

CENTER FOR  HOUSTON'S FUTURE



HOUSTON'S ECONOMIC FUTURE: HEALTH CARE 2022

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ABOUT CHF

Center for Houston's Future, an independent affiliate of the Greater Houston Partnership, focuses on understanding future global trends and their impact on the Houston region. CHF brings business, government, and community stakeholders together to engage in fact-based strategic planning, collaboration, and action on issues of great importance to the success of our region. It engages in economic research and strategic planning, holds community events, and develops leaders. Our strategic focus areas include health and health equity; energy, climate and energy transition; and the economic importance of immigration. Our Business/Civic Leadership Forum has graduated about 1,300 leaders.

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LETTER FROM THE CEO

The last two and a half years stretched the health care and life sciences sectors as our lives changed seemingly overnight with the onset of the coronavirus pandemic. The pandemic also led to an increased appreciation of the importance of these sectors, not just for the health of the population, but also for the health of the economy.

In this report, Center for Houston's Future (the Center) embarked on a project to analyze the intricacies of our regional health care sector, health equity issues uncovered by the pandemic, and the economic future of the industry.

This report builds on Center for Houston's Future's 2020 report, *Houston's Economic Future: Health Care*. After facing multiple and rapid changes, the region's health and health care sector remains key to the region's continued economic prosperity.

This work has been made possible with the support of HCA Houston Healthcare, which generously underwrote this report and served as an invaluable partner in connecting the Center to leaders in the local health care community. We are also thankful to the more than 50 participants in our interviews and roundtables for providing insights and context.

We are grateful for the spirit of collaboration in the region and hope this report helps to highlight ongoing and future initiatives in Houston that will play a key role in defining our future as a leader in the health and life sciences fields.



Brett A. Perlman

Model Forecasts for 2036

BASELINE SCENARIO



\$63.5 B

GDP increase
from 2021 to 2036

248%

% GDP increase
from 2020 to 2036

493,000

of jobs increase
from 2021 to 2036

LABOR SHORTAGE SCENARIO



\$49.3 B

GDP increase
from 2021 to 2036

\$-14.2 B

GDP compared to
baseline scenario

-158,000

of jobs compared to
baseline scenario

LIFE SCIENCES SCENARIO



\$103.8 B

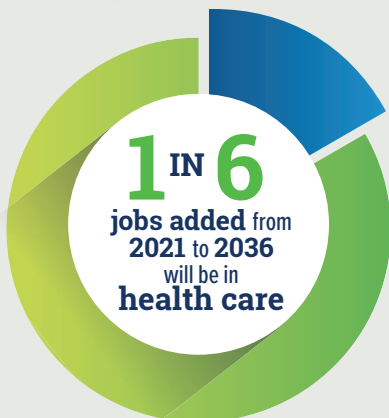
GDP increase
from 2021 to 2036

\$40.4 B

GDP compared to
baseline scenario

150,000

of jobs compared to
baseline scenario



Present-Day Houston

HEALTH CARE ACCOUNTS FOR:

11.2%

of the region's
employment

5.2%

of
GDP

Executive Summary

The story of health in Houston continues to be complex, contradictory, and multifaceted.

In our report, *Houston's Economic Future: Health Care*, published in late 2020, we identified a paradox of plenty: Houston is home to the Texas Medical Center (TMC), the largest medical center in the world, and renowned academic and research settings, but suffers from some of the worst health outcomes, with persistent and stark disparities based on income, ethnicity, and access to insurance. The last two years of the coronavirus pandemic stretched the health care system, exposing and worsening many of these underlying issues. It also demonstrated the economic risk of poor public health.

Here, we build on our last report and expand our horizon to examine the distinct factors that go into the health of our community and the health care sector as an economic driver. We interviewed experts, hosted roundtables with industry leaders, and reviewed academic literature to better understand the complexities of health, health care, and health equity in Houston.

We begin by looking at Houston's health care system, which spans TMC as well as hospitals and facilities across our region, through the lens of a health care evaluation and improvement framework called the "quintuple aim of health care." This framework, which was first published in the *Journal of the American Medical Association* in 2022, expands the Institute for Healthcare Improvement's "triple aim" to address workforce burnout and health equity in addition to the original aims of patient experience, per capita cost, and population health (including social determinants of health).

We then turn to the economic role of the health care sector, including the health service and life sciences industry clusters, as the largest employer in the Greater Houston area. Of note, we look at recent and projected trends in health technology, including telehealth, artificial

intelligence, wearable technology, and home health care. We envision Houston's potential as a robust life sciences hub and acknowledge the need to continue building an ecosystem in which talent can grow and flourish. And we consider rising health care workforce burnout rates coupled with a worsening health care workforce shortage. Finally, we revisit our 2020 economic models to show how the future of Houston's health care sector has been affected by events of the past two years. We conclude that Houston can realize significant economic benefits by focusing on health technology adoption, life sciences ecosystem development, and workforce shortage solutions.

Once again, our hope is to foster a community-wide conversation among business leaders, health professionals, and government officials on how to shape this future and make Houston's health care sector a model for our country.

Throughout this report, we highlight important initiatives underway in the region and consider their influence.

DEFINITION OF TERMS

Throughout this report, unless otherwise noted:

Houston MSA or the region is defined as the Houston Metropolitan Statistical Area (MSA), which is comprised of the following counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller.

Health refers to both physical and mental health. **Health care** refers to the sector that provides health care services and health innovations.

Health equity refers to the state in which everyone has a fair and just opportunity to attain their highest level of health.

EXECUTIVE SUMMARY: HEALTH CARE AS A SYSTEM

Our report looks at Houston's health care system through the framework of the "quintuple aim" for a baseline view of where we are today. It includes patient outcomes, per capita cost of care, population health, health equity, and workforce burnout. Some of our primary conclusions are:



PATIENT EXPERIENCE/MEDICAL OUTCOMES:

The pandemic increased mortality rates by 21.9 percent in 2020 over 2019 in Harris County. The pandemic also led to neglected preventative care, which is contributing to higher disease rates. Chronic disease rates continue to be high in the region, accounting for 41.9 percent of all deaths. Heart disease and cancer, for instance, are the leading causes of death. Covid-19 is also a top cause of death in the region. Diabetes remains a prevalent chronic disease, though initiatives such as Cities Changing Diabetes are working to improve that.



COST AND VALUE:

The cost of care in Houston and the U.S., in general, is significantly higher than other economically developed nations. This is particularly detrimental for the high proportion of the population that is uninsured (almost 1 in 4 in Harris County) or underinsured. Due to rising health care costs, comprehensive insurance plans have become more expensive and may have high deductibles. In fact, Texans carry the highest amount of medical debt in the country. Cost efficiency, transparency, and waste reduction in medicine can all play roles in helping solve this issue.



POPULATION HEALTH (INCLUDING SOCIAL DETERMINANTS OF HEALTH):

While we spend \$4.3 trillion on health care services, social determinants of health (SDoH) and health behaviors can account for up to 90 percent of health outcomes. Examples include economic stability, neighborhood conditions, education, and food security. A large part of the region's population faces social risk factors that lead to lifelong poor health outcomes.



EQUITY:

Texas ranked 46th in health equity and racial disparities in the 2022 Commonwealth Fund State Health Scorecard. Health disparities in Texas are consistently some of the worst in the nation. These disparities largely exist in racial and ethnic minority populations. As a result of social risk factors, racial and ethnic minorities often experience worse downstream health outcomes that follow them throughout life.



HEALTH CARE WORKFORCE BURNOUT:

The pandemic also increased burnout among health care workers. The result of chronic stress, burnout is exacerbating a health care workforce shortage. The U.S. turnover rate of registered nurses reached a high of 27.1 percent in 2021. Promoting a culture of self-care is one of the ways the health care workforce can learn how to handle stressors and build resilience.



EXECUTIVE SUMMARY:

HEALTH ISSUES



COVID-19 AND PREPARING FOR FUTURE HEALTH EMERGENCIES:

We can expect disease outbreaks, such as Covid-19 and monkeypox, to remain a prominent part of health discourse. Experts predict global warming and habitat destruction will increase the spread of disease. Houston must be better prepared for such outbreaks. The Texas Epidemic Public Health Institute was created to learn from Covid-19 and prepare for future health emergencies by building the infrastructure to monitor and develop or institutionalize protocols as needed.



MENTAL HEALTH:

Our region faces a surge in mental health issues, which experts say are being fueled partly by pandemic-related stressors. Children aged 12-17 have faced some of the largest issues. At the same time, our region does not have enough mental health professionals or inpatient facilities to meet demand. Those in crisis who want help might not be able to access it. Promising developments include more funding, increased use of telehealth, and a move toward integrated health, in which primary care and mental health care occur at the same time.



DIABETES:

The prevalence of diabetes varies significantly across the region, ranging from 5.7 percent in the 77007 zip code to 22.1 percent in the 77016 zip code. The Centers for Disease Control estimates that a third of Americans living with diabetes are unaware of having the disease. One program working to address diabetes at a community level in Houston is Cities Changing Diabetes. They predict that addressing health behaviors will reduce conditions like obesity, which in turn will reduce Type 2 diabetes cases by 149,000 cases by 2045. They estimate this will save Houston \$1.5 billion in health care expenses.



MATERNAL AND REPRODUCTIVE HEALTH:

Houston has some of the worst maternal health outcomes in the nation, earning an "F" rating from the March of Dimes. More than 80 percent of pregnancy-related deaths in Texas were preventable, according to 2017-2019 data from Maternal Mortality Review Committees (MMRCs). With one in four Texas births occurring in Houston, this is a major issue. Profound disparities exist: Black women are three times more likely to die in childbirth and have other adverse health outcomes. Poor medical outcomes devastate families and ripple through the economy. Health experts are eager to engage the business community in potential solutions. After the recent reversal of Roe vs. Wade, reproductive health outcomes are projected to worsen, leading to economic consequences such as women leaving the workforce, having lower educational attainments and wages, and facing increased insurance costs.

EXECUTIVE SUMMARY: OVERVIEW OF ECONOMICS OF HEALTH CARE IN HOUSTON



THE ROLE OF HEALTH CARE IN HOUSTON'S ECONOMY:

The health care and social service industry represents the largest employee base in the region, accounting for just over 11 percent of all workers. In the last nine years, the number of health and social service employees has increased by 25 percent. In addition, the sector is responsible for 5.2 percent of the region's GDP. When health care spending leads to health innovations and improved health outcomes, it can be a driver of local prosperity rather than a weight on broader economic wellbeing.



EFFECT OF COVID-19 ON HEALTH SERVICE AND LIFE SCIENCES JOBS:

The Covid-19 pandemic led to significant job cuts and unemployment. Houston's health care sector was no exception, though not hit as hard. Medical professionals not on the frontlines of the pandemic and those in elderly and nursing care facilities faced job losses similar to other industries. Hospital systems saw relatively few job losses. The life sciences industry, at the forefront of vaccine and therapeutics development during the pandemic, has also been resilient to job loss. Pharmaceutical preparation and manufacturing, surgical and medical device manufacturing, and cell therapies are current and potential future growth areas. Looking back, we see job growth rates across all industries in Houston from 2012 – 2021 were 12 percent. Health care growth remained stable at 25 percent, while life sciences growth was at 77 percent.



ECONOMIC OUTPUT OF THE HEALTH CARE SECTOR:

The GDP, or value add, for the Houston MSA fell from \$509.3 billion to \$488.2 billion between 2019 and 2020. GDP data for 2021 will not be released until December 2022 but preliminary data indicates the regional GDP fully recovered in 2021. GDP from health care jobs grew 22 percent from 2014 – 2020. GDP growth in all industries over this same time period was 10.5 percent, half that of health care.



HEALTH TECHNOLOGY ADOPTION:

Telehealth, artificial intelligence, virtual reality, and wearable technologies have experienced large growth in the Houston area. Many consumers used telehealth during the pandemic, driven by adjustments in regulations and payment structures. Some experts say the jury is still out on the ultimate usefulness of telehealth. These advances will require data to support their use. Artificial intelligence, virtual reality, and wearable technologies are showing the potential to provide tailored and improved patient care.



HOUSTON AS A LIFE SCIENCES HUB:

Houston, with its large and diverse patient population, widespread talent, and high caliber of research, offers unique advantages as a life sciences hub. The city is one of the top emerging life sciences clusters in the country with initiatives underway such as the TMC's Helix Park and BioPort, projected to bring in 123,000 new jobs combined, that will cement Houston's place as a major region for the life sciences. Homegrown and imported Houston biotech startups will play a role in Houston's continued growth. Houston produces a large concentration of PhDs in biological and biomedical sciences and is working to train and attract specialized talent. Public and private funding are helping drive growth via programs such as the Texas Enterprise Fund and Cancer Prevention and Research Institute of Texas (CPRIT). Furthermore, Houston is attracting international companies looking to enter the U.S. market. These opportunities can be expanded through a focused effort to market Houston's strengths, grow our talent pool, and enhance public incentive programs.



GROWING DEMAND FOR HEALTH CARE, DWINDLING SUPPLY OF HEALTH CARE WORKERS:

Demand for health care in Greater Houston is projected to grow at an increasing rate as baby boomers age. This demographic shift will result in a greater relative proportion of older patients with higher needs. There are not enough health care workers, especially in nursing, mental health, and primary care. Efforts are needed to retain and recruit workers.

EXECUTIVE SUMMARY: MODELING THE FUTURE OF HOUSTON'S HEALTH CARE SECTOR

Once again, we apply economic models to forecast scenarios for Houston's health care sector in 2036, the 200th anniversary of Houston and Texas. In this report, we explore the effect of the Covid-19 pandemic on projected employment and economic growth estimations. The scenarios and conclusions are:

LABOR SHORTAGE:

Health care is the largest sector in our region in terms of employment. We have seen workforce shortages increase at a faster rate than anticipated due to the pandemic. Our labor shortage scenario contemplates a situation where the Houston region fails to retain and generate sufficient workers.

The data from our model shows that the events of the past two years have amplified the original forecasts but did not change the underlying conclusions of the last report. Investing in life sciences will have a greater impact on GDP than other health service areas due to the high-multiplier nature of these jobs. Workforce shortages will negatively impact GDP growth, in addition to the health of our community.

LIFE SCIENCES THRIVES:

We have seen unprecedented growth and investment in Houston's life sciences industry cluster over the past two years. Growth in the life sciences industry can transform the health care sector into an engine of economic growth as measured by GDP by creating more high-multiplier jobs.

RAPID TECHNOLOGY ADOPTION:

Health technology adoption has been greatly expedited by the Covid-19 pandemic, but productivity gains have been difficult to isolate with so many factors changing at once. Therefore, we will not revisit this scenario at this time.

- ▶ **Under the baseline scenario**, we expect health care related employment to increase by 493,000. This represents a 68 percent direct job growth. Projections show the health care sector would provide \$63 billion in added GDP, assuming all jobs can be filled.
- ▶ **A labor shortage scenario** would restrict this employment growth such that total employment would rise by 335,000 jobs by 2036 compared to the baseline growth of 493,000 jobs. These figures are below the 2019 projection of 465,000 jobs added in a workforce shortage scenario. Updated modeling suggests the health care sector's contribution to GDP would be reduced by \$14 billion, resulting in a \$49 billion contribution to GDP in this scenario versus the baseline. This is consistent with the projections from 2019 but more pronounced.
- ▶ The life sciences industry has continued to grow over the past two years while most other sectors saw reductions in both jobs and GDP. The **life sciences thrives scenario** continues to show impressive growth potential for our region with an additional 643,000 jobs in 2036. This projection shows an added \$104 billion in total GDP, a 64 percent boost (\$40 billion) over the baseline case.

EXECUTIVE SUMMARY: CONCLUSIONS

The health care sector in Houston remains an essential pillar of Greater Houston's economy. Most importantly, we depend on this sector to keep the population healthy. We have an opportunity to leverage the lessons from the past two years to improve our health care system. Collaboration across geographies and stakeholder groups will be required to address issues including health equity, workforce burnout and shortages, adoption of health technologies, and growing our life sciences ecosystem. This report explores these issues and recommends specific ways that business, medical, and government stakeholders can work together to make Greater Houston stronger, healthier, and more prosperous.

Overview of Health in Houston

"We can't have a healthy economy without healthy people."

– David Erickson, Senior Vice President at Federal Reserve Bank of New York



Houston's Health Care System

In Center for Houston's Future's 2020 report, *Houston's Economic Future: Health Care*, we looked at the health care sector through an economic lens. We identified a paradox of plenty: Houston has world-class medical care resources but some of the nation's worst health outcomes. When the report was released, in October of that year, the world was in the throes of Covid-19. Since the start of the pandemic, over 1 million Americans¹ including over 89,000 Texans died of Covid-19.² People of color and/or with low incomes were disproportionately affected. This pandemic highlighted and exacerbated problems in our health care system and the health of our population. At the same time, it spurred tremendous innovation and technology adoption. It also made clear that poor health undermines our economic prosperity, and that the health of our population is itself an economic driver.

In this report, we continue to look at health care in terms of both health outcomes and economic outcomes, using "The Triple Aim Framework: care for individuals, care for populations, and lower per capita cost."³ The IHI Triple Aim framework was developed by the Institute for Healthcare Improvement in Cambridge, Massachusetts

(www.ihl.org) and is widely accepted as a useful tool for health system improvement. The original thesis holds that a health system should be considered not only in terms of medical outcomes and health care cost but also in terms of population health, including non-medical factors driving overall health. These factors are known as social determinants of health (SDoH). The revelation was that these aims are not in opposition but reinforce each other. In 2014, this was extended to include workforce burnout. This year, we will extend that view to a "quintuple aim" including health equity as proposed by Dr. Shantanu Nundy, a primary care physician and author of the book *Care After Covid*, and his colleagues, in a recent report released in the *Journal of the American Medical Association*.⁴ As they state, "quality improvement without equity is a hollow victory" that will be unsustainable. Once again, we will use this framework to structure our review of Houston's health care system by looking at each component of the quintuple aim in turn: patient experience / outcomes, per capita cost of care, population health, health equity, and clinician burnout.

Quintuple Aim



About the Triple Aim

The Institute for Healthcare Improvement's Triple Aim framework was developed in 2007 based on seven years of intensive testing with over 150 organizations, coalitions, and governments around the world. IHI is a recognized innovator, leader, and partner in improving health and health care. Donald M. Berwick MD, MPP, FRCP is president emeritus and senior fellow at the Institute and former administrator of the U.S. Centers for Medicare & Medicaid Services.

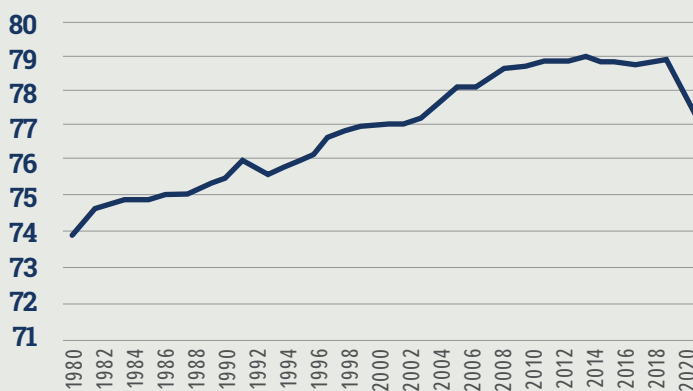
1. CDC. (2020, March 28). *COVID Data Tracker*. Centers for Disease Control and Prevention.
2. Texas Department of State Health Services. (2022, August 24). *COVID-19—Cases*. Texas Health and Human Services.
3. The IHI Triple Aim | IHI - Institute for Healthcare Improvement. (n.d.)
4. Nundy, S., Cooper, L. A., & Mate, K. S. (2022). The Quintuple Aim for Health Care Improvement: A New Imperative to Advance Health Equity. *JAMA*, 327(6), 521–522.

PATIENT EXPERIENCE/ MEDICAL OUTCOMES

Covid-19 reversed the nation's downward trend in mortality rates in 2020. In May of 2022, the United States surpassed 1 million Covid-19 deaths.⁵ By August 2022 just over 15,000 Houstonians and 89,000 Texans had died from the virus.⁶ A revolutionary Covid-19 vaccine was created and distributed in record-breaking time. More than 225 million Americans and 4.5 million Houstonians were fully vaccinated as of August 2022.⁷

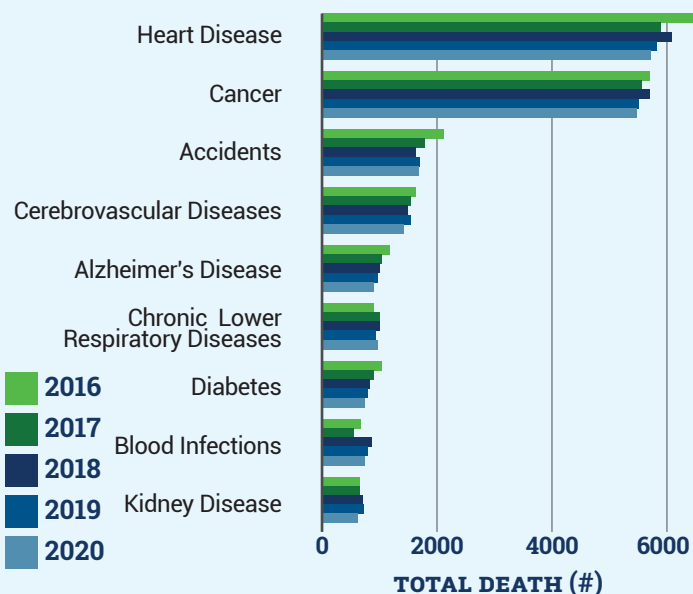
Looking specifically at the Houston MSA's most populous county, Harris County, the age-adjusted mortality rate increased by 21.9 percent in 2020 over the prior year. Even when the 3,626 Covid-19 deaths are not considered, the death count still increased by 9.2 percent in 2020. The top 10 leading causes of death in the Harris County were heart disease (20.5 percent), cancer (18.0 percent), Covid-19 (10.4 percent), accidents (6.4 percent), stroke (4.9 percent), Alzheimer's disease (3.7 percent), chronic lower respiratory diseases (2.9 percent), diabetes (2.9 percent), blood infections (1.9 percent), kidney diseases (1.9 percent), and suicide (1.9 percent).⁸ Similar statistics are seen across the Houston MSA.

U.S. Life Expectancy in Years



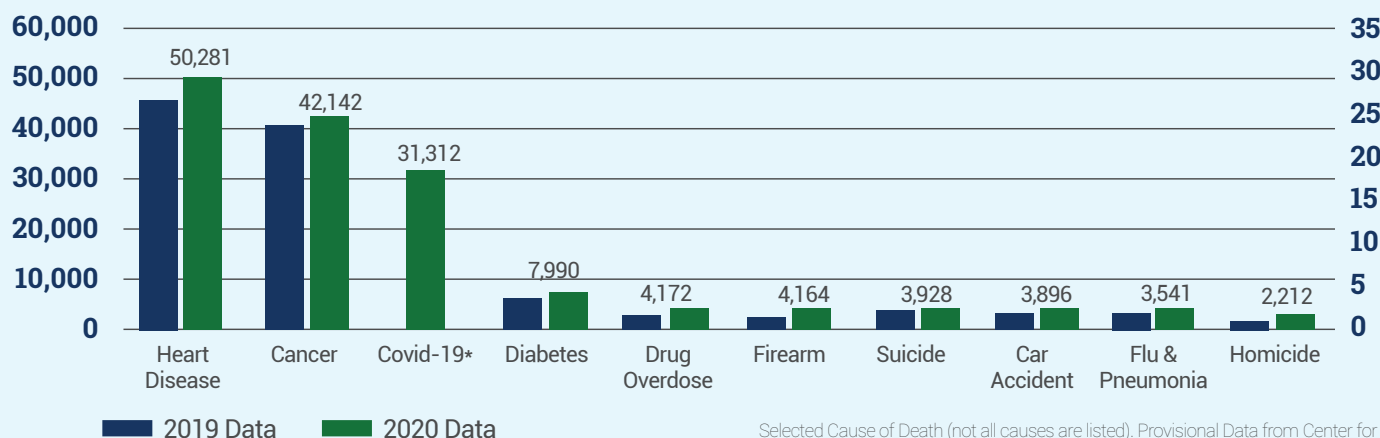
Source: National Center for Health Statistics: Health, United States, 2020-2021

Yearly Death Count by Leading Cause of Death in Harris County 2016-2020 (Excluding Deaths from Covid-19)



Source: County Health Rankings & Roadmaps (CHR&R), a program of the University of Wisconsin Population Health Institute.

