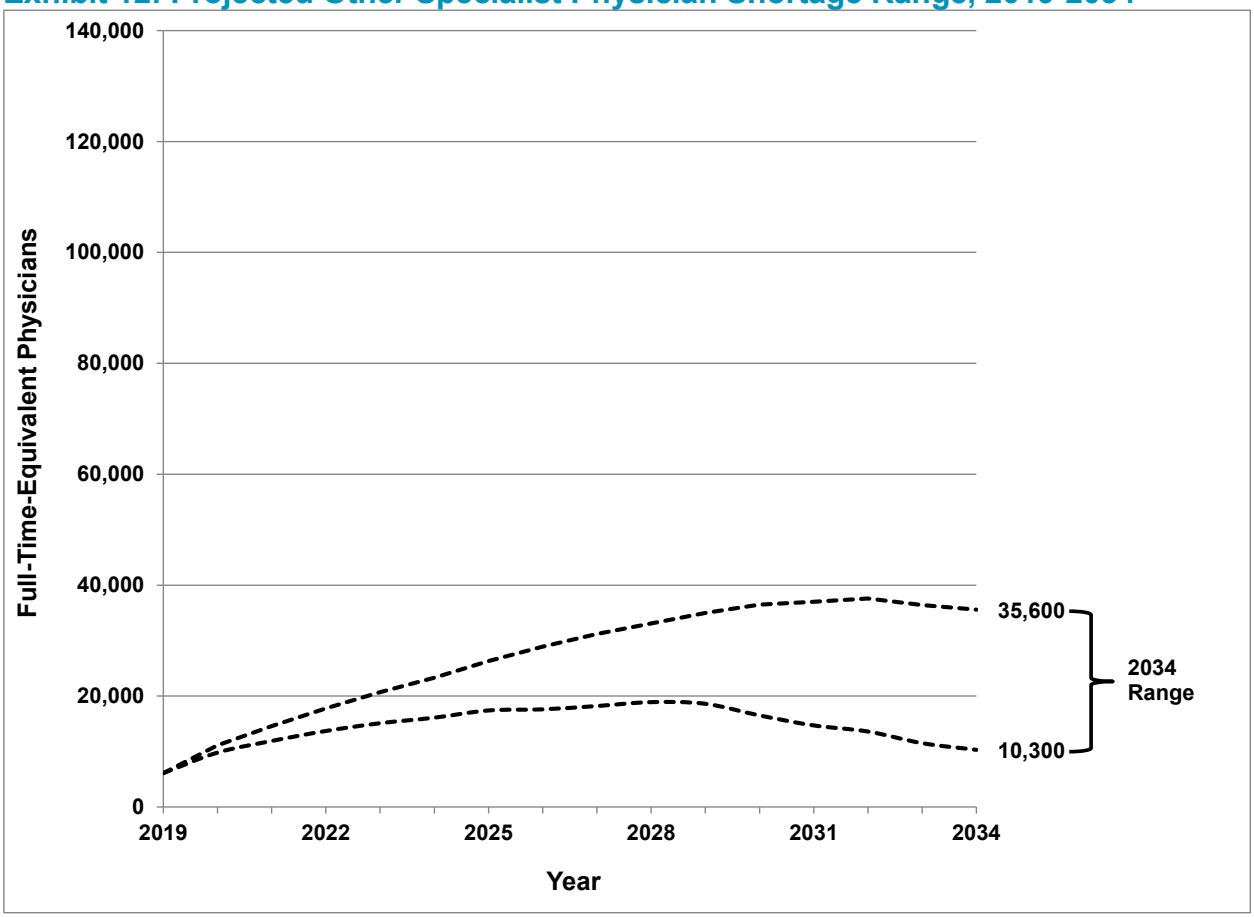


Exhibit 12: Projected Other Specialist Physician Shortage Range, 2019-2034



COVID-19 PHYSICIAN WORKFORCE IMPLICATIONS

Overview

The disruptions caused by COVID-19 have laid bare many problems and significant disparities in the health care system. Previous studies by the AAMC and others projected a growing shortage of physicians, mainly due to a growing and aging population, a high prevalence of chronic disease and unhealthy lifestyles, an aging health workforce, and constraints on the number of physicians trained.[19,31,32] Those studies, which controlled for demographic and health risk factors, showed disparities in patient access to health care services. Minority populations, people living in rural areas, and uninsured people use substantially fewer health care services than do populations with few barriers to accessing care. The COVID-19 pandemic exacerbated current shortages in provider supply in some areas, exposing deficiencies in the health care system such as disparities in health outcomes and insufficient numbers of health care workers to respond to the surge in need in key specialties and delivery settings.[1,33-35]

Because of lags in the release of national datasets, the projections in this report were generated with data collected pre-COVID-19, and because the situation is still evolving with an uncertain duration and trajectory, we did not expressly model the impact of COVID-19. While it is too early to reasonably quantify the impact COVID-19 will have on the market for physicians, in this section, we discuss the factors that likely will impact the market and how they are expected to affect supply and/or demand. Some of the immediate impacts have been quite large (e.g., extreme shortages for pulmonologists[36] and ICU nurses[37] and drastic decreases in demand for office visits and elective surgeries[38]), though these immediate disruptions are starting to resolve.[39] The disruptions are expected to continue to diminish with a successful vaccination campaign and improving economic conditions, so their direct long-term impacts might be small. However, some impacts will be longer term, affecting supply and demand projections through the projection period. We also discuss the expected duration of these COVID-19-related market impacts.

Supply Effects

Physician labor supply is being affected by the morbidity, mortality, and stress caused by COVID-19, both directly and indirectly — for example, through the COVID-19-induced recession. We discuss these factors briefly, along with the fact that the pandemic is disproportionately impacting people of color and women.

With health care workers on the front lines at increased risk of contracting COVID-19, any physician fatalities from the virus will decrease supply and further intensify the shortage. Health care worker deaths from COVID-19 are a great human tragedy, though the direct impact on physician supply is likely to be small. Preliminary data suggest that confirmed COVID-19 deaths per capita among physicians are lower than in the general population, and while the tally likely will change as more cases are investigated and reported, the total number of U.S. physician deaths from COVID-19 through October 2020 was 108.[40] About half of those physicians had retired from clinical practice, and three-quarters were over age 60 (mean age, 69 years). Additionally, some health care workers who contract COVID-19 report experiencing symptoms long after their recoveries, which can affect the amount, quality, or intensity of their work.

The Centers for Disease Control and Prevention (CDC) reports that 53% of COVID-19 cases among health care workers for which it had data through mid-July were people of color. The case fatality rate in non-Hispanic Asians was three times that in non-Hispanic Whites, and in non-Hispanic Black and Hispanic health care workers, fatality rates were 1.8 and 1.3 times that for non-Hispanic Whites, respectively.[41] Women were 79% of cases among health care workers and 62% of mortalities.[41] The Kaiser Family Foundation notes that "data collected by states, the media, and other organizations similarly find that people of color account for the majority of COVID-19 cases and/or deaths known among health care workers."[42] The disproportionate impact of COVID-19 on minority communities can have both longer-term supply effects as mentors and potential mentors die and demand implications as patients of color lose

their trusted providers. Because women bear a disproportionate amount of the child care burden, their labor supply has been disproportionately affected by closures of in-person schooling; studies confirm that female physicians spend disproportionately more time on household activities and child care relative to male physicians.[43,44] Current setbacks in women physicians' careers can translate into lifelong impacts on career advancement and achievement and into a reduction in the long-term supply of physician services through reductions in work-hours and loss of potential leadership opportunities for women physicians at a time when an increasing percentage of the nation's physicians are women.

News reports indicate that physician concerns about health risks to themselves and their families, trauma and burnout from front-line exposure, frustration over lack of personal protective equipment, and other nonfatal COVID-19 impacts are encouraging some current physicians to leave the field.[45-47] The pandemic may delay or extend trainees' training times or affect their choice of specialty, which could discourage them from choosing specialties already experiencing shortages.[48,49] While data are not yet available to quantify these impacts, anecdotes abound, and some relevant data are captured in estimates of retirements and practice closures discussed below. We will continue to study these potential impacts and report them in future reports.

It is likely that few early or midcareer physicians, who invested the effort and money required to enter medicine, will leave the field permanently compared with those who choose a more suitable practice setting or find other work temporarily in response to COVID-19. However, the situation may be quite different for physicians close to retirement age (and thus at higher risk from COVID-19 complications if the disease continues to mutate and becomes an annual event like the flu). While many factors influence physician retirement decisions, those who are financially able to retire may be more likely to accelerate retirement dates, which will have a short-term impact on supply. Counterbalancing this, other physicians who experienced adverse financial impacts from revenues lost to lockdowns and patients' apprehension about seeking care during the pandemic and/or the COVID-19-induced recession may delay their retirement plans. The net effect on retirements will likely not be known for several years.

The number of solo and small-group physician practices was declining before the pandemic, and the financial pressures of last spring's lockdowns and subsequent lower demand for non-emergent health care have intensified this trend.[50,51] This phenomenon has many potential impacts. To the extent that physicians who sold their practices are retiring or leaving the field, it decreases the supply of physicians. To the extent that physicians are selling to health systems or venture capital firms (or moving to employee or contract relationships with them), it intensifies the consolidation of providers and raises concerns about accessibility as smaller practices in underserved areas shut their doors.

COVID-19 appears to have accelerated a deepening crisis in the well-being of physicians, nurses, and other health care workers. Health care workers already experience burnout, post-traumatic stress disorder (PTSD), and suicide at disproportionate rates.[2,12,52-57] COVID-19 is adding undue stress to health care workers caused by safety concerns when they put themselves and their family members at risk of COVID-19 infection; many health care workers have found themselves in situations that require long hours at work and exposure to overwhelming numbers of preventable deaths, which leads to physical, mental, and emotional fatigue. Physician supply will decrease to the extent that providers leave the field (temporarily or permanently) in response to these factors, as will the quality of health care being delivered by providers who have burned out or have job-related depression and post-traumatic stress symptoms. The impact will be short term for some and long term for others. Given that physician burnout and job-related depression and PTSD were not being addressed adequately pre-pandemic, the effect is unlikely to resolve merely with a successful vaccination campaign.

In a rare COVID-19 bright spot, the pandemic has spurred a notable increase in medical school applications, dubbed the "Fauci effect." Medical school applications have increased sharply this year.[58] However, this effect will only translate into an increase in overall physician supply if training capacity in both medical schools and residency programs also increases. The Consolidated Appropriations Act of

2021 does provide funding for more GME slots over five years, the first increase in Medicare funding for GME in nearly 25 years.

Demand Effects

Soon after COVID-19 was discovered in the United States, demand for the services of people treating COVID-19 patients skyrocketed and demand for those in other specialties declined precipitously. The immediate impacts on physician supply of the drastic increase in demand for treatment of COVID-19 cases and the drastic decrease in demand for office visits and elective surgeries are likely to be short term; they have resolved somewhat already and are likely to resolve substantially with a successful vaccination campaign (although there are potentially longer-term implications for supply, as discussed earlier in this section). Demand for health care services and providers will also be affected as the general population experiences excess deaths from the pandemic, the related recession, and COVID-19-related impacts on the population's well-being, age, and geographic distribution.

Through March 8, 2021, more than 500,000 excess deaths of Americans were attributed to COVID-19.[59,60] While those seeking treatment for COVID-19 have increased demand for some services, the shrinking population means a decrease in demand for other services. To date, COVID-19-related deaths are about 0.2% of the U.S. population, with the majority of deaths among those close to their life expectancy. This means much of the decrease in demand could be more of a shift in demand to a year or so earlier rather than an overall decrease in demand over the full projection horizon for this study (between 2019 and 2034). That is, a substantial amount of the lost expected future health care demanded by people near life expectancy who died of COVID-19 could have shifted to the end-of-life care they received for COVID-19. With a successful vaccination campaign, the overall impact on health care demand from excess deaths is expected to be minimal. However, the large number of COVID deaths occurring in nursing homes may encourage more people to age in place going forward, which will affect the mix of settings in which health care is demanded — for example, shifting from nursing homes to home care.

In addition to COVID-19's outsized impact on the oldest age cohorts, it is also expected to cause the birth rate to fall, which will tend to decrease demand for health care services over time.[61,62] The extent and duration of this phenomenon will only be known with time, but the birth rate is expected to rebound with a successful vaccination campaign[63] and as economic conditions improve. Some of this decline in current births may be compensated for in subsequent years, as suggested by the explosion of egg freezing during the pandemic.[64-67]

Not all subpopulations are being affected equally by COVID-19, and the impacts of the pandemic will also vary over the projection horizon. People of color have experienced a disproportionate number of COVID-19 cases, hospitalizations, and deaths,[68-71] and Black and Hispanic people are being vaccinated at lower rates than White people.[72] This will affect the relative mix of care demanded as well as health care equity by race/ethnicity over the short and long term. As analyzed in the Health Care Utilization Equity Scenario, this effect on health care equity also causes an underestimation of the additional physicians required to achieve health care utilization equity.

In addition to it impacts on the size, age, and race/ethnicity of the U.S. population, COVID-19 may also be affecting the geographic distribution of the populations. As many American workers were required to work from home during COVID-19 and they missed getting outside safely during lockdowns, many moved to houses with more room inside and out. Data from the U.S. Postal Service suggest almost 16 million Americans moved (temporarily or permanently) from February to July,[73] and home sales in 2020 were at 14-year highs.[74] The moves are reported to be disproportionately to the South and West.[75] Data suggest that the pandemic accelerated a trend that predated COVID-19 of migration from urban to suburban areas and that much of the migration during COVID-19, although speculated to be from urban to rural areas, is also from urban to urban or from suburban to suburban areas.[76] Additionally, these trends could reverse as the current crisis abates and people satisfy their pent-up demand for the conveniences and

experiences of urban areas. Monitoring trends in geographic relocation is important for assessing the adequacy of the distribution of the health care workforce.

The potential change in insurance status and payor mix distributions deriving from COVID-19-related job losses also may affect demand for health care as well as providers' revenues from delivering this care. Generally, higher unemployment, with its attendant loss of employer-sponsored insurance, tends to produce higher rates of patients who are either uninsured or insured under public programs, both of which tend to lower provider revenues. A recent analysis by the Kaiser Family Foundation[77] suggests relatively few Americans have lost job-based health insurance during the pandemic and many of those who did likely found safety-net coverage through Medicaid or the Affordable Care Act's (ACA) individual market. The Biden administration created a Special Enrollment Period to allow eligible individuals to enroll in coverage through the ACA exchanges, which will further mitigate the effect of loss of insurance due to job loss. But the full impact will not be known for a while and is expected to end when the economy recovers.

Demand for some types of health care are increasing or are expected to increase due to the long-term effects of COVID-19, the screening and preventive appointments missed during the pandemic, and the mental and emotional toll of COVID-19.

Sequelae in COVID-19 patients are well documented worldwide, among both those who had severe cases requiring hospitalization and those with milder cases.[78-80] These patients are sometimes referred to as "long-haulers" and their conditions as "long COVID." Growing amounts of data show that for some COVID-19 patients, symptoms may come back months later in different forms, permanent damage may have been done to their organs, and/or the sequelae may become a chronic autoimmune issue.[81,82] In surveillance conducted in the United Kingdom, about 10% of diagnosed COVID-19 patients experienced some type of long-term sequelae including respiratory, cardiac, or neurological symptoms.[83,84] There are no data or models yet to predict how long these sequelae might last[85] or who might be at elevated risk,[86] but some patients might require associated health care services for the rest of their lives.[87,88] "Post-COVID clinics" are opening around the United States to address these patients' needs.[89]

Some of the appointments forgone during the pandemic-induced period of lower demand for office visits and elective procedures include recommended screenings that would have identified new disease and routine care crucial to the management of chronic conditions. Consequently, some delayed diagnoses will come at later stages of the conditions, while some patients will experience exacerbations of their neglected existing conditions. Thus, some of the demand for earlier-stage treatments will shift to later-stage treatments for conditions such as cancer,[90,91] diabetes, and cardiovascular disease.[92] Changes in case acuity mix could also change demand for various types of services and physicians. Studies of this effect to date have generally used data on numbers of missed appointments to estimate excess mortality, with little emphasis on the impacts on the health care workforce.[93-96] If the trajectories of these diseases are changed over the rest of the lifespan, the impact on health care markets could be long term. The net impact on overall demand is less clear, however, because excess and early deaths associated with missed appointments could decrease the demand for services that would have been sought over the missed portion of those lives, while the shift in case mix to higher acuity could increase the demand for services.

The mental health impacts of the pandemic have been widespread,[97-99] with anxiety and depression in U.S. adults having increased to four times pre-COVID-19 levels.[98] For some, their mental health will improve as the current crisis abates, but for others, the mental health effects will be long term (e.g., people experiencing untreated COVID-19-related PTSD). These mental health impacts will exacerbate existing shortages of mental health care providers. These mental health issues may also indirectly produce increased need for longer-term care deriving from increased alcohol and drug use, as well as higher rates of hypertension and other stress-related conditions.[97] Increased levels of self-medication are also affecting excess deaths. The AMA is tracking reports of increasing opioid overdoses in most states,[100] and a recent study estimates that "the pandemic and recession were associated with a 10 to 60 percent increase in

deaths of despair above already high pre-pandemic levels."[101] Reflecting the disproportionate impact of other effects of COVID-19 on people of color, Hispanic and Black people are also disproportionately experiencing mental health effects. Before COVID-19, these groups had lower rates than the U.S. adult population of any mental illness, serious mental illness, major depressive disorder, and suicidal ideation, but during COVID-19, they are disproportionately reporting symptoms of these conditions.[99]

Care-Delivery Effects

COVID-19 is also changing the way care is delivered. Patients' reluctance to visit traditional health care delivery settings after the discovery of COVID-19 led providers to invest in and adopt telemedicine infrastructure — and patients to engage providers via telemedicine — at an accelerated rate. Now that the infrastructure is in place and patients have familiarity with remote clinical services, much care will likely continue to be delivered via telehealth, subject to continued favorable regulatory and reimbursement policies. The impact of increased telemedicine use on the physician workforce supply and demand depends on whether patients simply substitute in-person visits for telemedicine visits rather than engage more or less often with their physicians (demand) and whether conducting in-person rather than telemedicine visits affects provider productivity or labor force participation decisions (supply).

Summary

Public health experts have been sounding the alarm for decades about the likely increasing frequency of pandemics; as disruptive as COVID-19 has been, it is milder than many scenarios predicted.[102] The current pandemic has demonstrated that to better ameliorate the morbidity, mortality, and economic impacts of future pandemics, we will need to train (or cross-train) more physicians to alleviate shortages in crucial specialties and settings; approach this ramp-up within a context of equity, diversity, and inclusion; focus on the well-being of the health care workforce so that our providers are healthy enough to provide high-quality care to patients; and improve the effectiveness and efficiency of care delivery by using promising technologies and team-based care.

PROVIDERS REQUIRED IF U.S. ACHIEVED EQUITY IN HEALTH CARE UTILIZATION

Achieving health equity is a national goal, with research suggesting substantial room for progress.[103-108] As discussed above, disparities in mortality and health outcomes associated with COVID-19 have raised awareness of the disparities in health and access to care by minority populations, people living in rural communities, and people without medical insurance.[109-111]

One component of achieving this goal is improving access to care for populations that have historically faced barriers to receiving care. The Health Care Utilization Equity (HCUE) Scenarios modeled for this report quantify the implications for physician demand if currently underserved populations were to have care-use patterns similar to those of populations facing fewer barriers to care — controlling for demographics, lifestyle choices, and disease prevalence. *This analysis is not included among the scenarios used to develop projected ranges of gaps between supply and demand across physician specialty categories*. Rather, it is intended as an additional point of consideration when gauging workforce adequacy and to stimulate discussion of how best to address health care utilization inequity. The analysis shows that due to sociodemographic differences, historically underserved populations have received less care than can be explained by utilization differences in age distribution, disease prevalence, and other health risk factors.

As shown in Exhibit 13, under current patterns of health care service use, the non-Hispanic White population uses about 287 FTE physicians per 100,000 population. The corresponding FTEs used per 100,000 population are 179 for the Hispanic population, 232 for the non-Hispanic Black population, and 204 for all other minority populations.[b]

We modeled two hypothetical scenarios to estimate the anticipated increase in the use of health care services if underserved populations had use patterns similar to a population not perceived as underserved. The first scenario (HCUE Scenario 1) assumes the care-use patterns of people without medical insurance and living outside suburban[c] metropolitan areas were similar to those of their insured peers living in suburban areas. For example, an uninsured male age 50 with diabetes living in a rural area was modeled as having the utilization patterns of an insured male age 50 with diabetes living in a suburban metropolitan area. Under this assumption, U.S demand would increase by 82,600 FTE physicians by 2034, and when considering the starting-year (2019) shortage of 19,800 FTEs, the total gap is 102,400 physicians (Exhibit 14). More APRNs and PAs would also be required to meet the additional demand for services.

The second HCUE scenario (HCUE Scenario 2) models the additional physicians required under a hypothetical scenario in which everyone utilized care as if they had equivalent utilization patterns to non-Hispanic White, insured populations living in suburban metropolitan areas. For example, an uninsured Black male age 50 with diabetes living in a rural area was modeled as having the utilization rate of an insured non-Hispanic White male age 50 with diabetes living in a suburban metropolitan area. Under this assumption, we estimated an additional 180,400 FTE physicians would be required relative to supply (Exhibit 15).

As in last year's report, we modeled all people having care-use patterns of people living in suburban metropolitan areas (National Center for Health Statistics (NCHS) Classification 2, from the 2013 NCHS Urban-Rural Classification Scheme for Counties)[112] — who typically have the greatest access to care. These modeled scenarios are not intended to describe what future demand for physicians is likely to be, but rather to highlight the large disparities in use of services between people with and without insurance, among people residing in counties across different levels of rurality, and by race and ethnicity.

Exhibit 13: Current Use of FTE Physician Services per 100,000 Population by Patient Race and Ethnicity, 2019

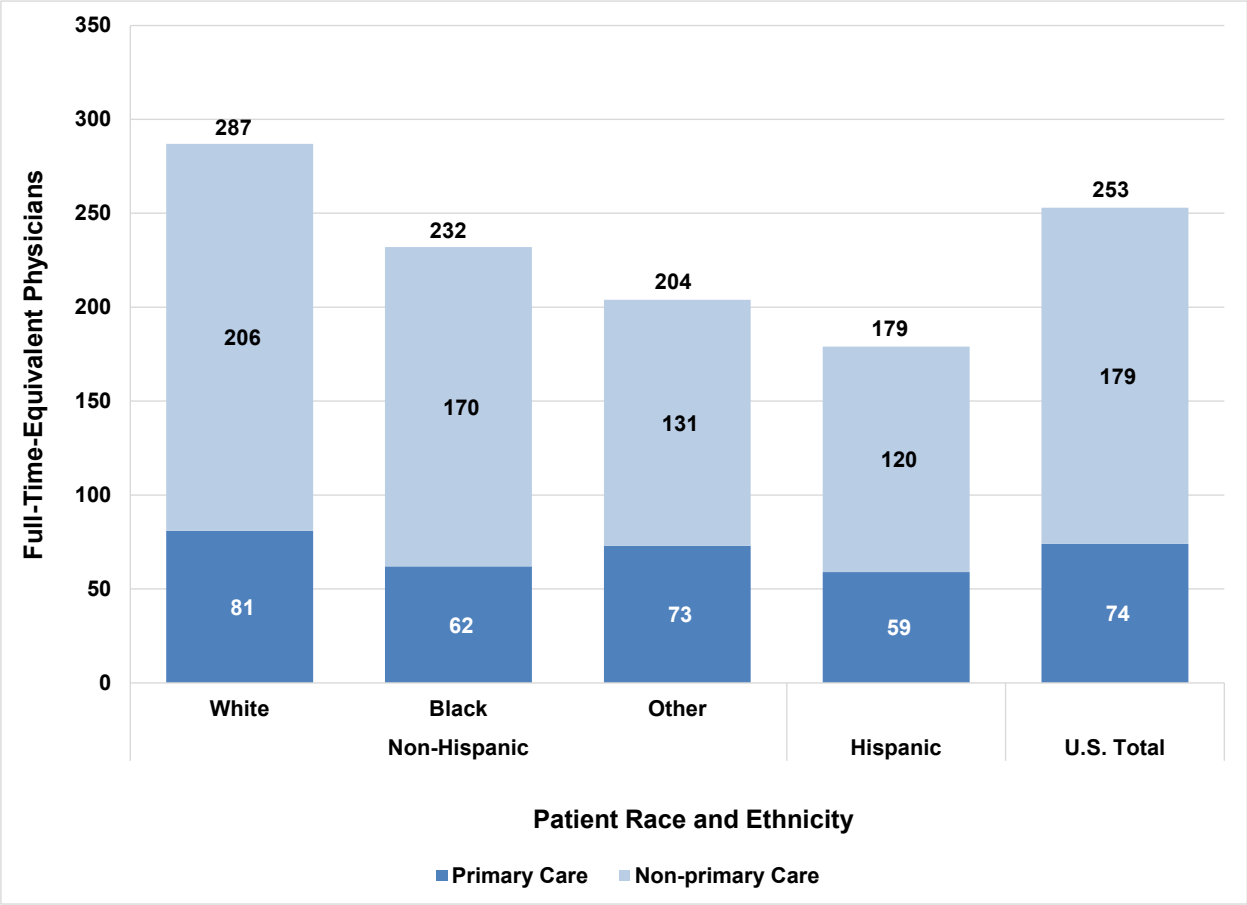


Exhibit 14: Health Care Utilization Equity Scenario 1, 2019

Specialty Group	Physicians				Additional Providers Required	
	Current Supply	Requirements Under Equity Scenario	Current Gap	% Gap	Advanced Practice Nurses	Physician Assistants
Total	**808,400**	**910,800**	**102,400**	**13%**	**18,100**	**9,500**
Primary Care	228,700	264,200	35,500	16%	7,900	1,200
Non-Primary Care	579,700	646,600	66,900	12%	10,200	8,300
Medical Specialties	137,900	156,500	18,600	13%	3,800	1,800
Surgical Specialties	152,700	166,600	13,900	9%	1,600	3,400
Other Specialties	255,800	288,300	32,500	13%	4,000	2,900
Hospitalists*	33,300	35,200	1,900	6%	800	200

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Exhibit 15: Health Care Utilization Equity Scenario 2, 2019

Specialty Group	Physicians				Additional Providers Required	
	Current Supply	Requirements Under Equity Scenario	Current Gap	% Gap	Advanced Practice Nurses	Physician Assistants
Total	**808,400**	**988,800**	**180,400**	**22%**	**33,400**	**19,900**
Primary Care	228,700	279,200	50,500	22%	13,300	2,900
Non-Primary Care	579,700	709,600	129,900	22%	20,100	17,000
Medical Specialties	137,900	162,500	24,600	18%	5,100	2,400
Surgical Specialties	152,700	184,700	32,000	21%	3,700	8,200
Other Specialties	255,800	324,800	69,000	27%	9,600	5,900
Hospitalist*	33,300	37,600	4,300	13%	1,700	500

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

The implications of these hypothetical scenarios vary substantially by patient race and ethnicity, census region, and urban-rural location (Appendix 2, Exhibits 40-43). For most specialties, demand for physician services by underserved populations would rise under the HCUE1 and HCUE2 Scenarios. However, for some underserved populations, demand would fall, reflecting a higher prevalence of select chronic conditions among these underserved populations and potential declines in demand for chronic disease services if these patients had improved access to preventive care. Under the HCUE2 Scenario, demand for services among minority populations would decline for nephrology, hematology, and oncology. These possible declines in demand could be due to the lowering of prevalence rates because of improved access to preventive care among minority populations for obesity, hypertension, diabetes, nonalcoholic fatty liver disease, various types of cancer, and other chronic diseases.[113-118] The decline in the use of hematology services might be overstated to the extent that diseases such as sickle cell disease are more prevalent among minority populations than in the non-Hispanic White population.[119,120]

SUPPLY MODELING

The microsimulation supply model projects future supply based on the number and characteristics of the current physician workforce and new physicians trained each year, hours-worked patterns, and retirement patterns. This section describes the modeled scenarios and projections, with a brief description of the supply model and model inputs and assumptions. Additional information about the supply model and its inputs can be found in Appendix 1; further details are documented elsewhere.[121,122]

Supply Modeling Inputs, Assumptions, and Scenarios

All supply projections start with 808,400 physicians active in 2019 as estimated from the AMA Physician Masterfile. Supply is defined as active physicians who have completed their GME and includes physicians involved in both patient-care and non-patient care activities (i.e., teaching, research, and administration). The beginning supply estimate includes only physicians under age 75 because past research suggests many physicians age 75 and older in the Masterfile are no longer practicing medicine. The starting-year supply consists of about 228,700 Primary Care physicians, 137,900 physicians in internal medicine and pediatric subspecialties, 152,700 physicians in Surgical Specialties, 33,300 Primary-Care-Trained Hospitalists, and 255,800 physicians working in Other Specialties.

Consistent with previous reports, we modeled Primary-Care-Trained Hospitalists separately from Primary Care physicians. The Hospitalist projections build on our work to identify hospitalists using Medicare fee-for-service billing records linked to the AMA Physician Masterfile. We defined hospitalists as physicians who generate 90% or more of their billing for hospital-based services. Because the Centers for Medicare and Medicaid Services has been delayed in releasing the latest hospital billing data, for this report, we used the analyses from last year's report that linked 2018 billing records to the 2018 AMA Physician Masterfile.

Our estimate of annual new physicians entering the workforce, 29,627, described in Appendix 1, is higher than last year's estimate, 28,980. One update to the approach we used to estimate total graduates is that this is the first year of GME reporting under a single GME accreditation system; in previous years, we combined graduate data from programs accredited by the Accreditation Council for Graduate Medical Education (ACGME), Association of American Colleges of Osteopathic Medicine (AACOM), and American Osteopathic Association (AOA) minus estimates of graduates from dually accredited programs.[123] An estimated 8,584 new physicians entered Primary Care, 5,809 entered internal medicine and pediatric subspecialties, 5,020 entered Surgical Specialties, 1,221 became Primary-Care-Trained Hospitalists, and 8,993 were new physicians entering Other Specialties. The scenarios model the continuation of these 29,627 physicians trained each year plus the anticipated increase in GME slots due to the Consolidated Appropriations Act of 2021. The number of GME slots will increase by 200 in each of the five years from 2023 to 2027. Assuming GME takes an average of four years to complete, then 200 additional physicians will complete training each year from 2028 to 2034, except in 2031, when 400 physicians will complete training. These new physicians are distributed proportionally based on the distribution across specialties consistent with the specialty mix of graduates from school year 2019-2020. This number of new physicians entering the workforce reflects the number the system can continue to train without new investment in GME.

Physician weekly-hours-worked patterns and retirement patterns differ by age, sex, and specialty category. For the second time, the updated projections use new data on hours worked and retirement estimated from the AAMC 2019 National Sample Survey of Physicians (NSSP). The survey analysis is described in Appendix 1.

As in the previous reports, this year, the Status Quo, Retirement, and Hours Worked Scenarios (described below) were included in the analysis comparing physician supply and demand to project a range for future

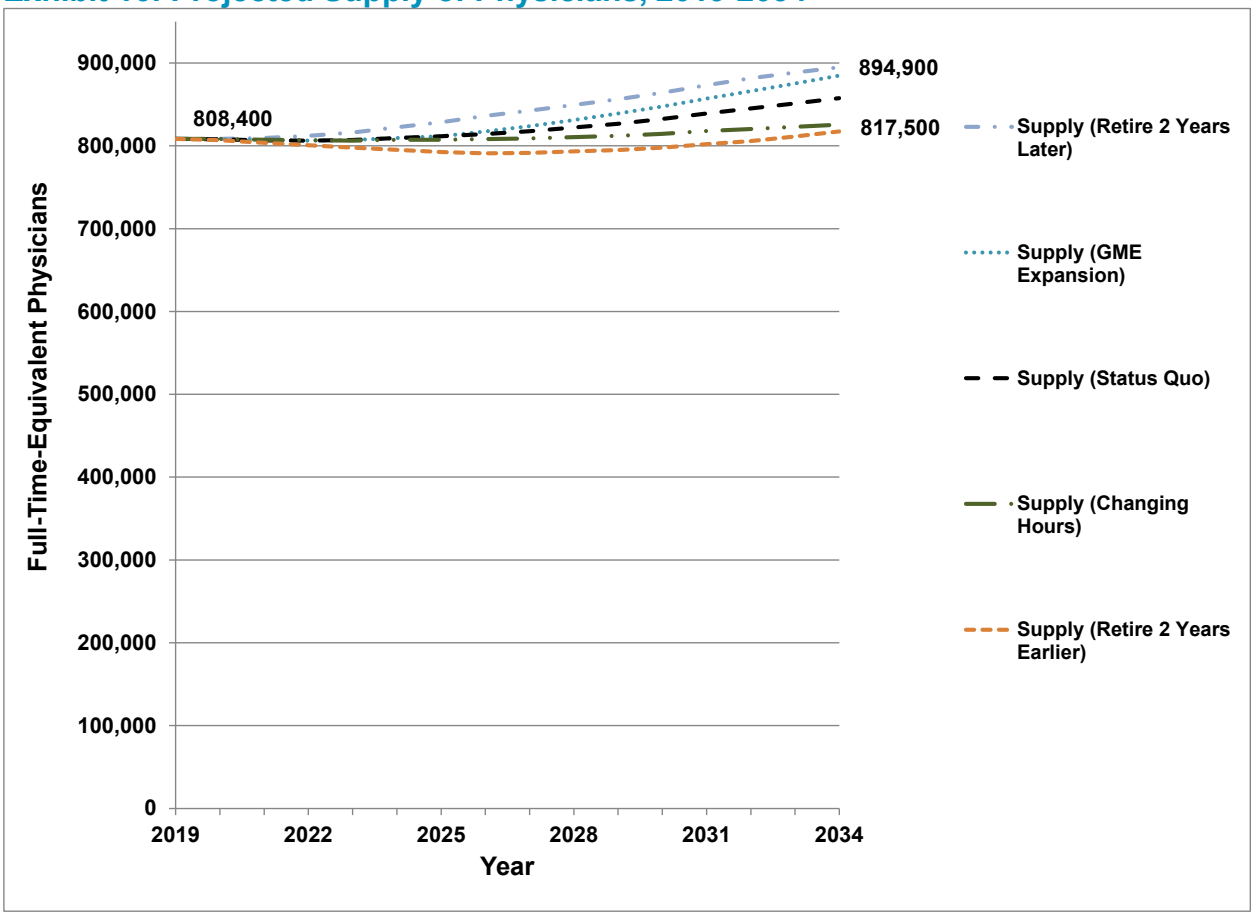
adequacy of physician supply. Also as in past years, modest GME expansion was modeled separately as a policy-oriented supply scenario but was not included in the shortage projections.

- **Status Quo Scenario**: This scenario models continuation of the status quo in terms of number and characteristics of physicians newly entering the workforce, hours-worked patterns, and retirement patterns. This scenario forms the basis for the other modeled supply scenarios.
- **Early- and Delayed-Retirement Scenarios**: Reflecting the uncertainty about future physician-retirement patterns, these scenarios model physicians retiring two years earlier or two years later, on average, than they do now. The scenarios assume physicians might delay or speed up retirement for financial, health, and other reasons. Burnout is one factor contributing to premature retirement, and, as discussed previously, COVID-19 has complicated retirement trends.[2,6,12,52-57]
- **Changing Hours Worked Scenario**: Our previous reports estimated the change in average weekly hours worked by physicians using the American Community Survey (ACS). While the ACS does not include physician specialty, which the NSSP does, the ACS does collect data on physician hours worked using the same format every year and can be used to estimate aggregate trends in physician hours worked. To increase sample size across age groups, we combined 2017-2019 ACS files when we estimated physician work-hours in 2018, and we combined 2012-2014, 2007-2009, and 2002-2004 files to estimate work-hours for, respectively, 2013, 2008, and 2003. The trend in recent years suggests that average hours worked has been relatively steady for physicians, with a decrease for males and a small increase for females. This modeled scenario simulates the supply implications if the average annual trend observed in the past 15 years were to continue. We modeled the change in hours worked by age and sex as a cohort effect.
- **GME Expansion Scenario**: This scenario assumes an increase in federally funded GME support to train an additional 15,000 physicians per year, with 3,000 new residency slots added per year over a five-year period. Given an average residency length of four years, this increase is modeled as an additional 3,750 new physicians starting to enter the workforce each year beginning in 2026. The scenario is based on the combined effects of the proposed Resident Physician Shortage Reduction Act and the Consolidated Appropriations Act of 2021, though the actual timing of adding new residency slots will likely vary slightly from what was modeled. The distribution of new residency slots across specialties is currently unknown, so for modeling purposes, we assume all specialties' residency slots will increase in proportion to their current distribution. This policy-related scenario was excluded from calculations of physician-shortage ranges.

Supply Projections

Updated annual projections for physician supply across all scenarios modeled are summarized in Exhibit 16. Under the Status Quo Scenario, total physician supply increases from 808,400 in 2019 to 857,700 by 2034 — a 6.1% increase. This is below the approximately 10.6% projected growth in the U.S. population over this period, contributing to a 4% decline in the physician-to-population ratio (declining from 246 to 236 physicians per 100,000 population by 2034).[21]

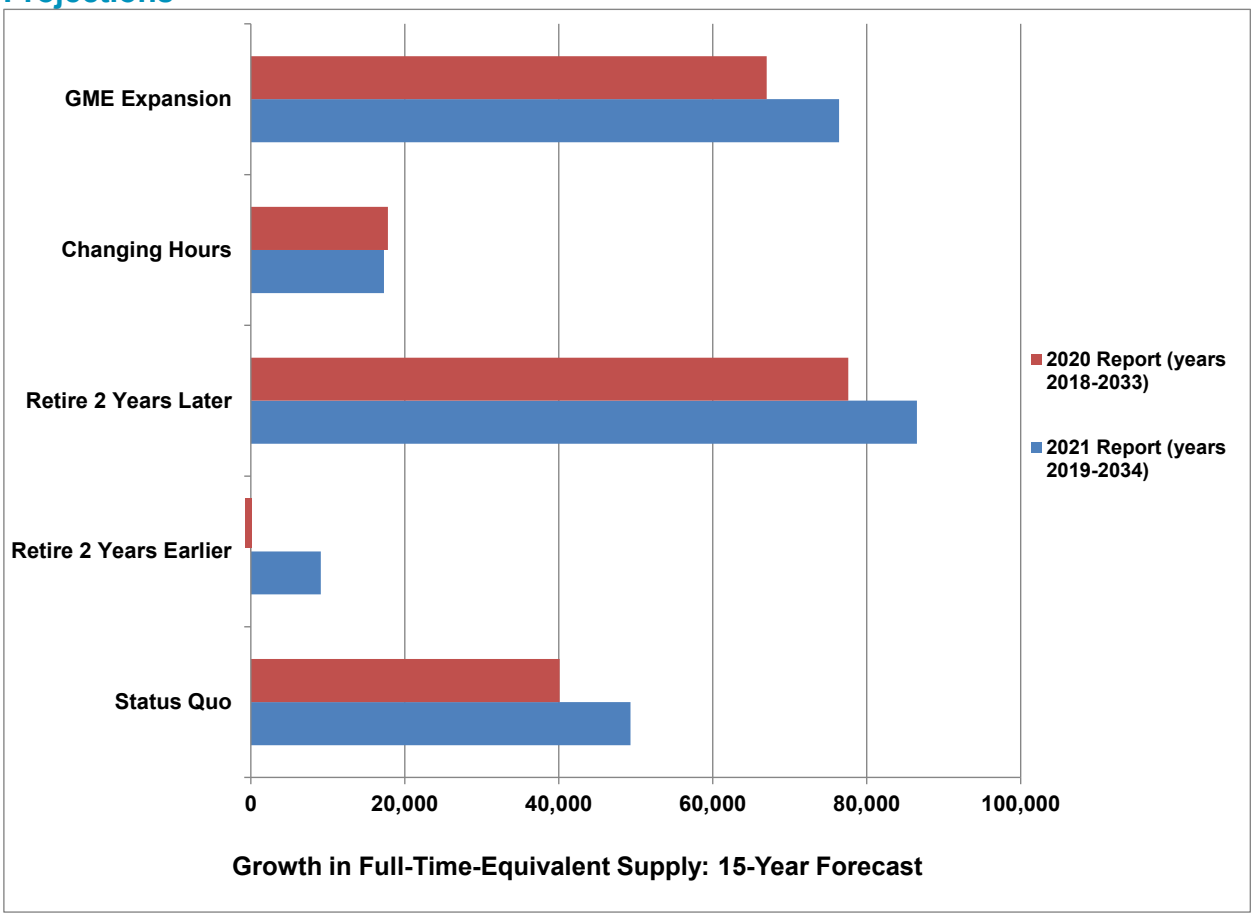
Exhibit 16: Projected Supply of Physicians, 2019-2034



As illustrated in Exhibit 17, this year's updated supply projections for 2019 to 2034 show faster growth in supply than the 2018 to 2033 projections. The 2020 report projected a 40,100 increase in supply, and this 2021 report projects a 49,300 increase in supply. The main contributor to the higher projection is the estimated additional 647 physicians entering the workforce annually as GME graduates plus additional physicians whose GME slots are funded through the Consolidated Appropriations Act of 2021.

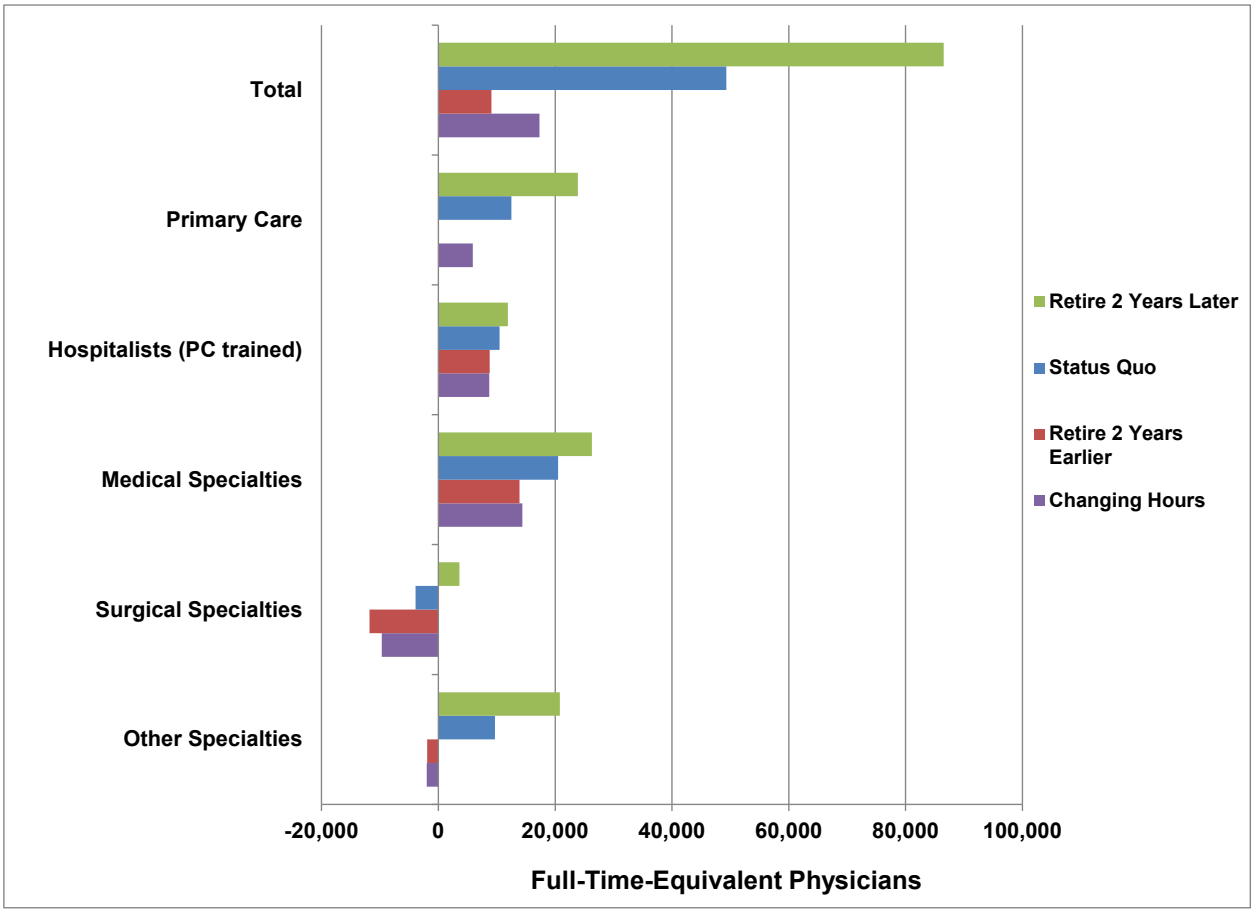
The GME Expansion Scenario is designed to approximate proposed legislation that would increase the number of physician residency slots. Because the legislation has yet to be passed, we modeled its effects delayed by one year in this study.

Exhibit 17: Projected Change in Physician Supply: 2021 vs. 2020 Report Projections



Note: The 2020 report value for the Retire 2 Years Earlier Scenario was -200 FTEs. Whereas there is projected growth in supply for the Medical Specialties and Primary-Care-Trained Hospitalist categories under all scenarios modeled, the results are mixed for the other specialty categories — for example, the supply of physicians in Surgery Specialties is projected to decline under all but the Delayed-Retirement Scenario (Exhibit 18).

Exhibit 18: Projected Change in Physician Supply by Specialty Category, 2019-2034



Note: The Retire 2 Years Earlier Scenario results in an increase of 100 FTE primary care physicians.

DEMAND MODELING

Future demand for health care services and the physicians to provide those services is the result of the complex interactions of patients' needs and decisions to seek care, medical and technical considerations of what care is feasible to provide, economic considerations, social norms and policies, and the intricacies of a complex health care system and decisions made by providers and administrators within this health system. While there is significant agreement about improvements needed in the health care system, there is less agreement about how the system should be reformed. There are, however, underlying trends and factors that will affect future demand for health care services and providers regardless of how policy and health system changes might affect how care is used and delivered.

Previous versions of this report highlighted that population growth and aging are the dominant factors affecting future demand for health care services. Other key factors with implications for physician demand include increasing use of APRNs, PAs, and other health care workers in care delivery; efforts to improve population health through preventive care; efforts to enhance the value of care delivery through managed-care principles and a variety of mechanisms such as ACOs, patient-centered care, value-based insurance design (VBID), and interventions to divert costly hospital-based care to appropriate ambulatory settings; policy initiatives to advance national goals of increasing equity in health outcomes and improving access to high-quality, affordable care; and less quantifiable trends such as advances in technology and medicine.

While some factors, such as an aging population and national goals to expand access to care, will increase demand for physicians, others could decrease demand, or increases and decreases in demand could offset each other. For example, advances in artificial intelligence could improve the productivity of radiologists, pathologists, and others in detecting and diagnosing cancers and other medical conditions, possibly leading to a lower demand for these physicians to care for the existing population.[124,125] However, increasing longevity by reducing cancer deaths and other preventable deaths means more physicians will be needed in the future to care for the larger population still living — many of whom have chronic conditions to be managed. Therefore, many of the above factors affecting care use and delivery might not decrease overall demand for physicians but simply shift demand from one care-delivery setting to another (e.g., shift care by hospitalists to care by community-based providers), shift demand across specialties (e.g., shift from oncology care by reducing cancer incidence to geriatric medicine because people are living longer), or shift demand to the future as increased longevity increases population size.

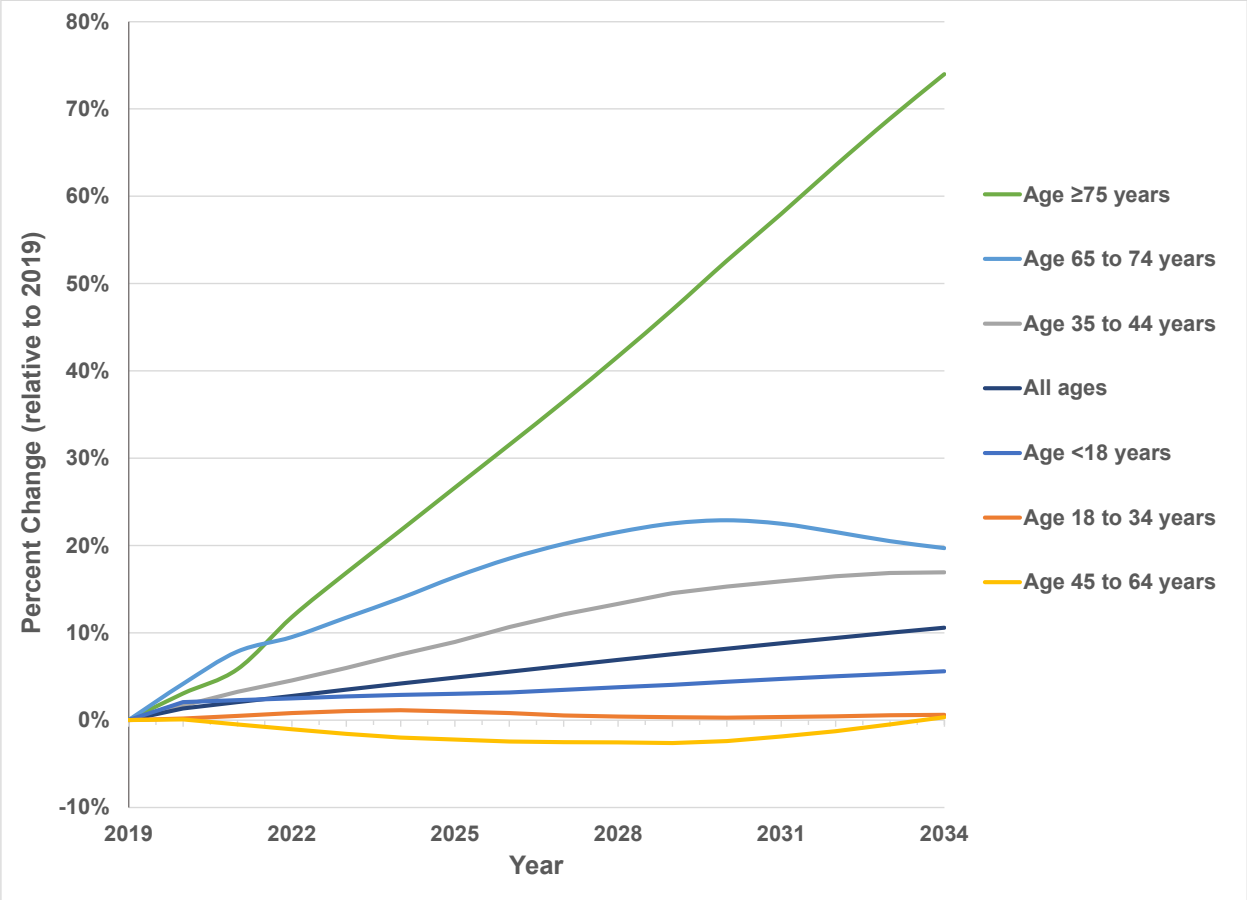
This section briefly describes the demand model inputs, assumptions, and scenarios and presents the projections. Additional information about the demand model and inputs is included in Appendix 1 and documented elsewhere.[121,122]

Demand Modeling Inputs, Assumptions, and Scenarios

Population Characteristics and Projections

Between 2019 and 2034, the U.S. population is projected to grow 10.6%, from about 328.2 million to 363.0 million people.[21] The population under age 18 is projected to grow by 5.6%; the population age 65 and older, by 42.4% — primarily due to the 74.0% growth in size of the population age 75 and older (Exhibit 19). As a result, the national prevalence and incidence of diseases that disproportionately affect older Americans is projected to grow rapidly. Demand for physicians who treat patients with these diseases is expected to grow, as well. For example, the microsimulation demand model finds that between 2019 and 2034, the prevalence of diagnosed diabetes is projected to increase 25% (from 26.5 million to 33.2 million people), and the population with heart disease is projected to increase 29% (from 12.2 million to 15.7 million). High rates of growth are projected for the size of the population with a history of stroke (29% growth), heart attack (28%), and cancer (23%) associated with an aging population and improved survival rates.[126-128]

Exhibit 19: Percent Change in Projected Population, by Age, 2019-2034



Between 2019 and 2034, the U.S. non-Hispanic White population is projected to decline by about 0.9%, the non-Hispanic Black population is projected to grow by 13.4%, the Hispanic population is projected to grow by 32.0%, and the non-Hispanic population of all other minority races is projected to grow by 36.4%.[b] Hence, a growing proportion of health care services will be for racial minority and Hispanic patients, underscoring the importance of increasing racial and ethnic diversity among the physician workforce.

The modeling approach involved creating a representative sample of the population in each U.S. county, with county files aggregating to states and states aggregating to a representative sample of the national population. Data sources used to construct the de-identified, representative samples of the population in each geographic location included the 2019 U.S. Census Bureau, for data on county demographics; the 2019 ACS; the 2018 and 2019 Behavioral Risk Factor Surveillance System (BRFSS); and the 2018 Centers for Medicare and Medicaid Services (CMS), for data on people living in nursing homes and residential care facilities. Sources of the state- and county-level population projections were individual states and IHS Markit, and the source of national population projections was the U.S. Census Bureau. Information for each person in the constructed population files consists of demographics (age, sex, race, and ethnicity); medical insurance type; household income; whether the person lives in the community, a residential care facility, or a nursing home; health-related lifestyle indicators of body weight status (normal, overweight, obese) and current smoker status; presence of chronic conditions (arthritis, asthma, cardiovascular disease, diabetes, or hypertension); patient history of cancer, heart attack, or stroke; and county of residence urban-rural classification using the 2013 NCHS Urban-Rural Classification Scheme for Counties.[112]

Demand for Health Care Services

Current patterns of health care use, estimated using the combined 2014-2018 files of the Medical Expenditure Panel Survey (MEPS) and the 2018 National Inpatient Sample (NIS), both from the Agency for Healthcare Research and Quality (AHRQ), indicate that annual use of health care services varies substantially by patient characteristics. The regression approach we used to model health care use patterns is described in Appendix 1. While regression results varied by specialty and care-delivery setting, the findings were largely consistent with expectations. Patient characteristics associated with greater use of health care services include older age, having medical insurance, presence of the chronic conditions modeled, living in a metropolitan area, and being non-Hispanic White. Some characteristics were associated with mixed results — for example, patients in a managed-care plan were associated with higher use of primary care services and lower use of some specialist services.

Patterns of Care Delivery

Current patterns of care delivery were calculated by first estimating the proportion of time physicians in each specialty spend in each care-delivery setting (e.g., ambulatory care, emergency care, hospital care) to estimate FTE care in that setting. Then, total national care use (e.g., office, outpatient, and emergency visits and hospital inpatient days by diagnosis category) was divided by the FTE count to create services-to-providers ratios. Many physicians provide services across multiple care-delivery settings, including ambulatory visits in physician offices and outpatient clinics, hospital rounds, and emergency department consults. To estimate FTEs by setting, estimates of the proportion of time physicians spend in different care-delivery settings were calculated from a variety of sources, including surveys conducted by professional associations and Medical Group Management Association (MGMA) data. For example, among the 2,280 Primary Care physicians in the 2019 NSSP, physicians spent 80% of their direct patient-care time providing ambulatory care, 9% providing inpatient care, 6% providing urgent care, and the remaining 5% providing care in nursing homes and assisted-living facilities, emergency departments, and other settings.

For modeling purposes, at the national level, we quantified current demand for health care services as equivalent to the level of health care services used, current demand for physicians as the current physician supply, and current demand for physician services as the level of health care services currently being provided by the current physician supply. Demand projections thus extrapolated into the future a “2019 level of care,” and included any imbalances between supply and demand, whether shortages or excesses. Our starting point in 2019 relies on federal government estimates that the nation requires about 13,758 primary care physicians and 6,100 psychiatrists to de-designate the federally designated primary care and mental health Professional Shortage Areas (HPSAs).[20] For modeling purposes, we assumed

these 19,858 physicians reflect national shortages. To the extent that shortages currently exist across specialties other than primary care and psychiatry (there are no current federal shortage designations for other specialties), our starting-point assumption may be conservative.[129-133]

Advanced Practice Registered Nurses and Physician Assistants

In 2020, an estimated 290,000 APRNs were licensed in the United States, with the American Association of Nurse Practitioners reporting 69% of them were involved in delivering primary care.[134] In 2019, there were 12,218 certified nurse midwives (CNMs), 102 certified midwives (CMs), and more than 60,000 certified registered nurse anesthetists (CRNAs).[135,136,d] At the end of 2019, there were about 139,700 certified PAs, and about 94.5% (132,000) of them were practicing clinically in the United States.[137] Of those in clinical positions, about 26.2% (34,500) reported working in the offices of primary care providers or practicing primary care, 25.3% (33,400) reported working in a surgical specialty, 14.8% (19,600) reported working in an internal medicine or pediatric subspecialty, 13.2% (17,400) reported working in emergency medicine, 3.5% (4,600) reported working as hospitalists, and the remainder reported working in various other specialties.

The supply of APRNs and PAs has grown rapidly over the past two decades, and if current growth trends in the number of new providers trained continues, we project the supply of these providers will more than double over the next 15 years (with growth rates varying by APRN and PA specialty category). At current rates of production, by 2034, APRN supply will grow by 309,000 FTEs and PA supply, by nearly 129,000 FTEs. There remains a paucity of information on the impact this rapid supply will have on the demand for physicians. The rate of growth in supply in APRNs and PAs vastly exceeds the rate of growth in demand for health care services, which raises the question of the degree to which this growth in supply might reduce the demand for physicians as the ratio of physicians to APRNs and PAs falls from current levels of about 2:1 to a projected 1:1 by 2034.

In this and previous reports, we modeled two scenarios that made different assumptions about the degree to which APRN and PA supply growth, beyond the growth required to maintain current staffing patterns, might offset demand for physicians. Both scenarios assume no demand effect from any change in the scope of practice for either profession. We modeled a High Use Scenario that assumes each additional APRN or PA beyond the supply needed to maintain current staffing patterns will ease demand for physicians in their specialty as follows: anesthesiology (by 60% of an FTE), Primary Care (50%), women's health (40%), Medical Specialties (30%), Other Specialties (30%), and Surgical Specialties (20%). The Moderate Use Scenario assumes the adjustment in physician demand is half the above percentages.

Constructive feedback we received on previous reports indicates the meaning of these percentages can be misunderstood, so we need to better articulate what they represent. The percentages imply nothing about the value of services APRNs and PAs provide relative to physicians, but rather, they simply estimate the extent to which these providers fill a currently unmet need or reduce demand for physicians.

Health care services are usually complex, requiring delivery by teams of people. Without the nurses, lab technicians, administrators, social workers, and many other types of workers who team with physicians to deliver care, the panel of patients each physician could manage would be relatively small. For example, if the patient panel a physician could handle alone is 500 while the patient panel a physician could handle working with a team is 1,000, then working with a team eases demand for physicians by 50%; working in teams, what would otherwise take 100 physicians would take only half as many. Quantifying the amount of this improved efficiency is challenging with currently available data. Complicating the issue is whether the additional team member provides the same services the physician would have (i.e., they substitute for the physician) or additional services the physician would not have (i.e., they complement the physician), as discussed in following example.