Number of Deaths by Select Causes 2019 & 2020 in Texas



Selected Cause of Death (not all causes are listed). Provisional Data from Center for Disease Control and Texas Department of Health Statistics. *No Covid-19 Deaths Recorded in 2019. Source: CDC Wonder, TDSHS Covid-19 Dashboard, TXDOT

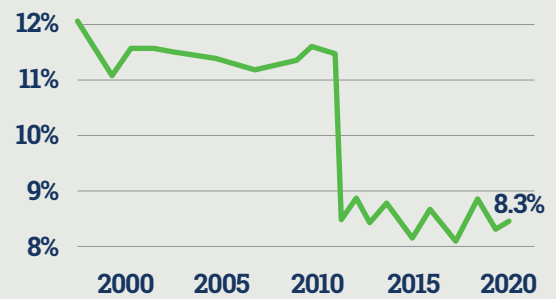
Chronic diseases remain a major cause of death in Houston, with heart disease and cancers accounting for 41.9 percent of all deaths.⁹ Up until 2020, rates for both were trending down. Rates of diabetes and kidney disease, the 7th and 9th leading causes of death respectively, have been increasing steadily for over a decade.¹⁰ Many diseases on this list are strongly influenced by social determinants of health (SDOH). Data from the 2021 Census Pulse surveys indicate Houstonians have become more sedentary, food insecure, and obese.¹¹

Mortality rates for heart disease and stroke increased, at 4.3 percent and 6.4 percent, respectively, in 2020. A study published by the *JAMA* network attributes this rise to pandemic-associated conditions: “periods of overcrowding of hospitals with patients who had Covid-19, resulting in fewer hospitalizations for acute cardiovascular problems, fewer visits for medical care, poorer medication adherence, and increased barriers to healthy lifestyle behaviors.”¹²

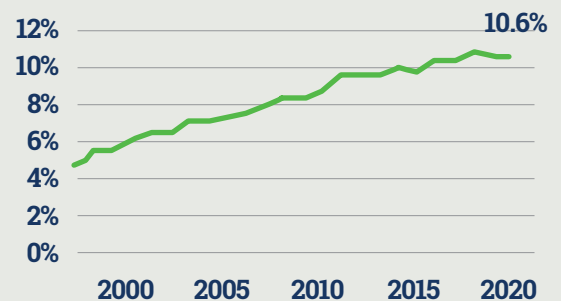
Suicide rates (not reflected in the chart above) are at an alarming level in our region. Suicide is the 10th leading cause of death in Harris County.¹³ In 2020, 3.1 percent of deaths in Harris County were the result of suicide — double what we see at the state and national levels.¹⁴ This, combined with a shortage of behavioral health workforce, is a rising concern for our region. We will explore mental health, chronic disease, and other specific health concerns in more depth later in this report, along with promising programs and recommendations. But first we will continue our evaluation of Houston’s health system.

The severity of the pandemic has highlighted and exacerbated problems in our health and social systems. We spoke with dozens of experts in health and social services working to improve our community’s health. They are encouraged by the increased visibility, funding, and political will that have been focused on health care over the past two years. The first section of this report will look at the issues and opportunities in the local health care system, review health conditions in our region, and then turn our attention to the health care sector as an economic driver.

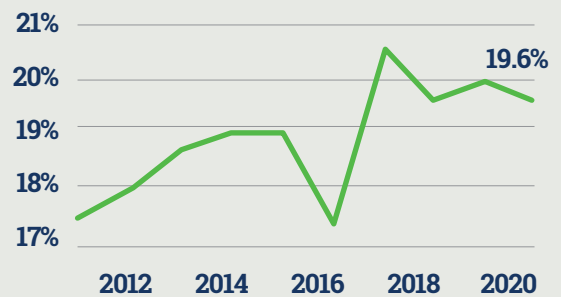
Percent of U.S. Adults with Heart Disease



Percent of U.S. Adults with Diabetes



Percent of U.S. Adults with Depression



Source: USAFACTS

5. CDC. (2020, March 28). *COVID Data Tracker*. Centers for Disease Control and Prevention.
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"As of February 2022, an estimated 19% of Texans have medical debt that is in collections, with an average debt amount of \$835.

Both numbers are above the national average of 13% and \$703 respectively... Medical debt can have long-lasting impacts on well-being and household finances, including reduced medical care, worse mental health, and lower credit scores."

– Chris Whaley, The RAND Corporation¹⁵

PER CAPITA COST AND VALUE

The cost of care in the United States as a percentage of GDP is far more than other developed nations. "In 2021, the United States spent an estimated \$12,318 per person on health care — the highest health care costs per capita across the OECD countries."¹⁶ **Rising health care spending can be viewed as both a weight on broader economic growth and as a driver of local prosperity.** When health care jobs and wages result in improved health technologies and improved health outcomes this can be good. The critical factor to consider is the value and quality we receive for the cost. Here we will consider the impact of the cost and value of care in our community.

Houston MSA spent 4 percent more than the national median on health care and 6 percent above the median on increasingly popular outpatient care options in 2020.¹⁷ Medicare data indicates the total cost of medical care in Houston in 2020 went down slightly, but some of the reduction may be due to delayed medical care during the initial months of the pandemic. Overall, the picture of health care costs in Houston is concerning. This is seen in patient medical debt, uninsured rates, the cost of employer-supplied insurance, prescription drug prices, and out-of-pocket expenses of the underinsured.

According to a 2022 report by the Consumer Financial Protection Bureau, Texans are collectively carrying the highest amount of medical debt (\$14.6 billion)¹⁸ and the seventh highest percent of residents with medical debt (29 percent). According to a Kaiser Health Tracking Poll in 2017, 45 percent of Americans said they would have a difficult time paying an unexpected \$500 medical bill.¹⁹ By 2020, individuals had more medical debt in collections than debt in collections from all other sources combined, including credit cards, phone bills, and utilities.²⁰ The stress from struggling to pay for medical care is called financial toxicity and translates into poor health outcomes. The issue extends beyond the uninsured to the underinsured.

In August, the Biden administration announced a plan to hold medical providers and debt collectors accountable for harmful practices, reduce the role medical debt plays in credit access, and forgive medical debt for more than half a million low-income veterans. Subsequently, three major credit reporting agencies agreed to remove nearly 70 percent of medical debt from credit reports. These measures are expected to improve the health of and alleviate financial strain for millions.²¹

Continued on page 16



Health Consumption Expenditures Per Capita U.S. Dollars, 2020 or Nearest Year

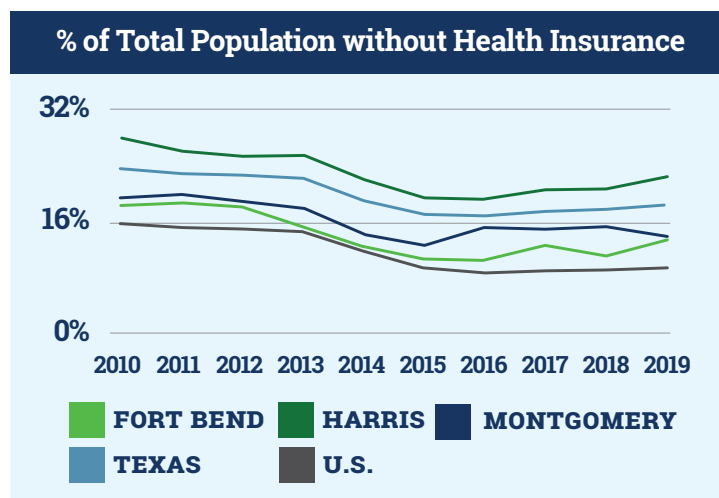
United States	\$11,945
Switzerland	\$7,128
Germany	\$6,731
Netherlands	\$6,299
Austria	\$5,899
Sweden	\$5,754
Comparable Country Average	\$5,736
France	\$5,564
Belgium	\$5,458
Canada	\$5,370
United Kingdom	\$5,268
Australia	\$4,919
Japan	\$4,691

Notes: U.S. Value obtained from National Health Expenditure data. Data from Australia, Belgium, Canada, Japan and Switzerland are from 2019. Data for Australia, France, and Japan are estimated. Data for Austria, Canada, Germany, Netherlands, and Sweden are provisional. Health consumption does not include investments in structures, equipment, or research. PPP adjusted for differences in currencies.

Source: Peterson-KFF analysis of National Health Expenditure (NHE) and OECD data

15. Whaley, C. M. (2022). Health Care Affordability: State Policy Options to Control Costs. RAND Corporation.
16. Peter G. Peterson Foundation. (2022, July 19). *How Does the U.S. Healthcare System Compare to Other Countries?* [Peter G. Peterson Foundation].
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18. Consumer Financial Protection Bureau. (2021). *Medical Debt Burden in the United States*. 54.
19. Montero, A., Kearney, A., Hamel, L., & Brodie, M. (2022, July 14). Americans' Challenges with Health Care Costs. KFF.
20. Muoio, D. (2021, July 21). *Medical debt now outweighs all other personal debt in U.S. Those in Medicaid non-expansion states are hit the hardest*. Fierce Healthcare.
21. Winters, M. (2022, March 18). *70 percent of medical collection debt will soon be removed from credit reports—And it could boost your credit score*. CNBC.

The national uninsured rate reached an all-time low of 8 percent in 2022. This national improvement is attributed to the American Rescue Plan's enhanced Marketplace subsidies and the continuous enrollment provision in Medicaid that has been in effect since 2020,²² both of which build on improvements from the Affordable Care Act. However, Texas uninsured rates continued to increase to 17.3 percent in 2020. The average rate across the Houston MSA is a staggering 22 percent of adults and 13 percent of children.²³ The cost of treating the uninsured creates a financial burden for hospitals that is passed on to those with health insurance and the employers who provide insurance for 53.5 percent of Texans.²⁴



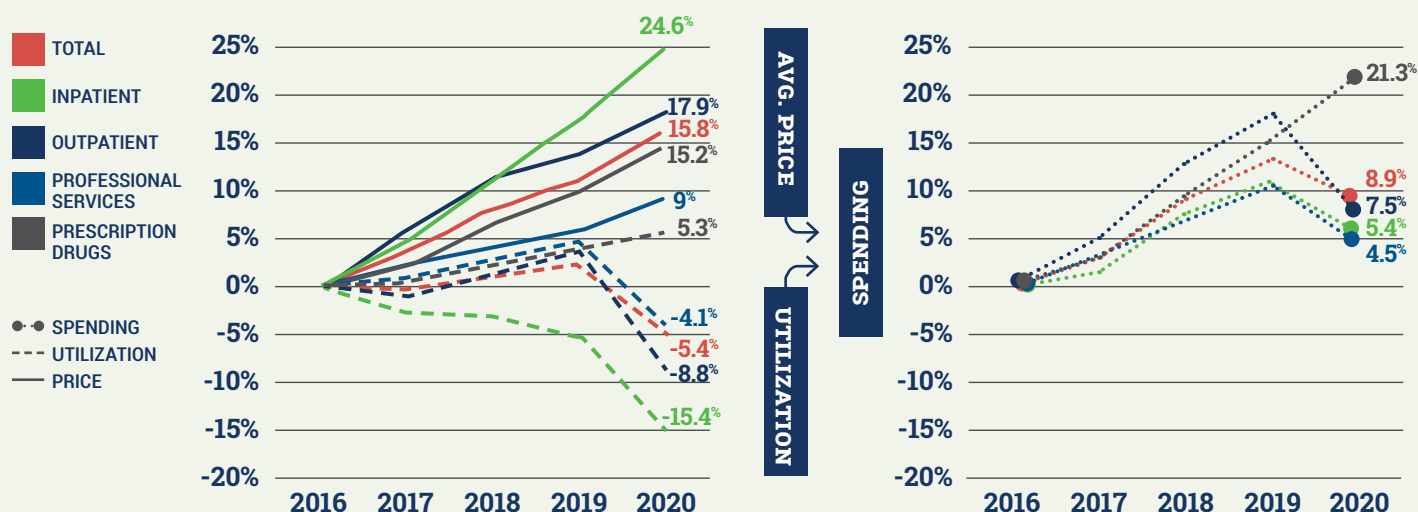
Source: Understanding Houston

The percentage of residents in Harris County, Fort Bend County, and Montgomery County who are uninsured has declined since the implementation of the Affordable Care Act in 2014. However, it remains well above the national average, and in recent years has begun to increase again.²⁵

The average national cost to provide employer-sponsored health insurance for a family is now over \$22,000 – a \$7,000 increase from 2011.²⁶ And the average deductible increased by 71 percent in the same period. Fifty-eight percent of workers now have deductibles above \$1,000, indicating they are underinsured.²⁷

Health care spending, a factor of both price and use, was down 3.6 percent nationally in 2020 due to the 7.5 percent drop in utilization numbers in the early months of the year.²⁸ A study by Kaiser Family Fund projected these costs to rebound in 2021 and continue to increase.²⁹ Even though per person spending in 2020 was lower than it was in 2019, it still is 9.3 percent higher than it was in 2016, showing the intensity of the upward trend in health care costs.

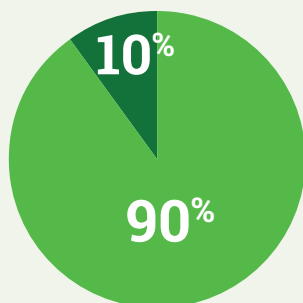
U.S. Change in Spending Per Person, Utilization, and Average Price by Service



Source: Health Care Cost Institute 2020 Health Care Cost and Utilization Report

BRANDED PRESCRIPTION DRUGS ACCOUNT FOR ONLY 10% OF DRUGS PRESCRIBED BUT NEARLY 80% OF TOTAL DRUG COSTS

U.S. SHARE OF PRESCRIPTIONS DISPENSED:

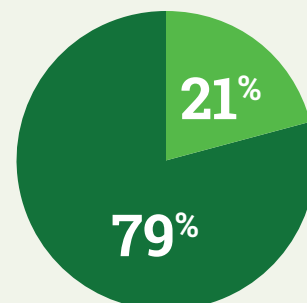


GENERIC DRUGS

BRANDED DRUGS

Source: Peter G. Peterson Foundation

U.S. SHARE OF PRESCRIPTION SPENDING:



High prescription drug prices contribute to the nation's overall cost of care. RAND Corporation found that U.S. drug prices were 256 percent of those in comparable countries. Policymakers point to a lack of federal price negotiation and a loosely managed patent review process. The current patent review process limits the number of drugs moving out of patent so they can be manufactured as generic drugs. U.S. prices for generic drugs were on average 84 percent of those in other countries based on the study by RAND.³⁰ Concerns about hampering innovation keep patent reforms at bay. However, price negotiation for select medications is one of several elements of the recently approved Inflation Reduction Act aimed at lowering the overall price of health care.

The Biden administration projects that the Inflation Reduction Act, passed in 2022, will reduce health care costs for “hundreds of thousands of Texans” and all 3.2 million Medicare recipients in the state.³¹ It does this by empowering the Secretary of Health and Human Services to negotiate prices with manufacturers, punish companies that raise prices faster than the rate of inflation, and limit patients' annual out-of-pocket spending to \$2,000. It also caps the cost of insulin at \$35 per month for Medicare patients.³²

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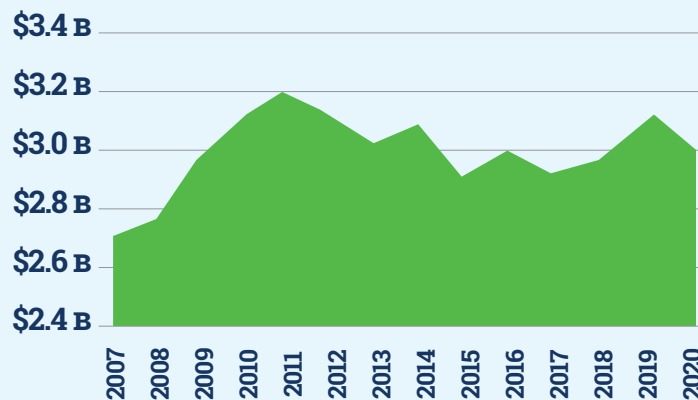
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26. KFF (2021, November 10). 2021 Employer Health Benefits Survey. KFF.
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30. Mulcahy, Andrew W., Christopher M. Whaley, Mahlet Gizaw, Daniel Schwam, Nathaniel Edenfield, and Alejandro U. Becerra-Ornelas, *International Prescription Drug Price Comparisons: Current Empirical Estimates and Comparisons with Previous Studies*. Santa Monica, CA: RAND Corporation, 2021.
31. Blackman, J., & Bureau, A. (2022, August 18). *Biden's White House touts Medicare savings for 3.2 million Texans in Inflation Reduction Act*. Houston Chronicle.
32. The White House, *The Inflation Reduction Act Will Cut Health Care Costs for Texans* (2022). The White House.

VALUE IN HEALTH CARE

In addition to looking at spending, it is important to understand the value and effectiveness of a health care system. As a state, Texas ranks 48th in the Commonwealth Fund's Scorecard on State Health System Performance Metrics for cost-effectiveness and efficiency. The Commonwealth Fund is a private U.S. foundation whose stated purpose is to "promote a high-performing health care system." Key indicators of effectiveness are hospital readmissions and emergency room admissions. The interpretation of this metric for the past two years is complicated by postponed elective procedures and reluctance to seek care for fear of contracting Covid-19. That said, hospital readmissions percentages are down slightly from 2019.³³

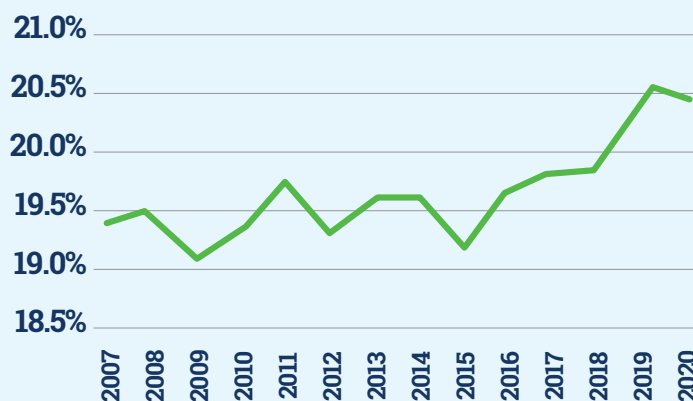
Emergency room admissions are down 20 percent from 2019.³⁴ A high number of ER visits often indicates a system's inability to route patients to affordable settings for care. Many patients who cannot afford regular medical care end up in the ER when unaddressed medical issues become acute. It is difficult to know how much the pandemic caused this reduction. It is also important to note that this data is based on Medicare patients, so it is not fully indicative of the population. However, this data gives us a sense that directionally the value provided by Houston's health system has been stable.

Harris Co. Total Medicare Actual Costs



Source: Medicare Public Use File

Harris Co. Hospital Readmissions



Source: Medicare Public Use File

Harris Co. ER Visits per 1000 Medicare Benefits



Source: Medicare Public Use File



OPTIONS TO CURB COST AND INCREASE VALUE

Options to curb costs exist. An estimated 220,000 Houstonians would receive health coverage if the Texas Legislature and governor agreed to **expand Medicaid** in Texas. The Bush School of Government & Public Service at Texas A&M University estimates this would bring an estimated \$1.2 billion in federal dollars to local health care.³⁵

As of July 2022, the state requires insurance providers to make pricing data publicly available, a push to increase **transparency** and drive down prices. Some believe that market forces will drive down costs and improve efficiencies if patients and payors better understand prices associated with medical care.

An estimated 25 percent of the \$3.6 trillion the U.S. spends on health care annually is potentially wasteful according to a study published in JAMA in 2019. Medical waste is low-value spending typically driven by failures of care delivery, failures of care coordination, overtreatment, pricing failures, administrative complexity, and fraud and abuse. The largest category of wasteful spending in the U.S. is administrative costs.³⁶ Technology solutions are being developed that could **reduce wasteful spending** in medical care without reducing the quality of care. Administrative waste could potentially be reduced by the adoption of technologies like natural language processing for Electronic Health Record documentation. Machine learning support for diagnosis and treatment management could prompt physicians with best practices and cost-saving options that could also reduce waste.

Many think that a move away from the fee-for-service model for health care is needed to reduce wasteful spending by aligning incentives (payment) with health outcomes. One option is the value-based care model that connects payments to quality of care rather than quantity of services. The Centers for Medicare and Medicaid Services are moving toward this model of care with programs for specific medical conditions.

33. Radley, D., Baumgartner, J., & Collins, S. (2022, June 16). *2022 Scorecard on State Health System Performance COVID-19 | Commonwealth Fund*. The Commonwealth Fund.
34. Center for Medicare and Medicaid Services. (n.d.). *MCBS Public Use File | CMS*. CMS.Gov. Retrieved August 26, 2022
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36. Shrank, W. H., Rogstad, T. L., & Parekh, N. (2019). Waste in the US Health Care System: Estimated Costs and Potential for Savings. *JAMA*, 322(15), 1501–1509.



POPULATION HEALTH

Population health includes health outcomes, patterns of health determinants, and the policies and interventions that link these two. Attention to social and environmental, as well as medical determinants of health is essential. Here we focus on the social determinants of health driving medical outcomes. These are the conditions in which people are born, grow, live, work and age that shape health. The Kaiser Family Foundation divides this into six subsections: economic stability, neighborhood and physical environment, education, food, community and social context, and health care system. These factors work together and shape health outcomes such as mortality, morbidity, and life expectancy. Adverse social determinants of health conditions are often concentrated in racial and ethnic minority populations. As a result, minorities generally have worse health outcomes. In fact, research has shown that as much as 80-90 percent of health outcomes are shaped by social, behavioral, and economic factors.³⁷ Nevertheless, the United States spends a much higher percentage of its GDP on medical care. The pandemic has underscored the importance of these non-medical factors and increased focus on addressing SDoH as a part of health care.



Preterm births in Harris County was **15% higher** than the national rate and **7% above** the Texas Rate. (2020)⁴⁵



The **childhood mortality rate** across Houston MSA ranges from **63 per 100,000** in Liberty County to **41** in Chambers and Brazoria Counties. (2022)⁴⁴



The percentage of adults with **diabetes** in Texas, **12%** is consistently higher than the national rate, **9.1%**. (2018)⁴⁶

37. University of Wisconsin Population Health Institute. County Health Rankings & Roadmaps 2022.

38. Silver, J. (05/02/2019). *Houston's income inequality spiked higher than anywhere else in Texas*. CultureMap Houston.

39. Portal, H. P. H. D. (2022, June). *Houston Public Health Data Portal: Indicators :: Severe Housing Problems :: County : Harris*. Houston State of Health.