A 2012 study by physicians with the University of California estimated that patients receiving care from primary care physicians received only 55% of recommended chronic and preventive services.[138] The

authors attributed this gap between services recommended and services provided to physicians being overworked, with panel sizes that were too large. The authors also provided estimates of the work done by primary care physicians that could be delegated to others — specifically, to APRNs and PAs. They estimated that 50%-77% of physician time to provide preventive care and 25%-47% of physician time to provide chronic care could be delegated to APRNs and PAs. The authors assumed that physicians would continue to provide all acute care services. One conclusion derived from the study is that primary care physicians working alone had insufficient time to provide all recommended services and address the acute care needs of a panel of 2,500 patients. However, by delegating work to an APRN or PA, one FTE primary care physician and one FTE APRN or PA could jointly take care of all the acute care needs and recommended preventive and chronic care services for this panel of 2,500.

This example raises important questions about what is unknown when modeling the implications of a rapidly growing supply of APRNs and PAs: (1) will patients continue to receive only 55% of recommended services with APRNs and PAs effectively substituting for physicians, (2) will patients start to receive closer to 100% of recommended services with the physician and the APRN or PA complementing one another, or (3) will the addition of the APRN or PA increase the total level of services that patients receive, with some substituting and some complementing? In the first case, the amount an APRN or PA can ease demand for physicians might approach 100% for services that could be delegated, but care stays at a level of 55% of recommended services. In the second case, if an APRN or PA provides only the services not currently being provided, the amount of physician demand being eased would be 0%, but the level of care would approach optimal. Most likely, as in the third case, APRNs and PAs will provide some substitute functions (freeing physicians to work at the top of their licenses) and some complementary functions (improving the level of care received by patients but lowering the percentage by which APRNs and PAs offset physicians).

Furthermore, some APRNs certified in family medicine or other primary-care-related area will choose to work in retail clinics or other settings that typically do not employ physicians in direct patient care. Ashwood et al. estimated that about 39% of retail clinic visits replace physician visits, and 58% of retail clinic visits are additional care that would not otherwise have occurred.[139] Many patients seen in retail clinics appear to be from populations with lower access to physician services for economic or other reasons.[140] An APRN working in a retail clinic seeing patients with noncomplex conditions who might otherwise be seen in a physician's office might offset a portion of an FTE physician. Another example where growth in the supply of APRNs and PAs might lead to growth in care they provide that does not overlap with care provided by physicians is APRN- and PA-led interventions to reduce hospital readmissions by conducting post-discharge follow-up care (often involving visits to the patient's home).[141-144]

To better understand the modeled assumptions and the sensitivity of physician-demand projections to greater use of APRNs and PAs, we looked at the following:

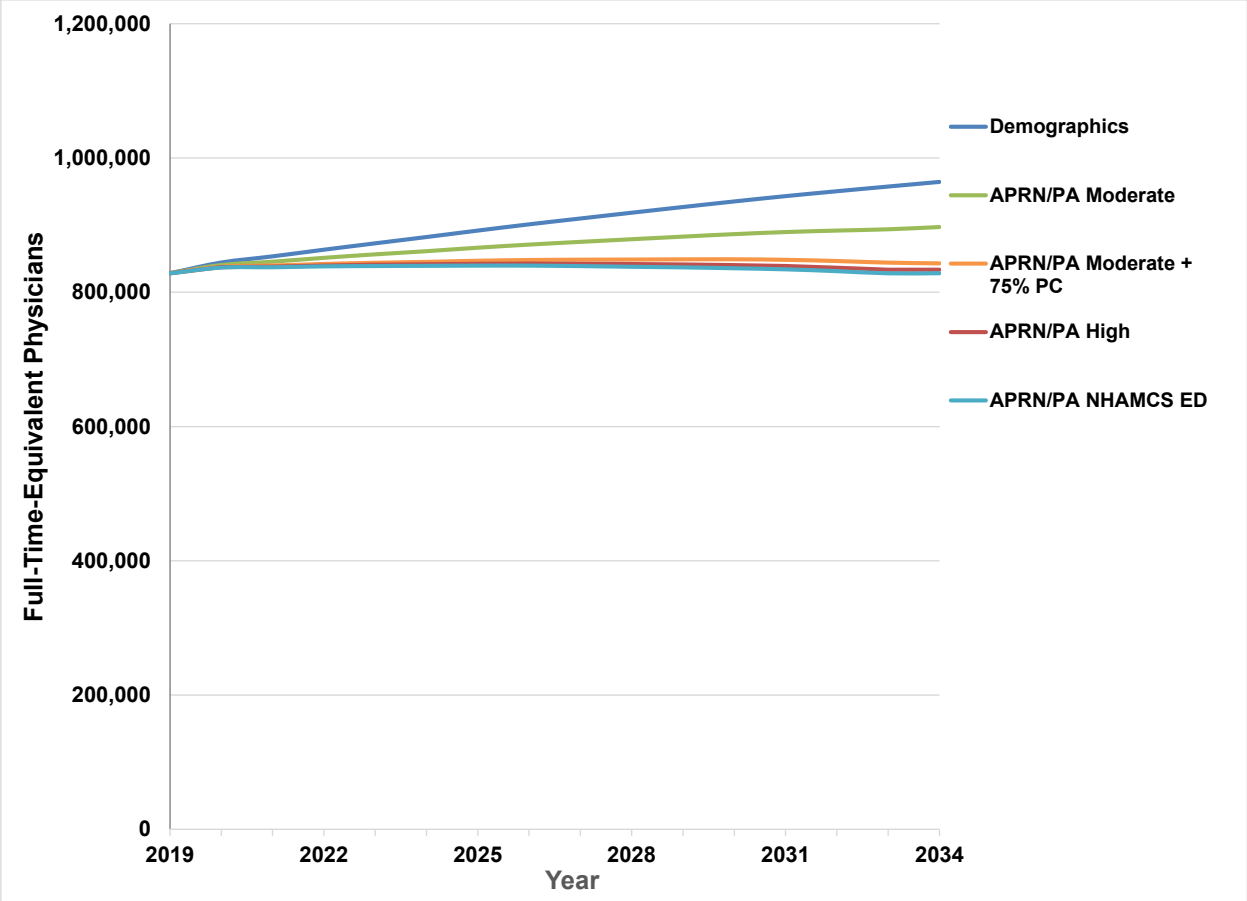
- The National Hospital Ambulatory Care Survey (NHAMCS) collects data on emergency department (ED) visits and indicates whether the patient was seen by a physician, PA only, APRN only, or a combination of physician and APRN or PA. Our analysis of NHAMCS data from 2011 to 2016 indicates that over time, the proportion of ED visits where a patient is seen exclusively by a physician has been declining and is highest for older patients. Overall, about 72% of ED patients were seen by a physician but not an APRN or PA, and 28% were seen by an APRN or PA (with many of these patients also seen by a physician). As a proxy for the degree to which APRNs and PAs and physicians overlap in the ED setting, we calculated the ratio of visits where an APRN or PA (and possibly a physician) saw the patient to visits where only a physician did: 2:5, or 39%. Keeping in mind that this ratio is calculated for the ED setting only, if we use it as a proxy for the degree to which APRNs and PAs offset demand for physicians across all specialty areas (rather than using the numbers modeled in the APRN/PA High Use and APRN/PA Moderate Use Scenarios), the overall physician-demand projections are almost identical to physician demand

under the APRN/PA High Use Scenario, at 828,400 physicians by 2034. Demand projections differ by specialty category under these two scenarios, however (Exhibit 20, APRN/PA NHAMCS ED Scenario).

- We modeled a scenario where APRNs and PAs in primary care mainly substitute for physicians rather than providing complementary care or increasing access to care (APRN/PA Moderate Use + 75% PC). For this scenario, we assumed each additional APRN or PA, beyond that needed to meet the demands of a growing and aging population, directly reduced demand for physicians by 0.75 FTE. Under this scenario, the demand for Primary Care physicians in 2034, 205,800, would drop below the estimated 2019 supply, 241,200; the projected demand would thus drop even lower than the current supply. Overall, under this scenario, total demand for physicians by 2034 is projected at 842,900, which is 121,300 fewer physicians than modeled under the Status Quo Scenario (Exhibit 20, APRN/PA Moderate Use +75% Primary Care). We think this scenario is unlikely to occur.

Among the unknowns is whether there is a market saturation point at which APRNs and PAs might have difficulty finding employment. A growing body of literature, both in the United States and internationally, indicates APRNs and PAs provide high-quality care, increase physician productivity, and, in some specialties, perform many of the same functions as physicians; however, there is little information to indicate the extent to which APRNs and PAs displace demand for physicians.[145-148] The supply of these providers has risen rapidly over the past two decades, and they continue to be in high demand, yet there is also continued high demand for physicians.[149]

Exhibit 20: Physician Demand Under Alternative Scenarios of the Degree to Which Advanced Practice Registered Nurses and Physician Assistants Reduce Demand for Physicians, 2019-2034



Scenarios Modeled

We projected physician demand under scenarios that reflect various assumptions about the use of health care services and care delivery. All the scenarios reflect changing demographics from 2019 to 2034 and assume no further increase in medical insurance expansion under the ACA. President Biden and congressional leaders have stated their intention to work together to strengthen the ACA and increase access to health care coverage. Congress has already passed legislation this year to expand subsidies in the ACA marketplaces and to provide incentives for additional states to expand Medicaid coverage. Additionally, President Biden has created a Special Enrollment Period to provide eligible individuals with the opportunity to enroll in coverage through the ACA exchanges. Though specific details on what additional steps the administration and Congress may take to further expand health insurance coverage are unclear, it is expected they will work to build on recent legislative activity.

As in previous reports, we modeled the implications of greater use of managed-care, retail clinics staffed primarily by APRNs, rapid growth in the supply of PAs and APRNs, and achieving certain population health goals to illustrate the potential impact of improved preventive care. Modeled scenarios used to estimate future adequacy of physician supply are the following:

- **Changing demographics (Status Quo Scenario):** This scenario extrapolates current health care use and delivery patterns to future populations using projected demographic shifts (age, gender, and race/ethnicity) from 2019 to 2034. Within each demographic group, the prevalence of disease and health risk factors is assumed to remain unchanged over time. Demand estimates by region and by urban-rural location apply national-average patterns of care to the population in each county — controlling for demographics, lifestyle choices, disease prevalence, insurance coverage, household income, and level of rurality. The demand scenarios summarized below all build on this scenario.
- **Managed care as a proxy for accountable care organizations (ACOs) and value-based payment models (Managed Care Scenario):** Over the past several decades, the U.S. health care system has explored different types of value-based and outcome-based payment and integrated care delivery models for both publicly and privately insured populations. This scenario models implications for physician demand of 100% of the insured U.S. population being enrolled in risk-based entities such as a health maintenance organization (HMO) or ACO. The key modeled impacts, based on an analysis of MEPS data, are a 5.0% increase in national demand for Primary Care physicians, a 2.7% decrease in demand for internal medicine and pediatric subspecialty physicians, a 2.9% decrease in demand for surgeons, a 3.1% increase in demand for Primary-Care-Trained Hospitalists, and a mixed impact on demand for physicians in Other Specialties category.
- **Expanded use of retail clinics (Retail Clinics Scenario):** Retail clinics provide a convenient, cost-effective option for patients with minor acute conditions, and the care is covered by many insurance plans.[150] In 2019, there were an estimated 1,949 retail clinics in the United States, led by CVS Pharmacy with 1,021 and Walgreens with 402.[151] Retail clinics may be an alternative to traditional primary care providers for some services, and there is evidence that retail clinics are serving a population underserved by primary care providers.[140] Ashwood et al. estimated that about 39% of clinic visits replace physician visits, 3% replace ED visits, and 58% are new visits that would not otherwise have occurred.[139] This scenario explores the demand implications of shifting care from Primary Care physician offices to retail clinics for 10 conditions typically treated at retail clinics.[140,152] It assumes the following:
    - Patients with chronic conditions will be seen by their regular primary care provider even for noncomplex health issues that could be treated in a retail clinic.
    - Care in retail clinics will primarily be provided by NPs (only an estimated 300 PAs practiced in retail clinics in 2019).[137]
    - For care provided in Primary Care physician offices, 83% of visits to a pediatrician's office are handled primarily by a physician (reflecting that between APRNs and physicians, 83% of the pediatric workforce are physicians) and 71% of adult primary care office visits are handled primarily by a physician.
    - We used the MGMA estimates for mean annual ambulatory patient encounters for general pediatricians and family physicians to translate the reduction in office visits to the reduction in demand for physicians.[153]

These assumptions suggest about 4,550 visits by children to a retail clinic rather than a pediatrician's office reduce demand for pediatricians by one physician, and about 5,430 retail clinic visits by an adult reduce demand for an adult Primary Care physician by one physician. Given the findings from Ashwood et al., these estimates might overstate the degree to which retail clinics reduce demand for Primary Care physicians.[139] Still, this scenario suggests that noncomplex health care services provided by 8,000-9,000 FTE Primary Care physicians could be diverted to retail clinics.

- **Increased use of APRNs and PAs under "moderate use" and "high use" assumptions (APRN/PA Moderate and High Use Scenarios):** These scenarios reflect the rapid growth in supply of APRNs and PAs and the assumptions described in the previous section, "Advanced Practice

Registered Nurses and Physician Assistants." For modeling purposes, the APRN/PA High Use Scenario assumes each additional APRN or PA beyond the supply needed to maintain current staffing patterns will ease demand for physicians in their specialty as follows: anesthesiology, 60% of an FTE; Primary Care, 50%; women's health, 40%; Medical Specialties, 30%; Other Specialties, 30%; and Surgical Specialties, 20%. The APRN/PA Moderate Use Scenario assumes the adjustment in physician demand is half the above percentages. The percentages imply nothing about the value of services APRNs and PAs provide relative to physicians, but rather, they simply estimate the extent to which these providers fill a currently unmet need or reduce demand for physicians.

- **Achieving select population health goals (Population Health Scenario):** Key risk factors and lifestyle behaviors that population health policies and programs target for disease prevention are obesity, hypertension, dyslipidemia, hyperglycemia, and smoking.[154-157] The goal of reducing the prevalence of those conditions is consistent with Healthy People goals and objectives of the CDC.[157] To assess the physician shortage under a Population Health Scenario, we used the Disease Prevention Microsimulation Model (DPMM).[158-161] We simulated the implications for health care demand of (1) a modest 5% sustained reduction in excess body weight among adults who are overweight or obese; (2) reductions in blood pressure, cholesterol, and blood glucose levels among adults who have elevated levels, with the magnitude of reductions determined by published reports of clinical trials about what can be achieved through appropriate medication and counseling[162-164]; and (3) 25% of smokers quitting smoking — though with high recidivism. The mechanisms by which this hypothetical scenario could be achieved included increased use of medical homes, VBID, and increased emphasis on preventive care to provide patients with testing and counseling and to improve patient adherence to treatment regimens.[165-171] The model assumes greater use of APRNs, PAs, and other health professions to provide the additional counseling and monitoring required to achieve the goals. This scenario illustrates the potential impact on the demand for physicians associated with improved population health and reduced disease prevalence and mortality. Modeling assumptions, methods, and the source of data for key parameters are described in more detail in the 2017 report[172] and include:
    - **Sustained 5% body weight loss for overweight and obese adults:** Numerous lifestyle interventions have achieved 5% or more body weight loss, on average. Although sustaining weight loss is challenging for many patients, a patient-centered medical home model with long-term counseling and pharmacotherapy will presumably help patients maintain weight loss. Reducing excess body weight lowers risk for cardiovascular disease, diabetes, various cancers, and other conditions.
    - **Improved blood pressure, cholesterol, and blood glucose levels for adults with elevated levels:** These goals can be achieved by appropriate screening and pharmacotherapy, as well as by weight loss. Clinical trials indicate that patients with hypercholesterolemia can reduce total blood cholesterol by 34.42 mg/dL (CI, 22.04-46.40) by using statins[162]; patients with uncontrolled hypertension can reduce systolic blood pressure by 14.5 mm Hg (CI, 14.2-14.8) and diastolic blood pressure by 10.7 mm Hg (CI, 10.5-10.8) by using antihypertensives[163]; and patients with elevated hemoglobin A1c levels can reduce A1c by one percentage point (CI, 0.5-1.25), with appropriate screening and pharmacotherapy, gradually reducing the level to where diabetes control is reached, at an A1c of 7.5%.[164]
    - **Smoking cessation:** Patients who stop smoking can lower their risk for various cancers, diabetes, cardiovascular disease, and other diseases.[173-175] Researchers report that compared with a similar population that continues to smoke, cessation at age 25 to 34 years extends life by about 10 years, on average.[174] Cessation at ages 35 to 44 extends life by nine years and at ages 45 to 54, by six years, on average.

The updates to the DPMM used in modeling changes in disease states and mortality leading to achieving the model population health goals included using (1) the most recent National Health and Nutrition Examination Survey data (2017-2018) and (2) recent published clinical trials and observational studies for some health conditions (to update health-transition equations).

This Population Health Scenario is a component of the new Evolving Care Delivery System Scenario (described in the "Evolving Care Delivery System Demand Implications" section), which explores the implications for physician demand of several changes in care delivery as the nation strives to achieve national objectives of improving access to high-quality, cost-effective care. This scenario produces three main impacts on physician demand: (1) In the early years after achieving the modeled population health goals, the demand for physicians falls due to the improved health of the population; (2) over time, as mortality rates fall, demand for physicians rises relative to the Status Quo Scenario because a larger population is still living; and (3) demand shifts between specialties — for example, to a lower demand for endocrinologists but higher demand for geriatricians.

Demand Projections

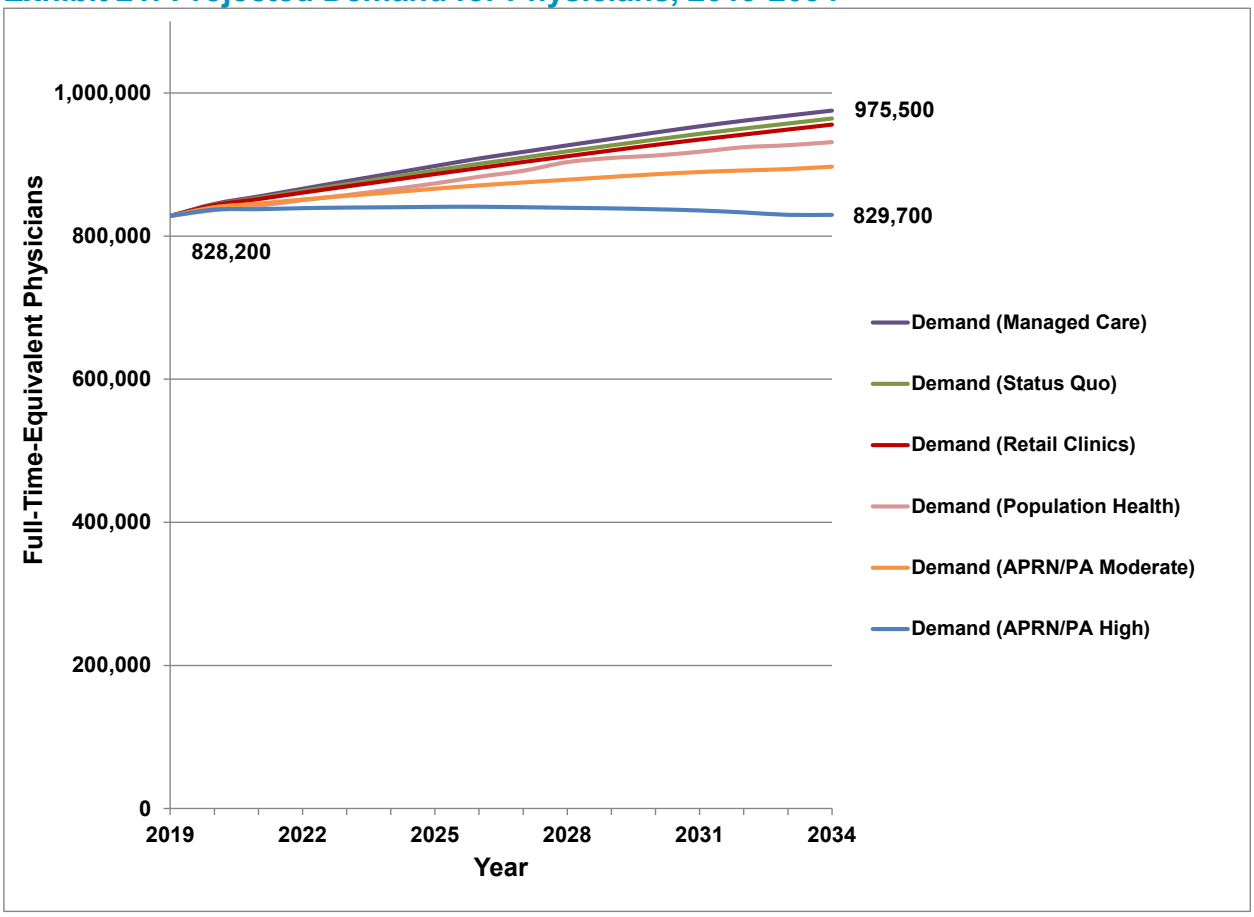
This section presents projected growth in demand for physicians at the national level and by population demographics (age and race/ethnicity). (Growth in demand is presented by census region and urban-rural geographic area in the "Geographic Distribution of Physician Supply and Demand" section.)

National Demand

Demand for physicians is projected to grow under all scenarios modeled, though under the high-APRN/PA scenario, the growth in FTE physician demand is low because this scenario models rapid growth in APRN and PA supply and a high degree of APRNs and PAs displacing physicians (Exhibit 21). Population growth and aging are the largest contributors to changing the demand for physician services. Between 2019 and 2034, changing demographics alone are projected to increase national demand for physicians by about 136,000 FTEs (16%). Demand for Primary Care physicians is projected to grow by 44,600 FTEs (18%). Higher growth rates are expected for Primary-Care-Trained Hospitalists (7,300 FTEs, 22%) and Medical Specialists (30,900 FTEs, 22%); lower growth rates are expected for Surgical Specialties (20,500 FTEs, 13%) and Other Specialties (32,700 FTEs, 12%) (Appendix 2, Exhibit 39).

Analysis of MEPS data finds that, controlling for demographics and health risk factors, patients who report being in an HMO have more touch points with the health care system than patients not in an HMO. The modeled Managed Care Scenario indicates that if all insured patients were moved into managed-care plans that were more like HMOs in terms of how patients use care, there would be a small net increase in physician demand, with the increase coming largely from higher demand for primary care providers. By 2034, according to that scenario, national demand would be about 11,300 physicians higher than it would be according to the Status Quo Scenario, with the additional demand for 13,000 Primary Care physicians partially offset by the reduced demand for 3,600 physicians in internal medicine and pediatric subspecialties. Demand for physicians in the Other Specialties category is 1,400 higher due primarily to higher demand for physiatrists, psychiatrists, and neurologists but lower demand for radiologists. Demand for surgeons increases slightly by 400 FTEs and for Primary-Care-Trained Hospitalists, it increases by 100 FTEs.

Exhibit 21: Projected Demand for Physicians, 2019-2034



The simulated increase in the use of retail clinics modeled demand only for primary care, with demand for Primary Care physicians declining by 8,400 physicians by 2034 relative to the Status Quo Scenario. The Retail Clinics Scenario used conservative assumptions about which type of primary care visits would be provided in a retail clinic because it assumes people with severe chronic disease continue to receive care from their normal primary care provider even for services often provided in retail clinics. Although this scenario only modeled demand that has historically been provided in primary care offices that might shift to retail clinics, the growth in retail clinics could reduce the number of avoidable emergency department visits. Ashwood et al. estimated that about 3% of clinic visits replace emergency department visits.[139]

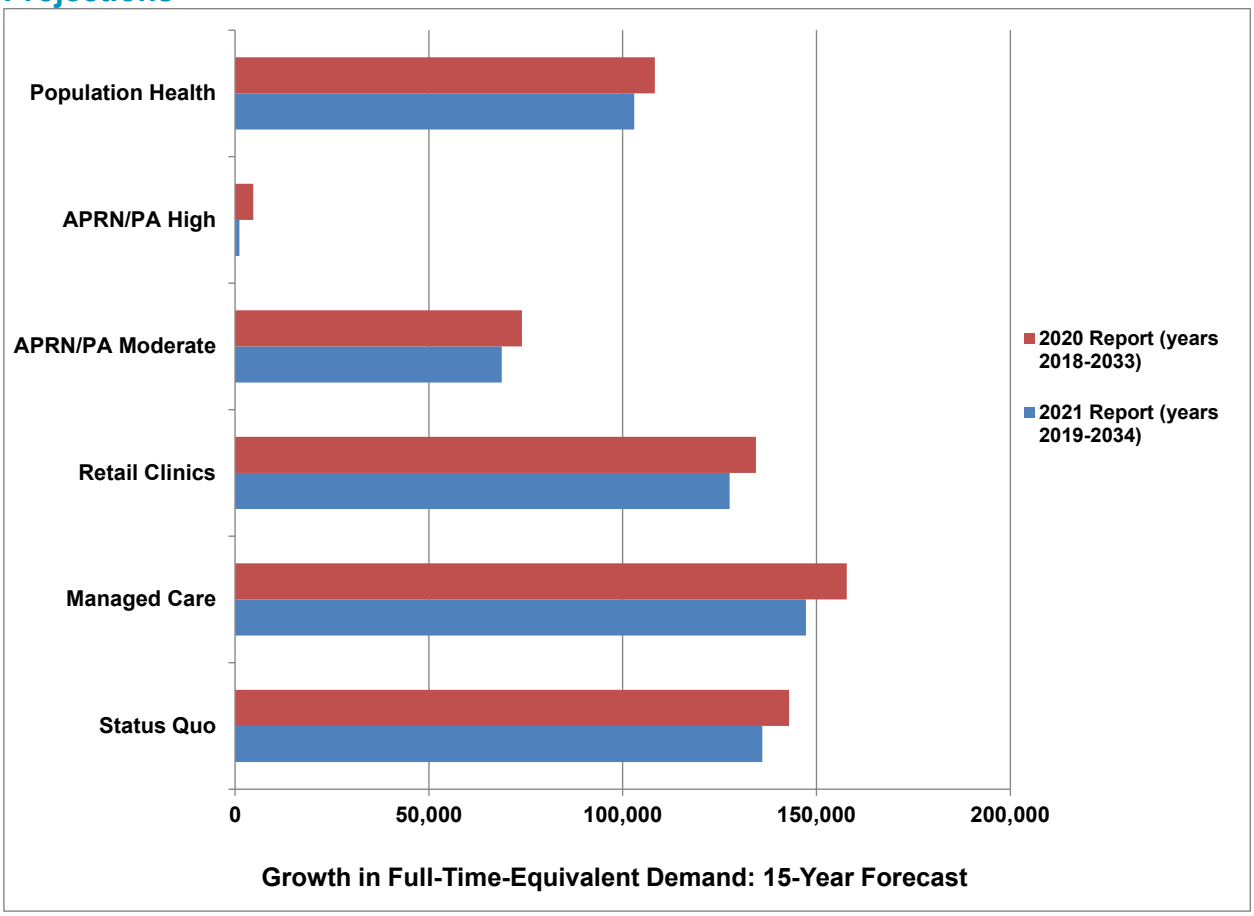
The impacts of increased use of APRNs and PAs are substantial and will vary by physician specialty and assumptions about the future level and scope of care delivery these professions provide. Relative to the Status Quo Scenario projections for 2034, under the APRN/PA Moderate Use Scenario, projected physician demand declines by 67,200 physicians by 2034 with increased use of APRNs and PAs, and under the APRN/PA High Use Scenario, by 134,500 physicians. The APRN/PA High and Moderate Use Scenarios model an approximate doubling of the APRN and PA workforce between 2019 and 2034 (with supply growth rates varying by APRN and PA specialty).

Under the Population Health Scenario, about 18 million more people would be alive by 2034 than projected by the Status Quo Scenario, and the care required by this still-living population will be more than offset by the reduction in care from people being healthier, on average. The net effect is a 28,800-FTE

increase in demand for physicians relative to the Status Quo Scenario. The Population Health Scenario includes the APRN/PA Moderate Use Scenario, under the assumption that achieving the modeled population health goals would happen through greater use of APRNs and PAs for counseling and follow-up care, beyond levels currently provided, to help patients achieve desired health outcomes. Furthermore, the additional 18 million people alive by 2034 under this scenario would require more APRN and PA services, so there would be fewer available APRNs and PAs to offset projected physician shortages. Physician demand under this scenario is 33,000 FTEs fewer than the Status Quo Scenario projections for 2034.

Exhibit 22 compares projected growth in physician demand from the updated projections with last year's report, with both reports covering a 15-year period (2018-2033 and 2019-2034). Under each scenario, the updated 15-year growth projections are slightly smaller than in the previous report. The new demand growth projections for 2019-2034 are almost identical to the projections for the years that overlap with the previous study (2019-2033).

Exhibit 22: Projected Change in Physician Demand: 2021 vs. 2020 Report Projections

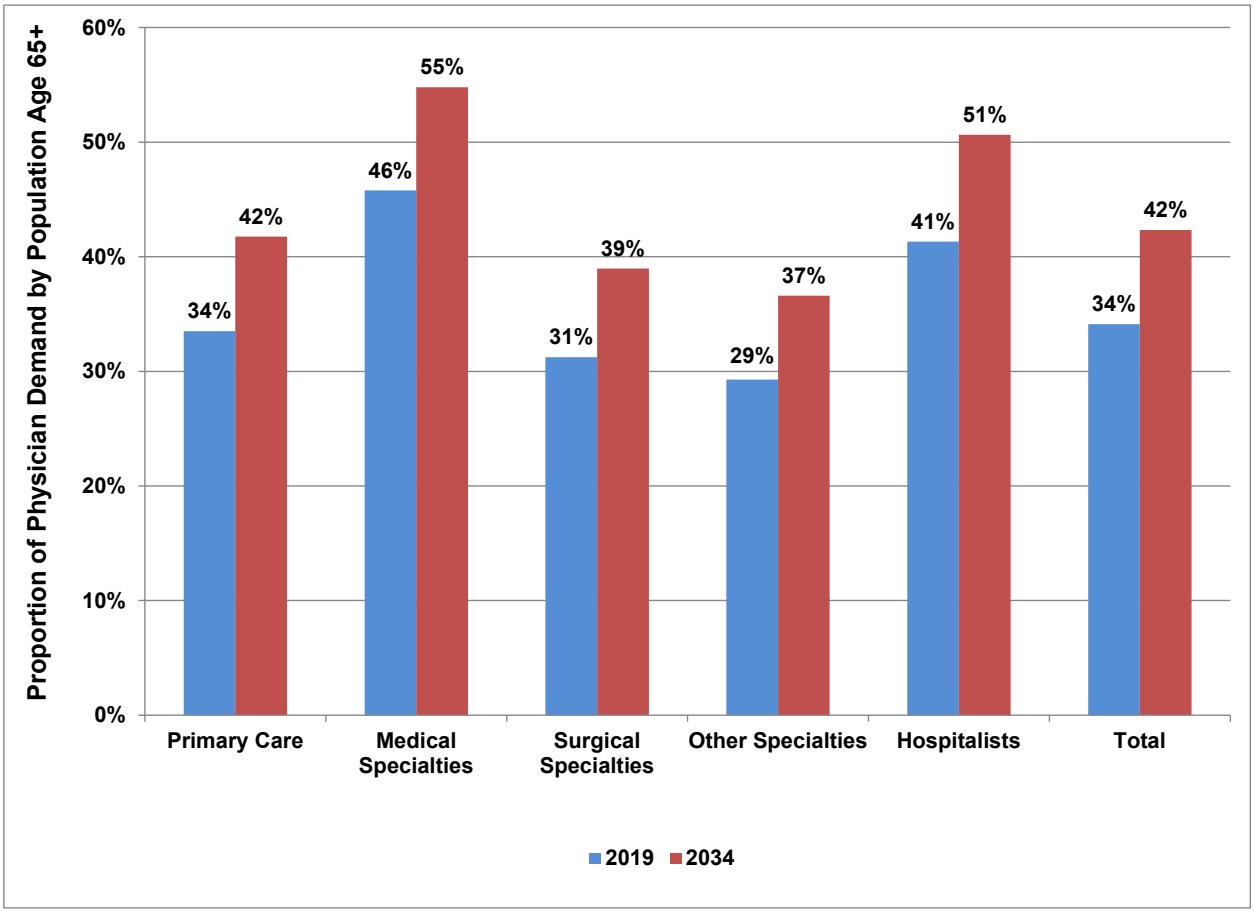


Demand by Population Demographics

Current and projected growth in demand for physician services reflects, in large part, the aging of the population and growth in size of racial and ethnic minority populations.

Physician Demand by Patient Age (Exhibit 23): Currently, about a third (34%) of FTE physician demand is from patients age 65 and older, equivalent to 280,700 FTE physicians to care for the population age 65 and older. By 2034, 42% of demand (equivalent to 407,300 FTE physicians) will be for the care of the population age 65 and older. These projections underscore the growing importance of the Medicare program in future years because an increasing proportion of patient care will be provided to Medicare enrollees.

Exhibit 23: Proportion of Physician Demand by Population Age 65+, 2019 and 2034

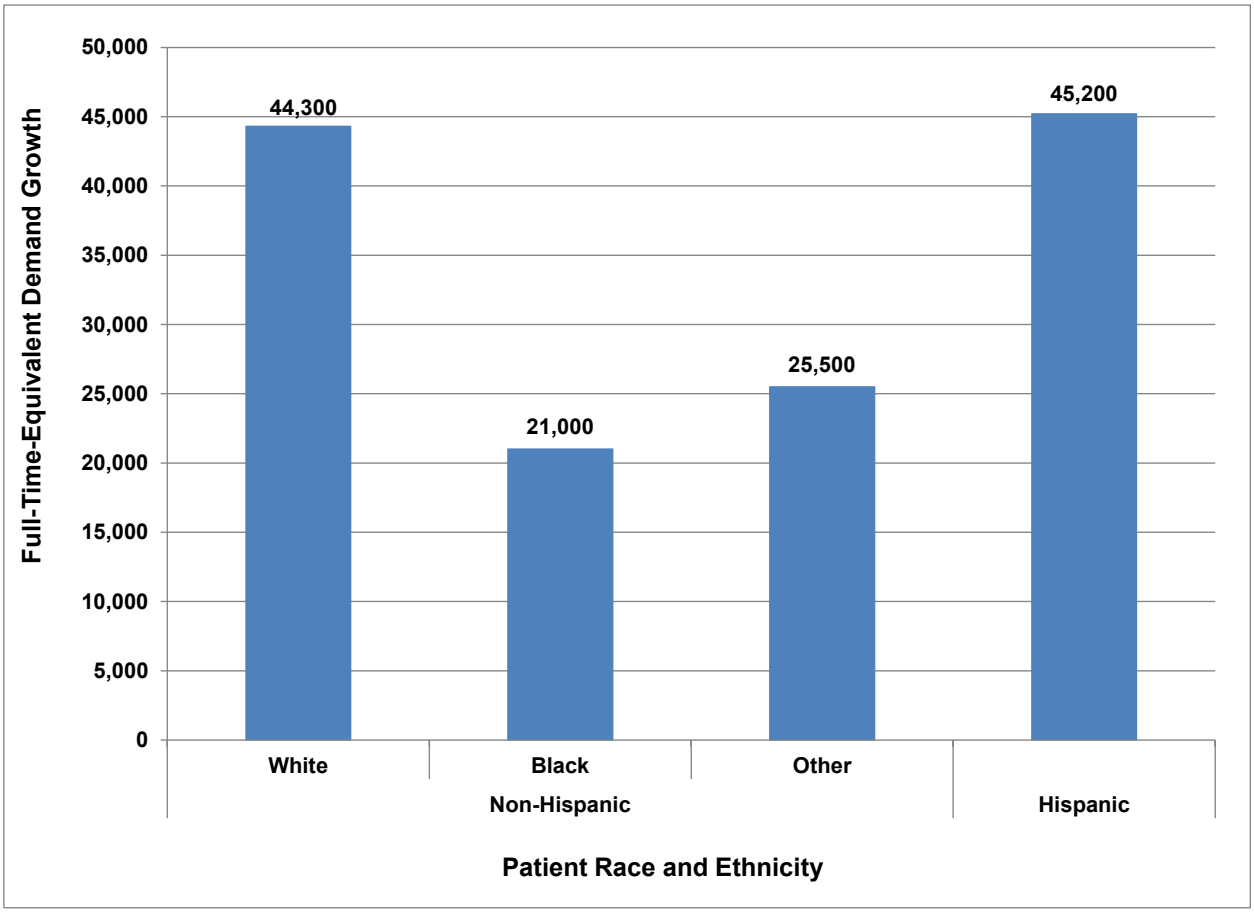


Physician Demand by Patient Race and Ethnicity (Exhibit 24): Patterns of health care use and delivery differ systematically by patient race and ethnicity, reflecting underlying differences in age distribution, disease prevalence (e.g., cardiovascular disease, diabetes), and health-related behaviors (e.g., obesity, smoking); economic factors (e.g., medical insurance coverage, household income); possibly cultural differences in care utilization; and other factors affecting access. For modeling purposes, we categorized patients into one of four mutually exclusive categories: non-Hispanic White, non-Hispanic Black, non-Hispanic all other, and Hispanic.[b]

In 2019, an estimated 60% of the U.S. population was non-Hispanic White, but this population accounted for about 67% (557,700 FTEs) of total physician demand. The Hispanic population, however, represented 18% of the U.S. population but accounted for about 14% (112,500 FTEs) of physician demand. Between 2019 and 2034, the non-Hispanic "all other population" is projected to grow the most rapidly in percentage terms (36.4% growth), followed by the Hispanic (32.0%), non-Hispanic Black (13.4%), and non-Hispanic White (-0.4%) populations. Based on changing demographics, demand for physician services is projected to grow by 138,900 FTEs from 2019 to 2034. This growth includes an additional 42,900 FTEs (8% growth) associated with an aging non-Hispanic White population, 47,200 FTEs (42% growth) associated with growth and aging of the Hispanic population, 27,200 FTEs (43% growth) associated with growth and aging of the non-Hispanic all other population, and 21,600 FTEs (23% growth) associated with growth and aging of the non-Hispanic Black population (Exhibit 24).

In 2019, an estimated 68.2% of physicians were White; 23.3% were Asian; 2.6% were Black or African American; 0.4% were American Indian or Alaska Native; 0.4% were Native Hawaiian or Other Pacific Islander; 3.8% were Hispanic, Latino, or of Spanish origin; 3.3% were other races; and 1.9% were multiple race/ethnicities (based on data from the NSSP, which allowed the selection of multiple categories). During the 2019-2020 academic year, the race/ethnicities of medical school enrollees were 49.8% non-Hispanic White, 22.5% Asian, 7.3% Black or African American, 6.5% Hispanic, and the remainder, other or multiple race/ethnicities (12.9%) or unknown race/ethnicity (1%).[176] These findings highlight that some minorities (Black or African American; Hispanic, Latino, or of Spanish origin; Native American and American Indian; and Native Hawaiian and Pacific Islander) are underrepresented among physicians relative to both U.S. and patient demographics. Furthermore, based on national demographic trends, demand for physician services is projected to grow proportionately faster for minority populations.

Exhibit 24: Projected Physician-Demand Growth by Patient Race and Ethnicity, 2019-2034



EVOLVING CARE DELIVERY SYSTEM DEMAND IMPLICATIONS

The U.S. health care system continually evolves to reflect changes in the nation's goals and priorities, changes in medicine and technology, changes in societal and patient expectations, and the economic realities of care delivery. Utilization-based health-workforce-demand projections have been criticized for assuming a perpetuation of the current health care system, which is represented by the demand Status Quo Scenario, rather than modeling the workforce needed for a future system. The HCUE Scenarios, discussed in the preceding section of this report, estimate total demand for physicians if the nation could achieve the goals of reducing the barrier to accessing care. While recognizing that the contemporary health care system is based on current health policy, infrastructure, and technology that will not transform overnight, the research presented in this section of the report explores trends in system transformation and their potential implications for the physician workforce. The projections combine elements of modeling scenarios described earlier in this report and information from the literature on other emerging trends. ***Because this work is an amalgamation of demand scenarios included in the shortage projections, this scenario is not included in calculating those projections*.**

A goal of ACA and subsequent legislation was to incentivize and reward health care providers for promoting quality and value, whereas the fee-for-service model creates incentives that rewarded quantity of services provided.[177-179] Changes encouraged by legislation and payment reform include strengthening the nation's primary care foundation,[180] promoting and achieving population health goals to improve disease prevention,[181-184] improving coordination of care to manage high-risk patients across the care continuum,[185,186] and making care more affordable by eliminating unnecessary spending and discouraging low-value care.[187] Only a few early ACA policies specifically targeted physician supply, with modest changes to GME funding and increased funding for health centers and the National Health Service Corps. Most recent changes in legislation and business practices primarily affect physician demand indirectly through changes in care-usage and care-delivery patterns.

Responses to changing financial incentives have led to changes in the organization of the health care industry. Payers and providers are consolidating horizontally and vertically and restructuring internal operations to increase efficiency, with a growing proportion of physicians being employees rather than practice owners.[188,189] There is some evidence that employee physicians work fewer hours per week in direct patient care than self-employed physicians, partly because they spend more time on administrative and indirect patient-care activities and they have less financial incentive to extend already long hours worked per week.[190-192]

Key mechanisms for producing value specifically promoted by the ACA or incentivized through payment reform include patient-centered care, team-based care, VBID, risk sharing, disease management, rewarding quality, and greater use of technology such as electronic medical records and telemedicine. These mechanisms are not mutually exclusive, and multiple mechanisms often contribute to the same goals. For example, improved medication adherence to control hypertension, hyperlipidemia, and hyperglycemia helps reduce risk for cardiovascular disease, stroke, and diabetes and sequelae.[193,194] There is strong evidence that medication adherence is improved through VBID,[169,170] patient-centered medical homes (PCMH),[166,168] disease management programs and counseling,[195,196] team-based care,[169,197,198] and increased use of technology.[199,200]

The challenges of modeling the implications of evolving care delivery on future demand for physicians include (1) the paucity of evidence about effects of evolving care delivery and the evidence that has been generated focuses on the earliest and, so far, most successful trials of the innovation; (2) much of the published literature evaluating interventions to change patient health and utilization outcomes pertains to a specific population or disease, so it cannot be generalized to the U.S. population; (3) multiple factors often

influence patient outcomes, so the impact of specific interventions or trends cannot be isolated (e.g., using technology in conjunction with PCMH); and (4) the mechanisms for achieving health system goals (e.g., technology) continue to evolve over time. Because of these challenges, rather than model a set of interventions such as VBID and PCMH, we modeled five major components of an improved health system:

1. **Improving population health:** This component of the Evolving Care Delivery System Scenario is the Population Health Scenario described previously and used to develop the physician-shortage ranges. This scenario modeled the national goals of making progress toward reducing excess body weight; reducing the prevalence of hypertension, hypercholesterolemia, and hyperglycemia; and smoking cessation; these are only a subset of targeted patient health outcomes. Achieving these goals, however, would (1) prevent or delay disease onset and disease severity, leading to lower demand for physician services, and (2) reduce mortality, with more people living to an older age, leading to increased demand for physician services. Model outcomes suggest that by 2034, there would be a net increase in physician demand of 28,800 FTEs to service a larger population due to reduced mortality. This scenario assumes APRNs and PAs would be a key workforce component, providing the additional counseling and follow-up required to meet the modeled population goals and helping care for the larger living population.
2. **Managing care and risk-bearing organizations:** As discussed in the "Demand Modeling" section, one demand scenario modeled differences in health care use patterns of patients in a managed-care plan compared with patients not in a managed-care plan as a proxy for differences in care-use and care-delivery patterns associated with applying managed-care principles. While ACOs differ in many ways from traditional managed-care plans, they share many of the same goals around disease prevention, shifting care to appropriate lower-cost settings and providers, care coordination, and improving care quality and efficiency. This component of the Evolving Care Delivery System Scenario incorporates the Managed Care Scenario modeled to forecast the range of physician shortages. The projected outcome of this scenario is a net 4,900-FTE increase in physician demand, due primarily to increased demand for primary care physicians, with decreased demand for physicians in many other specialties.
3. **Addressing unmet behavioral health needs:** The shortage of behavioral health providers and the unmet behavioral health needs in the United States have been well documented. This provider shortage extends beyond the 6,100 psychiatrists required to de-designate Mental Health Professional Shortage Areas. Nearly one in five adults with mental illness reports they were unable to obtain treatment because of barriers to getting the help they need, and the prevalence of undiagnosed needs is high.[201,202] Approaches to addressing unmet behavioral health needs include improving access to behavioral health services and training primary care providers and others to screen patients for behavioral health needs. While psychiatry is the only specialty focused on addressing patient mental health needs, primary care is essential for addressing and screening for patient behavioral health needs because it is the main point of entry into the health care system.[203] This is especially true in rural areas and underserved communities.[204] There is insufficient information to quantify how addressing unmet behavioral health needs will affect demand for Primary Care physicians, so, for this scenario, we model only the potential impact on demand for psychiatrists.

   Analysis of MEPS data finds that people without medical insurance, people living in underserved areas, and racial and ethnic minority populations have fewer annual visits to psychiatrists compared with their counterparts who are insured, living in suburban areas, and non-Hispanic White. We model a scenario where these disparities in access to psychiatrist services are cut in half, which raises demand for psychiatrists by close to 7,300 FTEs more than the baseline demand (Status Quo) scenario by 2034.

4. **Organizing care across care-delivery settings and coordinating multidisciplinary care:** Efforts to improve quality of care and better coordinate multidisciplinary care across delivery settings, as well as incentives through the Hospital Readmissions Reduction Program, have contributed to declines in the proportion of patients readmitted to the hospital following discharge.[205-208] Efforts continue to prevent avoidable hospitalizations and emergency visits through increased access to primary care and preventive services and to divert emergency visits to appropriate lower-cost settings such as physician offices, retail clinics, urgent care centers, and crisis centers for behavioral health conditions.[209-212] In some instances, efforts to reduce demand for hospital services will reduce overall demand for physicians. In other instances, these efforts will shift demand from hospital-based physicians to physicians practicing in ambulatory settings. For this analysis, we modeled the following assumptions:

    a. We modeled a gradual 5% reduction in hospital inpatient utilization, relative to the Status Quo demand projections, with a corresponding reduction in demand for Primary-Care-Trained Hospitalists. We assumed that reduced hospital demand for other physicians (e.g., in Medical and Surgery Specialties) would be offset by increased demand for these physician services in ambulatory or outpatient settings. This 5%-reduction assumption is likely conservative. Studies report participation in a PCMH team-based intervention reduced hospitalizations for PCMH-targeted conditions by 13.9% and for all other conditions, by 3.8%,[213] and reduced rehospitalization rates from 18.8% to 7.7%.[214]

    b. We modeled an 18% decline in emergency visits relative to the Status Quo demand projections, with a corresponding decrease in demand for emergency physicians. The modeled 18% decline starts with estimates by Truven Analytics that 71% of emergency visits by people with employer-sponsored health insurance are potentially avoidable (either by diverting the visit to an appropriate ambulatory setting or by having treated the medical condition that precipitated the visit).[215] We assume this 71% estimate approximates potentially avoidable emergency visits for the Medicaid, Medicare, and uninsured populations. Not all potentially avoidable emergency visits can be prevented or diverted, and we modeled a 25% reduction in these visits. So, the 18% decline assumption reflects a 25% reduction of the 71% of potentially avoidable emergency visits. We assume each averted emergency visit would be replaced by an ambulatory visit to a physician office or outpatient or clinic setting, with ambulatory visits prorated across Primary Care and Medical Specialists (with about two-thirds of redirected visits being patients seen by a Primary Care provider and one-third, seen by a Medical Specialist).

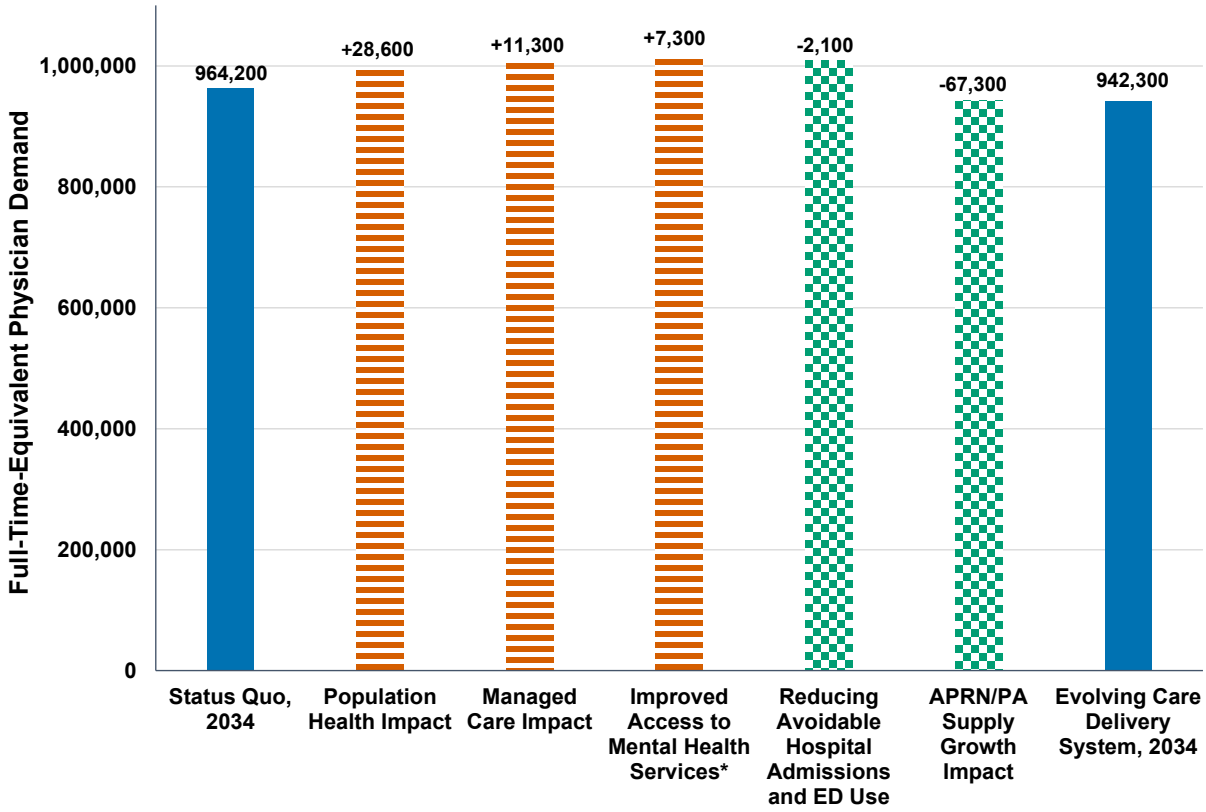
    The impact by 2034 of this scenario component is a 9,900-FTE decrease in demand for emergency physicians and a 2,100-FTE decrease in demand for Primary-Care-Trained Hospitalists, offset by an increase in demand for 6,200 FTE Primary Care physicians and 3,700 FTE physicians in internal medicine and pediatric subspecialties.

5. **Increased supply and expanding role of APRNs and PAs:** For this Evolving Care Delivery System Scenario, we include the APRN/PA Moderate Use Scenario under the assumption that to achieve national goals around improvements in population health and improved access to care, APRNs and PAs will help address many unmet patient needs and efforts to improve patient health outcomes.

    Other trends beyond the five modeled components of this Evolving Care Delivery System Scenario could change future demand for physician services, though we do not have enough information to quantify the magnitude of increases or decreases in demand these other factors could cause or which specialties each factor might apply to. Factors not modeled include potential advances in medicine and technology and increased use of existing technologies such as telemedicine.

The Status Quo Demand Scenario modeled that between 2019 and 2034, total demand for physicians would increase by 138,900 FTEs if care delivery is relatively unchanged, with this increase coming from a growing and aging population (Appendix 2, Exhibit 39). Many changes in care delivery could increase demand for physicians by expanding access to care, addressing unmet needs, or reducing mortality. Other changes might shift care across care-delivery settings or across provider types. The largest modeled impact on physician demand is the 67,200-FTE decrease in physician demand associated with more than doubling the size of the APRN and PA supply over the next 15 years if the APRN and PA training pipeline continues to expand (Exhibit 25). By 2034, demand would be about 938,800 FTE physicians — 28,300 FTEs (3%) lower than the 967,100-FTE estimate from the Status Quo Scenario.

Exhibit 25: Physician-Demand Implications of Evolving Care Delivery System Components by 2034

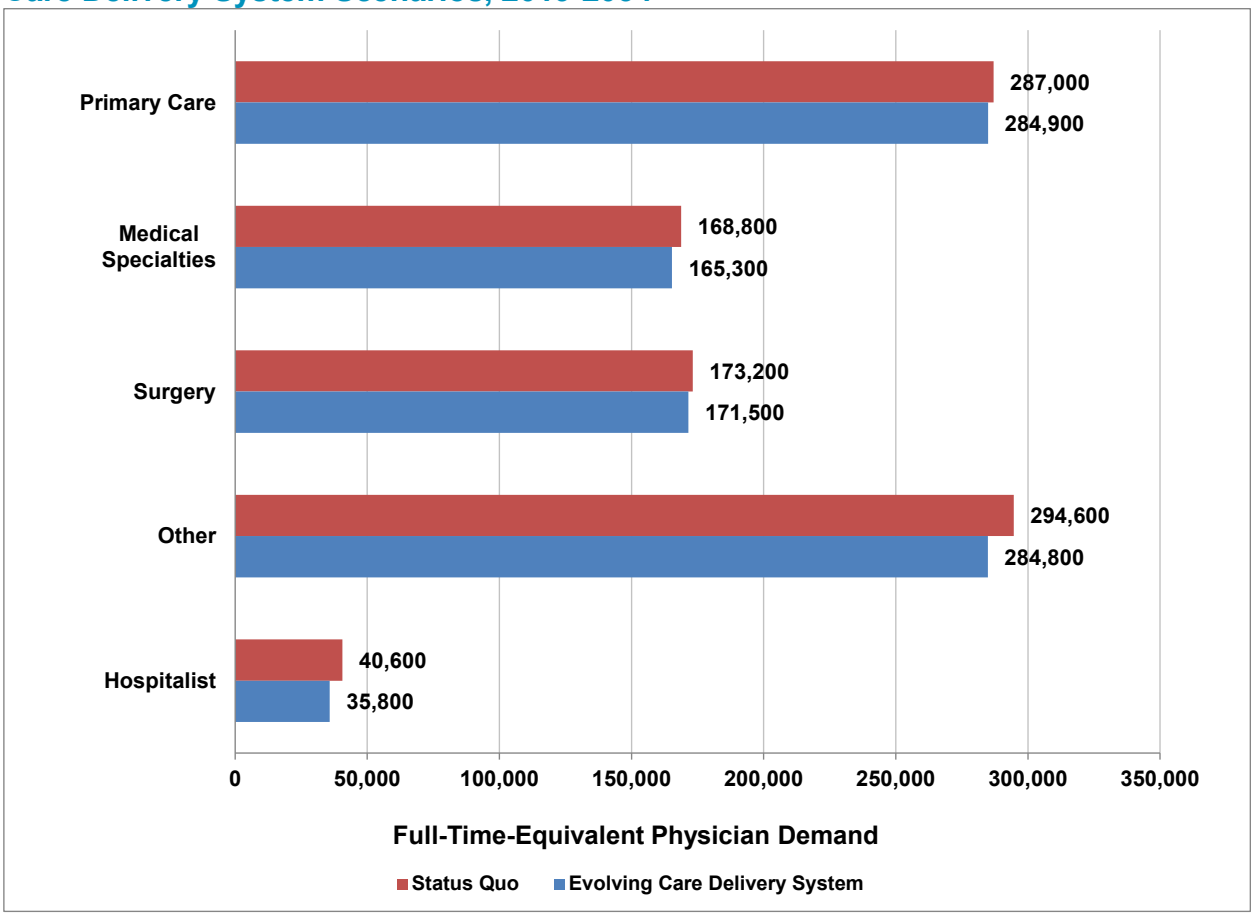


*The estimate for improving access to mental health services likely understates the total impact on physician demand because it reflects only the impact on demand for psychiatrists. The impact on demand for primary care physicians and specialist physicians who provide mental health services to their patients is unknown.

Note: The solid blue bars represent total demand by 2034 under the Status Quo and Evolving Care Delivery System Scenarios; the orange striped bars and green checkered bars show the estimated magnitude of trends or factors that will potentially increase or decrease demand, respectively, relative to the Status Quo Scenario

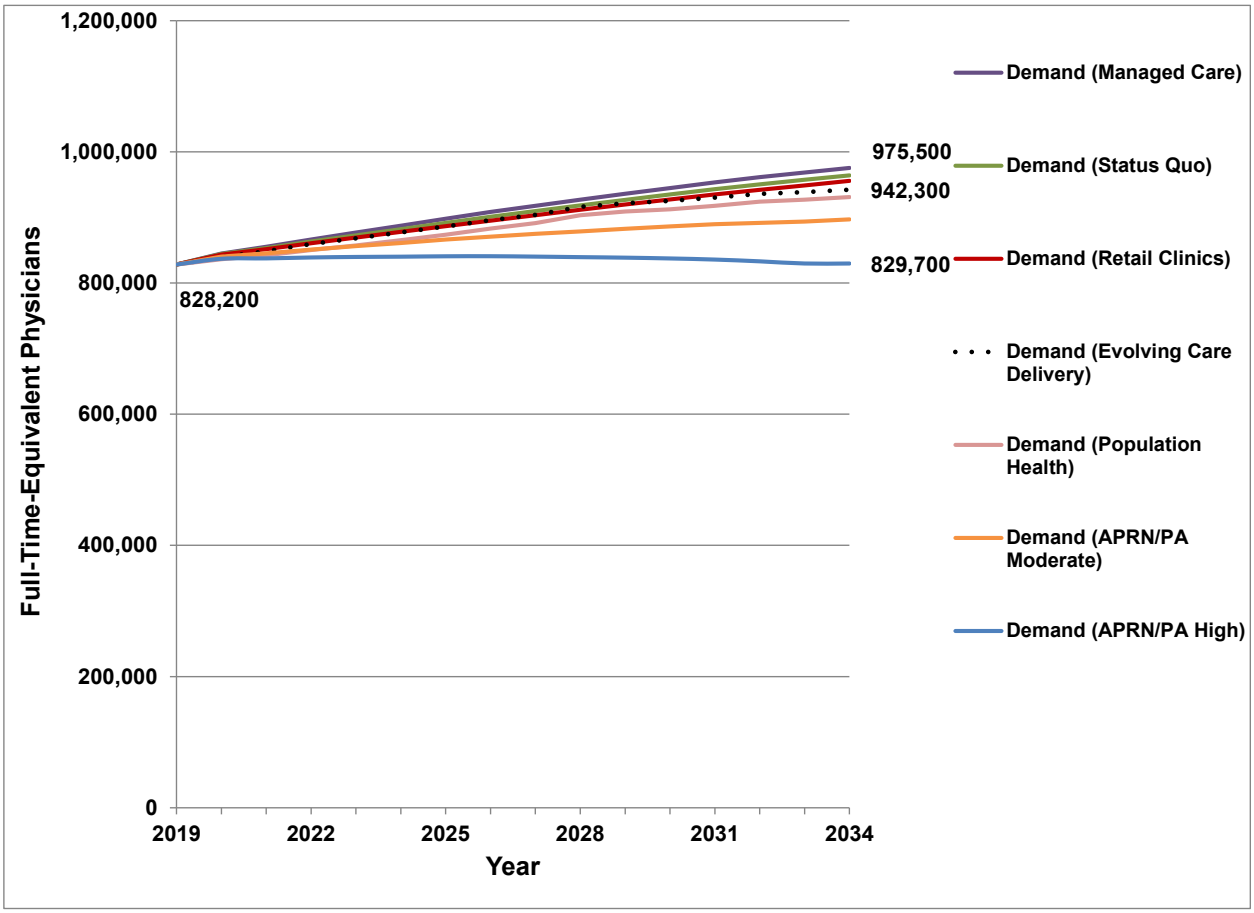
Modeling results suggest that by 2034, demand for Primary Care physicians under the Evolving Care Delivery System Scenario would be 900 FTEs lower than projected under the Status Quo Demand Scenario (Exhibit 26). Demand would be lower by 4,800 FTEs for Medical Specialties and by 8,200 FTEs for Surgery Specialties. The largest decline in demand (10,700 FTEs) is for Other Specialties, with much of this drop due to a decline in demand for emergency physicians and the impact on physician demand associated with the projected large growth in supply of CRNAs and psychiatric NPs. The 3,700-FTE drop in demand for Primary-Care-Trained Hospitalists is the net effect after considering factors associated with higher demand for hospitalists (reduced mortality from improved population health and managed care) and factors associated with lower demand for hospitalists (e.g., interventions to reduce hospitalizations and increased use of APRNs and PAs).