40. Portal, H. P. H. D. (n.d.). *Houston Public Health Data Portal: Demographics :: Population Age 25+ with Less Than High School Graduation*. Retrieved August 26, 2020

41. Schuler, D. A., & Koka, B. R. (n.d.). *Challenges of Social Sector Systemic Collaborations: What's Cookin' in Houston's Food Insecurity Space?* 36.

42. Shelton, K., Park, J., Villegas, C., Guajardo, L., Servidio, C., & Zhang, Z. (2020). *The 2020 State of Housing in Harris County and Houston* [Report]. Rice University Kinder Institute for Urban Research.

SOCIAL DETERMINANTS OF HEALTH

ECONOMIC STABILITY

Houston MSA has the largest income gap in Texas and **11th worst** in the nation. (2019)³⁸

Income gap is the difference in income between the top 10th and bottom 10th percentile of earners.



NEIGHBORHOOD AND PHYSICAL ENVIRONMENT



1 in 5 Harris County households report **severe housing problems** including overcrowding, lack of a kitchen, and overdue payments.³⁹

EDUCATION



20.8% of adults in the City of Houston **do not have a high school diploma.** (2022)⁴⁰

FOOD DESERTS AND INSECURITY



The food insecurity rate in Harris County is 16.4%, about 4 percentage points above the national average. That represents **724,750 food-insecure individuals.** (2019)⁴¹

COMMUNITY, SAFETY, AND SOCIAL CONTEXT



The **poverty rate** in the City of Houston is **20.6%** compared to 13% across the U.S. (2020)^{42, 43}

HEALTH CARE SYSTEMS (HEALTH INSURANCE)



Nearly a **third of adults** in Harris County (28%) and 15% of children have **no health insurance**, which is more than double the uninsured rate for the nation. (2019)⁴⁴

*Worse social determinants of health lead to **worse health outcomes** throughout an individual's lifetime.*



Houston's **Fifth Ward cancer cluster** has childhood leukemia rates nearly **5x the national average.**

(Based on an assessment conducted between 2000 - 2016.)⁴⁷



The **suicide rate** in Houston is **23% higher** than the state average at 16% per 100,000 age-adjusted. (2020)⁴⁴



Texas **ranks 30th** compared to other states with a **life expectancy of 76.5.**⁴⁸ Life expectancy varies across Houston MSA by as much as 23.4 years depending on where individuals live.⁴⁴

43. Olin, A. (2020, June 19). *Texas economy ranks near the top for racial equality in a nation with pervasive wealth inequality.* The Kinder Institute for Urban Research.

44. University of Wisconsin Population Health Institute. County Health Rankings & Roadmaps 2022. www.countyhealthrankings.org.

45. March of Dimes. (2022, January). *Preterm birth rate: Harris, 2014-2020.* March of Dimes | PeriStats.

46. Understanding Houston. (n.d.). *Health Risks & Outcomes: Understanding Houston.* Retrieved August 24, 2022.

47. Texas Department of State Health Services. (2021). *Assessment of the Occurrence of Cancer Supplemental Assessment Houston, Texas 2000-2016.*

48. CDC. (2022, August 24). *Life Expectancy at Birth by State.* Centers for Disease Control and Prevention.



"Health equity is achieved when every person has the opportunity to attain his or her full health potential and no one is disadvantaged from achieving this potential because of social position or other socially determined circumstances."

– Centers for Disease Control

HEALTH EQUITY

Texas ranked 46th in health equity and racial disparities in the 2022 Commonwealth Fund State Health Scorecard.⁴⁹ Significant health disparities are seen across Houston, including reduced access to treatment, shorter length of life, and increased rates of disease. For instance, Black people are more likely than white people to die from treatable conditions – 90.5 White people die from treatable health conditions per 100,000 population compared to 159.9 Black people.⁵⁰ Black people are also more likely to die from life-threatening illnesses such as cancer despite having similar incidence rates.⁵¹

The Kaiser Family Foundation's social determinants of health classifications show this. Poor upstream social determinants of health are concentrated in racial and ethnic minority populations who experience worse health outcomes.

Continued on page 24

49. Radley, D., Baumgartner, J., & Collins, S. (2022, June 16). *2022 Scorecard on State Health System Performance COVID-19* | Commonwealth Fund. The Commonwealth Fund.

50. Radley, D. C., Baumgartner, J. C., Collins, S. R., Zephyrin, L., & Schneider, E. C. (2021, November 18). *Achieving Racial and Ethnic Equity in U.S. Health Care: Scorecard* | Commonwealth Fund. The Commonwealth Fund.

51. Portal, H. P. H. D. (2021, December). *Houston Public Health Data Portal: Indicators :: All Cancer Incidence Rate :: County : Harris*. Houston State of Health.



MEDIAN HOUSEHOLD INCOME

WHITE FAMILY **\$88,582**

BLACK FAMILY **\$56,467**

HISPANIC FAMILY **\$59,870**

HOUSTON MSA (2020)

HOME OWNERSHIP

WHITE **71%**

BLACK **41%**

HISPANIC **52%**

HARRIS, FORT BEND & MONTGOMERY CO. (2017)

EDUCATIONAL ATTAINMENT (ADULTS AGED 25+)

BACHELOR'S OR HIGHER **49.8%** OF WHITE PEOPLE
26.0% OF BLACK PEOPLE
15.3% OF HISPANIC PEOPLE

LESS THAN HIGH SCHOOL **3.8%** OF WHITE PEOPLE
8.1% OF BLACK PEOPLE
35.7% OF HISPANIC PEOPLE

HARRIS COUNTY (2019)

FOOD INSECURITY AND HUNGER

1 in 14 WHITE TEXANS FACE THREAT OF HUNGER

1 in 4 BLACK TEXANS FACE THREAT OF HUNGER

1 in 5 HISPANIC TEXANS FACE THREAT OF HUNGER

HARRIS COUNTY (2020)

LIVING IN POVERTY

7.9% OF WHITE CHILDREN

26.4% OF BLACK CHILDREN

23.1% OF HISPANIC CHILDREN

HOUSTON MSA (2020)

LACKING HEALTH INSURANCE (AGES 19-64)

12.6% OF WHITE POPULATION

22.1% OF BLACK POPULATION

44% OF HISPANIC POPULATION

HARRIS, FORT BEND & MONTGOMERY COUNTIES (2019)

BLACK CHILDREN ARE 3X MORE LIKELY TO LIVE IN FOOD-INSECURE HOUSEHOLDS THAN WHITE CHILDREN.

	WHITE	BLACK	HISPANIC
 % LOW BIRTH WEIGHT HOUSTON MSA (2014-2020)	7.3%	12.4%	7.5%
 INFANT MORTALITY (PER 1000 LIVE BIRTHS) HOUSTON MSA (2014-2020)	4.8	8.3	4.8
 CHILDHOOD MORTALITY (PER 100,000 UNDER THE AGE OF 18) HOUSTON MSA (2017-2020)	40.7	75.5	41.1
 TEEN BIRTH RATE (PER 1000 WOMEN AGED 15-19) HOUSTON MSA (2014-2020)	18.5	23.8	31.6
 CANCER MORTALITY (PER 100,000 POPULATION) HARRIS COUNTY (2015-2019)	152.1	182.4	104.2
 PREMATURE AGE-ADJUSTED MORTALITY (PER 100,000 POPULATION) HOUSTON MSA (2018-2020)	378.0	514.3	276.4
 LIFE EXPECTANCY HOUSTON MSA (2018-2020)	77.8	75	82.5

Source: University of Wisconsin Population Health Institute County Health Rankings & Roadmaps 2022, Understanding Houston, Houston State of Health, Feeding America Map the Meal Gap.

ADDRESSING SDOH AND HEALTH EQUITY

Many programs are underway in Houston to address health equity and social determinants of health. A few that are approaching the issue in slightly different ways but that complement each other are the Texas Accountable Communities for Health (TACHI), Memorial Hermann Community Resource Centers, the Harris County Pathways Hub, and the Health Equity Collective.

TACHI

TACHI is a multi-year initiative launched by the Episcopal Health Foundation to support existing collaboratives across Texas becoming sustainable entities known as Accountable Communities for Health (ACH). ACHs are community-based partnerships between health care organizations and social services such as housing, public health, and employment training that focus on creating a shared vision and responsibility for the health of the community. One of the six TACHI sites is Greater Northside, which includes neighborhoods north of downtown Houston. The backbone organizations for this ACH are Memorial Hermann, Wesley Community Center, YMCA, and Avenue Community Development Corporation.

THE HARRIS PATHWAYS COMMUNITY HUB

The Harris County Pathways Community Hub uses a proven framework that includes a pre-negotiated financial reimbursement structure. The Network of Behavioral Health Professionals (NBHP) recently rolled out this program in Houston to assist individuals with maternal mental health issues. The model is centered on Community Health Workers (CHWs), who meet with high-risk families in their homes and in the community. They identify and mitigate client risk factors (more than 170 of them) by opening and closing "pathways." Pathways correspond to a range of health and social service risk factors, such as food insecurity, housing instability, and behavioral health issues. The model goes beyond information-sharing through an electronic platform—it details the steps that CHWs should take to resolve client risks and move them into a level of stability.⁵² The Pathway HUB program focuses on the whole person, not just one symptom, and guides patients through their entire wellness journey.

THE COMMUNITY RESOURCE CENTER

The Community Resource Center (CRC) model has been implemented by Memorial Hermann's Community Benefits Corporation to help improve the overall health of our community by providing one-stop locations where individuals and families in our community can get help signing up for health care and social services. The CRCs are strategically located at three of the system's community hospitals in the most vulnerable neighborhoods in the region. These centers are staffed with community health workers (aka navigators, *promotoras*) with the goal of reducing the impact of social determinants of health barriers: eligibility services, linkages to primary care, health literacy, food resources, access to clinical pharmacy, social services resources and referrals. This program leverages partnerships with the Houston Food Bank, Houston Parks and Recreation Department, and Bank of America to name a few.

THE HEALTH EQUITY COLLECTIVE

The Health Equity Collective is a multi-sector effort focused on creating a more equitable health ecosystem in Greater Houston. The Collective represents over 140 organizations aligned with a shared mission to establish an impactful, sustainable, data-driven system to promote health equity and address the social drivers of health outcomes. As a first step, it is building a Community Information Exchange linking various local community-based organizations to each other and to health care organizations to facilitate care navigation for social services in the Greater Houston area.

“Nurses need to know that just as they were here for our community during the height of Covid, we as a community are here for them now. Their efforts and sacrifices will not be forgotten. We will continue to be there for them.”

– Sherry Camacho, Chief Nursing Officer at HCA Healthcare Clear Lake/Mainland

HEALTH CARE WORKFORCE BURNOUT

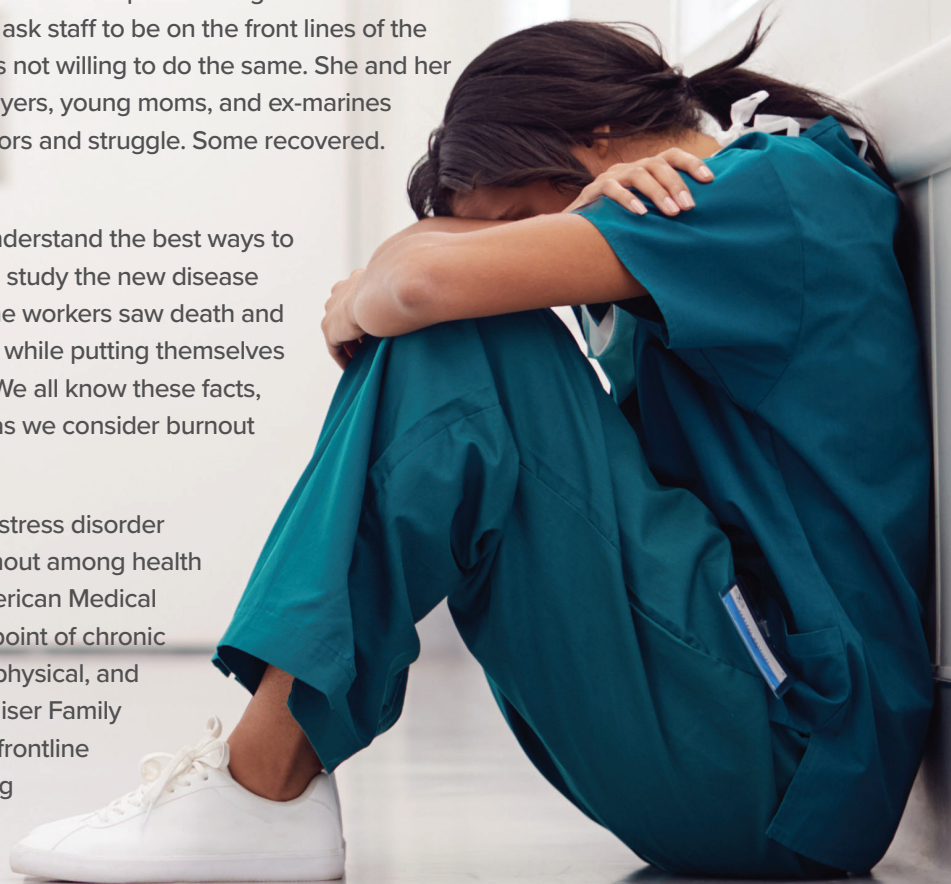
Sherry Camacho, chief nursing officer at HCA Houston Healthcare Clear Lake/Mainland, moved from her office to the hospital nursing floor in March 2020. She felt strongly she could not ask staff to be on the front lines of the pandemic, risking infection, if she was not willing to do the same. She and her staff watched high school football players, young moms, and ex-marines fight for their lives, end up on ventilators and struggle. Some recovered. Others did not.

Medical professionals struggled to understand the best ways to treat patients as researchers raced to study the new disease and provide guidance. These front-line workers saw death and suffering they never imagined, all the while putting themselves and their families at risk of infection. We all know these facts, but they are important to remember as we consider burnout and workforce shortages.

The pandemic spiked post-traumatic stress disorder (PTSD), compassion fatigue, and burnout among health care workers. The Association of American Medical Colleges defines burnout as the endpoint of chronic stress, which can include emotional, physical, and mental exhaustion. In April 2021, a Kaiser Family Fund Study found that 55 percent of frontline health care workers reported suffering from burnout.⁵³

A study by the University of Houston and HCA Houston Healthcare, directed by Dr. Teresa McIntyre, UH College of Nursing, examined stress, well-being, and turnover among frontline nurses in the region. The study concluded that burnout is a strong indicator that someone will quit their job or even their professions. This exacerbates our existing workforce shortage, placing more work and stress on the remaining workforce and propagating the cycle.⁵⁴

Continued on page 26



- 52. Pathways Community HUB (2022). Retrieved from Network of Behavioral Health Providers
- 53. Kirzinger, A., Kearney, A., Hamel, L., & Brodie, M. (2021, April 6). KFF/The Washington Post Frontline Health Care Workers Survey—Toll of the Pandemic. KFF.
- 54. McIntyre, T., Welty, L., Love, M., Shani, P., McIntyre, S., & Taylor, P. (2022). Occupational health impact of COVID-19 response on nurses' well-being and work outcomes at HCA Houston Healthcare Clear Lake and Mainland: Final report. University of Houston College of Nursing.

These issues are of critical importance across the health care workforce from nurses to doctors to emergency medical technicians. In this section, we will focus on nurses. Later in the report, we revisit workforce issues, including shortages of nurses, primary care doctors, and mental health professionals.

Dr. McIntyre found that 65 percent of nurses reported moderate to severe burnout. Workers who reported the most severe effects were frontline workers exposed directly to Covid-19 patients and younger health care workers who had yet to develop skills to cope with the harsh realities of the job.⁵⁵ Unaddressed burnout can cause depression and other mental and physical health problems.

Nurses also shared feelings of compassion fatigue, or physical and mental exhaustion from caring for sick or traumatized people for an extended time. Unlike burnout, caused by everyday work stresses, compassion fatigue results from taking on the emotional burden of a patient's suffering and is characterized by losing the ability to empathize. "So much of nursing is caring for patients," Camacho said. "When we care we are still nurses. When we cannot care anymore, we've lost that ability."

In the UH-HCA Houston Healthcare study, nurses called on employers to address burnout. First, they indicated a need to feel supported by management. They also need time and space to disconnect and decompress during a shift. Protected lunch breaks away from patients without interruption are critical for physical and mental recovery.⁵⁵

The study's final report recommended that organizations should implement a "culture of self-care," that includes education for new and existing personnel. Nurses should also be encouraged to express their feelings and ask for help without stigma or penalty.⁵⁵

Mental health programs are typically a part of a company's employee assistance program, or EAP. Mental Health America reports that while 75 percent of companies with 251 employees or more provide these programs, only 7 percent of employees use them.⁵⁶ Employers would benefit if more employees took advantage of the programs.

Based on the study findings, HCA Houston Healthcare Clear Lake/Mainland, has begun implementing programs to curb stress and reduce stigma around mental health issues. These include a "Zen Den" where nurses can detach and destress, onsite classes like yoga, and a wellness wagon that delivers self-care items and information on the company's EAP. It also formed a mental health peer support group based on the Alcoholics Anonymous model. And its broader HCA Healthcare Gulf Coast Division created the second most popular colleague network, a group focused on mental health. These programs have led to more open conversations on mental health issues and increased participation in EAPs.

Our health, independently and collectively, depends on the health care workers who were held out as heroes in the initial months of the pandemic. Hospitals and communities must not forget what they have been through, and **we must support the health care workers who have supported us through the pandemic.**

55. McIntyre, T., Welty, L., Love, M., Shani, P., McIntyre, S., & Taylor, P. (2022). Occupational health impact of COVID-19 response on nurses' well-being and work outcomes at HCA Houston Healthcare Clear Lake and Mainland: Final report. University of Houston College of Nursing.

56. Halpern, M. (n.d.). Improving Workplace Mental Health through EAP Usage. Mental Health America. Retrieved August 29, 2022

57. National Academies of Sciences, E. (2021). *The Future of Nursing 2020-2030: Charting a Path to Achieve Health Equity*. The National Academies Press.

CONCLUSION: HOUSTON HEALTH CARE SYSTEM

Looking at the health care system in Houston through the view of the Quintuple Aim of Health Care clarifies areas for improvement. Health disparities and unaddressed social determinants of health are limiting the benefit of our local health care expertise. The high cost of care and low accessibility underlie these issues. We must address both care costs and health equity to improve overall health outcomes. The final aim, reducing workforce burnout, is a national and local issue that must be addressed and will be discussed later in this report. Next, we will take a closer look at some of the specific health issues and solutions prevalent in Houston.

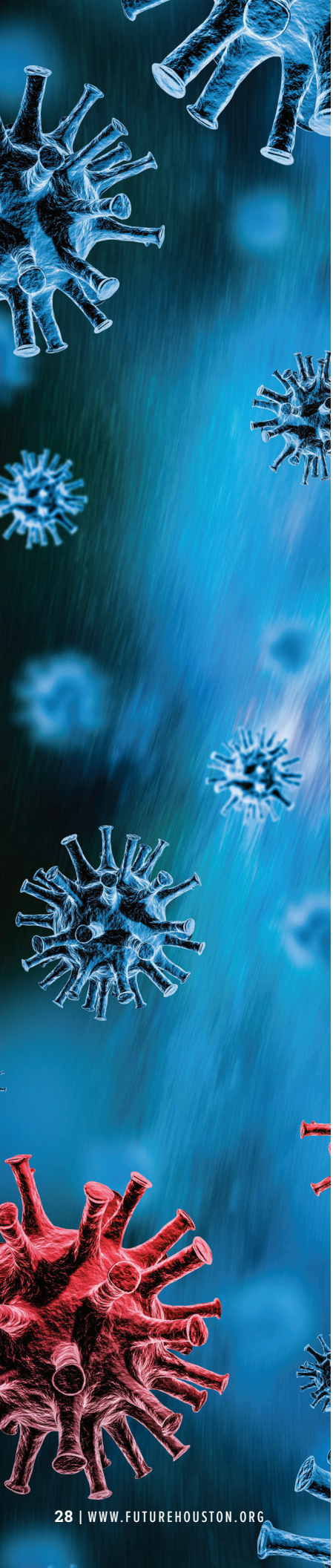
SUMMARY OF RECOMMENDATIONS TO ADDRESS NURSING WORKFORCE BURNOUT

from Occupational Health Impact of Covid-19 Response on Nurses' Well-Being and Work Outcomes at HCA Houston Healthcare Clear Lake/Mainland, a study by the University of Houston and HCA Houston Healthcare, directed by Dr. Teresa McIntyre, UH College of Nursing

The report states, “Hospital organizations need to recognize that their leadership, practices, and policies shape the environments in which nurses work, impacting their health and well-being, their job satisfaction and turnover, and subsequently the quality and cost of care they provide. Organizational level interventions focus on reducing occupational hazards and stresses that lead to burnout, and poor physical and mental health, while promoting a work environment and culture that supports nurses’ self-care and well-being.”

The following are recommendations from the report, in some cases verbatim, and in others, condensed and summarized.

- 1.** Creating a work culture that promotes nurse well-being requires an integrated and systematic organizational approach that involves an identifiable nurse well-being initiative.
- 2.** Engaging nurse leaders and staff in the process of identifying the problems associated with work stress, including Covid-19 burden, and developing the solutions, is essential for effective organizational interventions.
- 3.** Developing a plan of action focused on nurse leaders is also recommended as these nurses are most familiar with problems at the leadership/organizational level and can recommend or take action to implement solutions. A report (2021) by *National Academy of Medicine* outlines two areas for nurse leaders to take action to improve nurse well-being:
 - a.** Creating a culture that promotes nurse well-being: addressing workplace safety and civility, and ensuring that all nurses feel supported and respected. This involves listening to nurses’ concerns, ideas, and suggestions, and applying best practices for communication, decision-making, and conflict management.
 - b.** Advocating for resources for nurses: advocating for evidence-based interventions that promote nurses’ health, well-being, and resilience. Investing in mentorship, team/peer support, increasing awareness on mental health issues such as depression and suicidality, reducing the stigma associated with seeking help, and advocating for work-life balance.⁵⁷
- 4.** Managing job demand for nurses is a priority. Determining innovative best practices to address staffing shortages, work hours, shift schedules, overtime, scheduled restorative breaks, and work-life balance is recommended. Although voluntary breaks and breakrooms are beneficial for nurses, scheduled breaks are most important to support their well-being.
- 5.** Promoting the use of employee assistance programs (EAP) and other mental health resources is important. EAP programs are often underused by employees. Make sure resources are visible via virtual platforms, educational sessions, etc. Reduce stigma associated with mental and behavioral health treatment for nurses. And measure impact of EAP program (how many nurses are using it; success rate; is it meeting nurses’ mental health needs?).
- 6.** Conducting regular stress audits is essential to better understand work stress among nurses and its impact on their health, well-being, and work outcomes. Monitoring the long-term effects of COVID-19 work stress in terms of health and work outcomes is an important part of this continuous assessment. We recommend yearly stress audits with a shorter selection of measures monitoring levels of job demand, depression and suicidality, burnout and physical symptoms, and turnover intention.



Health Issues and Solutions in Houston

As we researched health and related problems in the Houston region, we focused on trending issues and innovative local solutions. First, we look at Covid-19 as an overall backdrop given its effect on people and on health care systems, and because experts tell us more pandemics can be expected as climate change intensifies. We then look at the Covid-19-induced rise in mental health issues and suicide rates creating a demand that outpaces our mental health resources. Next, we turn our attention to a chronic illness that continues to be a primary driver of health issues in our area, diabetes. Finally, we discuss maternal health, which is widely considered a barometer of any health system.