Exhibit 26: Projected Growth in Physician Demand Under Status Quo and Evolving Care Delivery System Scenarios, 2019-2034



Demand projections under the Evolving Care Delivery System Scenario fall within the range of the demand scenarios used to develop the physician-shortage ranges, with three demand scenarios projecting higher physician demand and three projecting lower physician demand (Exhibit 27). This is not surprising because this scenario combines elements of the Managed Care, Population Health, and APRN/PA Moderate Use Scenarios.

Exhibit 27: Evolving Care Delivery System Scenario Demand Projections, 2019-2034



While additional research will improve understanding of how care delivery — and its workforce implications — might evolve over time, the findings presented here suggest that changes in care delivery that decrease demand for physicians will be partially offset by changes in care delivery that increase demand for services. This is not surprising because the national priorities of expanding access to care, providing more comprehensive care, and reducing mortality will increase demand for health care services and providers. System changes to reduce the growth of health care expenditures will likely decrease physician demand in some specialties and care-delivery settings by shifting care from specialists to generalists, from physicians to nonphysicians, and from hospital-based physicians to community-based physicians.

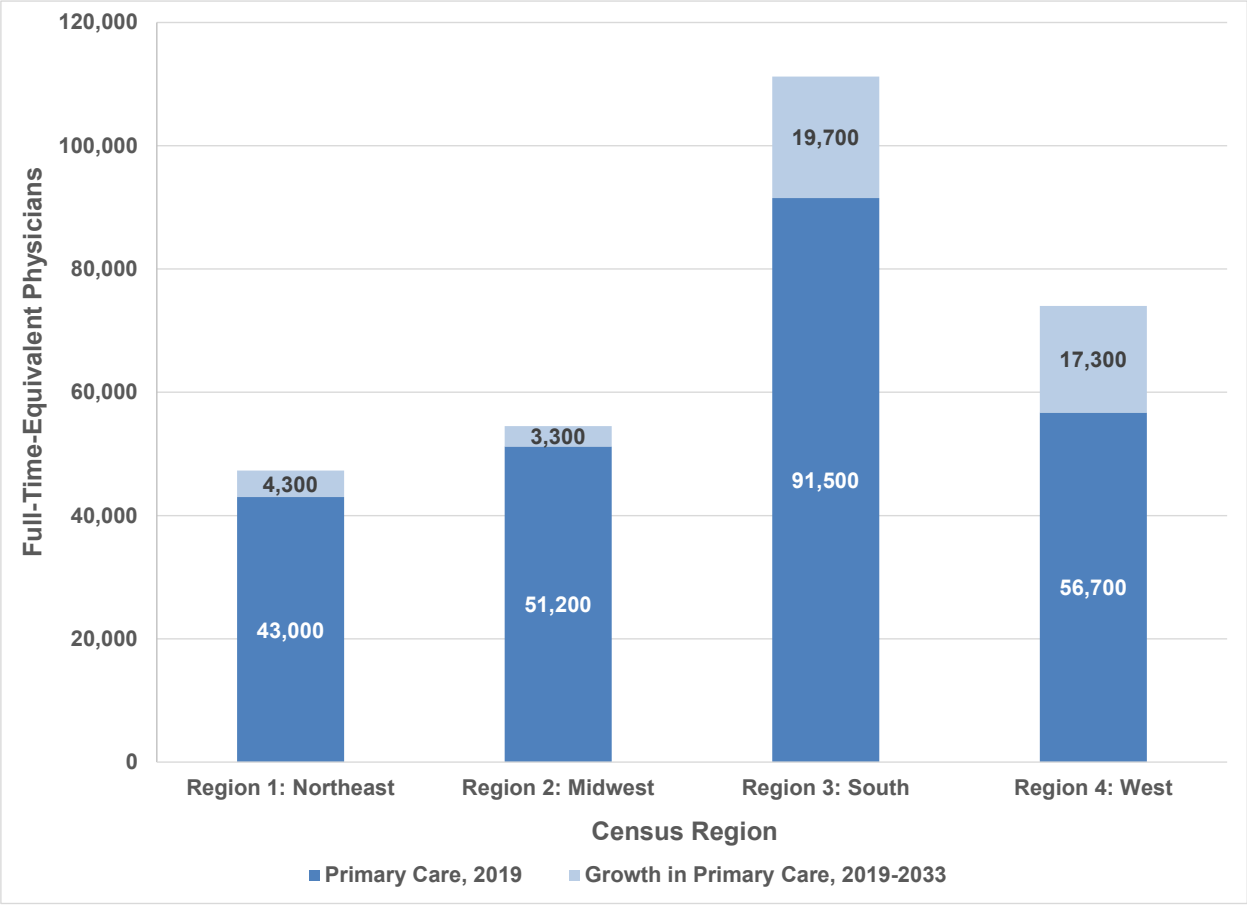
GEOGRAPHIC DISTRIBUTION OF PHYSICIAN DEMAND

Current supply and demand for physicians and projected growth in demand vary geographically by region and by urban-rural location.

Physician Demand by Census Region

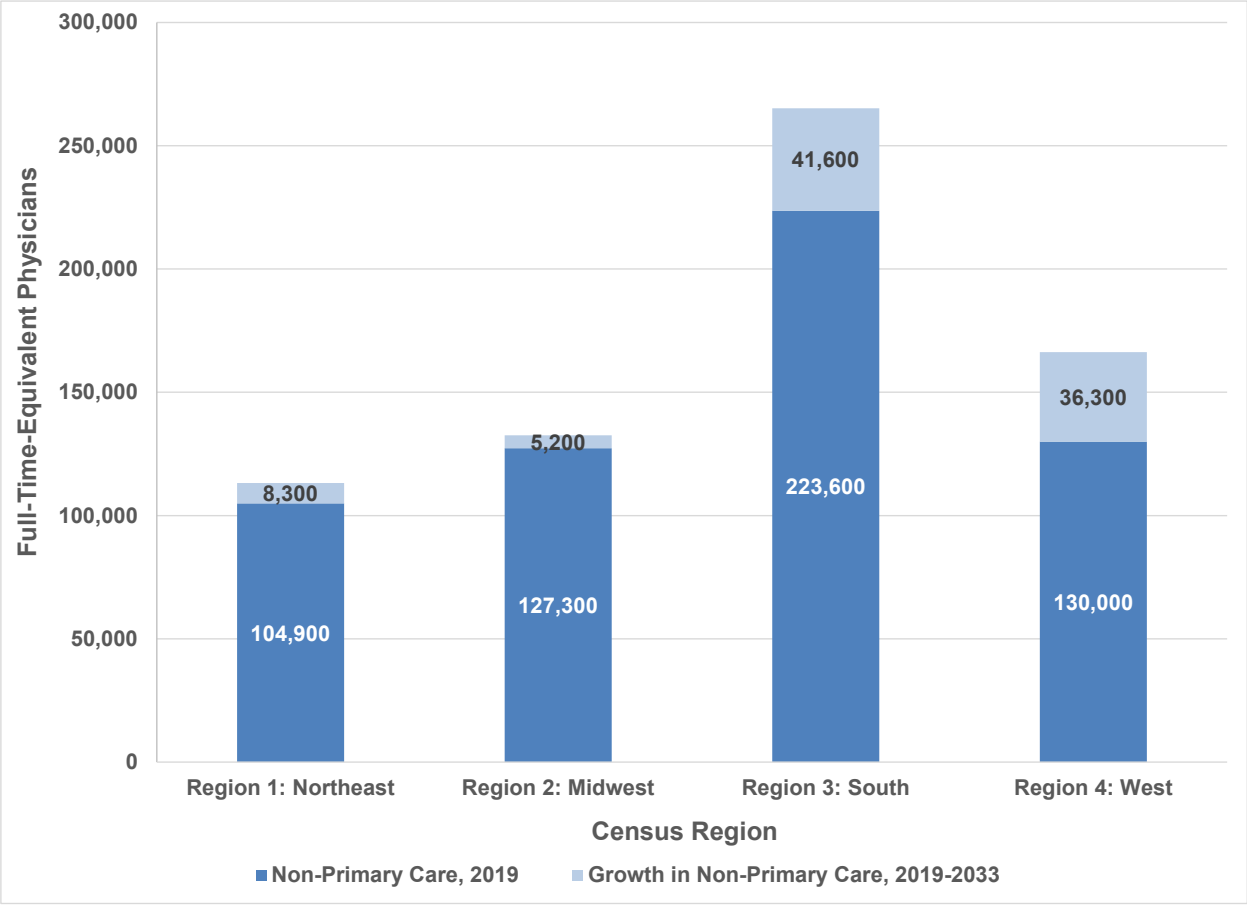
Utilization of physician services and projected growth in demand vary by census region due to differences in demographics and projected population growth, insurance coverage, health risk factors (e.g., obesity, smoking prevalence), disease prevalence, economic conditions, and care-access barriers. If care were evenly distributed across the United States after adjusting for demographics, socioeconomic factors, and prevalence of disease and health risk factors, physician demand in 2019 would be distributed as follows across census regions: 315,900 FTEs (38.1%) in the South Region, 186,900 FTEs (22.6%) in the West Region, 177,800 FTEs (21.5%) in the Midwest Region, and 147,600 FTEs (17.8%) in the Northeast Region. Demand growth from 2019 to 2034 is projected to be largest in the South (62,900 FTEs) and West (54,600 FTEs) and smallest in the Midwest (8,800 FTEs) and Northeast (12,600 FTEs) (see Appendix 2, Exhibit 34). Exhibits 28 and 29 show estimated current demand and projected growth in demand for, respectively, primary care and non-primary care physicians.

Exhibit 28: Physician Primary Care Demand and Demand Growth by Census Region, 2019-2034



Note: Demand is defined as the number of FTE physicians required to provide a national-average level of care given the demographics, prevalence of disease and health risk factors, insurance coverage, household income levels, and health care use patterns of the population residing in each region.

Exhibit 29: Physician Non-Primary Care Demand and Demand Growth by Census Region, 2019-2034



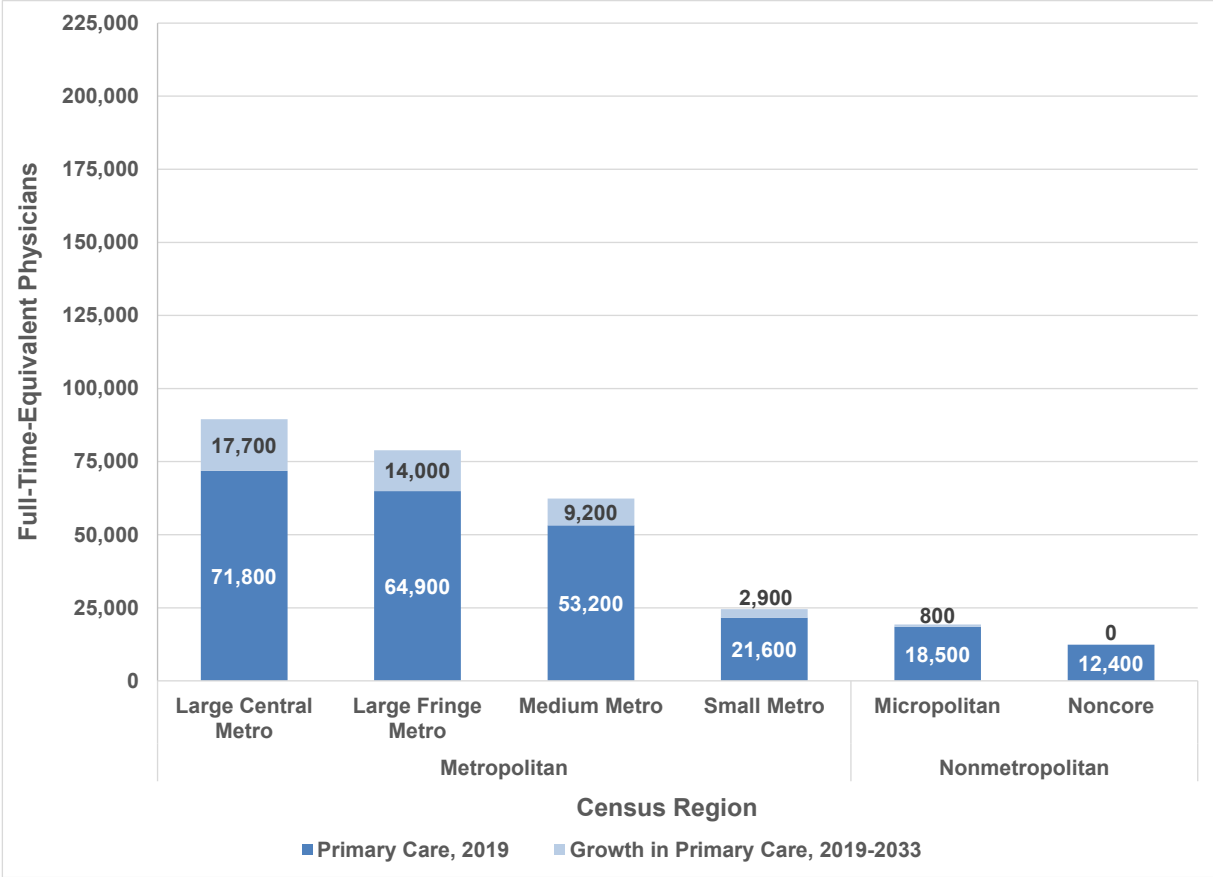
Note: Demand is defined as the number of FTE physicians required to provide a national-average level of care given the demographics, prevalence of disease and health risk factors, insurance coverage, household income levels, and health care use patterns of the population residing in each region.

Physician Demand by Urban-Rural Location

We estimated physician demand and demand growth across type of location, from urban to rural, as defined by the 2013 NCHS Urban-Rural Classification Scheme for Counties (Exhibits 30 and 31; Appendix 2, Exhibit 35).[128] Demand is defined by population residency location type controlling for geographic variation in population characteristics (demographics, disease prevalence, medical insurance coverage, lifestyle choices, and household income). Between 2019 and 2034, almost all (98%) projected growth in physician demand will be in metropolitan areas. In the most rural (noncore) areas, demand for most specialties is projected to decline as state population projections show people leaving the most sparsely populated counties.

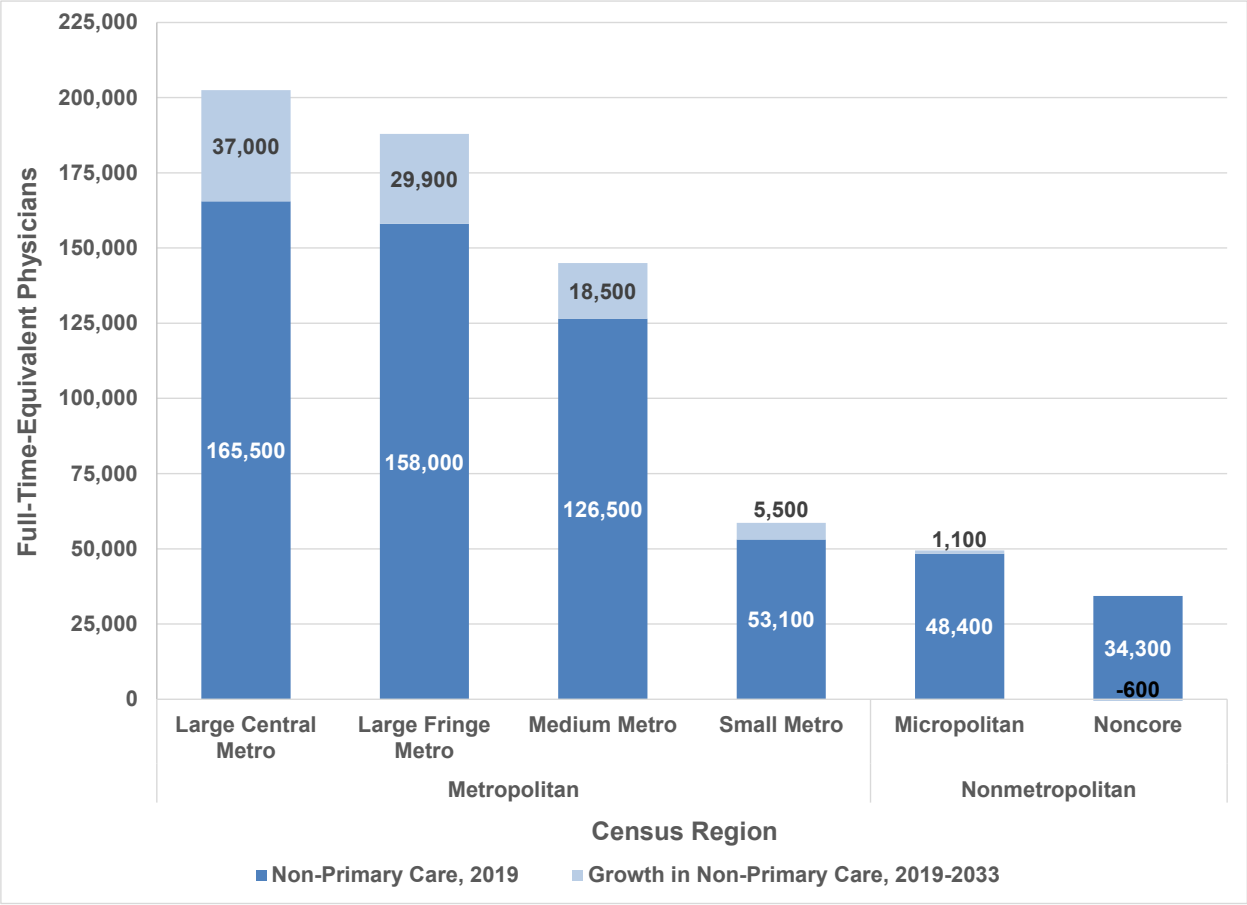
U.S. Census Bureau data find that before the COVID-19 pandemic, the percentage of Americans changing residence each year had reached an all-time low.[216] However, this same report by the Brookings Institute indicates that real estate data show some movement of the population away from the most densely populated areas to less densely populated areas — mostly from urban centers to suburban areas — though it is too soon to know whether pandemic-related migration patterns will persist in the long term.

Exhibit 30: Physician Primary Care Demand and Demand Growth by Metropolitan Designation, 2019-2034



Note: Demand is defined as the number of FTE physicians required to provide a national-average level of care given the demographics, prevalence of disease and health risk factors, insurance coverage, household income levels, and health care use patterns of the population residing in counties with each urban-rural designation using the 2013 NCHS Urban-Rural Classification Scheme for Counties.

Exhibit 31: Physician Non-Primary Care Demand and Demand Growth by Metropolitan Designation, 2019-2034



Note: Demand is defined as the number of FTE physicians required to provide a national-average level of care given the demographics, prevalence of disease and health risk factors, insurance coverage, household income levels, and health care use patterns of the population residing in counties with each urban-rural designation using the 2013 NCHS Urban-Rural Classification Scheme for Counties.

CONCLUSIONS

The COVID-19 pandemic and results of recent national elections show how quickly things can change within the health care system and national priorities and programs related to health care delivery. While there are still many unknowns about the long-term implications of COVID-19 for the physician workforce, by 2034, any overall supply or demand effect of COVID-19 will likely be small despite the disruptive short-term impact — though the impact on physicians themselves, and the way they practice, will be more profound. The implications of the 2020 national elections on future physician supply and demand are unknown, but they could include increased demand associated with expanded medical insurance coverage and efforts to improve access to care for underserved populations. The modeled Health Care Utilization Equity Scenarios presented in this report illustrate that more physicians and other health care providers are needed as part of any comprehensive equity-based strategy to reduce barriers to accessing care. The modeled Population Health Scenario presented in this report illustrates that improvements in population health could reduce demand for physicians in the short term, though in the long term, demand would likely rise as mortality rates decline.

In addition to epidemiological, political, and economic forces that can rapidly change business practices and public policies at the state and federal levels and thus create uncertainty when projecting future supply and demand for physicians, other factors will continue to reshape the U.S. health care system. These include changing demographics, advances in medicine and technology, and rapidly increasing supply of other health providers such as APRNs and PAs. Such changes underscore the need for reliable information about the capacity of the nation's future health care workforce in general — and the physician workforce in particular — that allows both public and private stakeholders to make well-informed investments to supply the U.S. population with the health care it needs.

The pace of change in the health care system, coupled with the long lead time needed to train new physicians, necessitates frequent updating of both health care workforce models and their resulting projections. Thus, the AAMC has committed to commissioning an annual update of national physician workforce projections with a threefold aim: (1) updating and improving workforce projections, (2) presenting new analyses on the workforce needed for a growing and aging population and an evolving health care system, and (3) identifying future directions for research to inform and improve these projections.

Despite the dizzying pace of debate around the organization, regulation, finance, and technology of health care delivery, the essential drivers of physician supply and demand are changing much less dramatically. We continue to project physician demand will grow faster than supply, leading to a projected total physician shortage of between 37,800 and 124,000 physicians by 2034, including a Primary Care physician shortage of between 17,800 and 48,000 physicians and a shortage of physicians in non-primary care specialties of between 21,000 and 77,100 physicians (which includes 15,800 to 30,200 physicians in Surgery Specialties). The projected shortage range is lower than in last year's report, reflecting in part larger estimates of the number of physicians trained each year, lower estimates of the starting-year shortage, and slightly lower growth in demand for physicians.

If the population health goals of a modest reduction in excess body weight; improved control of blood pressure, cholesterol, and blood glucose levels; and reduced smoking prevalence were achieved, the demand for physicians would be 28,800 FTEs higher by 2034 than it would be in the absence of achieving these goals. This appears to be somewhat of a paradox — that improving population health leads to greater demand for physicians. Our modeling suggests that improved health will reduce mortality and physician demand slightly in the initial years because the population is healthier. However, the reduction in mortality will lead to a larger and older population to support, which will increase demand for physicians.

To bring rates of care for currently underserved populations up to the rates for populations facing fewer sociodemographic, economic, and geographic barriers to care, 102,400 to 180,400 more physicians would be needed (relative to the current supply). Even assuming current utilization patterns continue, over the next 15 years, demand for physicians is projected to increase by 136,000 FTEs under the Status Quo Scenario. More than two-thirds (67%) of this growth is associated with the projected growth in demand for physician services by racial/ethnic minority populations, including a 457,200-FTE growth to provide care to the growing and aging Hispanic population, a 21,000-FTE growth for the growing and aging non-Hispanic Black population, and a 25,500-FTE growth for all other minority populations, which includes American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, some other race, and two or more races.

This report updates the Evolving Care Delivery System Scenario, which considers how the health care delivery system is evolving and the potential implications for physician demand. While this work was not used to construct the projected shortage ranges, it incorporates several of the demand scenarios used to construct those ranges: (1) greater use of managed-care principles, which shifts a portion of care from specialist physicians to primary care physicians and increases the overall demand for primary care services; (2) achieving select population health goals; and (3) the continued rapid growth in APRN and PA supply. We also modeled the potential physician workforce implications of addressing unmet behavioral health needs and reducing demand for hospital-based care through a combination of prevention and diversion to appropriate community-based settings. Some trends will increase demand for physicians to provide increased access and more comprehensive care, while other trends will decrease demand. The net effect is a 21,900-FTE (2.3%) decline in demand for physicians in 2034 for the Evolving Care Delivery System Scenario relative to the Status Quo Scenario, which extrapolates future demand based on current care-delivery patterns and taking changing demographics into account. This drop is primarily due to the approximate doubling of the APRN and PA workforces over the next 15 years. Additional research is needed to refine this work, but early findings suggest the evolving care-delivery system will not substantially change the total number of physicians required but will shift care across care-delivery settings and physician specialties.

The studies summarized in each of the previous five reports used the most recent data available to the modeling team, which continued to refine model inputs and assumptions and the scenarios. Key findings across those annual reports and this one include:

- While there are many unknowns about the prevalence and duration of long COVID on demand for physician services and on the physician workforce itself, some long-term COVID-19 complications appear to cause permanent damage to body organs that will increase overall demand slightly for some medical specialties.
- The trauma experienced by so many physicians during COVID-19 has been immense. Moreover, COVID-19 has shone a new light on long-term inequities within the physician workforce, including gender and racial inequities.
- COVID-19 has illuminated anew, and likely exacerbated, extant disaparities in health and health care access within the nation’s population, including those that persist along intersecting lines of race, ethnicity, and gender.
- The substantial inequities in access to care go beyond what can be explained by lack of medical insurance and geographic variation in the adequacy of physician supply. Efforts to improve access to care for racial and ethnic minority and other marginalized populations will require a large increase in physician supply in addition to policy and economic changes.
- Population growth and aging continue to have the greatest impact on demand growth.

- The rapid growth in the supply of APRNs and PAs will partially offset the projected growing shortage of physicians.
- A large number of physicians are nearing retirement, and retirement decisions have large short-term implications for physician supply.

APPENDIX 1: DATA AND METHODS

This appendix provides a brief overview of the workforce microsimulation models used, the data and assumptions, and information on select model inputs. Detailed technical documentation of the supply and demand models is available elsewhere.[120,121]

Synopsis of Study Methods

Consistent with the previous physician workforce reports, this 2021 update used a microsimulation approach to project the future supply of and demand for health care services and physicians. The workforce models have been used to model supply and demand for physicians and other health occupations for federal and state governments, trade and professional associations, and health systems.[217,218]

The supply model simulates career decisions of physicians given the number, specialty mix, and demographics of the current workforce and new physicians trained each year, as well as weekly-hours-worked patterns and projected retirement rates that differ by specialty category and physician age and sex. As described in the report, modeled scenarios to develop the projections range include (1) the Status Quo Scenario, which assumes no changes in the training pipeline absent additional investment in GME and continuation of current hours worked and retirement patterns as indicated by physicians participating in the AAMC 2019 National Sample Survey of Physicians (NSSP); (2) the Retire 2 Years Earlier or Retire 2 Years Later Scenarios, for changing physician-retirement patterns relative to current patterns of retirement intention; and (3) a Changing Hours Worked Scenario, in which the downward trend in hours worked observed over the past decade continues over time, where today's physicians work slightly fewer hours per week compared with older cohorts — though the decline in hours worked appears to have slowed in recent years. A modest expansion of GME programs is modeled as a policy scenario but not included in the projections ranges.

The demand projections start with the Status Quo Scenario, by extrapolating current levels of care into the future as the population grows and ages and modeling projected changes in disease prevalence and other health risk factors among the population if health care use and delivery patterns remained unchanged. Additional scenarios modeled were the (1) Managed Care Scenario, for the implications for physicians if the entire insured population were shifted into managed-care plans that more closely resemble HMOs; (2) Retail Clinics Scenario, for the implications of shifting noncomplex care for people without chronic conditions from Primary Care physician offices to retail clinics where care is predominantly provided by nurse practitioners (NPs); (3) APRN/PA High Use and APRN/PA Moderate Use Scenarios, for continued rapid growth in supply of APRNs and PAs, with varying assumptions about the degree to which additional providers offset demand for physicians; and (4) Population Heath Scenario, for the implications of improving population health with modest improvements in body weight, smoking cessation, and control of blood pressure, cholesterol, and blood glucose levels.

To convey the uncertainty associated with factors and trends that have implications for physician supply and demand, we modeled four supply scenarios and six demand scenarios used to develop the physician-adequacy ranges. Comparing each supply scenario with each demand scenario produces 24 paired projections of future supply adequacy for each of the five physician specialty groupings. The extreme high and low pairings of supply and demand scenarios are least likely to occur because multiple factors tend to mitigate highs and lows. Given the propensity of such systems-level "checks and balances" to avoid extremes, we used the 25th-to-75th percentile of the paired projections to reflect a likely range. Ranking the 24 supply-demand combinations from largest surplus to largest shortage, the midpoint of the sixth and seventh supply-demand combinations forms the lower bound (25th percentile) of any projected shortage, while the midpoint of the 18th and 19th supply-demand combinations forms the upper bound (75th percentile) of the projected shortage.

Supply Model Overview and Updates

Current Physician Workforce

Supply modeling started with using the 2019 AMA Physician Masterfile to identify the size and characteristics of the current workforce. In 2019, about 808,400 physicians who were under age 75 and had completed their GME were in active practice. The approximately 228,700 active Primary Care physicians were 28% of the workforce, and another 33,300 (4% of the workforce) were Primary-Care-Trained Physicians Practicing as Hospitalists. About 137,900 (17%) physicians were in Medical Specialties, 152,700 (19%) in Surgical Specialties, and 255,800 (32%) in the Other Specialties. Women constituted about a third of the workforce. Physicians within the traditional retirement age of between 65 and 75 were 16% of the active workforce, and those between age 55 and 64 made up 27% of the active workforce. Therefore, it is possible that more than a third of currently active physicians will retire within the next decade.