A CLOSER LOOK AT: COVID-19 AND POTENTIAL FUTURE PANDEMICS

In 2020, the downward trend in mortality rates, nationally and locally, was reversed by Covid-related deaths and an increase in non-Covid-19 related deaths. In Harris County, the age-adjusted mortality rate increased by 21.9 percent in 2020 over the prior year. Even when the 3,626 Covid-19 deaths are not considered, the death count still increased by 9.1 percent in 2020.⁵⁸

Although it did not start until March 2020, Covid-19 is the ninth leading cause of death over the past five years and the third leading cause of death in 2020 both nationally and locally. The United States surpassed 1 million Covid-19 deaths in May of 2022.⁵⁹ As of August 2022, over 15,000 Houstonians and 89,000 Texans had died from this virus.⁶⁰ In response, scientists created a revolutionary vaccine, which was distributed at record-breaking speed. Over 223 million Americans and 4.5 million Houstonians were fully vaccinated by August 2022.⁶³ Still 26 percent of Texans remain unvaccinated, making them 20 times more likely to be hospitalized for Covid-19. The vaccine prevented countless infections, hospitalizations, and deaths. This remarkable achievement shows the importance of investing in life sciences innovation to solve difficult health problems.

Effects of Covid-19 extend beyond initial infections and deaths. Long Covid-19, in which symptoms last 3 months or longer, is reported in 32.7 percent of adult Houstonians who experienced Covid-19. The underlying factors and implications of this are not yet understood. In August 2022, the Biden administration published a research plan to study causes and consequences of Long Covid-19 and associated conditions. More funding will be required to implement the recommendations.

Continued on page 30

Covid-19 Timeline

2020

MARCH 2020

- 4 First patient tests positive in Texas.
- 19 National emergency declaration, Texas restricts social gatherings.

JULY 2020

Peak of first wave in Texas with 360 hospitalizations per day at TMC.

NOVEMBER 2020

Texas reports more than 1 million cases.

DECEMBER 2020

First Covid-19 vaccination in Houston administered at Memorial Hermann Hospital. Houston MSA hits 300,000 positive Covid cases.

2021

FEBRUARY 2021

Houston is named one of five U.S. cities chosen to have a FEMA "Super" Vaccination Site at NRG Park.

MARCH 2021

Houston MSA reports 8,000 deaths from Covid. Harris County announces more than 1 million doses of vaccine administered.

MAY 2021

Over 1 million Houstonians fully vaccinated.

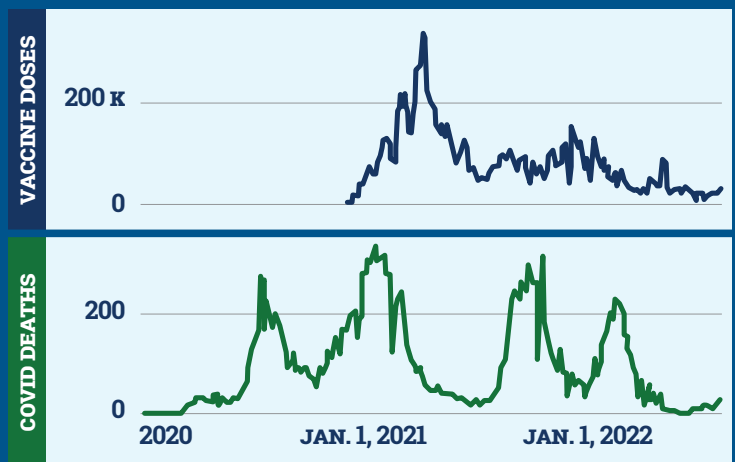
Source: Center for Houston's Future

Covid-19 Infection and Death by Houston MSA, State, and Nation (As of October 7, 2022)

USA	TEXAS	HOUSTON MSA
96,443,565 CONFIRMED CASES	7,880,387 CONFIRMED CASES	1,700,076 CONFIRMED CASES
1,056,702 DEATHS	89,268 DEATHS	16,437 DEATHS
624,198,981 DOSES ADMINISTERED	48,051,440 DOSES ADMINISTERED	11,721,789 DOSES ADMINISTERED
225,870,613 PEOPLE FULLY VACCINATED	18,071,414 PEOPLE FULLY VACCINATED	4,516,073 PEOPLE FULLY VACCINATED
68%	62%	63%

Source: CDC, Texas DSHS, Texas Covid Vaccine Tracker Data Updated on Oct 7th 2022, Retrieved Oct 11th, 2022

Texas Covid-19 Deaths & Vaccination Rates



Source: Texas Department of State Health Services

- 58. University of Wisconsin Population Health Institute. County Health Rankings & Roadmaps 2022. www.countyhealthrankings.org.
- 59. CDC. (2020, March 28). *COVID Data Tracker*. Centers for Disease Control and Prevention.
- 60. Texas Department of State Health Services. (2022, August 24). *COVID-19—Cases*. Texas Health and Human Services.

Around 40 percent of Americans delayed medical care in 2020 according to the CDC. That contributed to a rise in the rate of other diseases such as heart disease which is the number one killer in the U.S. and in Houston. As a result of the pandemic, many patients did not seek timely care, which strongly affected the increased mortality rate.

The pandemic created an intense need to re-think the way we do many things including providing health care. This has increased the use of outpatient clinics for standard care and created a model for drive-through clinics for testing and vaccinations. Perhaps the largest shift is the increased use of telehealth, opening a new avenue of access for those who may otherwise have difficulty seeing a doctor. The pandemic increased other technologies, including data analysis and visualizations, to improve the efficiency of hospitals. These solutions will be discussed in detail in the technology adoption section of this report.

2022 Long Covid-19, Delayed Medical Care by Houston MSA, State, and Nation		
U.S.	TEXAS	HOUSTON MSA
34.3% LONG COVID-19	36.8% LONG COVID-19	32.7% LONG COVID-19
40.1% DELAYED MEDICAL CARE	41% DELAYED MEDICAL CARE	39.8% DELAYED MEDICAL CARE

Source: U.S. Census Bureau, Household Pulse Survey

"The end of the Covid-19 public health emergency will not signal the end of the effects of the pandemic. These lingering effects may impact the health of the nation for years to come."

— Xavier Becerra, Secretary of Health and Human Services

LESSONS LEARNED FROM COVID-19

Covid-19 revealed a need to better prepare for infectious disease outbreaks. This can be viewed in three categories: bolstering U.S. medical supplies and production, increasing communication and coordination between public health agencies and the health care sector, and enhancing infectious disease tracking to catch future threats at the biological level before they spread.

The Texas Medical Center recently announced plans for a BioPort facility in Houston to house the manufacturing and distribution of medical supplies, pharmaceuticals, and cell and gene therapies domestically.

To address communication issues in Houston, committees were established at the city, county, and Texas Medical Center levels to present information on rates of infection, hospitalization, and death. This includes data on wastewater viral load across the City of Houston in partnership with Rice University and Baylor College Medicine, as an early indicator for community spread. This information sharing and collaboration was critical to our Covid-19 response and should be built upon for future preparedness.

Rochelle Walensky, director of the CDC, changed the organization's structure, staffing, and public messaging based on lessons from the CDC's Covid-19 response. In Texas, lawmakers are also preparing for the next pandemic and have established an organization to help Texas be proactive in handling future pandemics. Last year, the Texas Legislature passed legislation to create the Texas Epidemic Public Health Institute (TEPHI).⁶¹

61. *Texas Legislature Online—87(R) History for SB 1780*. (n.d.). Retrieved August 16, 2022

62. TEPHI. (n.d.). *About TEPHI*. Retrieved August 25, 2022

63. Metcalf, T. G., Melnick, J. L., & Estes, M. K. (1995). ENVIRONMENTAL VIROLOGY: From Detection of Virus in Sewage and Water by Isolation to Identification by Molecular Biology—A Trip of Over 50 Years. *Annual Review of Microbiology*, 49(1), 461–487.

64. CDC. (n.d.). *Covid Data Tracker: Wastewater Surveillance*. Centers for Disease Control and Prevention. Retrieved August 25, 2022

TEPHI aims to establish public health systems and infrastructure to ensure that Texans are fully prepared to handle future pandemics. The goals of TEPHI include “organizing a reserve of Texas public health officials, creating a data analysis infrastructure and a laboratory testing network, and providing guidance to small and rural organizations on public health protocols.”⁶² TEPHI will be a part of the University of Texas Health Science Center at Houston (UTHealth), with Dr. Eric Boerwinkle, Dean of UTHealth School of Public Health, as acting director.

Dr. Stephen Linder, director of Institute for Health Policy, UTHealth School of Public Health, said TEPHI’s first project will focus on developing curriculum and materials for local health departments on disaster preparedness. TEPHI will work to ensure Texans have resources to handle public health emergencies.

TEPHI is a collaborative agency with partnerships across state agencies, local health departments, the CDC, academic institutions, business entities, and community organizations. Engaged partners will provide viewpoints needed for a comprehensive state preparedness and response plan.

“The Texas Epidemic Public Health Institute (TEPHI) is a network of public health professionals and resources that will ensure the state is at the forefront of pandemic readiness and response to keep Texans safe and the economy strong.” – TEPHI website

WASTEWATER MONITORING FOR PANDEMIC SPREAD IN HOUSTON

Wastewater monitoring to track the spread of diseases, such as polio, has been in use since the 1940s and was used during Covid-19.⁶³

In September 2020, the CDC created the National Wastewater Surveillance System to learn how to best use wastewater monitoring in various communities. The CDC has used this data to create maps and understand Covid-19 spread. As of August 29th, there are 1155 sites that are using wastewater sampling data, with 970 sites contributing data to the CDC tracker.⁶⁴

Locally, Rice University, Houston Public Works, Baylor College of Medicine, and the Houston Health Department established a wastewater monitoring system using data from 39 wastewater treatment plants, 73 manholes, and 63 lift stations across the region.⁶⁵

In December 2021, the data showed researchers that the Omicron variant was detected in 8 local sites.⁶⁶ In August 2022, the Houston Health Department was recognized by the CDC as a National Wastewater Surveillance System Center of Excellence – one of two nationwide. Houston will train other regions on implementing wastewater surveillance.⁶⁷

While this technology has its benefits, including cost, researchers also state challenges such as the variance of virus level in human waste vs. viral loads from traditional nose swabs. Data can be inconsistent based on how and when water is collected as well as the filtration techniques used. Regardless, this technique has helped to monitor community spread. According to a survey conducted by the Rockefeller Foundation, communities are interested in using wastewater monitoring to track everything from new viruses, drugs, flu, and chronic conditions.⁶⁸

Such efforts, along with the new Texas Epidemic Public Health Institute (TEPHI), will help our region to prepare for future health emergencies and pandemics.

65. Mishanec, N. (2022, May 31). *Houston’s COVID cases are climbing again, wastewater data shows*. Houston Chronicle.

66. Houston Health Department. (2021, December 6). *Omicron variant detected in Houston’s wastewater, Houston Health Department reports*. City of Houston.

67. Houston Health Department. (2022, August 3). *Houston Health Department earns CDC designation as Center of Excellence for wastewater epidemiology*. Houston Health Department.

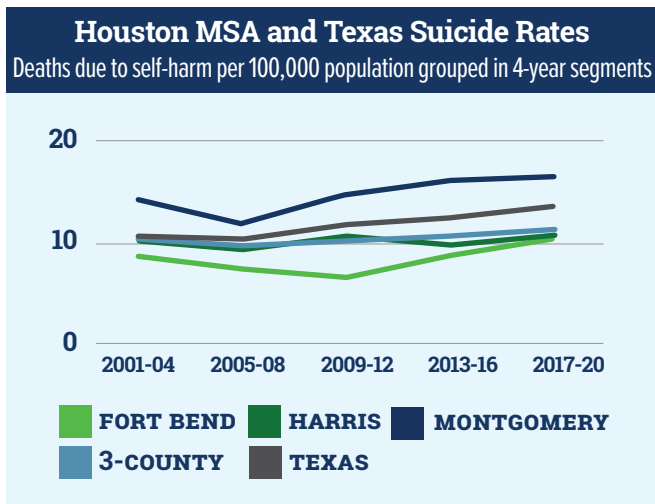
68. Keshaviah, A., Karmali, R. N., Vohra, D., Hu, X. C., & Diamond, M. B. (2022). *The Role of Wastewater Data in Pandemic Management*. 7.

A CLOSER LOOK AT: MENTAL HEALTH

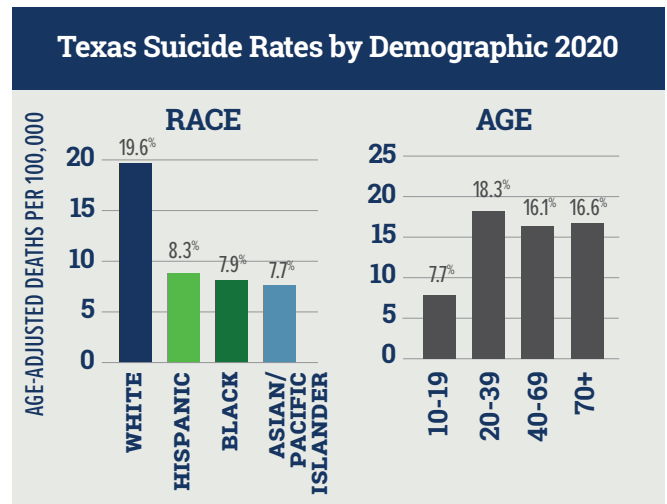
Covid-19 has had a profound negative effect on the mental health of the nation. This has brought a renewed focus on mental health trends, which were of concern even before the pandemic. One troubling statistic is that both the overall suicide rate and total number of suicides increased in the U.S. by approximately 4 percent from 2020 to 2021.⁷⁴ Locally, Montgomery County has the highest suicide rate in the region at 16.3 per 100,000 residents.⁷⁵ Mental Health America reports that the increased rates of anxiety reported at the onset of Covid-19 in 2020 persisted through 2021, especially in youth and Black Americans.⁷⁶

Untreated mental health issues may hit on the micro and macro levels, from personal devastation to reductions in economic productivity and higher cost of treatment. Depression alone was estimated to cost \$44 billion in lost workplace productivity in 2018.⁷⁷ And according to the Kaiser Family Foundation, 34.2 percent of Texas adults report mental health issues such as depression and anxiety.⁷⁸

While mental health issues are on the rise overall,⁷⁹ spikes can be seen in specific demographics. Nationwide in 2020, suicide was the second leading cause of death for people ages 10-14 and 25-34.⁸⁰ Other groups with higher-than-average suicide rates are veterans, people who live in rural areas, and young people who identify as lesbian, gay, or bisexual.^{81, 82} UH Psychology Professor Rheeda Walker reported in 2022 that suicide rates increased significantly among Black populations, particularly in ages 25-34, in the past two years.⁸³



Source: CDC



Source: CDC

77. One Mind At Work. (n.d.). *High Cost of Mental Disorders*. Retrieved from Tufts Medical Center.

78. KFF. (2021, December 13). Mental Health and Substance Use State Fact Sheets. KFF.

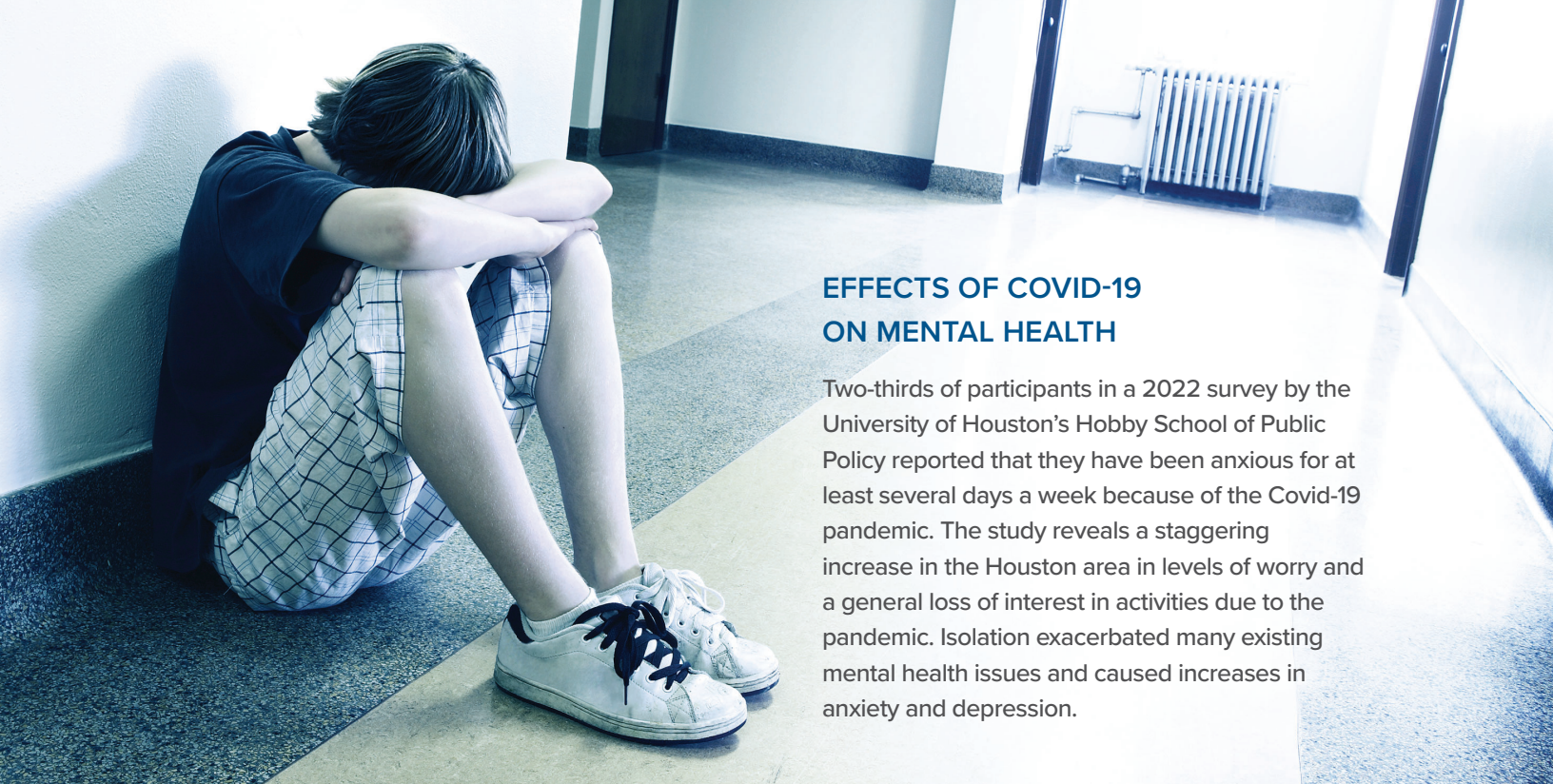
79. CDC. (2022, March 1). *Stats of the State—Suicide Mortality*. Centers for Disease Control and Prevention.

80. CDC. CDC WONDER: Underlying cause of death, 1999–2019. Atlanta, GA: US Department of Health and Human Services, CDC; 2020

81. Stone D, Holland K, Bartholow B, Crosby A, Davis S, Wilkins N. (2017) Preventing suicide: A technical package of policies, programs, and practices. [PDF – 6 MB] Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control.

82. Ivey-Stephenson A, Demissie Z, Crosby A, et al. (2020) Suicidal Ideation and Behaviors Among High School Students — Youth Risk Behavior Survey, United States, 2019. *MMWR Suppl*; 69(Suppl-1): 47–55.

83. Fickman, L. (2022, February 2). Suicide Rates Have Increased Dramatically Among African Americans. University of Houston: News & Events.



EFFECTS OF COVID-19 ON MENTAL HEALTH

Two-thirds of participants in a 2022 survey by the University of Houston's Hobby School of Public Policy reported that they have been anxious for at least several days a week because of the Covid-19 pandemic. The study reveals a staggering increase in the Houston area in levels of worry and a general loss of interest in activities due to the pandemic. Isolation exacerbated many existing mental health issues and caused increases in anxiety and depression.

MENTAL HEALTH IN CHILDREN

Half a million Texas children were diagnosed with anxiety or depression in 2020 – a 23 percent increase between 2016 and 2020, the Annie E. Casey Foundation reported in 2022.⁸⁴ On average, even before Covid-19, children with signs of mental illness did not get needed care until 8-10 years later.⁸⁵ Untreated mental health issues can lead to severe consequences such as dropping out of school, and increased drug use and criminal behaviors.

School resources are an important avenue for care, given that children spend 50 percent of their time in school. Three programs servicing students in Houston are Communities in Schools (CIS) Houston, Texas Child Health Access Through Telemedicine (TCHAT), and Mental Wellness Basics.

CIS Houston works inside schools to identify and treat mental illnesses early in childhood to mitigate potential future consequences. CIS Houston is active in 169 schools across 7 school districts in the Greater Houston area. CIS Houston has served 45,628 students and provided 6,149 students with counseling and other mental health services.

In addition to CIS, TCHAT, utilizes telehealth to provide telemedicine to kids at public schools. TCHAT uses medical schools as regional hubs and so far, has been accessible to over 2.2 million kids across Texas.⁸⁶

In 2020, HCA Healthcare collaborated with EVERFI, an international technology company driving social change through education, to launch an interactive mental health and wellness digital education course for middle and high school students. Since 2020, Mental Wellness Basics helped 10,909 students in the HCA Healthcare Gulf Coast Division service area build empathy around mental health issues, which can lessen stigma and encourage them to take action by seeking out help for themselves or others.



84. Zuvanich, A. (2022, August 9). *Mental health issues among Texas children exacerbated by pandemic*. Houston Public Media.

85. Meadows Mental Health Institute. (n.d.). *House Select Committee on Youth Health & Safety*. MMHPI - Meadows Mental Health Policy Institute. Retrieved August 26, 2022

86. TCMHCC. (n.d.). *Texas Child Health Access Through Telemedicine (TCHAT)* – TCMHCC. Texas Child Mental Health Care Consortium. Retrieved August 26, 2022

87. National Alliance on Mental Illness. (2017). *The Doctor is Out*. NAMI. Retrieved August 26, 2022

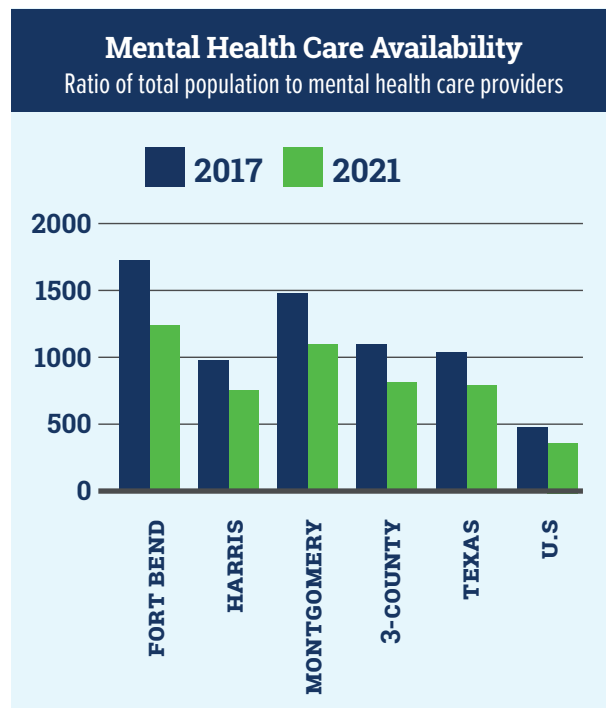
ACCESSIBILITY OF MENTAL HEALTH CARE IN HOUSTON

In 2020, half of the 60 million adults and children living with mental health conditions in the United States went without any treatment.⁸⁷ Reasons are many and include: a lack of insurance, reimbursement challenges, and a shortage of mental health care workers. In Texas, approximately 1 in 5 residents do not have health insurance.⁸⁸ In a 2022 Mental Health America report, Texas ranked last in the accessibility of mental health care out of the 50 states.⁸⁹

Houstonians needing mental health treatment are met with long waitlists to see a provider due to workforce shortages.⁹⁰ In 2021, the ratio of patients to providers was 730:1.⁹¹ This is well below Massachusetts at 180:1, but not as bad as the Texas ratio of 1,010:1. Said Brandy Hart, regional vice president of HCA Houston Healthcare. “We do not have enough people here who can provide care.”

Thomas Insel, former director of the National Institute of Mental Health, offers a unique perspective on the mental health care workforce shortage. He points out that the U.S. has as many mental health professionals as medical professionals, but that the larger issue in mental health care is the lack of standardization. This makes it difficult to reliably access high-quality care. Additionally, many communities lack the resources to treat a range of needs from chronic to acute. In his book *Healing*, Insel says that “The trouble is that, aside from a few federally funded institutions that had widely differing levels of care thanks to inadequate standardization, there was nowhere for patients who left the state facilities to go.”⁹²

Without standardization of care, there is no baseline of quality care. This creates large gaps in the quality of care. Kara Hill of Mental Health America of Greater Houston agrees but stresses that both the workforce shortage and the lack of standardization are among the largest factors contributing to the lack of quality mental health care in Houston. Shortages are largely attributed



Source: Understanding Houston

to the high rates of burnout and low wages that are typical for mental health providers in Houston.

Inpatient facilities are struggling to meet demand locally and nationally. In 2021, the *Houston Chronicle* reported “Texas’ mental health system is strained beyond capacity, with waitlists for hospital beds that stretch on for sometimes up to a year.” Waitlists had already grown 600 percent from 2012 until the start of Covid-19. As of March 2021, the state’s 10 public psychiatric hospitals had a waitlist of nearly 1,500 people, state data shows. Mental health advocates recommend that states have 50 public psychiatric hospital beds per 100,000 population, but Texas has fewer than 8 per 100,000.⁹³

Continued on page 36

88. Grubbs, S., & Wright, B. (2020, October). *Uninsured Texans*. Texas Comptroller of Public Accounts.

89. MHA. (n.d.). *Ranking the States 2022*. Mental Health America. Retrieved August 29, 2022

90. KFF. (2021, December 13). Mental Health and Substance Use State Fact Sheets. KFF.

91. University of Wisconsin Population Health Institute. County Health Rankings & Roadmaps 2022. www.countyhealthrankings.org.

92. Insel, T. R. (2022). *Healing: Our path from mental illness to mental health*. Penguin Press.

93. Stuckey, A. (2021, February 25). *How Texas fails the mentally ill: One man's death reveals a secretive system in crisis*. Houston Chronicle.

The *Houston Chronicle* article also highlighted severe oversight problems. The state contracts with private psychiatric hospitals to address some of the unmet need but officials at one point could not say which state hospitals have received these funds, much less report on the effectiveness of these contracts. The state began collecting that information in September of 2021.⁹⁴ This shortage of inpatient services is a result of years of neglect exemplified by this oversight issue.

The mental health care shortage is impacting our emergency rooms and exacerbating workforce burnout in hospitals. Regional hospital chief nursing officers pointed out that when patients in crisis are placed on waitlists rather than in treatment, they end up in hospital emergency rooms, sometimes for lengthy stays. This causes strain on medical staff who often are not trained to deal with mental health issues. This is a situation that can lead to workplace violence against nurses and others.

As more attention is being focused on mental health, various efforts are underway to find solutions. We highlight a few below.

TRAUMA-INFORMED CARE

Some area hospitals, including HCA Houston Healthcare, are now training staff to provide “trauma-informed care” to better address mental health issues and treat patients more holistically. A trauma-informed approach to care acknowledges that health care teams need a complete picture of a patient’s life situation in order to provide effective health care services. These trauma-informed practices can improve patient health outcomes, as well as provider and staff wellness. They can also help reduce avoidable care and excess costs for both the health care and social service sectors.



WORKFORCE DEVELOPMENT

The Network of Behavioral Health Providers created the Workforce, Recruitment, Education and Development Initiative to increase the mental health workforce by providing more opportunities in the field to young adults and teenagers to learn about the mental health care field as a future career path.⁹⁵



FUNDING

The federal American Rescue Plan Act gives states funding for mental health. In 2021, Texas allocated nearly \$400 million for projects that will add more than 500 inpatient psychiatric beds across the state and revamp old hospitals in Austin and San Antonio. In Harris County, part of this year’s \$70 million budget allocation will go toward a new facility, called the John S. Dunn Behavioral Sciences Center. This facility opened in February of 2022 to serve patients with shorter-term commitments from 29 contiguous counties spreading out from Houston.⁹⁶



94. Stuckey, A. (2021, February 25). *How Texas fails the mentally ill: One man’s death reveals a secretive system in crisis*. Houston Chronicle.

95. Network of Behavioral Health Providers. (n.d.). *Workforce Development*. The Network of Behavioral Health Providers (NBHP). Retrieved August 26, 2022

96. Stuckey, A. (2021, June 2). *Texas lawmakers allocate nearly \$400 million to state psychiatric hospitals*. Houston Chronicle.

INTEGRATED HEALTH

In addition to increased funding, many experts are looking to new models of care that address mental health as a part of our overall health. Integrated Behavioral Health is a promising care model supported by behavioral health experts. It is described by the director of Integrated Health Initiatives at Mental Health America of Greater Houston, Kara Hill, as “addressing behavioral health in a medical clinic during the physical health visit. Patients should be screened for mental health and physical health concerns and if needed, see the proper behavioral health specialist during the primary care visit.” If done properly, the implementation of integrated behavioral health can decrease behavioral health risks and complexity while increasing the quality of both mental and physical health. This model has been successfully implemented in some areas in Houston, in Texas, and throughout the nation. However, the standard delivery of care remains segregated for most providers, practices, and patients. Furthermore, proper implementation is challenging. It requires a transformation of the entire health care process that must come from leadership and be adopted by all levels and aspects of a health care organization. It is not enough to task one person or one team with “integrating health.” Programs that implement integrated health as an overhaul of the way care is delivered rather than an additional program can realize the full benefit of integrated health care.



PUBLIC OUTREACH



It can be hard to navigate the mental health system. Mental Health America is trying to make it easier to seek and get care with its I Don't Mind and MHA Screening initiatives. MHA Screening is a free website that offers online tests for mental illnesses as well as tools and resources for treatment. I Don't Mind focuses on reducing stigma around mental health and spurring conversations on people's struggles with mental illness.

Both can be accessed at <https://idontmind.com/>.

TELEHEALTH

The pandemic accelerated the use of telehealth for mental health care and highlighted the need to make mental health part of standard health care services. Dr. Jan Lindsay, a psychologist, associate professor at Baylor College of Medicine and a resident fellow in the Center for Health and Biosciences at Rice University's Baker Institute for Public Policy, has conducted studies that show video visits can offer the same quality of mental health care as in-person visits. In some cases, video telehealth can provide unique advantages compared to in-person care in terms of the comfort of the patient and convenience. In addition, using telehealth could help solve access issues, especially in rural areas. Telehealth can also be a valuable tool for implementing integrated health by allowing mental health providers to participate in medical appointments remotely. Critics point out the potential concern that newly formed remote mental health programs might provide poor-quality care and/or overprescribe medications at a larger scale than in-person programs. Telehealth is discussed further in the technology adoption section.



Mental health is foundational for physical health and productivity. Years of neglect have diminished our mental health service resources. Recent increases in funding and attention are promising but must be sustained if not increased.

A CLOSER LOOK AT: DIABETES

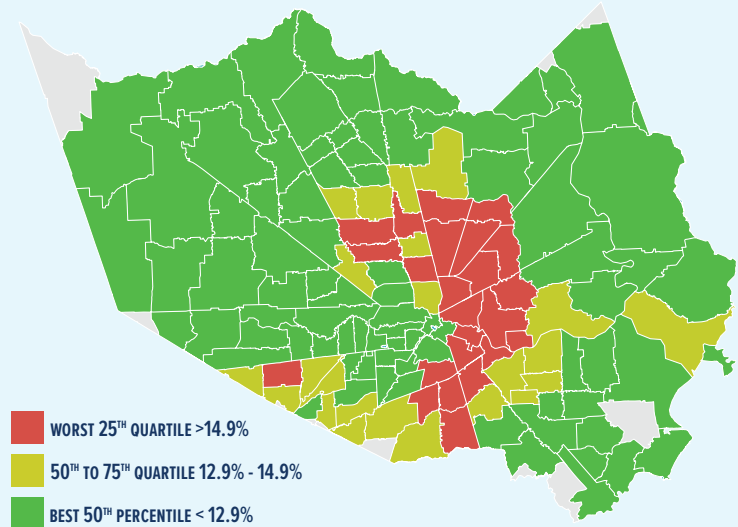
By 2060, the number of Americans with diabetes is expected to increase by 39.3 percent.⁹⁷ Diabetes is a chronic condition that impairs the way your body regulates and uses sugar. If not managed properly, diabetes can lead to disorders of the circulatory, nervous, and immune systems. Currently, the prevalence of diabetes varies significantly across the region, ranging from 5.7 percent in the 77007 zip code to 22.1 percent in the 77016 zip code.⁹⁸ Diabetes is further broken down into subtypes. Type 1 is genetic, and type 2 is associated with diet and obesity. Cities Changing Diabetes is working to reduce the prevalence of Type 2 diabetes. Due to the rise in obesity among both children and adults, Type 2 diabetes now accounts for 90-95 of all diagnosed cases in the United States according to the American Diabetes Association.⁹⁹

The Centers for Disease Control estimates that a third of Americans living with diabetes are unaware of having the disease. Currently, only a little over a half of patients receive formal diabetes education and self-management education and support (DSMES). DSMES has been demonstrated to be a cost-effective solution to reduce hospital admissions and risk of complications resulting in lower lifetime health care costs.

As the Center described in 2020, Cities Changing Diabetes was launched by Novo Nordisk, University College London, and the Steno Diabetes Center in Copenhagen, and now is in more than 45 cities worldwide, including two in the United States. In each city, the program includes a government health group, an academic institution, and a backbone community organization all working to create specific initiatives to encourage healthy behaviors and offer community support.

Cities Changing Diabetes was established in Houston in 2014. UT Public Health's Dr. Linder serves as the research lead. Dr. Faith Foreman-Hays, Deputy Assistant Director over the Office of Chronic Disease, Health Education & Wellness at Houston Health Department leads the Core Team governance structure of the coalition. And the Institute for Spirituality and Health serves as the local backbone organization.

Harris County Adults with Diabetes as of 2019



Prevalence of Adults with Diabetes in Houston. These maps are taken from the Houston State of Health and built from CDC-PLACES. This map ranks each zip code relative to the rate of diabetes in zip codes within Texas.



1 in 5

**37.3 MILLION AMERICANS HAVE
DIABETES, AND 1 IN 5 DON'T KNOW IT.**

Source: CDC

“Diabetes affects all Houstonians – our families, our communities, our schools, our workplaces, our places of worship, and ultimately our economy. ... It is through community-wide initiatives and public-private partnerships like Cities Changing Diabetes—Houston that Houston gets its best work done, and I am highly motivated to continue supporting this program.” – Mayor Sylvester Turner

These initiatives educate patients and caregivers in the broader Houston community on lifestyle changes to treat and prevent Type 2 diabetes. For example, the Faith & Diabetes initiative leverages trusted community groups to build grass-roots connections. Klaus Madsen, advisor to the Houston-based Institute for Spirituality and Health, said, “[The] biggest thing we’ve learned is that people living with diabetes or vulnerable to developing diabetes need support in their community to complement what they get from the health care system.”

The Center previously highlighted initiatives organized by Cities Changing Diabetes, MyDiabetesHQ.org (Formerly the Houston Diabetes Resource Center) to provide information, support, navigation, and referral for people living with diabetes and their caregivers, and a \$2.4 million grant from the Robert Wood Johnson Foundation to evaluate and share practices across cities in the program. Since then, Cities Changing Diabetes has expanded to include four initiatives that encourage healthy behaviors for people living with diabetes in Houston:

Faith & Diabetes	Peer Support	My Diabetes HQ	A Bite of Hope
Anchors diabetes education and support in communities of faith. Trains faith and lay leaders to conduct Diabetes Self-Management Education and Support classes in the community.	Provides community support through Facebook, Zoom, and in-person groups for people living with pre-diabetes and diabetes as well as their caregivers.	Connects patients with community health navigators via this platform to help answer questions and provide additional resources, including referral to a medical home with safety net providers. This was an expansion of the Houston Diabetes Resource Center.	Fosters healthy nutrition habits among elementary school students and their parents via afternoon programs, and ‘cook with a doctor,’ programs in which doctors and chefs share healthy cooking techniques. In addition, the program is transforming the local foodscape in the Alief area by improving the sustainability of immigrant- and women-owned restaurants through business training in collaboration with Baker Ripley.

Initiatives conducted by Cities Changing Diabetes in Houston

In 2022, the Houston initiative received additional funding from Novo Nordisk to extend the work for three years, recognizing the global contributions of the Cities Changing Diabetes network in addressing SDoH and engaging partners in communities of faith. The goal is to create intentional, sustainable nutrition and education programs to address drivers of Type 2 Diabetes. Through these initiatives, Cities Changing Diabetes aims to increase attention and actions to reduce incidences of diabetes and slow progression of the disease from obesity to prediabetes to diabetes and ultimately diabetes with complications. Furthermore, they expect that these initiatives will decrease health care spending. Cities Changing Diabetes predicts that addressing health behaviors will reduce conditions like obesity which in turn will reduce Type 2 diabetes cases by 149,000 cases by 2045. They estimate this will save Houston **\$1.5 billion** in health care expenses.¹⁰⁰

Since 2014, the Cities Changing Diabetes coalition has created innovative programs and is planning future initiatives to further help Houstonians. This organization’s work, according to Stuart Nelson, acting president of the Institute for Spirituality and Health, places Houston “ahead of the pack in terms of creating a robust ecosystem” with layers of support for Houstonians living with Type 2 diabetes. Nelson states, “We are strengthening the linkages between clinical services and community-based programs to reduce costs and ultimately improve the life of people living with diabetes across Houston.”



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 99. American Diabetes Association. (2022, July 28). Statistics About Diabetes | ADA.
 100. Cities changing Diabetes. (n.d.). *Houston*. Cities Changing Diabetes. Retrieved August 25, 2022



A CLOSER LOOK AT: MATERNAL HEALTH

“We can’t have a healthy economy without healthy people. Yet the U.S. maternal mortality ratio—the ultimate indicator of maternal health—has only worsened since 1987, despite medical advances.”

— David Erickson, Senior Vice President at
Federal Reserve Bank of New York

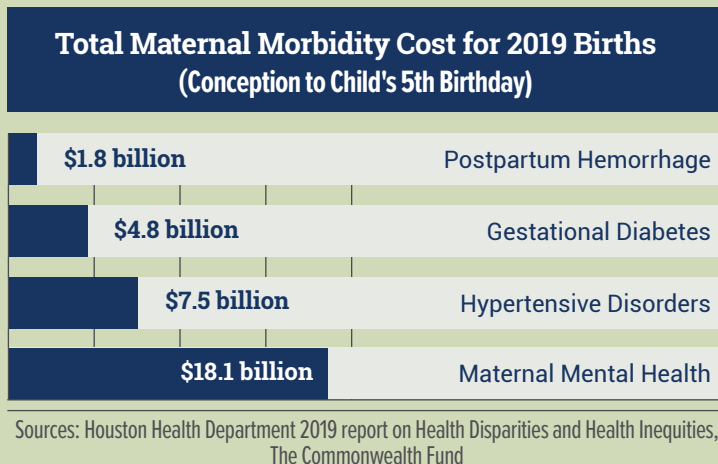
The number of maternal deaths in the United States rose 14 percent in 2020 as Covid-19 exacerbated our nation’s already poor maternal health outcomes.¹⁰¹ The Center released a full report on maternal health and the associated social determinants of health in 2022 that can be found at <https://www.centerforhoustonfuture.org/maternalhealth>. Given how important maternal health is to our economy and workforce, the report included a focus on business engagement.

The United States has the highest maternal mortality rate among wealthy developed nations despite spending a greater percentage of GDP on health care. Poor maternal outcomes cost the nation an estimated \$32 billion in 2019.¹⁰² Outcomes in Houston are worse than the national average. The 2021 March of Dimes Report Card assigned Houston an “F” rating versus the nation’s rating of “C-” based on the number of pre-term births and other maternal health factors.

Populations most impacted by Covid-19 saw the greatest rise in maternal mortality.¹⁰³ Many factors that influence maternal health also drive public health and health resiliency. These statistics are alarming. They are also avoidable. More than 80 percent of pregnancy-related deaths were preventable, according to 2017-2019 data from Maternal Mortality Review Committees (MMRCs).¹⁰⁴

POOR MATERNAL OUTCOMES COST THE NATION \$32 BILLION IN 2019.

Figure 2: Cost and Causes of Maternal Morbidity for 2019 Births



18% of Texans lack medical access due to cost

12% of households & 10% of mothers are food insecure

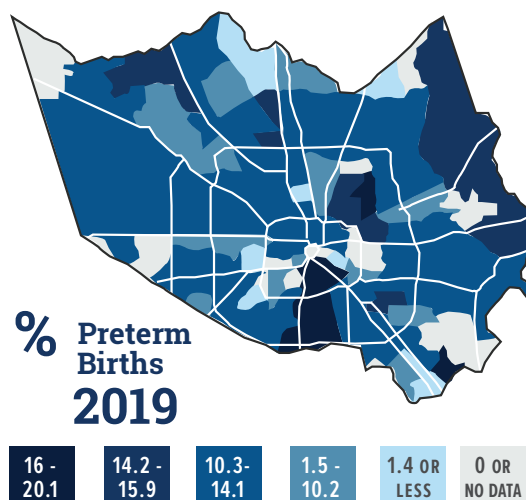
20% 1 in 5 households reported severe housing problems

Source: Houston Health Department 2019 report on Health Disparities and Health Inequities

Perhaps the most glaring statistics in maternal health are those revealing racial inequity. **Black women are three times more likely to die in childbirth and 50 percent more likely to have a preterm birth than White women.**¹⁰⁵ This disparity for Black women is specific to the United States and it spans all levels of income and education.

Where someone lives also plays a significant role in preterm birth rates in Harris County as in the rest of the U.S. Preterm birth rates vary by zip code from as high as 20.1 percent in under-resourced areas to below 9.4 percent in affluent areas according to 2020 data from the Department of State Health.

Continued on page 43



U.S. Maternal Mortality Rates Per 100,000 Live Births by Race and Metro Status, 2018

POPULATION	OVERALL	WHITE	BLACK	HISPANIC	METRO	NON-METRO
MATERNAL MORTALITY RATE	17.4%	14.7%	37.1%	11.8%	16.7%	21.6%

Source: Race/Ethnicity: "Maternal Mortality in the United States: Changes in Coding, Publication, and Data Release, 2018" National Vital Statistics Report

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103. Clerk, M. (2022, February 25). Increase in Maternal Mortality During COVID Underscores Need for Policy Changes. *Center For Children and Families*.
104. Trost, S., Beaugard, J., Chandra, G., Njie, F., Berry, J., Harvey, A., & Goodman, D. A. (2022, September 19). *Pregnancy-Related Deaths: Data from Maternal Mortality Review Committees in 36 US States, 2017–2019* | CDC. Centers for Disease Control and Prevention.
105. PRB. (2021, December 6). *Black Women Over Three Times More Likely to Die in Pregnancy, Postpartum Than White Women, New Research Finds*. Population Reference Bureau.



SPOTLIGHT: REPRODUCTIVE HEALTH: ABORTION IN TEXAS

A CONTEMPORARY ISSUE FROM AN ECONOMIC PERSPECTIVE

As we look at maternal health, we cannot ignore changes in reproductive policies. We will provide a brief look at the state of reproductive law and some potential economic consequences of these changes. This is an issue worthy of more study and consideration than we can fully explore in this report.

On June 23, 2022, the U.S. Supreme Court overturned *Roe vs. Wade*, a 1973 ruling providing federal protection for abortion, turning legislative authority over to states. In 2021, Texas enacted SB8, known as the “fetal heartbeat ban,” making it illegal to obtain an abortion after 6 weeks gestation. A Texas trigger law further restricted abortion upon the overturning of *Roe*, criminalizing abortion access including instances of rape and incest. All abortion clinics and many reproductive health clinics have since closed in Texas.¹⁰⁶

In Texas, we will likely see an increased birth rate, increased high-risk pregnancies, additional strain on social services and childcare resources, and increases in women’s poverty and unemployment. We can also expect an increase in

high-risk pregnancies, subsequently increasing costs and jeopardizing the health of mothers.

The majority of those seeking abortions are young, low-income and/or minority women facing complicating life factors.¹⁰⁷ Thirty seven percent of individuals who get abortions are under 24 years old.¹⁰⁸ About 1 in 4 women of childbearing age are uninsured in Texas.¹⁰⁹ Mothers who can stay in the workforce experience a one-third drop in earnings known as the “motherhood penalty.”¹¹⁰ A Turnaway Study of the effects of denied abortions on women’s lives over multiple years shows that not being able to terminate an unwanted pregnancy increases the amount of debt past due for 30 days or more by 78 percent.¹¹¹ In Texas, women play a critical role in the economy as 48 percent of the workforce. Additionally, mothers are the sole, primary, or co-breadwinners in 59.7 percent of families, according to 2017 data.¹¹² These statistics indicate significant economic fallout for individuals and families due to unwanted and unplanned pregnancies. Increased budgets for medical and social services to support women and children should be considered in the wake of these changes in abortion laws.

106. Kirstein, M., Dreweke, J., Jones, R. K., & Philbin, J. (2022, October 3). 100 Days Post-Roe: At Least 66 Clinics Across 15 US States Have Stopped Offering Abortion Care. Guttmacher Institute.

107. Guttmacher Institute. (2019, September). *Induced Abortion in the United States*. Guttmacher Institute.

108. Sanger-Katz, M., Miller, C. C., & Bui, Q. (2021, December 14). Who Gets Abortions in America? *The New York Times*.

109. March of Dimes. (n.d.). *Uninsured women: Texas, 2010-2020*. March of Dimes | PeriStats. Retrieved August 26, 2022

110. Texas Comptroller of Public. (2018, June). *Women in the Texas Workforce*. Comptroller.Texas.Gov.

111. Gibson, K. (2020, January 20). Women denied abortions live in financial distress years later, study finds. CBS.

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Our report offers three strategies for the business community to improve maternal health outcomes in the Houston region, which would, in turn, increase productivity and reduce costs: internal policy implementation, employee education, and cooperative community investment.



1

Houston businesses can implement family-friendly workplace policies to improve morale and employee retention. These policies, set out in the **Best Place for Working Parents® Houston Campaign**, include dependent care flexible savings accounts, company-paid health care coverage and paid time off for maternal medical care.

2

Employers who cannot afford to provide health insurance can educate employees on services such as Federally Qualified Health Clinics. These providers offer a wide range of quality comprehensive primary and preventive care services, regardless of ability to pay or health insurance status.