New Entrants

For this year's report, estimates of the number of physicians completing GME came from published information on programs accredited by the ACGME.[123] In previous years, the information was from the three accrediting organizations: ACGME, the AACOM, and/or the American Osteopathic Association, and some programs were dually accredited. The age and sex distribution of new physicians was derived from analysis of the 2019 AMA Physician Masterfile. We estimate about 29,627, physicians completed GME between 2019 and 2020 (higher than the 28,980 estimate in last year's report). About 8,584 physicians (29.0% of new graduates) entered the workforce as Primary Care providers; 1,221 (4.1%) entered as new Primary-Care-Trained Hospitalists; 5,809 (19.6%) entered in internal medicine and pediatric subspecialties; 5,020 (16.9%) entered in Surgical Specialties; and 8,993 (30.4%) entered in Other Specialties. The estimate of Primary-Care-Trained Hospitalists entering the workforce is the same as last year's report, which was based on an analysis of 2018 Medicare payments because the Centers for Medicare and Medicaid Services (CMS) has yet to release the 2019 Medicare payment files.

Hours-Worked Patterns

Supply projections consider differences in average hours per week spent in patient care by physician age, sex, and specialty group. This component of the model is based on ordinary least squares regression analysis of the 2019 NSSP (n = 6,000). The dependent variable was weekly patient-care hours worked, and explanatory variables were physician age group (<35, 35-44, 45-54, 55-59, 60-69, 70-74, and 75+ years), sex, age-by-sex-interaction term, and region of the country. Separate regressions were estimated by specialty category (Primary Care, Medical Specialties, Surgical Specialties, and Other Specialties). Using these newer, national data, we found that physicians worked fewer hours, on average, than we found in previous reports using the older, state-level data. However, patterns of differences in weekly hours worked by physician age and sex were similar to those found with the older data. Younger male and female physicians start off working about the same number of hours each week, but by age 35 and beyond, female physicians work about four to six fewer hours per week than their male peers in the same specialty category. Surgeons tend to work slightly more hours per week, followed by the Medical Specialties, Primary Care, and Other Specialties. Physicians in the oldest age group modeled (age 75+) work about 11-18 fewer hours per week than their peers under age 35 in the same specialty category, with the drop in hours largest for surgeons and smallest for Primary Care physicians.

Retirement Patterns

Retirement patterns by physician age, sex, and specialty category were estimated from the 2019 NSSP.

Demand Model Overview and Updates

Demand for physicians is calculated based on projected demand for health care services and staffing patterns for care delivery. Demand for health care services is defined as the level of care likely to be sought by consumers given their needs, care-use patterns, and economic considerations such as level of health insurance coverage and cost of care. Demand differs from "need," which is based on clinical and epidemiological considerations.

For modeling purposes, at the national level, we quantified current demand for health care services as equivalent to the level of health care services used, current demand for physicians as the current physician supply, and current demand for physician services as the level of health care services currently being provided by the current physician supply. Demand projections are thus extrapolating a "2019 level of care" that includes any imbalances between supply and demand, whether shortages or excesses, into the future. An exception pertains to the federal government estimate that the nation requires about 13,758 primary care physicians and 6,100 psychiatrists to de-designate the federally designated primary care and mental health Professional Shortage Areas (HPSAs) in 2019.[20] For modeling purposes, we assume these nearly 19,858 physicians reflect a national shortage in 2019, the starting year for the projections. To the extent that other shortages already exist in specialties other than primary care and psychiatry, our starting-point assumption may be conservative.[129-133]

The microsimulation approach simulates demand for health care services for a representative sample of the 2019 U.S. population projected to 2034. Modeling is done at the county level, which is then aggregated to the state level and by the urban-rural designation of the counties where people reside. The population files for each county were constructed to create a representative sample of the population in each county by statistically combining de-identified data for individuals in the U.S. Census, American Community Survey, Behavioral Risk Factor Surveillance System, Medicare Beneficiary Survey, and CMS Minimum Dataset for Nursing Home Residents. The resulting constructed database for each county contains a health profile for a representative sample of the population that includes demographics (age, sex, race/ethnicity), health risk factors (obesity, smoking), insurance type, household income, and presence of a history of various chronic diseases. County-level population projections, by demographic, were then used to reweight the population file to reflect population growth, aging, and greater racial and ethnic diversity in future years.

Prediction equations in the demand model come from regression analysis of the MEPS and the NIS. They were used to quantify the relationship between patient characteristics available in these data sets and in the constructed population database and patient annual use of health care services. Negative binomial regression was used to quantify the relationship between patient characteristics and annual office and outpatient visits to a physician by specialty type. This regression approach was used because many patients had no annual visits to a particular physician specialty and other patients had one or more visits during the year, which produces a skewed distribution for annual visits. Logistic regression was used to model the relationship between patient characteristics and hospital admission and emergency department visits for about two dozen diagnosis categories. Poisson regression with NIS data was used to model hospital length of stay, by admission diagnosis category, as a function of patient characteristics available in NIS (demographics, insurance type, presence of diabetes). Separate regressions were estimated for adults and children. The estimated coefficients from these regressions were applied to the constructed population files to forecast future demand for health care services by physician specialty, care-delivery setting, and geographic location.

Current staffing patterns, measured as FTE physicians per unit of health care used (e.g., office or outpatient visits, emergency visits, home health visits, inpatient days, residents) based on national averages, were then applied to the projected demand for health care services by care-delivery setting and physician specialty.

Exhibit 32 summarizes, by demand model component, the data sources incorporated into this 2021 workforce projections update.

Exhibit 32: Summary of Demand Modeling Data Sources

Model Component	Data Sources
National and state population files	2019 American Community Survey https://www.census.gov/programs-surveys/acs 2018-2019 Behavioral Risk Factor Surveillance System https://www.cdc.gov/brfss/ 2018 CMS Minimum Dataset for Nursing Home Residents https://www.cdc.gov/nchs/nnhs/ 2018 Medicare Beneficiary Survey, Residential Care https://www.cms.gov/Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/MCBS-Public-Use-File
Weights for population projections	2017 U.S. Census Bureau national population projections and 2019 county population totals; state-county population projections to estimate demand by region and urban-rural location https://www.census.gov/ https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-total.html
Health care use equations	2014-2018 Medical Expenditure Panel Survey (Pooled) https://www.meps.ahrq.gov/mepsweb/
Hospital inpatient day equations	2018 National Inpatient Sample https://www.hcup-us.ahrq.gov/db/nation/nis/NIS_Introduction_2018.jsp
Health care use calibration and validation	2018 National Inpatient Sample https://www.hcup-us.ahrq.gov/db/nation/nis/NIS_Introduction_2018.jsp 2017 and 2018 National Hospital Ambulatory Medical Care Survey https://www.cdc.gov/nchs/ahcd/about_ahcd.htm#NHAMCS 2016 National Ambulatory Medical Care Survey https://www.cdc.gov/nchs/ahcd/about_ahcd.htm#NAMCS
Physician staffing ratios	2019 AMA Masterfile https://www.ama-assn.org/practice-management/masterfile/ama-physician-masterfile
Urban-rural classification	2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties https://www.cdc.gov/nchs/nnhs/index.htm
Population health scenario (person-level data on health risk factors)	2017-2018 National Health and Nutrition Examination Survey https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2017

APPENDIX 2: ADDITIONAL TABLES AND CHARTS

Exhibit 33: Projected Physician Demand by Patient Race and Ethnicity, 2019-2034

Specialty Group and Year	Non-Hispanic			Hispanic	Total
	White	Black	Other		
2019					
Total	**565,500**	**95,300**	**59,300**	**108,100**	**828,200**
Primary Care	159,900	25,500	21,200	35,800	242,400
Non-Primary Care	405,600	69,800	38,100	72,300	585,800
Medical Specialties	93,900	18,400	8,700	16,900	137,900
Surgical Specialties	108,000	15,400	10,200	19,100	152,700
Other	181,600	31,200	17,000	32,100	261,900
Hospitalist*	22,100	4,800	2,200	4,200	33,300
2034					
Total	**609,800**	**116,300**	**84,800**	**153,300**	**964,200**
Primary Care	174,900	31,800	30,800	49,500	287,000
Non-Primary Care	434,900	84,500	54,000	103,800	677,200
Medical Specialties	106,600	23,600	12,900	25,700	168,800
Surgical Specialties	113,900	18,100	14,100	27,100	173,200
Other	189,400	36,700	23,700	44,800	294,600
Hospitalist*	25,000	6,100	3,300	6,200	40,600
Growth 2019 to 2034					
Total	**44,300**	**21,000**	**25,500**	**45,200**	**136,000**
Primary Care	15,000	6,300	9,600	13,700	44,600
Non-Primary Care	29,300	14,700	15,900	31,500	91,400
Medical Specialties	12,700	5,200	4,200	8,800	30,900
Surgical Specialties	5,900	2,700	3,900	8,000	20,500
Other	7,800	5,500	6,700	12,700	32,700
Hospitalist*	2,900	1,300	1,100	2,000	7,300

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Exhibit 34: Projected Physician Demand by Census Region, 2019-2034

Specialty Group and Year	Region 1: Northeast	Region 2: Midwest	Region 3: South	Region 4: West	Total
2019					
Total	**147,900**	**178,500**	**315,100**	**186,700**	**828,200**
Primary Care	43,000	51,200	91,500	56,700	242,400
Non-Primary Care	104,900	127,300	223,600	130,000	585,800
Medical Specialties	24,700	29,300	53,900	30,000	137,900
Surgical Specialties	27,500	33,300	57,500	34,400	152,700
Other	46,900	57,500	98,900	58,600	261,900
Hospitalist*	5,800	7,200	13,300	7,000	33,300
2034					
Total	**160,500**	**187,000**	**376,400**	**240,300**	**964,200**
Primary Care	47,300	54,500	111,200	74,000	287,000
Non-Primary Care	113,200	132,500	265,200	166,300	677,200
Medical Specialties	28,200	32,300	67,400	40,900	168,800
Surgical Specialties	29,000	34,000	66,900	43,300	173,200
Other	49,300	58,300	114,500	72,500	294,600
Hospitalist*	6,700	7,900	16,400	9,600	40,600
Growth 2019 to 2034					
Total	**12,600**	**8,500**	**61,300**	**53,600**	**136,000**
Primary Care	4,300	3,300	19,700	17,300	44,600
Non-Primary Care	8,300	5,200	41,600	36,300	91,400
Medical Specialties	3,500	3,000	13,500	10,900	30,900
Surgical Specialties	1,500	700	9,400	8,900	20,500
Other	2,400	800	15,600	13,900	32,700
Hospitalist*	900	700	3,100	2,600	7,300

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Note: Category totals might not sum to totals because of rounding.

Exhibit 35: Projected Physician Demand by Urban-Rural Location, 2019-2034

Specialty Group and Year	Metropolitan				Nonmetropolitan		Total
	Large Central	Large Fringe	Medium	Small	Micropolitan	Noncore	
2019							
Total	**237,300**	**222,900**	**179,700**	**74,700**	**66,900**	**46,700**	**828,200**
Primary Care	71,800	64,900	53,200	21,600	18,500	12,400	242,400
Non-Primary Care	165,500	158,000	126,500	53,100	48,400	34,300	585,800
Medical Specialties	38,300	38,200	30,600	12,900	9,800	8,100	137,900
Surgical Specialties	41,700	40,800	33,100	14,600	13,200	9,300	152,700
Other	76,400	70,500	55,400	22,500	22,600	14,500	261,900
Hospitalist*	9,100	8,500	7,400	3,100	2,800	2,400	33,300
2034							
Total	**292,000**	**266,800**	**207,400**	**83,100**	**68,800**	**46,100**	**964,200**
Primary Care	89,500	78,900	62,400	24,500	19,300	12,400	287,000
Non-Primary Care	202,500	187,900	145,000	58,600	49,500	33,700	677,200
Medical Specialties	50,000	48,000	36,800	15,000	10,600	8,400	168,800
Surgical Specialties	50,200	47,700	37,300	15,800	13,300	8,900	173,200
Other	90,500	81,500	61,900	24,200	22,600	13,900	294,600
Hospitalist*	11,800	10,700	9,000	3,600	3,000	2,500	40,600
Growth 2019 to 2034							
Total	**54,700**	**43,900**	**27,700**	**8,400**	**1,900**	**-600**	**136,000**
Primary Care	17,700	14,000	9,200	2,900	800	0	44,600
Non-Primary Care	37,000	29,900	18,500	5,500	1,100	-600	91,400
Medical Specialties	11,700	9,800	6,200	2,100	800	300	30,900
Surgical Specialties	8,500	6,900	4,200	1,200	100	-400	20,500
Other	14,100	11,000	6,500	1,700	0	-600	32,700
Hospitalist*	2,700	2,200	1,600	500	200	100	7,300

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Note: Demand location is defined by population residency location using the 2013 NCHS Urban-Rural Classification Scheme for Counties (cdc.gov/nchs/data_access/urban_rural.htm#2013_Urban-Rural_Classification_Scheme_for_Counties). Category totals might not sum to totals because of rounding.

Exhibit 36: Summary of Projected Gap between Physician Supply and Demand, 2019-2034

Specialty Group	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Total Physicians																
75th Percentile	19,800	36,400	46,400	56,600	65,900	73,700	82,600	92,400	99,700	106,200	111,700	113,800	116,400	119,900	121,500	124,000
25th Percentile	19,800	29,700	35,900	41,400	45,500	48,200	51,400	53,100	52,800	55,200	54,300	51,000	47,400	44,500	40,400	37,800
Primary Care																
75th Percentile	13,700	18,900	21,900	25,200	28,200	30,900	33,800	36,400	38,900	41,000	42,700	44,300	45,300	46,400	47,300	48,000
25th Percentile	13,700	16,500	17,100	19,100	20,200	20,900	22,000	21,900	22,400	23,100	22,900	22,400	21,400	20,400	19,400	17,800
Non-Primary Care																
75th Percentile	6,100	16,900	24,200	31,300	37,400	43,300	49,800	55,700	60,900	65,300	69,800	73,500	76,100	78,200	77,100	77,100
25th Percentile	6,100	13,100	18,100	22,900	26,200	28,100	30,700	32,100	32,300	33,600	32,700	30,000	27,400	25,200	22,100	21,000
Medical Specialties																
75th Percentile	-	3,100	4,700	6,400	7,800	8,800	10,000	11,400	12,200	12,700	12,900	13,000	13,100	13,300	13,200	13,400
25th Percentile	-	2,400	2,800	4,000	4,600	5,100	5,500	6,200	6,800	6,700	6,400	5,900	5,300	4,500	4,000	3,800
Surgical Specialties																
75th Percentile	-	2,900	5,400	8,000	10,300	12,400	14,900	17,100	19,200	21,100	23,000	24,700	26,100	27,600	28,900	30,200
25th Percentile	-	2,100	3,900	5,700	8,200	9,600	10,800	11,800	12,800	13,600	14,400	15,000	15,400	15,700	15,800	15,800
Other Specialties																
75th Percentile	6,100	11,100	14,600	17,800	20,700	23,300	26,300	28,900	31,200	33,100	35,000	36,500	37,000	37,600	36,400	35,600
25th Percentile	6,100	9,800	11,900	13,700	15,100	16,100	17,400	17,600	18,200	18,900	18,600	16,500	14,700	13,600	11,500	10,300
Hospitalist*																
75th Percentile	-	-100	-400	-800	-1,000	-1,300	-1,500	-1,800	-2,000	-2,300	-2,400	-2,600	-2,700	-2,800	-2,800	-2,700
25th Percentile	-	-500	-1,200	-1,700	-2,300	-2,900	-3,500	-3,900	-4,400	-5,000	-5,300	-6,000	-6,300	-6,700	-7,100	-7,000

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Note: The shortage range for total physicians can differ from the sum of the ranges for the specialty categories. The demand scenarios modeled project future demand for physician services, but scenarios can differ in terms of whether future demand will be provided by Primary Care or non-primary care physicians. Likewise, the range for total non-primary care can differ from the sum of the ranges for the specialty categories. The negative numbers are projected excess supply, and the positive numbers are projected shortages.

Exhibit 37: Projected Physician Supply, 2019-2034

Year	Workforce Participation Scenarios				Policy Scenario
	Status Quo	Retire 2 Years Earlier	Retire 2 Years Later	Changing Hours Worked	GME Expansion
2019	808,400	808,400	808,400	808,400	808,400
2020	807,800	806,880	808,500	808,400	807,800
2021	806,600	803,740	809,400	807,400	806,600
2022	806,400	800,730	812,100	806,800	806,400
2023	807,200	797,760	816,240	806,400	807,200
2024	809,500	795,250	822,400	807,400	809,500
2025	811,500	792,600	828,660	807,500	811,500
2026	814,400	791,020	836,240	808,100	817,400
2027	817,800	791,625	842,625	809,000	823,800
2028	822,300	793,260	849,340	810,600	831,300
2029	826,800	794,840	856,380	812,100	839,000
2030	832,500	797,760	864,360	814,600	847,500
2031	839,200	802,055	873,210	817,900	857,200
2032	845,100	805,800	881,700	820,400	866,200
2033	851,300	811,400	888,500	823,100	875,400
2034	857,700	817,500	894,900	825,700	884,800
% Growth, 2019-2034	6%	1%	11%	2%	9%

Exhibit 38: Physician Supply Projection Summary by Specialty Category, 2019-2034

Specialty Group and Year	Workforce Participation Scenarios				Policy Scenario
	Status Quo	Retire 2 Years Earlier	Retire 2 Years Later	Changing Hours Worked	GME Expansion
2019					
Total	**808,400**				
Primary Care	228,700				
Non-Primary Care	579,700				
Medical Specialties	137,900				
Surgical Specialties	152,700				
Other Specialties	255,800				
Hospitalists*	33,300				
2034					
Total	**857,700**	**817,500**	**894,900**	**825,700**	**884,800**
Primary Care	241,200	228,800	252,600	234,600	248,800
Non-Primary Care	616,500	588,700	642,300	591,100	636,000
Medical Specialties	158,400	151,800	164,200	152,300	163,600
Surgical Specialties	148,800	140,900	156,300	143,000	153,400
Other Specialties	265,500	253,900	276,600	253,800	274,000
Hospitalists*	43,800	42,100	45,200	42,000	45,000
Growth 2019 to 2034					
Total	**49,300**	**9,100**	**86,500**	**17,300**	**76,400**
Primary Care	12,500	100	23,900	5,900	20,100
Non-Primary Care	36,800	9,000	62,600	11,400	56,300
Medical Specialties	20,500	13,900	26,300	14,400	25,700
Surgical Specialties	-3,900	-11,800	3,600	-9,700	700
Other Specialties	9,700	-1,900	20,800	-2,000	18,200
Hospitalists*	10,500	8,800	11,900	8,700	11,700

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

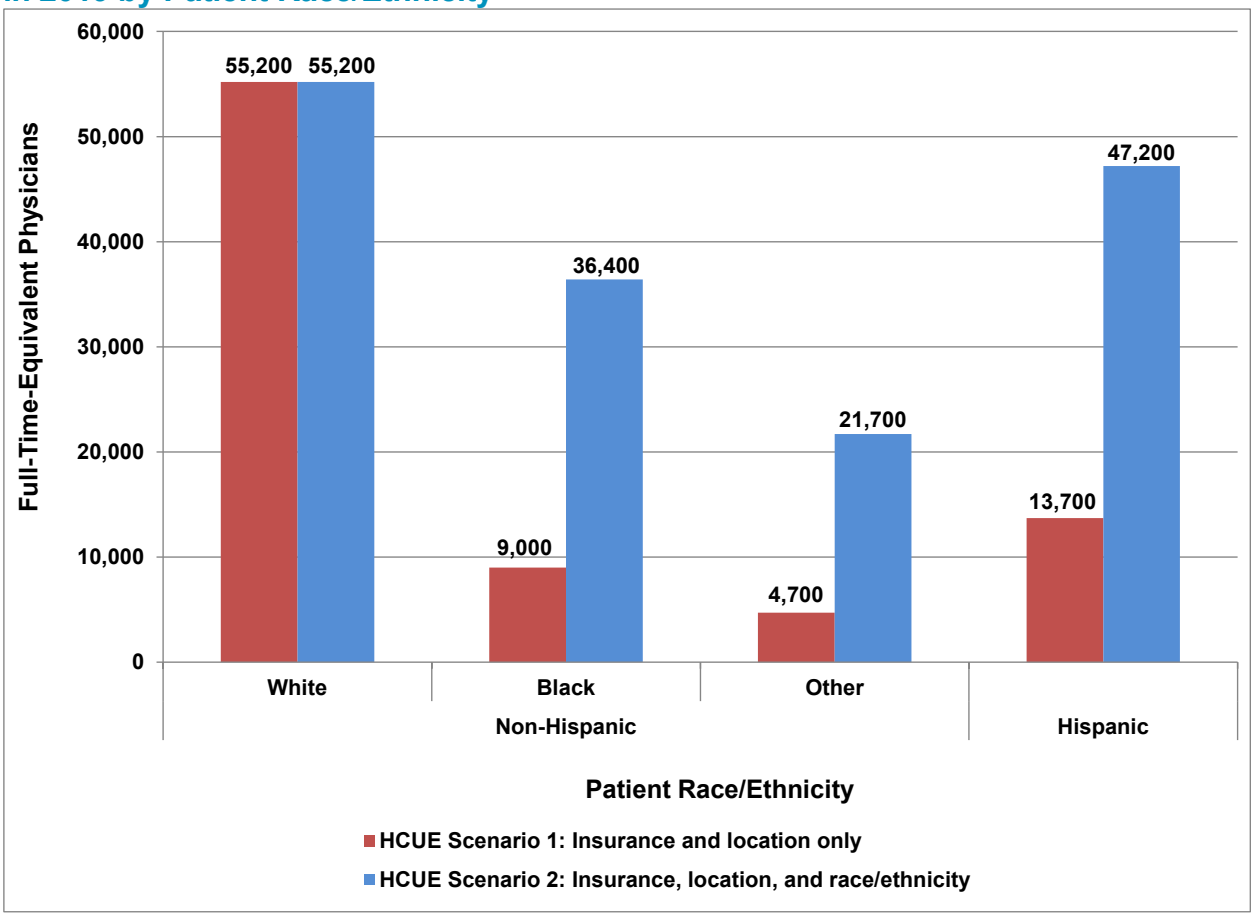
Note: Category totals might not sum to totals because of rounding.

Exhibit 39: Projected Physician Demand by Scenarios Modeled, 2019-2034

Specialty Group and Scenario	2019	2034	Growth 2019 to 2034	% Growth 2019 to 2034
Scenario 1: Status Quo				
Total	**828,200**	**964,200**	**136,000**	**16%**
Primary Care	242,400	287,000	44,600	18%
Non-Primary Care	585,800	677,200	91,400	16%
Medical Specialties	137,900	168,800	30,900	22%
Surgical Specialties	152,700	173,200	20,500	13%
Other Specialties	261,900	294,600	32,700	12%
Hospitalists*	33,300	40,600	7,300	22%
Scenario 2: Status Quo + Managed Care				
Total		**975,500**	**147,300**	**18%**
Primary Care		300,000	57,600	24%
Non-Primary Care		675,500	89,700	15%
Medical Specialties		165,200	27,300	20%
Surgical Specialties		173,600	20,900	14%
Other Specialties		296,000	34,100	13%
Hospitalists*		40,700	7,400	22%
Scenario 3: Status Quo + Increased Use of Retail Clinics				
Total		**955,800**	**127,600**	**15%**
Primary Care		278,600	36,200	15%
Non-Primary Care		677,200	91,400	16%
Medical Specialties		168,800	30,900	22%
Surgical Specialties		173,200	20,500	13%
Other Specialties		294,600	32,700	12%
Hospitalists*		40,600	7,300	22%
Scenario 4: Status Quo + Increased Use of APRNs and PAs ("Moderate Offset" Level)				
Total		**897,000**	**68,800**	**8%**
Primary Care		259,900	17,500	7%
Non-Primary Care		637,100	51,300	9%
Medical Specialties		162,300	24,400	18%
Surgical Specialties		164,700	12,000	8%
Other Specialties		273,200	11,300	4%
Hospitalists*		36,900	3,600	11%
Scenario 5: Status Quo + Increased Use of APRNs and PAs ("High Offset" Level)				
Total		**829,700**	**1,500**	**0%**
Primary Care		232,900	-9,500	-4%
Non-Primary Care		596,800	11,000	2%
Medical Specialties		155,800	17,900	13%
Surgical Specialties		156,100	3,400	2%
Other Specialties		251,700	-10,200	-4%
Hospitalists*		33,200	-100	0%
Scenario 6: Status Quo + Increased Use of APRNs ("Moderate Offset" Level) + Population Health Goals Achieved				
Total		**931,200**	**103,000**	**12%**
Primary Care		267,800	25,400	10%
Non-Primary Care		663,400	77,600	13%
Medical Specialties		165,800	27,900	20%
Surgical Specialties		171,800	19,100	13%
Other Specialties		287,700	25,800	10%
Hospitalists*		38,100	4,800	14%

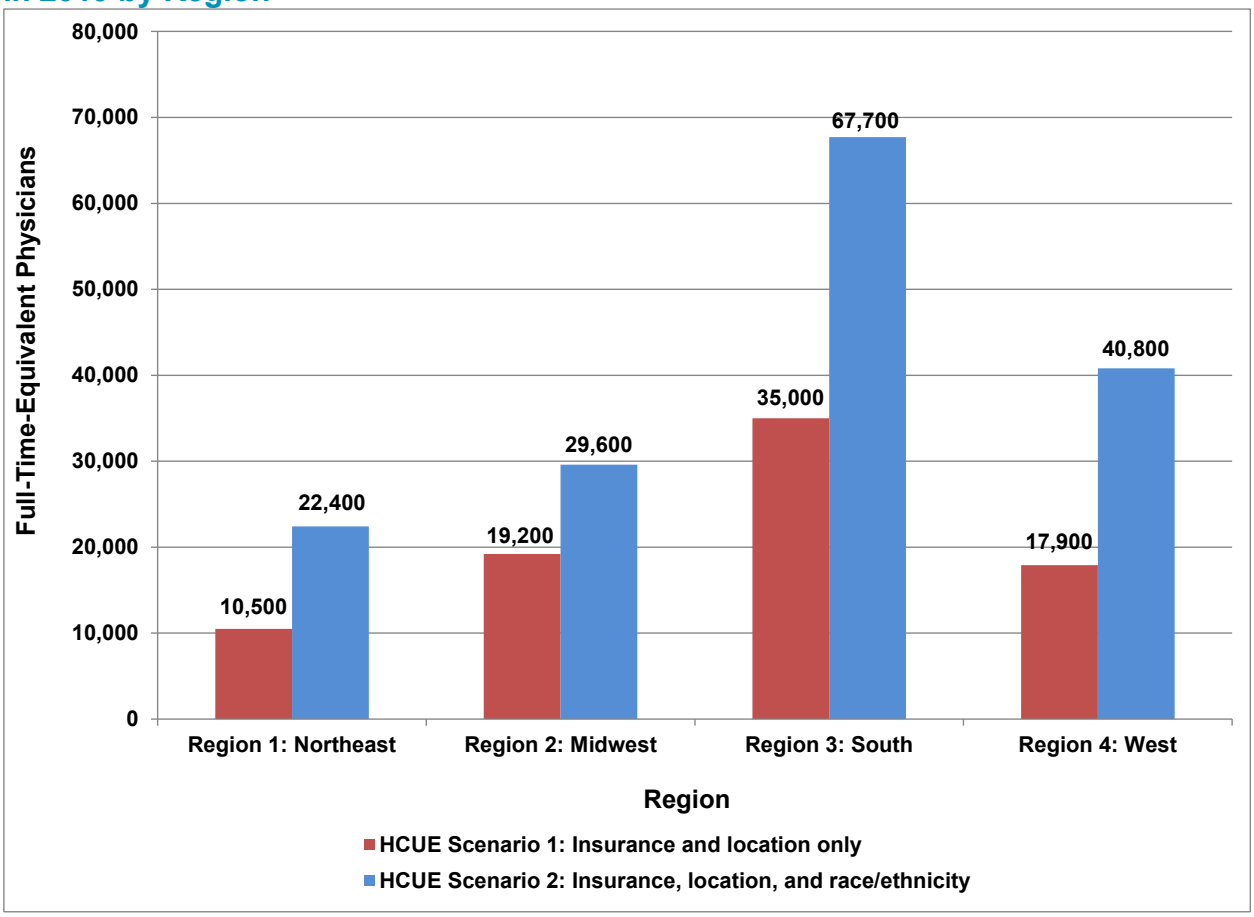
*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty. APRNs = advanced practice nurses; PAs = physician assistants.

Exhibit 40: Additional Physician Demand to Achieve Health Care Utilization Equity in 2019 by Patient Race/Ethnicity



Note: This chart compared physician demand under the Health Care Utilization Equity Scenarios with demand under the Status Quo Scenario.

Exhibit 41: Increase in Physician Demand to Achieve Health Care Utilization Equity in 2019 by Region



Note: This chart compared physician demand under the Health Care Utilization Equity Scenarios to demand under the Status Quo Scenario.

Exhibit 42: Physician Demand by Health Care Utilization Equity Scenario and Region in 2019

Specialty Group and Demand	Region 1: Northeast	Region 2: Midwest	Region 3: South	Region 4: West	U.S. Total
Baseline Demand*					
Total	**147,900**	**178,500**	**315,100**	**186,700**	**828,200**
Primary Care	43,000	51,200	91,500	56,700	242,400
Non-Primary Care	104,900	127,300	223,600	130,000	585,800
Medical Specialties	24,700	29,300	53,900	30,000	137,900
Surgery	27,500	33,300	57,500	34,400	152,700
Other	46,900	57,500	98,900	58,600	261,900
Hospitalist**	5,800	7,200	13,300	7,000	33,300
Additional Demand From HCUE1 Scenario					
Total	**10,500**	**19,200**	**35,000**	**17,900**	**82,600**
Primary Care	2,400	5,400	9,600	4,400	21,800
Non-Primary Care	8,100	13,800	25,400	13,500	60,800
Medical Specialties	2,500	4,300	7,600	4,200	18,600
Surgery	2,000	2,700	5,600	3,600	13,900
Other	3,300	6,300	11,600	5,200	26,400
Hospitalist**	300	500	600	500	1,900
Additional Demand From HCUE2 Scenario					
Total	**22,400**	**29,600**	**67,700**	**40,800**	**160,500**
Primary Care	4,600	7,500	16,900	7,700	36,700
Non-Primary Care	17,800	22,100	50,800	33,100	123,800
Medical Specialties	3,400	4,900	9,600	6,700	24,600
Surgery	4,800	5,200	13,300	8,700	32,000
Other	8,900	11,200	26,300	16,500	62,900
Hospitalist**	700	800	1,600	1,200	4,300

*Applying the national-average patterns of care use to the characteristics of the population in each region.

**Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Note: Category totals might not sum to totals because of rounding.

Exhibit 43: Increase in Physician Demand to Achieve Health Care Utilization Equity in 2019 by Urban/Rural Area

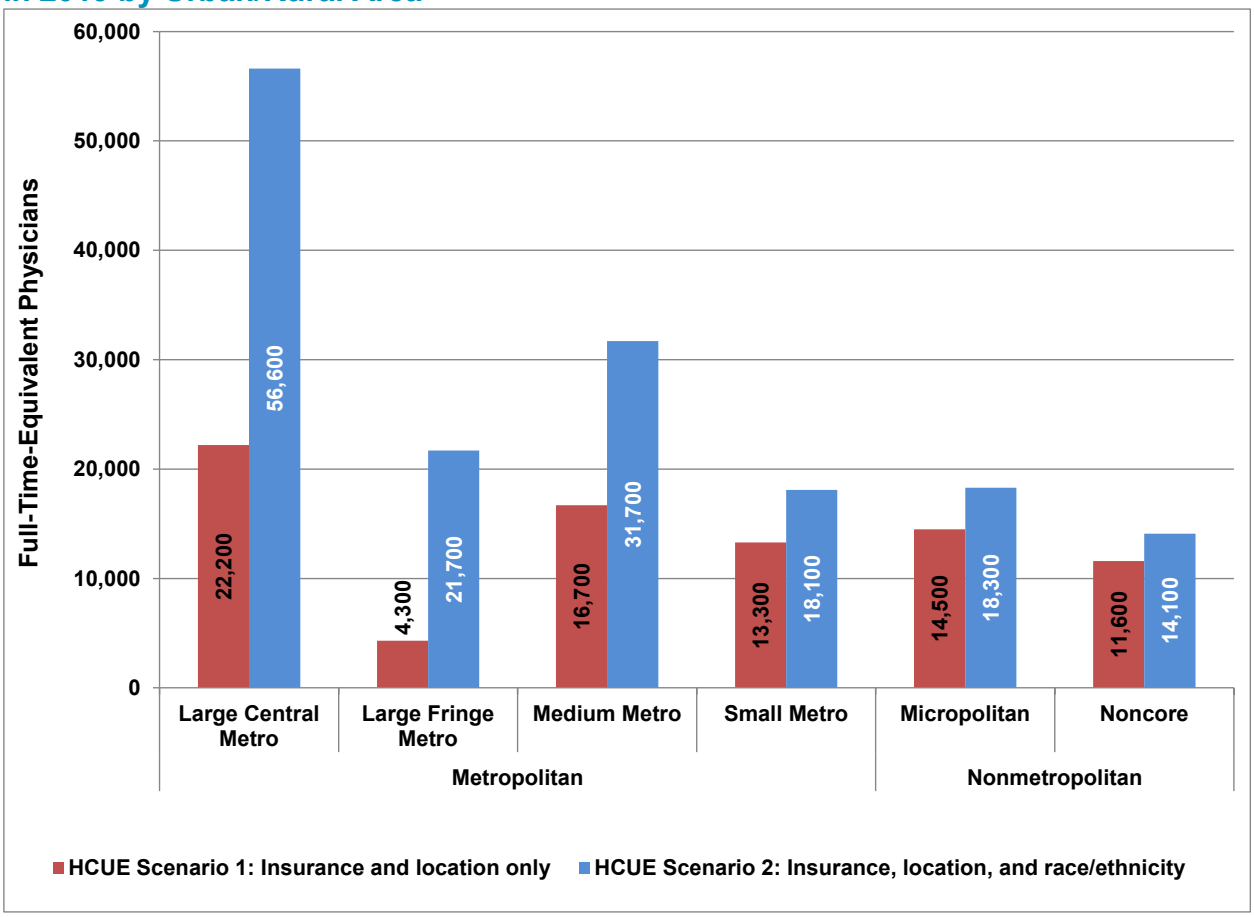


Exhibit 44: Physician Demand by Health Care Utilization Equity Scenario and Urban/Rural Area in 2019

Specialty Group and Demand	Metropolitan				Nonmetropolitan	
	Large Central Metro	Large Fringe Metro	Medium Metro	Small Metro	Micropolitan	Noncore
Baseline Demand						
Total	**237,300**	**222,900**	**179,700**	**74,700**	**66,900**	**46,700**
Primary Care	71,800	64,900	53,200	21,600	18,500	12,400
Non-Primary Care	165,500	158,000	126,500	53,100	48,400	34,300
Medical Specialties	38,300	38,200	30,600	12,900	9,800	8,100
Surgery	41,700	40,800	33,100	14,600	13,200	9,300
Other	76,400	70,500	55,400	22,500	22,600	14,500
Hospitalist*	9,100	8,500	7,400	3,100	2,800	2,400
Additional Demand from HCUE1 Scenario						
Total	**22,200**	**4,300**	**16,700**	**13,300**	**14,500**	**11,600**
Primary Care	4,100	1,400	3,500	3,500	4,900	4,400
Non-Primary Care	18,100	2,900	13,200	9,800	9,600	7,200
Medical Specialties	6,300	700	3,400	2,300	3,900	2,000
Surgery	6,300	900	3,100	1,800	1200	600
Other	4,600	1200	6,600	5400	4,000	4,600
Hospitalist*	900	100	100	300	500	0
Additional Demand from HCUE2 Scenario						
Total	**56,600**	**21,700**	**31,700**	**18,100**	**18,300**	**14,100**
Primary Care	10,700	4,700	6,400	4,500	5,600	4,800
Non-Primary Care	45,900	17,000	25,300	13,600	12,700	9,300
Medical Specialties	9,000	2100	4,500	2,600	4,200	2,200
Surgery	14,400	5,000	6,500	2,900	2,000	1200
Other	20,500	9,300	13,700	7,700	5,900	5,800
Hospitalist*	2,000	600	600	400	600	100

*Includes only hospitalists trained in primary care; hospitalists in non-primary care specialties are included with their individual specialty.

Note: Category totals might not sum to totals because of rounding.

NOTES

a. **Primary Care** consists of family medicine, general internal medicine, general pediatrics, and geriatric medicine. The **Medical Specialties** category consists of allergy and immunology, cardiology, critical care, dermatology, endocrinology, gastroenterology, hematology and oncology, infectious diseases, neonatal and perinatal medicine, nephrology, pulmonology, and rheumatology. **Surgical Specialties** consists of general surgery, colorectal surgery, neurological surgery, obstetrics and gynecology, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, thoracic surgery, urology, vascular surgery, and other surgical specialties. The **Other Specialties** category consists of anesthesiology, emergency medicine, neurology, pathology, physical medicine and rehabilitation, psychiatry, radiology, and all other specialties. Hospitalists trained in adult primary care are modeled as their own category and have been moved out of the Primary Care category. **Hospitalists** trained in non-primary care specialties are modeled within their trained specialty.

b. The "Other," "all other minority races," and "non-Hispanic all other" categories include American Indian and Alaska Native (7.6% growth estimated between 2019 and 2034), Asian (33.8% growth), Native Hawaiian and Other Pacific Islander (19.0% growth), and "some other race" and "two or more races" (50.5% growth).[21] Sample sizes in files used to develop physician-demand projections, such as the Medical Expenditure Panel Survey, are too small to model these minority populations separately.

c. This geographic designation is for large fringe metropolitan counties in metropolitan statistical areas (MSAs) with populations of 1 million or more that do not qualify as large central medium metro counties in MSAs with populations of 250,000-999,999 based on the 2013 NCHS Urban-Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data_access/urban_rural.htm#2013_Urban-Rural_Classification_Scheme_for_Counties

d. Clinical nurse specialists (CNSs) are not included in the workforce projections due to lack of data for modeling CNS supply and demand. Whereas other APRNs concentrate on direct patient care, CNSs often work in health care administration and are less likely to affect demand for physicians or directly affect physician productivity than are other APRNs and PAs.

REFERENCES

1. Maness SB, Merrell L, Thompson EL, Griner SB, Kline N, Wheldon C. Social determinants of health and health disparities: COVID-19 exposures and mortality among African American people in the United States. *Public Health Rep*. 2021;136(1):18-22. doi:10.1177/0033354920969169
2. Sasangohar F, Jones SL, Masud FN, Vahidy FS, Kash BA. Provider burnout and fatigue during the COVID-19 pandemic: lessons learned from a high-volume intensive care unit. *Anesth Analg*. 2020;131(1):106-111. doi:10.1213/ANE.0000000000004866
3. Morgan PA, Smith VA, Berkowitz TSZ, et al. Impact of physicians, nurse practitioners, and physician assistants on utilization and costs for complex patients. *Health Aff (Millwood)*. 2019;38(6):1028-1036. doi:10.1377/hlthaff.2019.00014
4. Kleinpell R, Ward NS, Kelso LA, Mollenkopf FP, Houghton D. Provider to patient ratios for nurse practitioners and physician assistants in critical care units. *Am J Crit Care*. 2015;24(3):e16-e21. doi:10.4037/ajcc2015274
5. Xue Y, Kannan V, Greener E, et al. Full scope-of-practice regulation is associated with higher supply of nurse practitioners in rural and primary care health professional shortage counties. *J Nurs Regul*. 2018;8(4):5-13. doi:10.1016/S2155-8256(17)30176-X
6. Jha AK, Iliff AR, Chaoui JA, Defossez S, Bombaugh MC, Miller YR. A Crisis in Health Care: A Call to Action on Physician Burnout. Harvard Global Health Institute and Massachusetts Medical Society; 2018. https://www.massmed.org/Publications/Research,-Studies,-and-Reports/Physician-Burnout-Report-2018/. Accessed April 20, 2021.
7. Busis NA, Shanafelt TD, Keran CM, et al. Burnout, career satisfaction, and well-being among U.S. neurologists in 2016. *Neurology*. 2017;88(8):797-808.
8. Shanafelt TD, Dyrbye LN, West CP. Addressing physician burnout: the way forward. *JAMA*. 2017;317(9):901-902.
9. Cimbak N, Stolarski A, Moseley J, O'Neal P, Whang E, Kristo G. Burnout leads to premature surgeon retirement: a nationwide survey. *J Surg Res*. 2019;2(3):159-169.
10. Vetter MH, Salani R, Williams TE, Ellison C, Satiani B. The impact of burnout on the obstetrics and gynecology workforce. *Clin Obstet Gynecol*. 2019;62(3):444-454. doi:10.1097/GRF.0000000000000452
11. Silver MP, Hamilton AD, Biswas A, Warrick NI. A systematic review of physician retirement planning. *Hum Resour Health*. 2016;14(1):67.
12. Sriharan A, Ratnapalan S, Tricco AC, Lupea D. Women in health care experiencing occupational stress and burnout during COVID-19: a review. *medRxiv*. Published online Jan. 1, 2021. doi:10.1101/2021.01.08.21249468
13. Pizer SD, Frakt AB, Sheetz K, Clancy C. Testing novel payment and delivery approaches through the Veterans Health Administration's new center for innovation. *Ann Intern Med*. 2019;170(2):112. doi:10.7326/M18-2225
14. Ramanuj P, Ferenchik E, Docherty M, Spaeth-Rublee B, Pincus HA. Evolving models of integrated behavioral health and primary care. *Curr Psychiatry Rep*. 2019;21(1):4. doi:10.1007/s11920-019-0985-4
15. Pereira V, Gabriel MH, Unruh L. Multiyear performance trends analysis of primary care practices demonstrating patient-centered medical home transformation: an observation of quality improvement indicators among outpatient clinics. *Am J Med Qual*. 2019;34(2):109-118. doi:10.1177/1062860618792301

16. Kaufman BG, Spivack BS, Stearns SC, Song PH, O'Brien EC. Impact of accountable care organizations on utilization, care, and outcomes: a systematic review. *Med Care Res Rev*. 2019;76(3):255-290. doi:10.1177/1077558717745916
17. Vogenberg FR. U.S. healthcare trends and contradictions in 2019. *Am Health Drug Benefits*. 2019;12(1):40-47.
18. Advincula WDC, Choco JAG, Magpantay KAG, et al. Development and future trends in the application of visualization toolkit (VTK): the case for medical image 3D reconstruction. AIP Conference Proceedings. 2019;2092(1). doi:10.1063/1.5096690
19. AAMC. *The Complexities of Physician Supply and Demand: Projections From 2018 to 2033*. Washington, DC: AAMC; 2020. https://www.aamc.org/system/files/2020-06/stratcomm-aamc-physician-workforce-projections-june-2020.pdf. Accessed Jan. 22, 2021.
20. Bureau of Health Workforce. *Designated Health Professional Shortage Areas Statistics: Third Quarter of Fiscal Year 2019 Designated HPSA Quarterly Summary*. Rockville, MD: Health Resources and Services Administration; 2019. [No longer available.] The latest report is here: https://data.hrsa.gov/Default/GenerateHPSAQuarterlyReport.
21. U.S. Census Bureau. 2017 national population projections datasets. https://www.census.gov/data/datasets/2017/demo/popproj/2017-popproj.html. Accessed Dec. 15, 2020.
22. Buser BR, Swartwout J, Lischka T, Biszewski M. Single accreditation system for graduate medical education: transition update. *J Am Osteopath Assoc*. 2019;119(4):257. doi:10.7556/jaoa.2019.043
23. Salsberg E, Quigley L. Are we facing a physician assistant surplus? *JAAPA*. 2016;29(11):40-44. doi:10.1097/01.JAA.0000502865.59093.ef
24. Hooker RS. When will physician assistant supply exceed demand? *JAAPA*. 2016;29(11):10-12. doi:10.1097/01.JAA.0000502868.43846.31
25. Morgan P, Leach B, Himmerick K, Everett C. Job openings for PAs by specialty. *JAAPA*. 2018;31(1):45-47. doi:10.1097/01.JAA.0000527701.08322.18
26. Cawley JF. Will demand for PAs remain strong? *JAAPA*. 2018;31(1):8. doi:10.1097/01.JAA.0000527708.15945.ce
27. Wachter RM, Goldman L. Zero to 50,000 — the 20th anniversary of the hospitalist. *N Engl J Med*. 2016;375(11):1009-1011. doi:10.1056/NEJMp1607958
28. Sun R, Karaca Z, Wong HS. *Trends in Hospital Inpatient Stays by Age and Payer, 2000-2015*. Rockville, MD: Healthcare Cost and Utilization Project, Center for Delivery, Organization, and Markets, Agency for Healthcare Research and Quality; 2018. https://www.hcup-us.ahrq.gov/reports/statbriefs/sb235-Inpatient-Stays-Age-Payer-Trends.jsp. Accessed July 30, 2020.
29. Park J, Jones K. Use of hospitalists and office-based primary care physicians' productivity. *J Gen Intern Med*. 2015;30(5):572-581. doi:10.1007/s11606-014-3007-6
30. Kotala R, West DJ. Performance of hospitalists and inpatient clinical outcomes. *Hosp Top*. 2018;96(4):102-107. doi:10.1080/00185868.2018.1488547
31. Streeter RA, Zangaro GA, Chattopadhyay A. Perspectives: using results from HRSA's Health Workforce Simulation Model to examine the geography of primary care. *Health Serv Res*. 2017;52:481-507. doi:10.1111/1475-6773.12663
32. Dall TM, Gallo PD, Chakrabarti R, West T, Semilla AP, Storm MV. An aging population and growing disease burden will require a large and specialized health care workforce by 2025. *Health Aff (Millwood)*. 2013;32(1544-5208 (Electronic)):2013-2020. doi:10.1377/hlthaff.2013.0714

33. Rodriguez RM. Tackling another COVID-19 pandemic disparity: distance from major academic medical centers encumbers emergency and critical care physician surge capacity. *Acad Emerg Med*. 2020;27(11):1212-1214. doi:10.1111/acem.14123
34. Ahmed H, Carmody JB. On the looming physician shortage and strategic expansion of graduate medical education. *Cureus*. 2020;12(7):e9216. doi:10.7759/cureus.9216
35. Nguemeni Tiako MJ, Forman HP, Nuñez-Smith M. Racial health disparities, COVID-19, and a way forward for U.S. health systems. *J Hosp Med*. 2021;16(1):50-52. doi:10.12788/jhm.3545
36. Ellison A. Physician shortage forces Arizona hospital to shut down ICU. Becker's Hospital Review. https://www.beckershospitalreview.com/patient-flow/physician-shortage-forces-arizona-hospital-to-shut-down-icu.html. Published Jan. 26, 2021. Accessed Jan. 31, 2021.
37. Goldhill O. Hospitals in half the states are facing a massive staffing shortage. *STAT*. Published Nov.19, 2020. https://www.statnews.com/2020/11/19/covid19-hospitals-in-half-the-states-facing-massive-staffing-shortage/. Accessed Jan. 31, 2021.
38. Stuart B. How the COVID-19 pandemic has affected provision of elective services: the challenges ahead. Health Affairs [blog]. Oct. 8, 2020. https://www.healthaffairs.org/do/10.1377/hblog20201006.263687/full/. Accessed Jan. 31, 2021.
39. Mehrotra A, Chernew M, Linetsky D, Hatch H, Cutler D, Schneider EC. *The Impact of the COVID-19 Pandemic on Outpatient Care: Visits Return to Prepandemic Levels, but Not for All Providers and Patients*. The Commonwealth Fund. Published Oct. 15, 2020. doi:10.26099/41xy-9m57
40. Kaplan RM. Physician deaths from COVID-19 have been lower than expected. *Occup Med (Lond)*. 2021;71(1):25-27. doi:10.1093/occmed/kqaa210
41. Hughes MM, Groenewold M, Lessem SE, et al. Update: characteristics of health care personnel with COVID-19 — United States, February 12-July 16, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69:1364-1368. doi:10.15585/mmwr.mm6938a3
42. Artiga S, Rae M, Pham O, Hamel L, Muñana C. COVID-19 risks and impacts among health care workers by race/ethnicity. Kaiser Family Foundation. https://www.kff.org/racial-equity-and-health-policy/issue-brief/covid-19-risks-impacts-health-care-workers-race-ethnicity/. Published Nov. 11, 2020. Accessed Jan. 31, 2021.
43. Ly DP, Jena AB. Sex differences in time spent on household activities and care of children among U.S. physicians, 2003-2016. *Mayo Clin Proc*. 2018;93(10):1484-1487. doi:10.1016/j.mayocp.2018.02.018
44. Brubaker L. Women physicians and the COVID-19 pandemic. *JAMA*. 2020;324(9):835-836. doi:10.1001/jama.2020.14797
45. Abelson R. Doctors are calling it quits under stress of the pandemic. *New York Times*. Published Nov. 15, 2020; updated Nov. 25, 2020. https://www.nytimes.com/2020/11/15/health/Covid-doctors-nurses-quitting.html. Accessed April 29, 2021.
46. Physicians Foundation. *The Physicians Foundation 2020 Physician Survey: Part 1, COVID-19 Impact Edition.* Columbia, SC: Physicians Foundation; 2020. https://physiciansfoundation.org/research-insights/2020physiciansurvey/. Accessed April 29, 2021.
47. Annals of Family Medicine. COVID-19 Collection: Primary Care Covid-19 Survey — Larry Green Center and Primary Care Collaborative. https://www.annfammed.org/content/covid-19-collection-primary-care-covid-19-survey-larry-green-center-and-primary-care. Accessed April 29, 2021.

48. Byrnes YM, Civantos AM, Go BC, McWilliams TL, Rajasekaran K. Effect of the COVID-19 pandemic on medical student career perceptions: a national survey study. *Med Educ Online*. 2020;25(1):1798088. doi:10.1080/10872981.2020.1798088
49. Sell NM, Qadan M, Delman KA, et al. Implications of COVID-19 on the general surgery match. *Ann Surg*. 2020;272(2):e155-e156. doi:10.1097/SLA.0000000000004032
50. Physicians Foundation. The Physicians Foundation 2020 physician survey: part 1. https://physiciansfoundation.org/research-insights/2020physiciansurvey/. Published Aug. 18, 2020. Accessed Jan. 25, 2021.
51. Basu S, Phillips RS, Phillips R, Peterson LE, Landon BE. Primary care practice finances in the United States amid the COVID-19 pandemic: study estimates the potential impact of COVID-19 on operating expenses and revenues of primary care practices. *Health Aff (Millwood)*. 2020;39(9):1605-1614. doi:10.1377/hlthaff.2020.00794
52. Mental Health America. The mental health of healthcare workers in COVID-19. https://mhanational.org/mental-health-healthcare-workers-covid-19. Accessed Jan. 24, 2021.
53. Young KP, Kolcz DL, O'Sullivan DM, Ferrand J, Fried J, Robinson K. Health care workers' mental health and quality of life during COVID-19: results from a mid-pandemic, national survey. *Psychiatr Serv*. 2021;72(2):122-128. doi:10.1176/appi.ps.202000424
54. Shaukat N, Ali DM, Razzak J. Physical and mental health impacts of COVID-19 on healthcare workers: a scoping review. *Int J Emerg Med*. 2020;13(1):40. doi:10.1186/s12245-020-00299-5
55. Greenberg N, Weston D, Hall C, Caulfield T, Williamson V, Fong K. Mental health of staff working in intensive care during COVID-19. *Occup Med (Lond)*. Published online 2021. doi:10.1093/occmed/kqaa220
56. Johnson SU, Ebrahimi OV, Hoffart A. PTSD symptoms among health workers and public service providers during the COVID-19 outbreak. *PLoS One*. 2020;15(10):e0241032. doi:10.1371/journal.pone.0241032
57. Kang L, Ma S, Chen M, et al. Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak: A cross-sectional study. *Brain Behav Immun*. 2020;87:11-17. doi:10.1016/j.bbi.2020.03.028
58. AMA. Applications to medical school up big. Is it the "Fauci effect"? https://www.ama-assn.org/residents-students/preparing-medical-school/applications-medical-school-big-it-fauci-effect. Published Dec. 18, 2020. Accessed April 27, 2021.
59. Centers for Disease Control and Prevention. Excess deaths associated with COVID-19. https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm. Published March 8, 2021. Accessed March 8, 2021.
60. Lu D. 2020 was especially deadly. Covid wasn't the only culprit. *New York Times*. https://www.nytimes.com/interactive/2020/12/13/us/deaths-covid-other-causes.html. Published Dec. 13, 2020. Accessed Jan. 25, 2021.
61. Kearney MS, Levine PB. Half a million fewer children? The coming COVID baby bust. The Brookings Institution. https://www.brookings.edu/research/half-a-million-fewer-children-the-coming-covid-baby-bust/. Published June 15, 2020. Accessed Oct. 20, 2020.
62. Wilde J, Chen W, Lohmann S. *COVID-19 and the Future of U.S. Fertility: What Can We Learn From Google?* IZA Institute of Labor Economics. https://www.iza.org/publications/dp/13776/covid-19-and-the-future-of-us-fertility-what-can-we-learn-from-google. Published 2020. Accessed Dec. 15, 2020.
63. Mizumoto K, Chowell G. Temporary fertility decline after large Rubella outbreak, Japan. *Emerg Infect Dis*. 2020;26(6):1122-1129. doi:10.3201/eid2606.181718

64. Glass G. Are more people freezing their eggs during the pandemic? The Lily. https://www.thelily.com/america-expected-a-pandemic-baby-boom-it-got-an-egg-freezing-one-instead/. Published 2020. Accessed Jan. 25, 2021.
65. Sheehy K. Coronavirus sparks egg-freeze frenzy at NYC fertility clinic. CCRM IVF [reposted from the *New York Post*]. Accessed Jan. 25, 2021. https://www.ccrmivf.com/news-events/coronavirus-egg-freezing/
66. Santilli M. I'm continuing my egg freezing cycle even though some doctors say not to. Yahoo!. https://www.yahoo.com/lifestyle/m-continuing-egg-freezing-cycle-161500367.html. Published May 1, 2020. Accessed Jan. 25, 2021.
67. Gregory S. COVID-19 leads to more women freezing their eggs. BioNews. https://www.bionews.org.uk/page_152631. Published Oct.19, 2020. Accessed Jan. 25, 2021.
68. Artiga S, Corallo B, Pham O. Racial disparities in covid-19: key findings from available data and analysis. Kaiser Family Foundation. https://www.kff.org/racial-equity-and-health-policy/issue-brief/racial-disparities-covid-19-key-findings-available-data-analysis/. Published Aug. 17, 2020. Accessed Jan. 25, 2021.
69. Centers for Disease Control and Prevention. Health equity considerations and racial and ethnic minority groups. https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html. Published Feb. 11, 2020. Accessed April 20, 2021.
70. Wood D. As pandemic deaths add up, racial disparities persist — and in some cases worsen. NPR. https://www.npr.org/sections/health-shots/2020/09/23/914427907/as-pandemic-deaths-add-up-racial-disparities-persist-and-in-some-cases-worsen. Published Sept. 23, 2020. Accessed Jan. 25, 2021.
71. Johnson A, Martin N. How COVID-19 hollowed out a generation of young Black men. ProPublica. https://www.propublica.org/article/how-covid-19-hollowed-out-a-generation-of-young-black-men. Published Dec. 22, 2020. Accessed Jan. 25, 2021.
72. Ellis NT, McPhillips D. White people are getting vaccinated at higher rates than Black and Latino Americans. CNN. https://www.cnn.com/2021/01/26/us/vaccination-disparities-rollout/index.html. Published Jan. 26, 2021. Accessed Jan. 31, 2021.
73. Paez Bowman C. Coronavirus moving study shows more than 15.9 million people moved during COVID-19. MYMOVE.com. https://www.mymove.com/moving/covid-19/coronavirus-moving-trends/. Published Jan. 26, 2021. Accessed Jan. 31, 2021.
74. Friedman N. U.S. Home sales rise to new 14-year high, offering a boost to economy. *Wall Street Journal*. https://www.wsj.com/articles/existing-home-sales-rose-9-4-in-september-11603375549. Updated Oct. 22, 2020. Accessed Jan. 25, 2021.
75. Davis E. Americans moved west and south in 2020 amid coronavirus pandemic, study finds. *U.S. News*. https://www.usnews.com/news/best-states/articles/2021-01-04/americans-moved-west-and-south-in-2020-amid-coronavirus-pandemic-study-finds. Published Jan. 4, 2021. Accessed Jan. 25, 2021.
76. Patino M. The truth about American migration during Covid. Bloomberg City Lab. https://www.bloomberg.com/news/articles/2020-09-16/the-truth-about-american-migration-during-covid. Published Sept. 16, 2020. Accessed Oct. 20, 2020.
77. McDermott D, Cox C, Rudowitz R, Garfield R. How has the pandemic affected health coverage in the U.S.? Kaiser Family Foundation. https://www.kff.org/policy-watch/how-has-the-pandemic-affected-health-coverage-in-the-u-s/. Published December 2020. Accessed Jan. 25, 2021.
78. Sleat D, Wain R, Miller B. *Long Covid: Reviewing the Science and Assessing the Risk*. London, UK: Tony Blair Institute for Global Change; 2020.

79. del Rio C, Collins LF, Malani P. Long-term health consequences of COVID-19. *JAMA*. 2020;324(17):1723. doi:10.1001/jama.2020.19719
80. Huang C, Huang L, Wang Y, et al. 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet*. 2021;397(10270):220-232. doi:10.1016/S0140-6736(20)32656-8
81. Woodruff MC, Ramonell RP, Lee FE-H, Sanz I. Clinically identifiable autoreactivity is common in severe SARS-CoV-2 infection. *medRxiv*. Published online Oct. 28, 2020. doi:10.1101/2020.10.21.20216192
82. Sample I. "Autoantibodies" may be driving severe Covid cases, study shows. *Guardian*. Dec.13, 2020. https://www.theguardian.com/science/2020/dec/13/autoantibodies-may-be-driving-severe-covid-cases-study-shows. Accessed Jan. 25, 2021.
83. Greenhalgh T, Knight M, A'Court C, Buxton M, Husain L. Management of post-acute covid-19 in primary care. *BMJ*. Published online Aug. 11, 2020. doi:10.1136/bmj.m3026
84. National Institute for Health Research. Living with COVID: NIHR publishes dynamic themed review into 'ongoing COVID.' https://www.nihr.ac.uk/news/living-with-covid-nihr-publishes-dynamic-themed-review-into-ongoing-covid/25891. Published Oct. 15, 2020. Accessed Jan. 25, 2021.
85. Tenforde MW. Symptom duration and risk factors for delayed return to usual health among outpatients with COVID-19 in a multistate health care systems network — United States, March-June 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(30);993-998. doi:10.15585/mmwr.mm6930e1
86. Sudre CH, Murray B, Varsavsky T, et al. Attributes and predictors of long-COVID: analysis of COVID cases and their symptoms collected by the Covid Symptoms Study App. *medRxiv*. doi:10.1101/2020.10.19.20214494v1
87. Pantelis C, Jayaram M, Hannan AJ, et al. Neurological, neuropsychiatric and neurodevelopmental complications of COVID-19. *Aust N Z J Psychiatry*. Published online Oct. 1, 2020. doi:10.1177/0004867420961472
88. Rolfe RJ, Smith CM, Wolfe CR. The emerging chronic sequelae of COVID-19 and implications for North Carolina. *N C Med J*. 2021;82(1):75-78. doi:10.18043/ncm.82.1.75
89. Peltz J. "We know this is real": New clinics aid virus "long-haulers." *Associated Press*. Jan. 19, 2020. https://apnews.com/article/new-york-jamaica-coronavirus-pandemic-new-york-city-74bbc1b8433e936ba6a31c25d5f36873. Accessed Jan. 25, 2021.
90. York J. 30,000 cancer cases undetected in France due to Covid-19. Connexion. https://www.connexionfrance.com/French-news/30-000-cancer-cases-undetected-France-due-to-Covid-19. Published Oct. 26, 2020. Accessed Jan. 25, 2021.
91. ESMO. Fewer cancer diagnoses during COVID-19 outbreak in the Netherlands. https://www.esmo.org/oncology-news/fewer-cancer-diagnoses-during-covid-19-outbreak-in-the-netherlands. Published May 14, 2020. Accessed Jan. 25, 2021.
92. De Rosa S, Spaccarotella C, Basso C, et al. Reduction of hospitalizations for myocardial infarction in Italy in the COVID-19 era. *Eur Heart J*. Published online May 15, 2020. doi:10.1093/eurheartj/ehaa409
93. Sharpless NE. COVID-19 and cancer. *Science*. 2020;368(6497):1290. doi:10.1126/science.abd3377
94. Thompson H. French public warned: 'do not delay GP visit due to Covid.' Connexion. https://www.connexionfrance.com/French-news/French-public-warned-Do-not-delay-GP-help-due-to-Covid-as-cancer-cases-estimated-to-have-been-missed. Published Dec. 8, 2020. Accessed Jan. 25, 2021.