3

Businesses can improve health outcomes for employees by investing in community health programs in the areas where they live. If businesses work together, they can offer more robust services. Innovative funding models are available -- such as the Collaborative Approach to Public Goods Investing (CAPGI) -- to distribute funding equitably and allow for partnerships with public entities.

These three strategies offer a strong starting point for businesses to get involved in solving this critical problem.

CONCLUSION: A CLOSER LOOK AT HEALTH ISSUES AND SOLUTIONS

Solutions to key issues in Houston's health care system have a common thread. They all benefit from collaboration, transparency, and sustainable funding. The greatest health care challenges in our community require clear sightlines for coordinated efforts.

Texas is preparing for future pandemics through TEPHI, which is built on partnerships across state and local agencies, business entities, and community organizations to synthesize data and disseminate protocols. Promising mental health programs include in-school behavioral health treatment and integrated behavioral health which addresses behavioral health issues as a part of medical care. Chronic disease solutions are being developed by community-based collaborations like Cities Changing Diabetes, which leverages data infrastructure to identify communities of need, and faith communities to develop grassroots initiatives in those communities. Other health solutions like improving maternal health will require similar investments in quality data collection for clear sightlines, collaborations, and sustainable funding.

Overview of Health Care Sector Economics in Houston

Role of Health Care in Houston's Economy

In this section we look at health care as an economic driver in our region. Health care and social assistance is the largest industry in the Houston MSA, employing over 350,000 workers, accounting for 11.3 percent of all employment¹¹³ and 5.2 percent of GDP.¹¹⁴ As such, it is important to consider trends, issues, and opportunities in this sector. In our 2020 report, we considered three evolving trends: health service workforce shortages, life sciences investments, and health technology adoption. Covid-19 accelerated trends in each. We will explore developments in each trend and revisit our scenario-based economic models to consider the future.

Top Industry by Employment by Geographic Area, 1990-2020



Source: Quarterly Census of Employment and Wages

Note: Health Care and Social Assistance became the top industry by employment in many areas of Texas by 2020.

CURRENT STATE OF HEALTH CARE SECTOR IN HOUSTON

Overall, the health care sector in Houston grew around 25 percent from 2012 – 2021. Life sciences jobs account for 2 percent of Houston's health care sector and are the fastest growing industry cluster with 77 percent growth over the past 9 years. The next fastest growing industry is outpatient centers at 42.9 percent increase from 2012 - 2021. Workforce shortages have increased. Even before the pandemic, the Texas Center for Workforce Studies projected that Texas would be short 60,000 nurses by the end of the decade.¹¹⁵ As of the first quarter of 2022, there were over 17,000 open job listings for registered nurses in the Houston MSA. Our third topic, health technology, has seen many exciting developments and implementations over the past two years that will be discussed in the technology adoption section of this report.



Houston MSA Job Growth Rates by Industry in 2022

(Over-the-year net change for private-industry supersector employment in the Houston metropolitan area in thousands)



Trade, Transportation, and Utilities
Leisure and Hospitality
Education and Health Services
Professional and Business Services
Construction
Manufacturing
Mining and Logging
Financial Activities
Information
Other Services

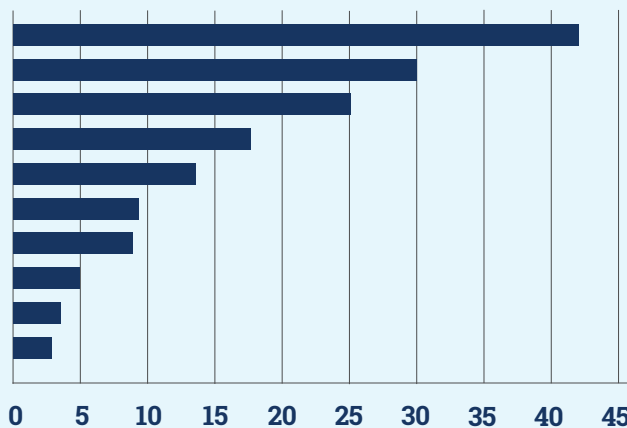


Chart Notes: The Education and Health Services industry cluster had the third highest growth rate from April 2021 to April 2022.

Source: U.S. Bureau of Labor Statistics

Houston MSA Job Growth Rates in Health Care Industry 2014-2021

Residential Mental Retardation, Mental Health, Substance Abuse and Other Facilities
Nursing & Community Care Facilities
Hospitals
Other Ambulatory Health Care Services
Home Health Care Services
Outpatient Care Centers
Life Sciences
Offices of Physicians, Dentists, and other Health Practitioners
Retail - Health, Personal Care Stores, & General and Consumer Goods Rental
(except video tapes and discs)
Medical, Diagnostic & Dental Laboratories

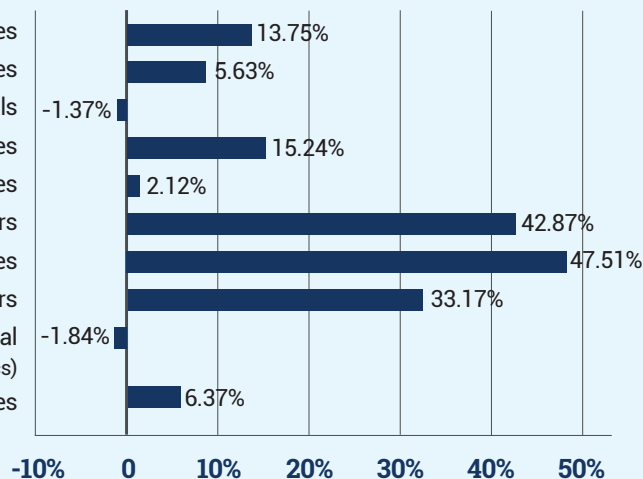


Chart Notes: Total job growth rates from 2014 to 2021 in health care were greatest in life sciences and outpatient care centers.

Source: U.S. Bureau of Labor Statistics

113. Texas Workforce Commission. (2022, July). *Metropolitan Statistical Area Profiles: Houston-The Woodlands-Sugar Land—Texas LMI*. Texas Labor Market Information.

114. Bureau of Economic Analysis. (n.d.). *Gross Domestic Product (GDP) by County and Metropolitan Area: GDP in Current dollars (CAGDP2)*. Retrieved August 11, 2022

115. Texas Department of State Health Services. (2020). *Updated Nurse Supply and Demand Projections 2018-2032*. 25-15750, 3.

EFFECT OF COVID-19 ON HEALTH SERVICE JOBS

Texas lost 1.4 million jobs in the spring of 2020 due to COVID-19, with the unemployment rate peaking at 12.9 percent in April 2020.¹¹⁶ This underscores the importance of our health system in protecting not only our health but also our financial wellbeing - a healthy economy depends on a healthy workforce. Health care professionals were tasked with treating patients while facing their own risk of infection, as well as studying the virus and developing treatments and vaccines. It was a herculean effort that demonstrated the best of our health care system.

As of April of 2022, all 370,000 Houston job losses were recovered. The Houston area accounted for about one-third of the jobs created in Texas in July. Houston's job growth remains strong as of August 2022, adding around 20,000 jobs in each of the past three months and bringing the unemployment rate down to 4.8 percent.



U.S. Job Losses in Great Recession and Covid-19 Crisis

Percent decline in nonfarm payroll employment from pre-recession peak.



Chart Notes: Comparing the Covid-19 Recession to the Great Recession you see job losses and recoveries were both more dramatic and swifter in the Covid-19 Recession.

Source: Bureau of Labor Statistics

Houston MSA Annual Employment Growth Rate

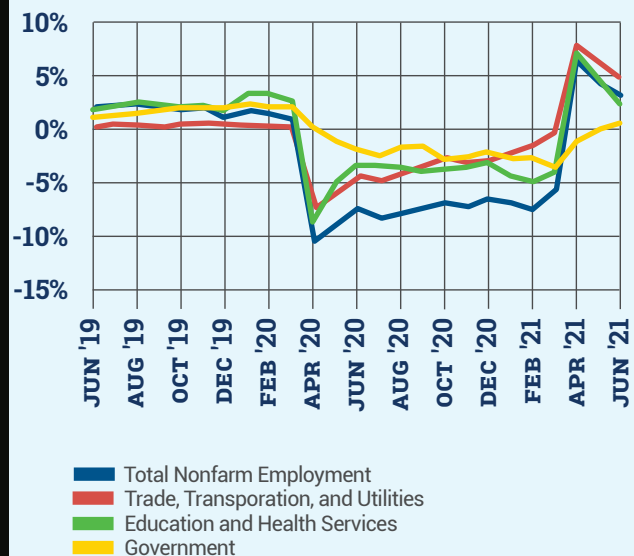
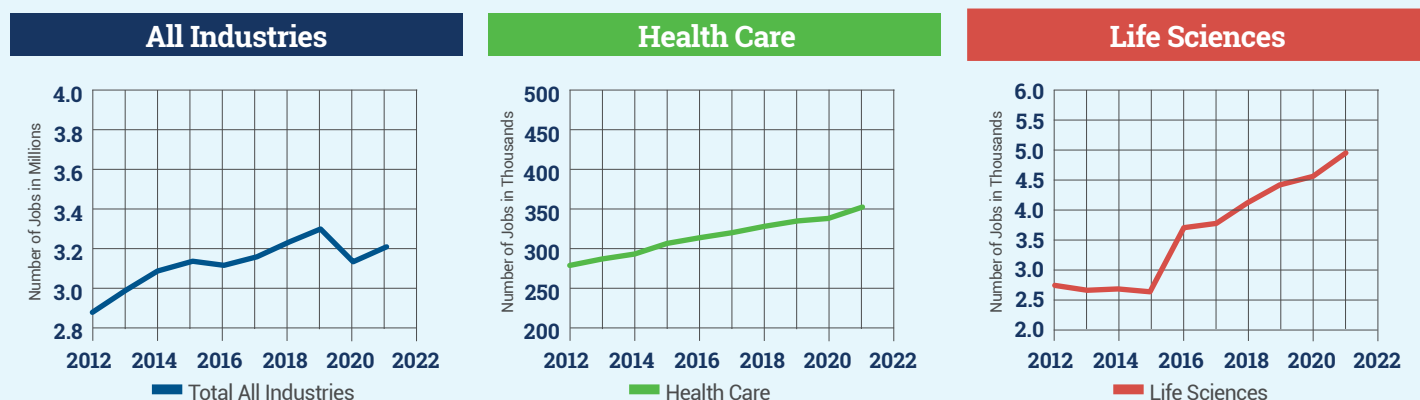


Chart Notes: Houston MSA job losses and recoveries were swift with health care jobs slightly more resilient than other industries.

Source: Bureau of Labor Statistics

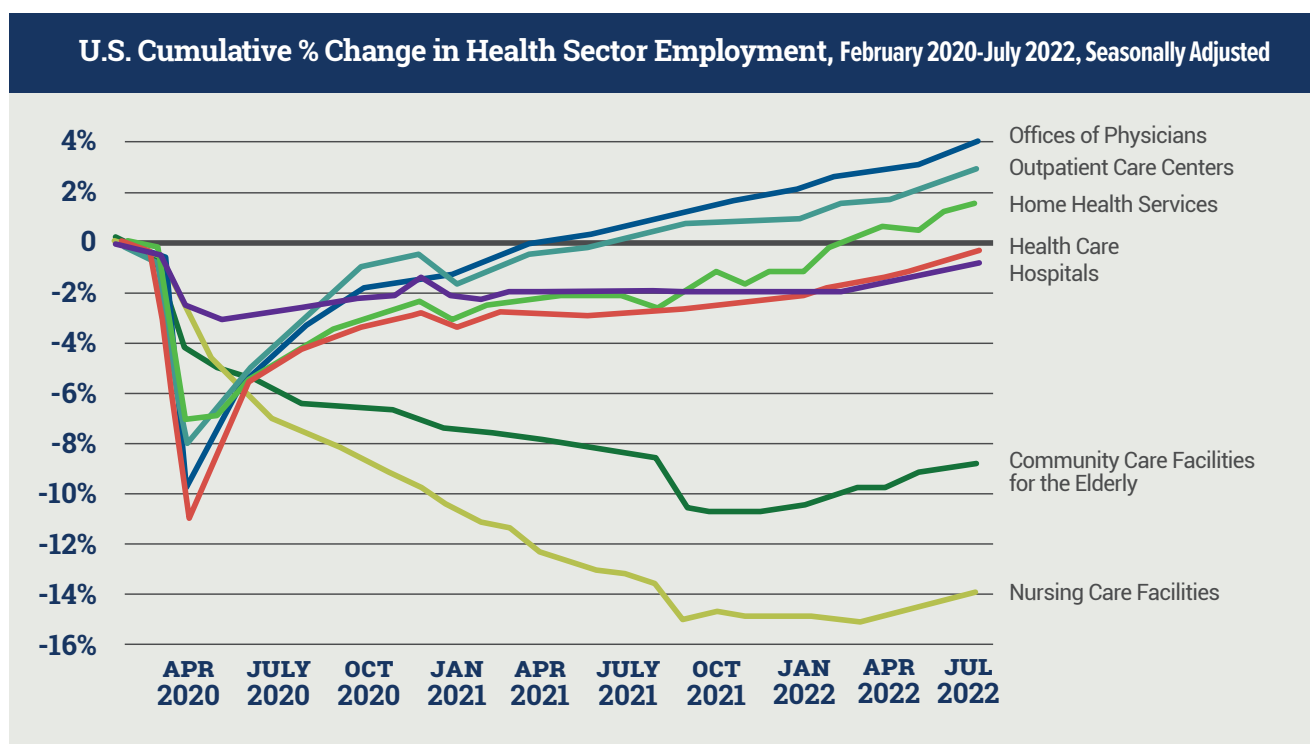
Houston MSA # of Jobs



Source: Bureau of Labor Statistics

Nationally and locally, health care jobs saw fewer losses than other industries. Medical professionals not working in hospitals or caring directly for Covid-19 patients experienced job losses early on that were quickly recovered. The life sciences industry, central to creating vaccines and therapeutics for Covid-19, was extremely resilient throughout the pandemic. And so far 2022 has been a record year for life sciences job growth and revenue.

Outpatient care centers fared best. These centers were widely used for both Covid-19 and non-Covid-19 visits as an alternative to ERs while traditional doctors' offices were adjusting to new protocols. This trend toward outpatient care is continuing even now. Not all health care areas were resilient. Nursing homes and elderly care facilities have seen a slow decline in job numbers that is continuing.



Source: Bureau of Labor Statistics Current Employment Survey (CES)

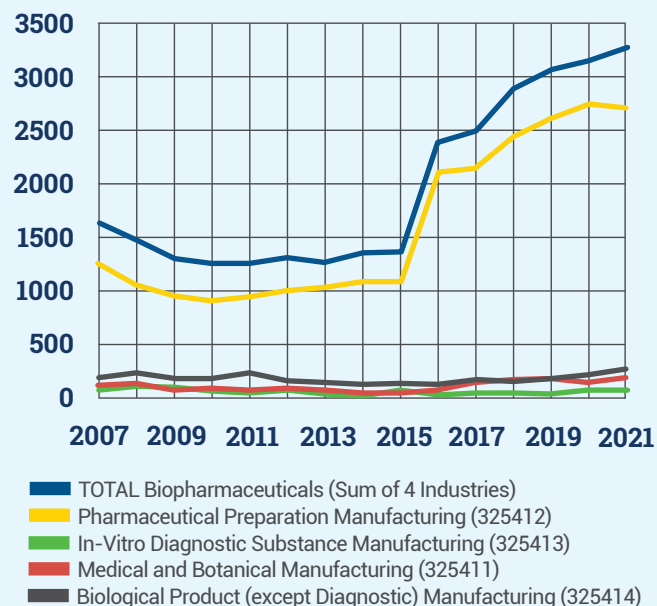
EFFECT OF COVID-19 ON LIFE SCIENCES JOBS

The life sciences industry cluster produces pharmaceuticals, medical devices, and digital health innovations. Based on numbers reported from the Bureau of Labor Statistics, growth in all areas of life sciences is “lumpy” but trending upward. The number of jobs in this industry cluster is small relative to the rest of the health care sector, so minor gains or losses in absolute numbers can show up as sizable percentage swings. The life sciences industries with both the most jobs and growth currently are pharmaceutical preparation manufacturing, and surgical and medical device manufacturing. One life sciences area that can benefit from Houston’s unique attributes is cell and gene therapies, which fall under biological product manufacturing. We discuss this topic in more depth in the CTMC Spotlight.

HEALTH CARE'S REGIONAL ECONOMIC OUTPUT

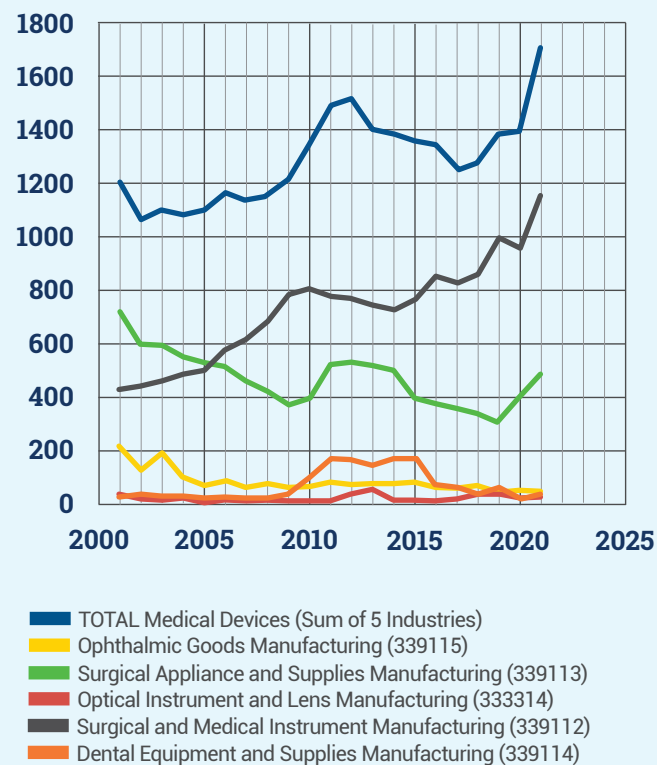
In Center for Houston’s Future’s 2020 report, *Houston’s Economic Future: Health Care*, we considered the sector as an economic driver for the region. Health care provides 5.2 percent of our regional GDP. GDP for most sectors declined over the past two years with total GDP being reduced by 4 percent from 2019 to 2020. In the 2020 report we identified the life sciences industry as a robust growth engine within medical care. This is because life sciences jobs and GDP have grown at a greater rate than the rest of health care. It is also because life sciences jobs tend to create goods that require supplies and therefore create more indirect jobs. Next, we will discuss the exciting developments and investments in Houston’s life sciences industry over the past two years.

Houston MSA Life Sciences Biopharmaceutical Jobs



Source: Bureau of Labor Statistics

Houston MSA Life Sciences Medical Devices Jobs



Source: Bureau of Labor Statistics

HOUSTON AS A LIFE SCIENCES HUB

Houston's Life Sciences Ecosystem is at a Tipping Point. Covid-19 highlighted the importance of life sciences inventions for treatments and vaccines. And it created a demand for reliable onshore production. **2022 has seen the most private financing of biotech of any year other than 2021**, despite a weakening in public markets. Nationwide, \$18 billion has been invested in private biopharma companies in the first six months of the year.¹¹⁷

Investments in Houston's life sciences industry have made it the fourth fastest-growing major life sciences cluster in the country. Houston has more than 1,700 life sciences companies and is one of the top 20 markets for National Institutes of Health (NIH) funding. Millions of square feet and billions of dollars in life sciences development are underway or planned. Phase 1 of the world's largest life sciences campus, TMC Helix Park, is on track for completion in 2023. This campus alone is projected to bring 23,000 permanent new jobs to Harris County, representing all pay scales and educational backgrounds, and \$5.4 billion in annual GDP growth for the state. And TMC just announced the development of BioPort, a biomanufacturing and medical supplies center in Houston to help the region and other areas of the country avoid supply chain issues for critical medical products. BioPort is projected to create 100,000 new jobs.



“Houston is the only place with this level of talent, this caliber of research, and a growing diversity of patients within 2 square miles combined with significant public and private capital. This level of collaboration and research is truly unique. And, we are soon to have the world's largest dedicated facilities in those 2 miles. Not to mention the significant resources across Texas to develop talent and participate in this ecosystem. This enables vertical integration that you don't have elsewhere. THAT is why Houston is at a tipping point.”

– Tatianna Yale, Chief Investment and Planning Officer, TMC

This is great news for Houston. Houston's health services and life sciences industries collectively employ over 360,000 people, making it larger than the energy sector. The life sciences industry promises significant life-saving and economic benefits. Unlike health service job growth which typically tracks population growth, life sciences jobs have grown at a pace more rapid than other industries. In addition to the rapid growth in direct jobs, this field generates many indirect jobs increasing the value added per job to the GDP.

In 2022, CBRE and JLL both highlighted Houston in their list of top life sciences hubs in the nation. Travis McCready, head of life sciences for JLL's Americas markets, said “Innovation is happening at a more rapid pace than ever before, the fruits of research into cell and gene therapy are just now being harvested, and revenue growth has taken off in the past five years as the sector becomes larger, an atypical growth track.”¹¹⁸

Industry experts discussed Houston's opportunities, barriers, and successes at a life sciences innovation roundtable convened by Center for Houston's Future. All agreed that several years of investment have led to more commercialization and production of our researchers' life-saving innovations staying in Houston, rather than moving to more expensive domestic markets on the East and West coasts.

117. Pitchbook. (n.d.). *Venture Capital, Private Equity and M&A Database | PitchBook*. Pitchbook. data cut July 2022

118. Egan, J. (2022, September 29). Houston named a market to watch within the life science sector. *InnovationMap*.



HOMEGROWN AND PLANNING TO STAY: THREE HOUSTON BIOTECH STARTUP SUCCESSES

Successful local biotech companies have landed investments via multiple paths. Three different examples are **CTMC**, **Volumetric** and **Procyron**.

- ▶ **CTMC** started as an initiative at The University of Texas MD Anderson Cancer Center in 2019 to accelerate the development and manufacturing of innovative cell therapies for cancer, bringing the entire product development chain in-house. Officials recruited an experienced CEO, Dr. Jason Bock from Teva Biopharmaceuticals, to Houston as head of the initiative. Then in 2022, they entered a joint venture with National Resilience to form CTMC. This is a departure from both the typical funding strategy and development process. They brought together a powerful team with expertise in both high science and drug development in a state-of-the-art 60,000 square foot facility.
- ▶ **VOLUMETRIC BIOTECHNOLOGIES** was co-founded by a Rice professor, Dr. Jordan Miller, and a lab technician, Dr. Bagrat Grigoryan, to develop the ability to manufacture human organs using bioprinting. In 2021, 3D Systems acquired Volumetric and announced plans to establish world-class research capability in Houston to accelerate the development and commercialization of human tissues with blood vessels and bio-printed constructs for non-organ applications.
- ▶ **PROCYRION** is a medical device company developed through Fannin Innovation Studio. They are commercializing a mechanical circulatory support device designed by the Texas Heart Institute to treat heart failure patients too sick for medication alone. The company has an established team and received support from venture capital at the C level, and they plan to stay in Houston.



The Life Sciences Ecosystem

Key factors for any life sciences ecosystem are talent, capital, and infrastructure. It also helps to be in a thriving and livable environment with business-friendly policies, like Texas. Houston has an additional attribute that is unique and difficult to replicate: The largest, most concentrated, and most diverse patient population in the country for research, clinical trials, and data analysis.

Big players such as Abbott, Bayer, Merck, Alanza, and Novartis already have a strong local presence. Scalable Health Labs at Rice University is one example of interdisciplinary research, as researchers are engineering sensors for different physical and mental health conditions. This also represents an example of health care technology integration. Life sciences and health care have led local venture capital funding in four of the last five years and accounted for 26 percent of all VC funding here in 2021.



TALENT

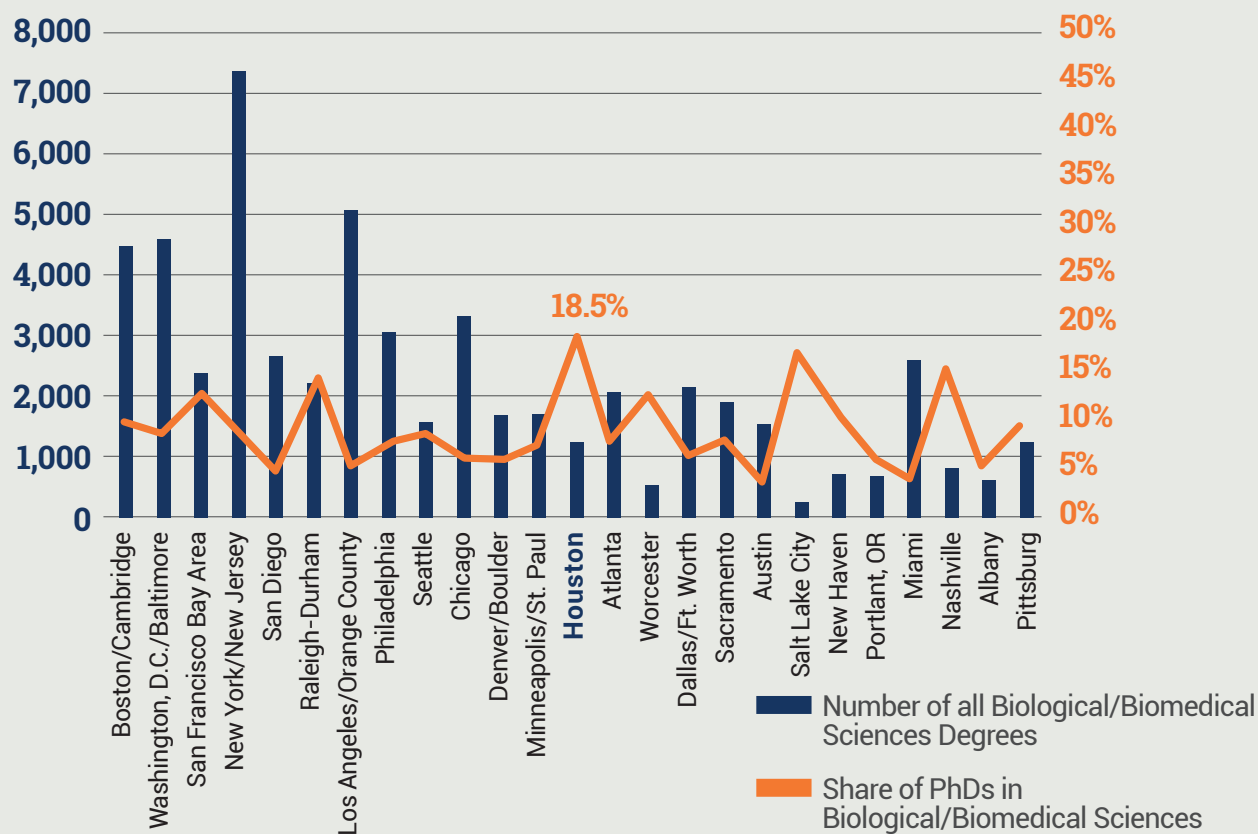
A 2022 report by commercial real estate firm CBRE listed Houston as one of the cities with significant pockets of life sciences talent, spanning from C-suite to lab tech and world-class researchers.



“We should think about life science innovation in terms of creating a sustainable ecosystem. Where are people located, where are populations growing, and where is talent growing? Houston and Texas are growing. Our population is disproportionately young, educated, and diverse.”

— JR Reale, Executive In Residence, TMC Innovation

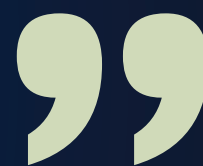
PhDs as Share of Biological/Biomedical Sciences Degrees in 2022



Source: U.S. Dept. of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System

“In this role at CTMC, people are working with patient samples. Therefore, there is no room for failure . . . and there is a huge lag between the start date of an employee and when they can assist in manufacturing because of training.”

— Dr. Jason Bock, CEO of CTMC



RESEARCHERS: The Houston MSA produces the largest concentration of PhDs among biological and biomedical sciences degrees in the nation, at 18.5 percent. In addition, all 41 hospitals in the Texas Medical Center are teaching and research institutions that provide unparalleled training opportunities for academic scientists. This research and innovation talent pool dates to the first successful heart transplant in 1968 at Baylor College of Medicine. The thousands of PhDs we graduate each year are often recruited away from Houston to areas with more non-academic opportunities. We will be able to retain this talent by providing more hands-on training opportunities in Houston.

CEOs: Participants in our roundtable drew a distinction between early-stage and late-stage biotech companies when it comes to leadership and venture capital.

Initial stages benefit from angel investors and leadership to support the researchers who discover innovative solutions. Researchers are typically not trained to run companies and may work to form and launch a biotech company with an accelerator program or a less experienced CEO to navigate a pre-clinical phase. As a product moves from clinical trials to commercialization, it is often acquired or financed by later-stage venture capitalists who, in turn, recruit more experienced executive leaders.

Houston is building its bench of CEOs. Dr. Atul Varadhachary, managing partner at Fannin Innovation Studio, described this as a buy vs. build decision. We “buy” more experienced talent by

attracting them to Houston which is possible with later-stage, well-funded companies. Experienced CEOs are unlikely to relocate for early-stage companies, so we need to also “build” local talent to lead these startups. Fannin’s internship and fellowship programs help grow the next generation of early-stage CEOs. As a further benefit, locally grown CEOs with roots in Texas are more likely to stay here.

REGULATORY EXPERTISE is crucial to navigate from development to commercialization, aiding with the FDA approval process. Products may take years to get to market, however. And as most companies only have one or few products moving through the process, it may be five years since an executive worked with the FDA. In an evolving landscape, it is important to keep in constant touch with regulatory agencies.

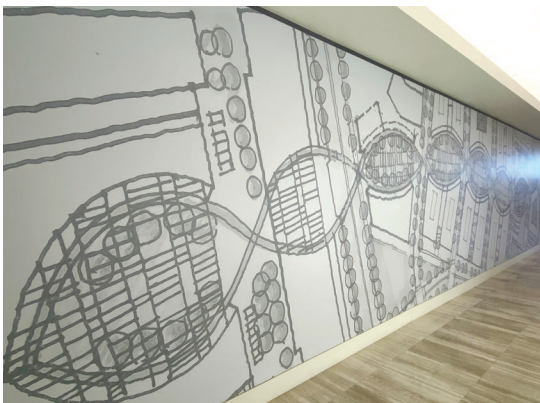
BIOTECH PRODUCTION AND MANUFACTURING require a specialized skill set. Currently, most line workers have a minimum of a bachelor’s degree in a STEM field as well as training from a biotech company. No national standard or unified effort exists for these fast-evolving life sciences positions. TMC is building a training facility for life sciences production lines, which will be an asset for attracting life sciences manufacturing. Houston’s community colleges (San Jacinto - Generation Park, Houston Community College, and Lone Star) are in conversation on bio-manufacturing training. With these current and developing assets, Houston has a strong talent pool and business environment for life sciences manufacturing.



INFRASTRUCTURE

Houston is experiencing a life sciences real estate boom. Multiple major life sciences and innovation developments are underway in and around the Texas Medical Center. Examples follow:

HELIX PARK (FORMERLY TMC3)



- ▶ Phase 1 completed, 2023
- ▶ 950,000 sq. ft. of research space on a 37-acre campus
- ▶ TMC partnered with University of Texas MD Anderson Cancer Center, Texas A&M University Health Sciences Center, and the University of Texas Health Science Center at Houston
- ▶ Projected \$5.4 billion annual state impact
- ▶ 23,000 permanent new Harris County jobs representing virtually all industries, pay scales, tax levels, and educational backgrounds, and 19,000 construction jobs.

This life-sciences-focused mixed-use campus, when fully built out, will include 6 million square feet of development centered around a series of parks in the shape of a double helix. Tatianna Yale, chief investment and planning officer for Texas Medical Center, said all the collaborative building space and half of the industry research building is already leased. Helix Park will provide an environment for innovators from health care, science, academia, government, and industry to collaborate on new medicines, medical devices, diagnostic and digital health platforms, and treatment solutions. This includes a health-tech accelerator, lab space, and biodesign programs for TMC created startups.

TMC BIOPORT

- ▶ Completion TBD (in negotiations for land purchase)
- ▶ 500-acre biomanufacturing and medical supplies distribution center
- ▶ Master plan design by Elkus Manfredi Architects

TMC BioPort is projected to bring 100,000 jobs to the region in manufacturing and distribution for such things as cell and gene therapies, pharmaceuticals, and medical supplies. This project is part of a strategy to reduce the dependence on overseas manufacturing. Covid-19 highlighted the risk of this dependency for personal protective equipment and critical supplies at the largest medical center in the world. The new campus will enable local manufacturing of pharmaceuticals and medical devices developed by scientists in Houston's academic institutions and Texas Medical Center. The campus will also include a workforce training center to provide jobs for students coming out of high school.

“Leveraging the unmatched scale of the Texas Medical Center, these new moon-shot investments are building a launchpad to rocket Space City into a new era as a global hub for scientific and human progress.”

– Scott Carter, Senior Vice President, Life Sciences & Healthcare at CBRE in Houston¹¹⁹

“Houston is already fortunate to have such a strong health care and higher education ecosystem. The TMC3 project stands to be the cornerstone of our regional life sciences strategy. It will create new jobs, advance innovative medical technologies and health care solutions,” said Mayor Sylvester Turner. “In addition, the TMC3 Helix Park will create a place for the community to gather and continue to expand our amazing park system. Houston will be among the most competitive cities in the country for life sciences businesses.”

LEVIT GREEN LIFE SCIENCES CAMPUS

- Phase 1 completed, fourth quarter, 2022
- 290,000 sq. ft. of purpose-built lab and office space
- Hines partnered with 2ML Real Estate and Harrison Street

The first phase of the 53-acre Levit Green life sciences campus is set to be finished by year's end and at build-out will encompass roughly 4 million square feet of development on a site between Hermann Park and Texas 288. The initial five-story building will overlook a plaza and a manufactured lake and include lab incubator space for entrepreneurs and early-stage life sciences companies.

THE ION INNOVATION HUB

- Opened in May 2022
- 266,000 sq. ft. of collaborative space
- Rice University Management Group

The Ion anchors a 16-acre innovation district focused on collaborations among entrepreneurs, incubators, accelerators, corporations, academics, and the Houston community. The former Sears building accommodates multiple uses, including office space, shared workspace, prototyping and maker resources, restaurants, and indoor/outdoor communal areas. Houston Methodist recently announced plans to locate a center for health care innovation in the Ion.

TEXAS A&M INNOVATION PLAZA

- Completion, Early 2024
- Up to 485,000 sq. ft. of life sciences and office space
- Texas A&M University partnered with Medistar Corp. and Healthcare Trust of America

Innovation Plaza, in TMC, is centered around a common green space and will include three towers: EnMed Tower, an academic building anchored by the university's engineering-medicine program; Life Tower, student housing building; and the 30-story Horizon Tower with 17 floors of life sciences, dry and wet labs, and office space.

GENERATION PARK BIOMANUFACTURING FACILITY

- Open
- 63,350 square foot facility
- A collaborative project led by McCord Development

Generation Park is a 4,200-acre multi-use development providing a hub for life sciences companies pursuing pharmaceutical innovation and manufacturing, clinical care, and genetic therapy development. The GMP Biopharma Manufacturing Facility at Generation Park is designed for contract manufacturing and end-user requirements for all development phases. The facility is next door to a future biomanufacturing workforce institute offering the gold standard of training for the biopharma manufacturing industry.



CAPITAL

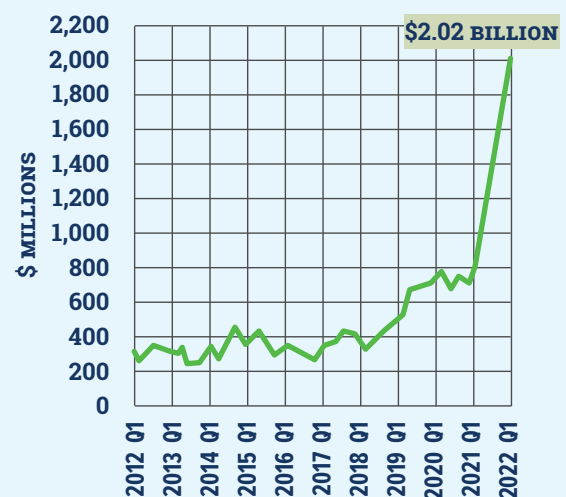
Public and private funding is driving rapid growth in Houston's life sciences sector.

Public and private funding is driving rapid growth in Houston's life sciences sector. Support and investment have increased with government emphasis on the life sciences industry's pivotal role in combating the Covid-19 pandemic, onshoring trends, and rapid expansion of biomanufacturing. Houston captured more than half of the \$870 million in grant money awarded to Texas by the National Institutes of Health in 2021. The Texas Enterprise Fund has awarded over \$118 million to life sciences companies since 2004 to attract new businesses to the state according to Texas Healthcare & Bioscience Institute. Tax and incentive programs should be reviewed to ensure Texas and Houston are cost competitive.

Houston companies raised a record high \$2.02 billion in 2021, nearly tripling 2020 venture capital (VC) funding over the prior year based on analysis of Pitchbook data. That gives Houston one of the fastest-growing pipelines in the nation for VC funding in life sciences. CBRE reports that VC funding in the sector rose 937 percent in the past five years.

On an industry basis, health care raised \$518.4 million in VC funding in the four quarters ending in the fourth quarter of 2021, up 65 percent from the prior period.

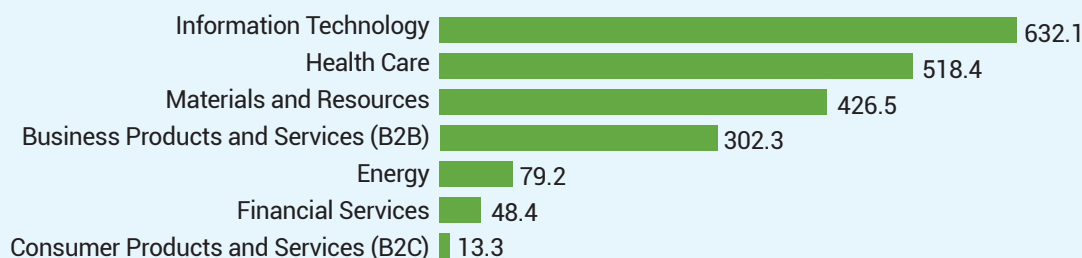
Houston Venture Capital Funding (4-Quarter Total)



Note: Funding includes all Venture Capital types (Angel & Seed, Early Stage, Later Stage)/

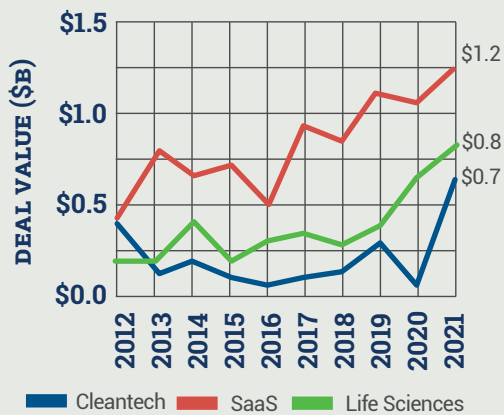
Source: Greater Houston Partnership analysis of PitchBook data through fourth quarter of 2021

Houston VC Funding by Industry, \$ millions 2021 (4-quarter total)

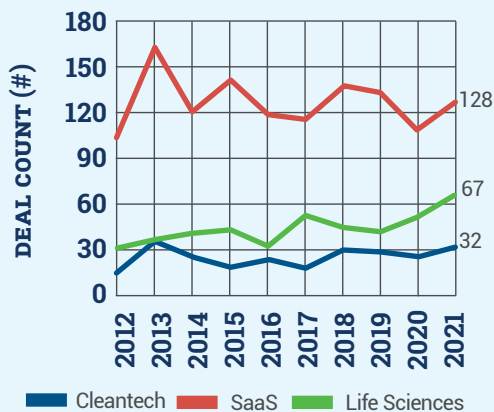


Source: Greater Houston Partnership analysis of PitchBook data

Houston CleanTech and Life Sciences reach new highs



Houston All Key Verticals Score Gains in Deal Count



Source: Texas Venture Capital Ecosystem Review analysis of Pitchbook data

Participants in our technology and life sciences roundtable discussed priorities for venture capital funding.

- ▶ Investors select investments by **management teams**, not just research or products. Amazing research and ideas cannot get to market without the right management team. In turn, the best executives can find strong research and products.
- ▶ Investment growth and sustainability require a **virtuous cycle**, in which money is made and then reinvested back into Houston life sciences companies.
- ▶ It is critical to **match life sciences companies** (pre-clinical, clinical, commercialization, growth) **with the right type of venture capital investors** (seed funding, early stage, late stage, and growth capital).
- ▶ Investors can **add more value than just funding**, from expertise to velocity and problem-solving.
- ▶ **A portfolio fund** of Houston life sciences companies would allow investors to see more consistent value, as science can have a long, high-risk investment period.
- ▶ **Matching private funds invested in Houston with public funds** like the Cancer Prevention and Research Institute of Texas (CPRIT) model would leverage Houston capital which can bring executives and people to Houston.



PATIENTS

Houston has one additional attribute that no other life sciences hub can match – our density and diversity of patients.

2020 Census data shows that Houston is the most diverse city in the nation. Texas is growing at a faster rate than the U.S., and Houston's population is more educated than many other U.S. cities. The **TMC offers a dense and diverse patient population that is a benefit for patient trials, research, and data analysis**. Cities worldwide are trending in this same demographic direction, meaning Houston is the city of the future. This makes Houston attractive to both domestic and international companies.



QUALITY OF LIFE

Houston ranks No. 1 in the nation for life sciences wages relative to the cost of living by CBRE, making it more attractive for life sciences professionals to enjoy a high quality of life.

Census data from 2020 shows that Houston is a destination of choice. Our city is projected to lead the nation in population growth over the next five years according to the Texas Demographic Center. This will strengthen the appeal of its labor market. Teleport lists Houston among the top cities given its “high ratings in startups, health care, and leisure and culture.”¹²⁰

INTERNATIONAL OPPORTUNITIES

International life sciences companies are attracted to Houston as an easy access point into the U.S. market with business-friendly policies and a robust international transportation infrastructure. CPRIT relocation grants have been successful in recruiting both domestic and international companies to Houston. International companies see Houston as an attractive location for both sales and manufacturing. Tracey Davies, chief strategic initiatives and intellectual property officer at CPRIT, has seen a lot of success with international companies coming to Texas.

TMC Innovation has been working to strengthen international relationships over the past 10 years. TMC’s BioBridge program facilitates the exchange of ideas and research at a global scale to better the patient experience and provide groundbreaking solutions for complex health care problems. It now has four BioBridges partners: Australia, UK, Denmark, and Ireland. The aim is to attract startups that are ready to enter the U.S. market using Houston as an entry point. TMC supports these companies via venture funding and boot camp participation. In return, Houston gains talent and creative thinking. TMC brings the best and brightest companies to Houston where they can scale and add to our life sciences ecosystem. TMC intends to work with 40-50 international companies per year. Currently, half of TMC Innovation’s companies are international.

LIFE SCIENCES CONCLUSIONS AND RECOMMENDATIONS

The life sciences industry is transforming health care at record speed, and Houston has the talent, institutions, and spirit of collaboration to play a critical role in this sector. Our region is making substantial investments in infrastructure and talent development, key steps for a thriving industry.

To capitalize on this momentum, we recommend a continued focus on talent development, cohesive marketing of Houston’s strengths, and a review of tax and incentive programs. We also see an opportunity in local early-stage investment cultivation. We can engage a range of colleges across our 13-county region to develop degree programs and certifications sought by life sciences companies. And we can deepen our bench of biotech angel investors, including drawing energy investors into the fold. A more aggressive marketing and recruiting campaign for talent and companies could be modeled on other life sciences hubs. Houston has an exceptional story that is ready to be told.



“We do find in talking with international companies ... their commitment is to effort-based operations in North America and in Texas.”

– Tracey Davies, Chief Strategic Initiatives and Intellectual Property Officer, CPRIT

SPOTLIGHT: CTMC

A JOINT VENTURE BETWEEN RESILIENCE AND MD ANDERSON CANCER CENTER

CTMC+

Cell Therapy is a technique used to reengineer the human body's immune cells to fight cancer. One type of immunotherapy, chimeric antigen receptor (CAR) T-cell therapy, was successful in curing Emily Whitehead of Pennsylvania of cancer in a 2012 clinical trial.¹²¹ This treatment requires just one infusion of these engineered immune cells, compared to other therapies for cancer, such as chemotherapy that require a longer course.¹²² Since then, this therapy has evolved to become a commercially available treatment option.¹²³ Currently, six CAR T-cell therapies are approved by the FDA and over 1000 patients in the United States have received CAR T-cell therapies.¹²⁴

CTMC is a joint venture between National Resilience, Inc. and MD Anderson Cancer Center to accelerate cell therapies reaching patients. CTMC's proximity to the clinical expertise and patient volumes at MD Anderson and other TMC institutions is crucial for both patient blood collection as a starting point for the cell therapy and for product infusion. This is also helpful for enrolling patients in clinical trials. The MD Anderson partnership allows for access to decades worth of research data and assistance in the FDA approval process. Shaving off weeks from this detailed process saves valuable funds and enables products to reach patients quickly.

CTMC is currently supporting the development of more than 10 therapeutics invented at MD Anderson and biotech partners. The partnership with Resilience provides cutting-edge, robust manufacturing technology and a commercial manufacturing network that CTMC partners can use following successful clinical trials.

Dr. Jason Bock, CEO of CTMC, said the company is unique because it creates “an adjacency between the patient, clinic, and manufacturer, which is a catalyst for Houston biotechnology.”



Top: Dr. Jason Bock, CEO of CTMC

Middle: One of CTMC's Research Facilities

Bottom: Experimental Set-Up for Cell Therapy

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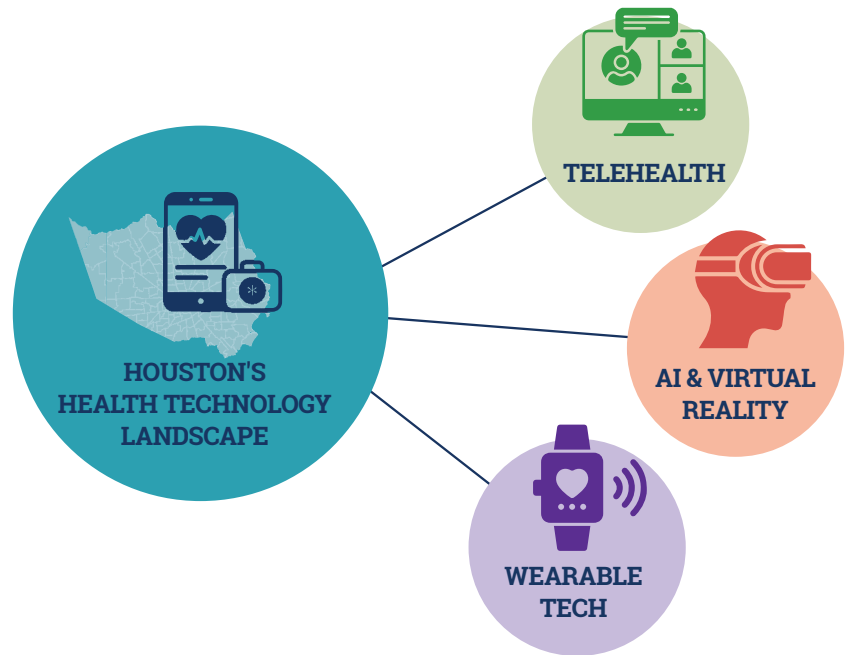
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HOUSTON'S HEALTH TECHNOLOGY ADOPTION



Interest in and adoption of advanced health technology has increased in the past two years. Here we discuss trends, opportunities, and concerns across virtual/telehealth, artificial intelligence, wearable technology, and home health care.