95. Wise J. Covid-19: Cancer mortality could rise at least 20% because of pandemic, study finds. *BMJ*. 2020;369:m1735. doi:10.1136/bmj.m1735
96. Maringe C, Spicer J, Morris M, et al. The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national, population-based, modelling study. *Lancet Oncol*. 2020;21(8):1023-1034. doi:10.1016/S1470-2045(20)30388-0
97. Hamel L, Kearney A, Kirzinger A, Lopes L, Muñana C, Brodie M. KFF Health Tracking Poll — July 2020. Kaiser Family Foundation. https://www.kff.org/coronavirus-covid-19/report/kff-health-tracking-poll-july-2020/. Published July 27, 2020. Accessed Aug. 25, 2020.
98. Kaiser Family Foundation. Adults reporting symptoms of anxiety or depressive disorder during COVID-19 pandemic. https://www.kff.org/other/state-indicator/adults-reporting-symptoms-of-anxiety-or-depressive-disorder-during-covid-19-pandemic/. Published Jan.14, 2021. Accessed Jan. 25, 2021.
99. Czeisler M, Lane RI, Petrosky E, et al. Mental health, substance use, and suicidal ideation during the COVID-19 pandemic — United States, June 24-30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(32):1049-1057. doi:10.15585/mmwr.mm6932a1
100. American Medical Association. *Reports of Increases in Opioid- and Other Drug-Related Overdose and Other Concerns During COVID Pandemic*. Chicago, IL: AMA; 2020. Updated April 15, 2021. https://www.ama-assn.org/system/files/2020-12/issue-brief-increases-in-opioid-related-overdose.pdf. Accessed April 20, 2021.
101. Mulligan CB. Deaths of Despair and the Incidence of Excess Mortality in 2020. Cambridge, MA: National Bureau of Economic Research; 2020. doi:10.3386/w28303
102. Britt RR. This pandemic is not even the 'big one.' Medium. https://elemental.medium.com/this-pandemic-is-not-even-the-big-one-df8660da2564. Published Jan.19, 2021. Accessed Jan. 31, 2021.
103. Health Resources and Services Administration. Goal 3: achieve health equity and enhance population health. https://www.hrsa.gov/about/strategic-plan/goal-3.html. Published March 31, 2017. Accessed Jan. 27, 2020.
104. Centers for Disease Control and Prevention. Health equity. https://www.cdc.gov/chronicdisease/healthequity/index.htm. Published Aug. 28, 2019. Accessed Jan. 27, 2020.
105. American Public Health Association. Achieving health equity in the United States. https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2019/01/29/achieving-health-equity. Accessed Jan. 27, 2020.
106. AAMC. *Policy Priorities to Improve Our Nation's Health: Health Equity*. Washington, DC: AAMC; 2016. https://www.aamc.org/system/files/c/2/472868-healthequity.pdf. Accessed Dec. 15, 2020.
107. Zimmerman FJ, Anderson NW. Trends in health equity in the United States by race/ethnicity, sex, and income, 1993-2017. *JAMA Netw Open*. 2019;2(6):e196386. doi:10.1001/jamanetworkopen.2019.6386
108. Nelson HD, Cantor A, Wagner J, et al. Achieving health equity in preventive services: a systematic review for a national institutes of health pathways to prevention workshop. *Ann Intern Med*. 2020;172(4):258-271. doi:10.7326/M19-3199
109. Centers for Disease Control and Prevention. COVID-19 racial and ethnic health disparities. https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/racial-ethnic-disparities/index.html. Published Dec. 10, 2020. Accessed Jan. 30, 2021.

110. Infectious Diseases Society of America. *COVID-19 Policy Brief: Disparities Among Rural Communities in the United States*. Arlington, VA: IDSA; 2020. https://www.idsociety.org/globalassets/idsa/public-health/covid-19/covid19-health-disparities-in-rural-communities_leadership-review_final_ab_clean.pdf. Accessed Jan. 30, 2021.
111. Pollack HA, Kelly C. COVID-19 and health disparities: insights from key informant interviews. Health Affairs [blog]. Oct. 27, 2020. https://www.healthaffairs.org/do/10.1377/hblog20201023.55778/full/. Accessed Jan. 30, 2021.
112. Centers for Disease Control and Prevention. 2013 NCHS urban-rural classification scheme for counties. https://www.cdc.gov/nchs/data_access/urban_rural.htm. Updated June 1, 2017. Accessed Dec. 15, 2020.
113. Arroyo-Johnson C, Mincey KD, Ackermann N, Milam L, Goodman MS, Colditz GA. Racial and ethnic heterogeneity in self-reported diabetes prevalence trends across Hispanic subgroups, national health interview survey, 1997-2012. *Prev Chronic Dis*. 2016;13:150260. doi:10.5888/pcd13.150260
114. Chang S-H, Yu Y-C, Carlsson NP, Liu X, Colditz GA. Racial disparity in life expectancies and life years lost associated with multiple obesity-related chronic conditions: racial disparity and obesity-related conditions. *Obesity (Silver Spring)*. 2017;25(5):950-957.
115. Fei K, Rodriguez-Lopez JS, Ramos M, et al. Racial and ethnic subgroup disparities in hypertension prevalence, New York City Health and Nutrition Examination Survey, 2013-2014. *Prev Chronic Dis*. 2017;14:160478. doi:10.5888/pcd14.160478
116. Heidemann DL, Joseph NA, Kuchipudi A, Perkins DW, Drake S. Racial and economic disparities in diabetes in a large primary care patient population. *Ethn Dis*. 2016;26(1):85-90. doi:10.18865/ed.26.1.85.
117. Rich NE, Oji S, Mufti AR, et al. Racial and ethnic disparities in nonalcoholic fatty liver disease prevalence, severity, and outcomes in the United States: a systematic review and meta-analysis. *Clin Gastroenterol Hepatol*. 2018;16(2):198-210.e2.
118. Saadi A, Himmelstein DU, Woolhandler S, Mejia NI. Racial disparities in neurologic health care access and utilization in the United States. *Neurology*. 2017;88(24):2268-2275.
119. Naik RP, Irvin MR, Judd S, et al. Sickle cell trait and the risk of ESRD in Blacks. *J Am Soc Nephrol*. 2017;28(7):2180-2187. doi:10.1681/ASN.2016101086
120. Reeves SL, Jary HK, Gondhi JP, Kleyn M, Spector-Bagdady K, Dombkowski KJ. Incidence, demographic characteristics, and geographic distribution of sickle cell trait and sickle cell anemia births in Michigan, 1997-2014. *Mol Genet Genomic Med*. 2019;7(8):e795. doi:10.1002/mgg3.795
121. Health Resources and Services Administration. *Technical Documentation for Health Resources Services Administration's Health Workforce Simulation Model*. Rockville, MD: U.S. Department of Health and Human Services; 2020. https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/data-research/technical-documentation-health-workforce-simulation-model.pdf. Accessed May 15, 2020.
122. Dall T, Reynolds R, Chakrbarti R, Iacobucci W, Jones K. *Health Workforce Microsimulation Model Documentation*. Washington, DC: IHS Markit; 2020. https://cdn.ihs.com/www/pdf/1118/Health-Workforce-Microsimulation-Model.pdf. Accessed Jan. 30, 2021.
123. Brotherton SE, Etzel SI. Graduate medical education, 2019-2020. *JAMA*. 2020;324(12):1230-1250. doi:10.1001/jama.2020.14635
124. McKinney SM, Sieniek M, Godbole V, et al. International evaluation of an AI system for breast cancer screening. *Nature*. 2020;577(7788):89-94. doi:10.1038/s41586-019-1799-6

125. Chang HY, Jung CK, Woo JI, et al. Artificial intelligence in pathology. *J Pathol Transl Med*. 2019;53(1):1-12. doi:10.4132/jptm.2018.12.16
126. Man S, Schold JD, Uchino K. Case fatality decline from 2009 to 2013 among Medicare beneficiaries with ischemic stroke. *J Stroke Cerebrovasc Dis*. 2020;29(2):104559. doi:10.1016/j.jstrokecerebrovasdis.2019.104559
127. Yang R, Zhou Y, Wang Y, Du C, Wu Y. Trends in cancer incidence and mortality rates in the United States from 1975 to 2016. *Ann Transl Med*. 2020;8(24):1671-1671. doi:10.21037/atm-20-7841
128. Pandey A, Keshvani N, Khera R, et al. Temporal trends in racial differences in 30-day readmission and mortality rates after acute myocardial infarction among Medicare beneficiaries. *JAMA Cardiol*. 2020;5(2):136-145. doi:10.1001/jamacardio.2019.4845
129. Battafarano DF, Ditmyer M, Bolster MB, et al. 2015 American College of Rheumatology Workforce Study: supply and demand projections of adult rheumatology workforce, 2015-2030. *Arthritis Care Res (Hoboken)*. 2018;70(4):617-626. doi:10.1002/acr.23518
130. Burton A. How do we fix the shortage of neurologists? Lancet Neurol. 2018;17(6):502-503. doi:10.1016/S1474-4422(18)30143-1
131. Buchman TG, Coopersmith CM, Meissen HW, et al. Innovative interdisciplinary strategies to address the intensivist shortage. *Crit Care Med*. 2017;45(2):298-304. doi:10.1097/CCM.0000000000002209
132. Stonehocker J, Muruthi J, Rayburn WF. Is there a shortage of obstetrician-gynecologists? *Obstet Gynecol Clin North Am*. 2017;44(1):121-132. doi:10.1016/j.ogc.2016.11.006
133. Ellison EC, Pawlik TM, Way DP, Satiani B, Williams TE. Ten-year reassessment of the shortage of general surgeons: increases in graduation numbers of general surgery residents are insufficient to meet the future demand for general surgeons. *Surgery*. 2018;164(4):726-732. doi:10.1016/j.surg.2018.04.042
134. American Association of Nurse Practitioners. NP fact sheet. https://www.aanp.org/about/all-about-nps/np-fact-sheet. Published August 2020. Accessed Jan. 29, 2021.
135. American College of Nurse-Midwives. Essential facts about midwives. https://www.midwife.org/acnm/files/cclibraryfiles/filename/000000007531/EssentialFactsAboutMidwives-UPDATED.pdf. Accessed Jan. 29, 2021.
136. American Association of Nurse Anesthetists. Certified registered nurse anesthetists fact sheet. https://www.aana.com/membership/become-a-crna/crna-fact-sheet. Accessed Jan. 29, 2021.
137. National Commission on Certification of Physician Assistants. *2019 Statistical Profile of Certified Physician Assistants*. Johns Creek, GA: NCCPA; 2020. https://prodcmsstoragesa.blob.core.windows.net/uploads/files/2019StatisticalProfileofCertifiedPhysicianAssistants.pdf. Accessed Jan. 12, 2021.
138. Altschuler J, Margolius D, Bodenheimer T, Grumbach K. Estimating a reasonable patient panel size for primary care physicians with team-based task delegation. *Ann Fam Med*. 2012;10(5):396-400. doi:10.1370/afm.1400
139. Ashwood JS, Gaynor M, Setodji CM, Reid RO, Weber E, Mehrotra A. Retail clinic visits for low-acuity conditions increase utilization and spending. *Health Aff (Millwood)*. 2016;35(3):449-455.
140. Mehrotra A, Wang MC, Lave JR, Adams JL, McGlynn EA. Retail clinics, primary care physicians, and emergency departments: a comparison of patients' visits. *Health Aff (Millwood)*. 2008;27(5):1272-1282.
141. Smith J, Pan D, Novelli M. A nurse practitioner–led intervention to reduce hospital readmissions. *J Nurse Pract*. 2016;12(5):311-316.

142. Nabagiez JP, Shariff MA, Khan MA, Molloy WJ, McGinn JT Jr. Physician assistant home visit program to reduce hospital readmissions. *J Thorac Cardiovasc Surg*. 2013;145(1097-685X (Electronic)):225-231, 233. doi:10.1016/j.jtcvs.2012.09.047
143. Mora K, Dorrejo XM, Carreon KM, Butt S. Nurse practitioner-led transitional care interventions: an integrative review. *J Am Assoc Nurse Pract*. 2017;29(12):773-790. doi:10.1002/2327-6924.12509
144. Zozaya-Monohon M, Corona AR. Success of a nurse practitioner-led interdisciplinary team. *J Nurse Pract.* 2019;15(7):e143-e146. doi:10.1016/j.nurpra.2019.03.019
145. DeWolfe C, Birch S, Callen Washofsky A, Gardner C, McCarter R, Shah NH. Patient outcomes in a pediatric hospital medicine service staffed with physicians and advanced practice providers. *Hosp Pediatr*. 2019;9(2):121-128. doi:10.1542/hpeds.2018-0028
146. Kurtzman ET, Barnow BS. A comparison of nurse practitioners, physician assistants, and primary care physicians' patterns of practice and quality of care in health centers. *Med Care*. 2017;55(6):615-622. doi:10.1097/MLR.0000000000000689
147. Lovink MH, Persoon A, Koopmans RTCM, Van Vught AJAH, Schoonhoven L, Laurant MGH. Effects of substituting nurse practitioners, physician assistants or nurses for physicians concerning healthcare for the ageing population: a systematic literature review. *J Adv Nurs*. 2017;73(9):2084-2102. doi:10.1111/jan.13299
148. Yang Y, Long Q, Jackson SL, et al. Nurse practitioners, physician assistants, and physicians are comparable in managing the first five years of diabetes. *Am J Med*. 2018;131(3):276-283.e2. doi:10.1016/j.amjmed.2017.08.026
149. The Physicians Foundation. *2018 Survey of America's Physicians: Practice Patterns and Perspectives*. Austin, TX: The Physicians Foundation; 2018. https://physiciansfoundation.org/wp-content/uploads/2018/09/physicians-survey-results-final-2018.pdf. Accessed Jan. 29, 2021.
150. Bachrach D, Frohlich J, Garcimonde A, Nevitt K. *Building a Culture of Health: The Value Proposition of Retail Clinics*. Robert Wood Johnson Foundation and Manatt; 2015. http://www.manatt.com/uploadedFiles/Content/5_Insights/White_Papers/Retail_Clinic_RWJF.pdf. Jan. 15, 2020.
151. Michas F. Number of retail clinics in the U.S. in 2019, by location. Statista. https://www.statista.com/statistics/1168697/us-leading-retail-clinic-locations/#statisticContainer. Published September 2020. Accessed March 4, 2021.
152. BlueCross BlueShield. Retail Clinic Visits Increase Despite Use Lagging Among Individually Insured Americans. BlueCross BlueShield; 2017. https://www.bcbs.com/the-health-of-america/reports/retail-clinic-visits-increase-despite-use-lagging-among-individually. Accessed Dec. 15, 2020.
153. Medical Group Management Association. MGMA 2016 Provider Compensation and Production Report: Based on 2015 Survey Data. Englewood, CO: MGMA; 2016.
154. Patel SA, Winkel M, Ali MK, Narayan KMV, Mehta NK. Cardiovascular mortality associated with 5 leading risk factors: national and state preventable fractions estimated from survey data. *Ann Intern Med*. 2015;163(4):245-253.
155. Song M, Giovannucci E. Preventable incidence and mortality of carcinoma associated with lifestyle factors among white adults in the United States. *JAMA Oncol*. 2016;2(9):1154-1161.
156. Mehta NK, Patel SA, Ali MK, Venkat Narayan KM. Preventing disability: the influence of modifiable risk factors on state and national disability prevalence. *Health Aff (Millwood)*. 2017;36(4):626-635.

157. Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services. Healthy People: 2020 topics and objectives. https://www.healthypeople.gov/2020/topics-objectives. Accessed May 14, 2020.
158. Su W, Huang J, Chen F, et al. Modeling the clinical and economic implications of obesity using microsimulation. *J Med Econ*. 2015;18(11):886-897. doi:10.3111/13696998.2015.1058805
159. Chen F, Su W, Becker SH, et al. Clinical and economic impact of a digital, remotely-delivered intensive behavioral counseling program on Medicare beneficiaries at risk for diabetes and cardiovascular disease. *PLoS One*. 2016;11(10):e0163627. doi:10.1371/journal.pone.0163627
160. Dall TM, Storm MV, Semilla AP, Wintfeld N, O'Grady M, Venkat Narayan KM. Value of lifestyle intervention to prevent diabetes and sequelae. *Am J Prev Med*. 2015;48(3):271-280. doi:10.1016/j.amepre.2014.10.003
161. Semilla AP, Chen F, Dall TM. Reductions in mortality among Medicare beneficiaries following the implementation of Medicare Part D. *Am J Manag Care*. 2015;21(1936-2692 (Electronic)):s165-s171.
162. Taylor F, Huffman MD, Macedo AF, et al. Statins for the primary prevention of cardiovascular disease. *Cochrane Database Syst Rev*. 2013;(1469-493X (Electronic)):CD004816.
163. Baguet JP, Legallicier B, Auquier P, Robitail S. Updated meta-analytical approach to the efficacy of antihypertensive drugs in reducing blood pressure. *Clin Drug Investig*. 2007;27(1173-2563 (Print)):735-753.
164. Sherifali D, Nerenberg K, Pullenayegum E, Cheng JE, Gerstein HC. The effect of oral antidiabetic agents on A1C levels: a systematic review and meta-analysis. *Diabetes Care*. 2010;33(1935-5548 (Electronic)):1859-1864.
165. Proia KK, Thota AB, Njie GJ, et al. Team-based care and improved blood pressure control. *Am J Prev Med*. 2014;47(1):86-99.
166. Costello T, Dorrell M, Kellams T, Kraska K. Review of pharmacologic weight loss medications in a patient-centered medical home. *J Pharm Technol*. 2016;32(1):37-41.
167. Hibbard JH, Greene J, Sacks RM, Overton V, Parrotta C. Improving population health management strategies: identifying patients who are more likely to be users of avoidable costly care and those more likely to develop a new chronic disease. *Health Serv Res*. 2017;52(4):1297-1309.
168. Lauffenburger JC, Shrank WH, Bitton A, et al. Association between patient-centered medical homes and adherence to chronic disease medications: a cohort study. *Ann Intern Med*. 2017;166(2):81-88.
169. Agarwal R, Gupta A, Fendrick AM. Value-based insurance design improves medication adherence without an increase in total health care spending. *Health Aff (Millwood)*. 2018;37(7):1057-1064.
170. Look KA. Value-based insurance design and medication adherence: opportunities and challenges. *Am J Manag Care*. 2015;21(1):e78-90.
171. Morgado MP, Morgado SR, Mendes LC, Pereira LJ, Castelo-Branco M. Pharmacist interventions to enhance blood pressure control and adherence to antihypertensive therapy: Review and meta-analysis. *Am J Health Syst Pharm*. 2011;68(3):241-253.
172. Dall T, Chakrabarti R, Iacobucci W, Hansari A, West T. *The Complexities of Physician Supply and Demand: Projections From 2015 to 2030: 2017 Update*. Report prepared for the AAMC by IHS Markit. Washington, DC: AAMC; 2017. https://aamc-black.global.ssl.fastly.net/production/media/filer_public/a5/c3/a5c3d565-14ec-48fb-974b-99fafaeecb00/aamc_projections_update_2017.pdf. Accessed Dec. 15, 2020.

173. Yang W, Dall TM, Zhang Y, et al. Simulation of quitting smoking in the military shows higher lifetime medical spending more than offset by productivity gains. *Health Aff (Millwood)*. 2012;31(1544-5208 (Electronic)):2717-2726.
174. Jha P, Ramasundarahettige C, Landsman V, et al. 21st-Century hazards of smoking and benefits of cessation in the United States. *N Engl J Med*. 2013;368(4):341-350.
175. Centers for Disease Control and Prevention. Smoking and Tobacco Use: Health Effects. https://www.cdc.gov/tobacco/basic_information/health_effects/index.htm. Accessed Dec. 15, 2020.
176. AAMC. FACTS Table B-3: total U.S. medical school enrollment by race/ethnicity and sex, 2015-2016 through 2019-2020. https://www.aamc.org/system/files/2019-11/2019_FACTS_Table_B-3.pdf. Published Nov. 3, 2020. Accessed Jan. 25, 2021.
177. Blumenthal D, Abrams M, Nuzum R. The Affordable Care Act at 5 years. *N Engl J Med*. 2015;372(25):2451-2458.
178. Iglesia EGA, Greenhawt M, Shaker MS. Achieving the Quadruple Aim to deliver value-based allergy care in an ever-evolving health care system. *Ann Allergy Asthma Immunol*. 2020;125(2):126-136. doi:10.1016/j.anai.2020.04.007
179. Medicare Access and CHIP Reauthorization Act of 2015, Pub L No. 114-10, 129 Stat 87 (2015).
180. Davis K, Abrams M, Stremikis K. How the Affordable Care Act will strengthen the nation's primary care foundation. *J Gen Intern Med*. 2011;26(10):1201-1203.
181. Koh HK. A 2020 vision for healthy people. *N Engl J Med*. 2010;362(18):1653-1656.
182. Milani RV, Lavie CJ. Health care 2020: reengineering health care delivery to combat chronic disease. *Am J Med*. 2015;128(4):337-343.
183. DeVore S, Champion RW. Driving population health through accountable care organizations. *Health Aff (Millwood)*. 2011;30(1):41-50.
184. Thorpe KE, Ogden LL. The foundation that health reform lays for improved payment, care coordination, and prevention. *Health Aff (Millwood)*. 2010;29(6):1183-1187.
185. Jacquin L. A strategic approach to healthcare transformation. *Healthc Financ Manage*. 2014;68(4):74-79.
186. Blumenthal D, Anderson G, Burke S, Fulmer T, Jha AK, Long P. *Tailoring Complex-Care Management, Coordination, and Integration for High-Need, High-Cost Patients* [discussion paper]. Washington, DC: National Academy of Medicine; 2016.
187. Cutler DM. From the Affordable Care Act to affordable care. *JAMA*. 2015;314(4):337-338.
188. Casalino LP. The Medicare Access and CHIP Reauthorization Act and the corporate transformation of American medicine. *Health Aff (Millwood)*. 2017;36(5):865-869.
189. Barnes H, Martsolf GR, McHugh MD, Richards MR. Vertical integration and physician practice labor composition. *Med Care Res Rev*. Published online Nov. 13, 2020:1077558720972596. doi:10.1177/1077558720972596
190. Singleton T, Miller P. The physician employment trend: what you need to know. *Fam Pract Manag*. 2015;22(4):11-15.
191. Lagarde M, Blaauw D. Physicians' responses to financial and social incentives: a medically framed real effort experiment. *Soc Sci Med*. 2017;179:147-159.
192. Singleton T, Miller P. Employment contracts for family physicians in an evolving market. *Fam Pract Manag*. 2016;23(4):28-32.
193. Capoccia K, Odegard PS, Letassy N. Medication adherence with diabetes medication: a systematic review of the literature. *Diabetes Educ*. 2016;42(1):34-71.

194. Bansilal S, Castellano JM, Garrido E, et al. Assessing the impact of medication adherence on long-term cardiovascular outcomes. *J Am Coll Cardiology*. 2016;68(8):789-801.
195. Shillington A, Ganjuli A, Clewell J. The impact of patient support programs on adherence, clinical, humanistic, and economic patient outcomes: a targeted systematic review. *Patient Prefer Adherence*. 2016;10:711-725.
196. Zullig LL, Ramos K, Bosworth HB. Improving medication adherence in coronary heart disease. *Curr Cardiol Rep*. 2017;19(11):113. doi:10.1007/s11886-017-0918-y
197. Pawloski PA, Asche SE, Trower NK, et al. A substudy evaluating treatment intensification on medication adherence among hypertensive patients receiving home blood pressure telemonitoring and pharmacist management. *J Clin Pharm Ther*. 2016;41(1365-2710 (Electronic)):493-498.
198. Hawes EM, Lambert E, Reid A, Tong G, Gwynne M. Implementation and evaluation of a pharmacist-led electronic visit program for diabetes and anticoagulation care in a patient-centered medical home. *Am J Health Syst Pharm*. 2018;75(12):901-910.
199. Zhang Y, Lu M. A review of recent advancements in soft and flexible robots for medical applications. *Int J Med Robot*. 2020;16(3):e2096. doi:10.1002/rcs.2096
200. Sikdar S, Guha S. Advancements of healthcare technologies: paradigm towards smart healthcare systems. In: Jain S, Paul S, eds. *Recent Trends in Image and Signal Processing in Computer Vision. Vol 1124.* Advances in Intelligent Systems and Computing [series]. Springer Singapore; 2020;113-132. doi:10.1007/978-981-15-2740-1_9
201. Substance Abuse and Mental Health Services Administration. *Key Substance Use and Mental Health Indicators in the United States: Results From the 2018 National Survey on Drug Use and Health*. Rockville, MD: Center for Behavioral Health Statistics and Quality, SAMHSA; 2019. https://www.samhsa.gov/data/. Accessed Aug. 19, 2020.
202. Han B, Compton WM, Blanco C, Colpe LJ. Prevalence, treatment, and unmet treatment needs of U.S. adults with mental health and substance use disorders. *Health Aff (Millwood)*. 2017;36(10):1739-1747. doi:10.1377/hlthaff.2017.0584
203. U.S. Preventive Services Task Force. Recommendation from the Community Preventive Services Task Force for use of collaborative care for the management of depressive disorders. *Am J Prev Med*. 2012;42(5):521-524.
204. Xierali IM, Tong ST, Petterson SM, Puffer JC, Phillips RL, Bazemore AW. Family physicians are essential for mental health care delivery. *J Am Board Fam Med*. 2013;26(2):114-115.
205. Duggal R, Zhang Y, Diana ML. The association between hospital ACO participation and readmission rates. *J Healthc Manag*. 2018;63(5):e100-e114.
206. Mehtsun WT, Papanicolas I, Zheng J, Orav EJ, Lillemoe KD, Jha AK. National trends in readmission following inpatient surgery in the hospital readmissions reduction program era. *Ann Surg*. 2018;267(4):599-605.
207. Cardarelli R, Bausch G, Murdock J, Chyatte MR. Return-on-investment (ROI) analyses of an inpatient lay health worker model on 30-day readmission rates in a rural community hospital: ROI of a care transition model in Appalachia. *J Rural Health*. 2017;34(4):411-422. doi:10.1111/jrh.12250
208. Wasfy JH, Zigler CM, Choirat C, Wang Y, Dominici F, Yeh RW. Readmission rates after passage of the hospital readmissions reduction program: a pre-post analysis. *Ann Intern Med*. 2017;166(5):324-331.
209. Huntley AL, Chalder M, Shaw ARG, et al. A systematic review to identify and assess the effectiveness of alternatives for people over the age of 65 who are at risk of potentially avoidable hospital admission. *BMJ Open*. 2017;7(7):e016236.

210. Daly MR, Mellor JM, Millones M. Do avoidable hospitalization rates among older adults differ by geographic access to primary care physicians? *Health Serv Res*. 2018;53:3245-3264.
211. Ingber MJ, Feng Z, Khatutsky G, et al. Initiative to reduce avoidable hospitalizations among nursing facility residents shows promising results. *Health Aff (Millwood)*. 2017;36(3):441-450.
212. Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health Aff (Millwood)*. 2010;29(9):1630-1636.
213. Green LA, Chang H-C, Markovitz AR, Paustian ML. The reduction in ED and hospital admissions in medical home practices is specific to primary care-sensitive chronic conditions. *Health Serv Res*. 2018;53(2):1163-1179.
214. Hawes EM, Smith JN, Pinelli NR, et al. Accountable Care in Transitions (ACTion): a team-based approach to reducing hospital utilization in a patient-centered medical home. *J Pharm Pract*. 2018;31(2):175-182.
215. Truven Health Analytics. Study finds most emergency room visits made by privately-insured patients avoidable. https://www.businesswire.com/news/home/20130425005100/en/Truven-Health-Analytics-Study-Finds-Most-Emergency-Room-Visits-Made-by-Privately-Insured-Patients-Are-Avoidable. Published April 25, 2013. Accessed March 17, 2021.
216. Frey WH. Just before COVID-19, American migration hit a 73-year low. The Brookings Institution. https://www.brookings.edu/blog/the-avenue/2020/12/15/just-before-covid-19-american-migration-hit-a-73-year-low/. Published Dec. 15, 2020. Accessed Jan. 30, 2021.
217. Health Resources and Services Administration. Projecting Health Workforce Supply and Demand. https://bhw.hrsa.gov/data-research/projecting-health-workforce-supply-demand. Published 2021. Accessed Jan. 30, 2021.
218. Texas Department of State Health Services. *Texas Projections of Supply and Demand for Primary Care Physicians and Psychiatrists, 2017-2030*. Austin, TX: Texas Health and Human Services; 2018. https://dshs.texas.gov/legislative/2018-Reports/SB-18-Physicians-Workforce-Report-Final.pdf.

Association of
American Medical Colleges
655 K Street, NW, Suite 100, Washington, DC 20001-2399
T 202 828 0400
aamc.org

21-023A (06/21)