KEY UPDATES IN TELEHEALTH:

- ▶ During the pandemic, more people used telehealth. Rates have since fallen but are still higher than pre-pandemic.
- ▶ Telehealth offers more access to health care in rural communities lacking doctors and hospitals as well as patients with mobility issues.
- ▶ Texas lawmakers passed legislation expanding access to telehealth, be it audio-only or video.
- ▶ Health care doctors should be trained specifically on how to best use telehealth. Locally, the Michael E. DeBakey VA Medical Center is teaching health care professionals best practices for telehealth.

SPOTLIGHT: FANNIN INNOVATION STUDIO

BRIDGING THE GAP BETWEEN ACADEMIA AND COMMERCIALIZATION

Fannin Innovation Studio (Fannin) aims “to build successful life sciences startups while helping to catalyze the formation of a thriving and sustainable life sciences entrepreneurship ecosystem in Houston,” according to its mission statement. Fannin has created a broad pipeline of product development programs. They advance this pipeline both internally and through Fannin-founded entities with a combination of investor and grant funding. Fannin’s “pooled management team” approach evolved to address the biotech development gap in places, like Houston, which have a powerful research engine but lack the critical mass of commercialization expertise. By leveraging one management team across multiple product development projects, they make efficient use of talent, spread the risk of any one project failing, and provide more learning opportunities to interns and fellows. Since its inception, Fannin has brought in 35 programs, of which 15 are active. And Fannin has had over \$160 million invested across their programs.

The for-profit entity, which commercializes therapeutics and medical devices, is looking beyond individual product success. Fannin Innovation Studio is working to develop Houston’s life sciences ecosystem by helping to create a new generation of biotech entrepreneurs. Becoming a successful product developer requires experiential learning, which Fannin provides through their internship and fellowship programs. Interns, who work part-time for a few months, are typically from local institutions. In contrast, the Entrepreneur Fellowship is a two-year full-time program, with applicants from across the country. This apprenticeship program is in high demand and can accept only about 10 percent of its internship and fellowship applicants.

Fannin’s interns and fellows work directly on product development with programs within the Studio or in its spun-out companies and get a broad range of experience including in R&D, diligence, intellectual property, regulatory processes, grant writing, and business development. This gives scientists and engineers who aspire to be entrepreneurs some hands-on experience in the early-stage product development required to successfully move innovation towards the market.

Dr. Abria Magee, program manager for Product Development Research with CPRIT, is an example of local science talent who had trouble finding a position that provided fellowship training she needed to stay in Houston and in her own field. She said, “postdoc fellowship programs like the one offered at Fannin Innovation Studio are really important for enabling STEM graduates and PhDs who want to live in Houston and work in industry to make that transition and stay in this great city.”

Fannin launched its internship program in 2012 and its fellowship program in 2014, and has graduated 285 fellows and interns, including many who have gone on to roles at local biotech, venture capital firms, and institutions.



SPOTLIGHT: CANCER PREVENTION AND RESEARCH INSTITUTE OF TEXAS (CPRIT) AND ADVANCE RESEARCH PROJECTS AGENCY FOR HEALTH (ARPA-H):

The Cancer Prevention and Research Institute of Texas (CPRIT) is a state agency established in 2007 to fund cancer prevention, research, and product development, and to support a thriving life sciences industry in the state. Texas voters overwhelmingly approved constitutional amendments in 2007 and again in 2019 to create what is now a \$6 billion Texas fight against cancer. CPRIT, which recently passed the \$3 billion mark in investments, is now the largest public funder of cancer research of all the states, and the second largest in the world.

CPRIT funding is having a substantial effect in advancing cancer fighting drugs and therapies. Statewide, CPRIT funding has created over 9,200 permanent jobs in Texas in 2021 and led to \$55.4 million in annual state and local tax collection.¹²⁵

Houston-area life sciences and health care sectors have seen big benefits from CPRIT-funded initiatives and research, which have helped expand our life sciences infrastructure. More than \$1.2 billion in research grants have been awarded to research entities in the Houston area, bringing more than 143 researchers and their labs here. Twenty-eight companies in the Houston area have been awarded CPRIT grants, with 12 of them relocating from other states or countries.

In the Houston area alone, there are 117 clinical trials underway with 36,218 patients, all stemming from agency funding. Additionally, CPRIT funded over 51 cancer prevention projects delivering education and screening services in Harris County.

“CPRIT will continue to provide grant funds to promote merit-based, peer-reviewed cancer-related research, product development, and prevention of cancer through screenings and education,” said Tracey Davies,

chief strategic initiatives and intellectual property officer at CPRIT. “Within cancer projects, the agency also looks for opportunities that have the added benefit of helping grow the broader life sciences industry in Texas.”

Houston is already a center for the state’s life sciences industry, and it can do more if it partners with other areas of the state. That includes military-focused health care operations in San Antonio and UT Southwestern Medical Center in Dallas.

Texas stands to reap gains as a life sciences hub if it lands the headquarters of the federal Advanced Research Projects Agency for Health (ARPA-H). The Biden Administration, in April 2021, announced the launch of ARPA-H to support transformative high-risk, high-reward research to drive biomedical and health breakthroughs that would provide transformative solutions for all patients.

Texas – and Houston – are making the case to be the headquarters for the new federal agency, through a statewide coalition, the Coalition for Health Advancement and Research in Texas (CHART). CPRIT is part of the group.

As CHART says, there are many reasons why Texas is the best place for the agency to be based: leading expertise in public-private partnerships to advance innovative research; density and diversity of patients; military medical expertise in San Antonio; two of the country’s four most specialized biosafety labs; number and quality of PhDs and scientists; and more.

“ARPA-H is an agency to serve the entire country, and Texas is the best and most convenient, platform, with demonstrated experience and success in similar initiatives, from which ARPA-H can achieve its promise,” said Davies.

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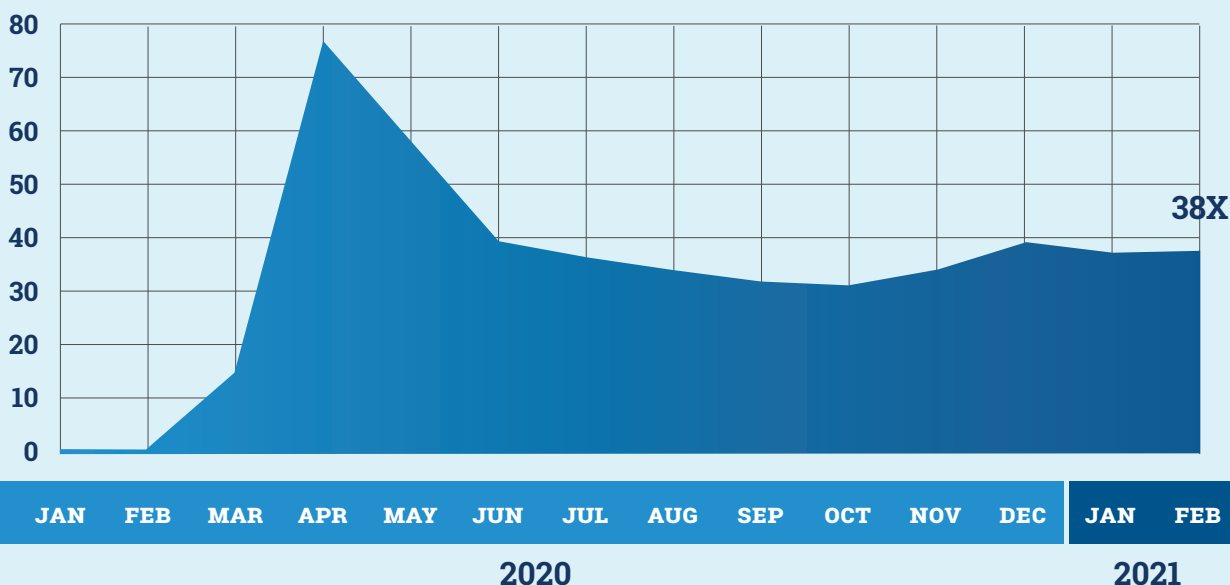
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Growth in telehealth usage peaked in April 2020 but has since stabilized.

U.S. Telehealth Claims Volumes, Compared to Pre-Covid 19 Levels (February 2020 - 2021)



Includes cardiology, dental/oral, dermatology, endocrinology, ENT medicine, gastroenterology, general medicine, general surgery, gynecology, hematology, infectious diseases, neonatal, nephrology, neurological medicine, neurosurgery, oncology, ophthalmology, orthopedic surgery, poisoning/drug tox./com. of TX, emergency department, hospital inpatient, and psychiatry inpatient claims; excludes certain low-volume specialties. Source: Compiled database; McKinsey analysis.

Source: <https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality>

TELEHEALTH USAGE TRENDS

Congress, the administration, private insurers, and health care providers responded to Covid-19 by increasing flexibility in regulations and reimbursement requirements for the temporary use of telehealth for medical and mental health care. Telehealth was quickly adopted for medical appointments, with levels rising to 78 times higher than before the pandemic.¹²⁶ Insurance companies and Centers for Medicare and Medicaid Services increased reimbursement for telehealth visits. Previously, they only covered certain behavioral health or primary care visits.¹²⁷

In Texas, lawmakers expanded Medicaid telehealth coverage to include audio-only visits, instead of just video-enabled visits. Additionally, legislation ordered managed care organizations to reimburse telemedicine visits.¹²⁸

By July 2020, some health care providers found telemedicine more effective than they expected for a range of services including new patient visits, exams, follow-up visits, and pre- and post-surgical consultations.

Telehealth quickly gained favor.¹²⁹ In Texas, 39 percent of people used telehealth to communicate with their health care providers.¹³⁰

In 2021, as the Covid-19 landscape shifted with the availability of vaccines and drugs, the rate of telehealth use shifted, with telemedicine visits being reduced from 78 times above pre-pandemic levels to 38 times pre-pandemic levels.¹²⁶

Limits to care across state lines are returning now that many states are ending their emergency declarations. A recent report by the Associated Press described issues caused by the patchwork of legislation across the country including lost access for follow up care and reduced access for people in communities without local specialists and mental health professionals.¹³¹ The Texas legislature is expected to consider multiple bills related to telehealth in the next session.

Continued on page 64

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130. Sim, S.-C., Marks, E., Sutton, J., Ben-Porath, E., & Evans-Pigford, A. (2020, October). *Texas' Views on the COVID-19 Pandemic*. Episcopal Health Foundation.

131. Alonoso-Zaldivar, R. (2022, April 13). *Bipartisan push on mental health crisis that COVID worsened*. AP NEWS.

Patients are more likely to use telehealth over in-person visits if they can be seen faster by a health care provider for specialties like behavioral health, and virtual urgent care. Patients prefer in-person visits for primary or specialty physician appointments and pre- and post-surgery visits, even if it means waiting longer for an appointment.¹³²

Medical professionals we spoke to agreed telehealth is a useful tool that was especially important for providing care during the pandemic's early months. Many also expressed concerns about the overuse and improper use of telehealth. Physicians are finding telehealth less effective than in-person visits for certain new patient visits and pre-surgery visits.¹³³ Some also question whether all communities would have access to benefit equally from telehealth. And they cite a need for proper training for medical providers on effectively caring for patients over telehealth. Participants in the Center's roundtable conversation agreed that this should be added to the curriculum of medical schools.

The Michael E. DeBakey VA Medical Center offered telehealth options before Covid-19 and has developed training and standards that could be applied broadly. They have found telehealth to be most beneficial to women's mental health. The Michael E. DeBakey VA Medical Center has also successfully led efforts to integrate mental health treatment into overall care by offering telehealth options during medical visits. Much can be learned from the VA because they have a single payer and a single data source for patients, enabling comprehensive studies as innovations are applied.

WHAT DOES THE FUTURE HOLD?

While telehealth seems here to stay in mainstream use, overall adoption may keep falling. When asked by McKinsey and Company in February of this year, physicians predicted that by the start of 2023, telehealth will represent less than 33 percent of their visits, with 29 percent of physicians expecting to return to only in-person care.¹³³ Some patients see it differently. Asked in July 2021, 40 percent of patients surveyed by McKinsey and Company said they planned to use telehealth for future visits.¹³⁴ Interesting blends of in-person and virtual visits are being explored including virtual physician-aided visits at close-to-home urgent care sites or during in-home appointments with home health aides.

Telehealth appears to offer financial savings in addition to convenience. The Agency of Healthcare Research and Quality determined that telehealth reduces health care expenditures. Telehealth visits are 27 percent the cost of physically seeing a primary care provider and 2 percent the cost of a visit to the emergency room.¹³⁵



“The more we can do to bring the 21st century to rural and underserved communities, the better chance we have at closing the social and economic gap that has widened due to lack of reliable, high-speed internet.”

— Representative Trent Ashby, District 57



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TELEHEALTH DISPARITIES AND BARRIERS

Telehealth adoption has not been universal. Nationwide, those with incomes under \$50,000 or who are uninsured, along with Blacks, Latino or Asian Americans, were less likely to use telemedicine.¹³⁶ Some would-be users do not have home internet or electronic devices. Others find it difficult to communicate with their health care providers over video or phone. And some report privacy concerns. Populations with lower income, over age 65, or in rural areas were less likely to have adequate internet connections.¹³⁷ In 2021, Texas lawmakers passed legislation to expand broadband coverage to all areas of the state.¹³⁸ This could help increase telehealth adoption in currently underserved populations.

OTHER CONCERNS

Other concerns raised by experts include adequate protection of and cybersecurity for health information and the need for proper training, dubbed by Deloitte as “web-side training.”¹³⁴ Some medical professionals, including those in Houston, already have access to training to teach them how to communicate, maintain trust and convey empathy in a virtual environment. A national survey by Deloitte shows that such training, while not yet common, is picking up steam. Training is also available in keeping health information protected as required by federal law.¹³⁹

In one of our roundtables, experts noted that medical schools are not universally teaching telehealth practices. They should, because as Dr. Augusto Sepulveda, associate chief medical officer for HCA Healthcare Gulf Coast Division, noted, it is important that “providers know how to treat patients virtually when the human face-to-face connection is lost.” Locally, Baylor College of Medicine and its affiliate DeBakey Veterans Affairs Medical Center are instructing students about telehealth.

In summary, telehealth is likely here to stay. Steps are already being taken to reduce barriers and improve access for those who want it. To ensure that telemedicine best benefits patients and doctors, training and other action is still required.

ARTIFICIAL INTELLIGENCE AND VIRTUAL REALITY

Digital and other advanced technologies, such as artificial intelligence (AI) and virtual reality (VR) have the chance to do everything from improving a patient’s telemedicine experience to aiding in medical diagnoses. AppliedVR may be able to help with pain management. Using special headsets and software, patients are immersed in a virtual environment. The goal is to shift attention patterns, which, in turn, can alter how pain is processed.¹⁴⁰

Locally, Houston Methodist anticipated that patients would have questions about Covid-19 vaccines once they were introduced but did not have staff to field the calls. The hospital used AI phone automation, Syllable, to help answer questions and schedule appointments. Medical staff focused on answering other patient-specific questions. During the first month of 2021, Methodist found that as vaccines became more widely available, an estimated 91 percent of related calls – which could number in the thousands a day - were handled by the Syllable Voice Assistant. The hospital expects to expand use of this technology.¹⁴¹

Methodist also turned one wing of its hospital into its Technology Hub to design and showcase new digital health technology. There, the hospital is testing the use of natural language processing to input patient information into electronic medical records as physicians talk to patients. The hope is it will let doctors spend more time with patients, reduce their administrative workloads, and help curb burnout.¹⁴² As reflected in a survey conducted by Deloitte in 2021, health care executives and doctors expect to more widely adopt AI and related tools. We expect the same in Houston.

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138. Messer, J., & Conine, S. (n.d.). *HOUSE BILL 5, EXPANDING BROADBAND SERVICE, SIGNED BY GOVERNOR ABBOTT*.

139. Fera, B. (n.d.). *Virtual health accelerated*. Deloitte Insights. Retrieved August 26, 2022

140. AppliedVR. (n.d.). *Why Therapeutic VR?* AppliedVR. Retrieved August 26, 2022

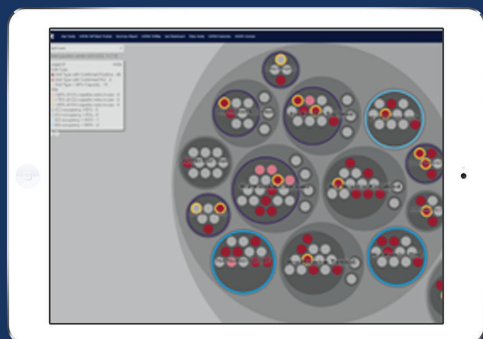
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SPOTLIGHT: HCA HEALTHCARE'S NEXT-GEN ANALYTICS TREATMENT (NATE)

In Center for Houston's Future's 2020 report, we highlighted HCA Healthcare's Sepsis Prediction and Optimization Therapy, or SPOT, an AI algorithm used to identify, treat, and reduce sepsis infections. Out of SPOT, HCA created Next-Gen Analytics Treatment (NATE), a web application that aggregates clinical data to provide a real-time view of a hospital and its units and patients. This technology was quickly adopted by 185 hospitals at the start of the pandemic, according to Tyler Forehand, senior director of data science products at HCA Healthcare's headquarters in Nashville. This enabled hospitals to track and manage fast-changing patient needs. A Covid-19 application was rapidly created to track which units had Covid-19 positive patients to ensure they were isolated from other patients.

The following image shows the web application in use in Houston. The key shows units with COVID-positive patients as well as those on ventilators.



NATE ARDS provides clinical teams with improved access to clinical information and proven protocols for patients with acute respiratory distress syndrome.

“For patients with similar lung injury at the time of ventilation, the introduction of NATE ARDS resulted in greater adherence to best practice protocols, in turn resulting in decreased mortality and shorter length of stay on ventilators,” said Dr. Jonathan Perlin, HCA Healthcare's chief medical officer and president of clinical operations.

As of April 2021, more than 70,000 HCA medical professionals were using NATE.¹⁴³ With the NATE platform, applications can quickly be developed to track parameters as needed. Samantha Coleman, HCA Houston Healthcare's vice president of nursing informatics, stressed NATE's flexibility.

“Our data analytics and engineering department helped us gain near real-time, situational awareness of our hospital's care opportunities during the pandemic. The applications developed for Covid-19 and Acute Respiratory Distress Syndrome (ARDS) in the Next-Generation Analytics for Treatment & Efficiency (NATE) platform... saved our colleagues countless hours in prioritizing clinical needs.”

—Dr. Mujtaba Ali-Khan, Division Chief Medical Officer,
HCA Healthcare Gulf Coast Division

SPOTLIGHT: GREATER HOUSTON HEALTH CONNECT

The Greater Houston HealthConnect, GHHC, was created in 2012 out of a Center of Houston's Future collaboration with the City of Houston and the Harris County Healthcare Alliance. The independent nonprofit connects electronic health records systems of separate health care providers. HealthConnect is accessible at more than 1,250 hospitals and clinics and serves more than 15 million patients.¹⁴⁴

During Covid-19, GHHC's health information exchange provided public health authorities with real-time data on the spread of the virus. GHHC aggregated data, including clinical information, demographics, and underlying conditions, for about 1 million patients. Doctors used the data to help manage the virus.

WEARABLE TECHNOLOGY

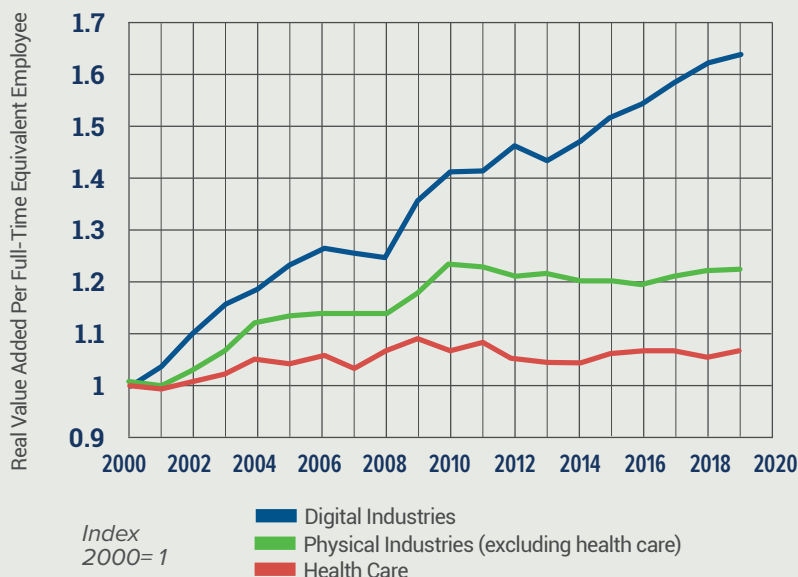
Wearable technology includes devices such as smart patches and smart watches. Smart patches typically deal with a specific issue, such as monitoring heart activity or controlling diabetes, while smart watches can be used for a range of functions, from tracking physical activity, Covid-19 symptoms, and heart rate. Deloitte predicts the number of people using smart watches and smart patches will continue to grow, with about 440 million devices in use by 2024.¹⁴⁵

This technology also helps doctors to monitor patients. Users, in some cases, can synchronize data from the devices to electronic health records that doctors can review. This technology does raise some concerns. Some doctors wonder if the data can be trusted, either because patients do not use the devices correctly or the devices themselves provide bad data.

According to a survey by Deloitte, many patients (60 percent) worry about how the devices store their health data.¹⁴⁶ Shane Chen, chief operating officer at HOPE Clinic in Houston, said during a Center for Houston's Future roundtable that she has seen several patients decline to use remote monitoring devices that track hypertension and diabetes due to data privacy and tracking worries.



U.S. Health Care Productivity: Giant Challenge and Opportunity



Productivity Levels for different industries, as calculated by Bret Swanson at the American Enterprise Institute

HEALTH TECHNOLOGY ADOPTION CONCLUSIONS

As we predicted in 2020, technology adoption has increased. It is difficult to quantify the resulting productivity gains that some experts believe have resulted. The American Enterprise Institute, a Washington think tank, promotes health technology adoption as a way to boost productivity. It concludes that sectors that aggressively and creatively leverage digital technologies outperform those that do not.¹⁴⁷

In sum, health technology adoption is increasing in our region, from telemedicine to AI to remote patient monitoring. Medical providers and patients alike report benefits and gains as well as a range of concerns. What is clear is that we can expect more exciting innovation to occur from the ground up in Houston.

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HEALTH CARE WORKFORCE SHORTAGE

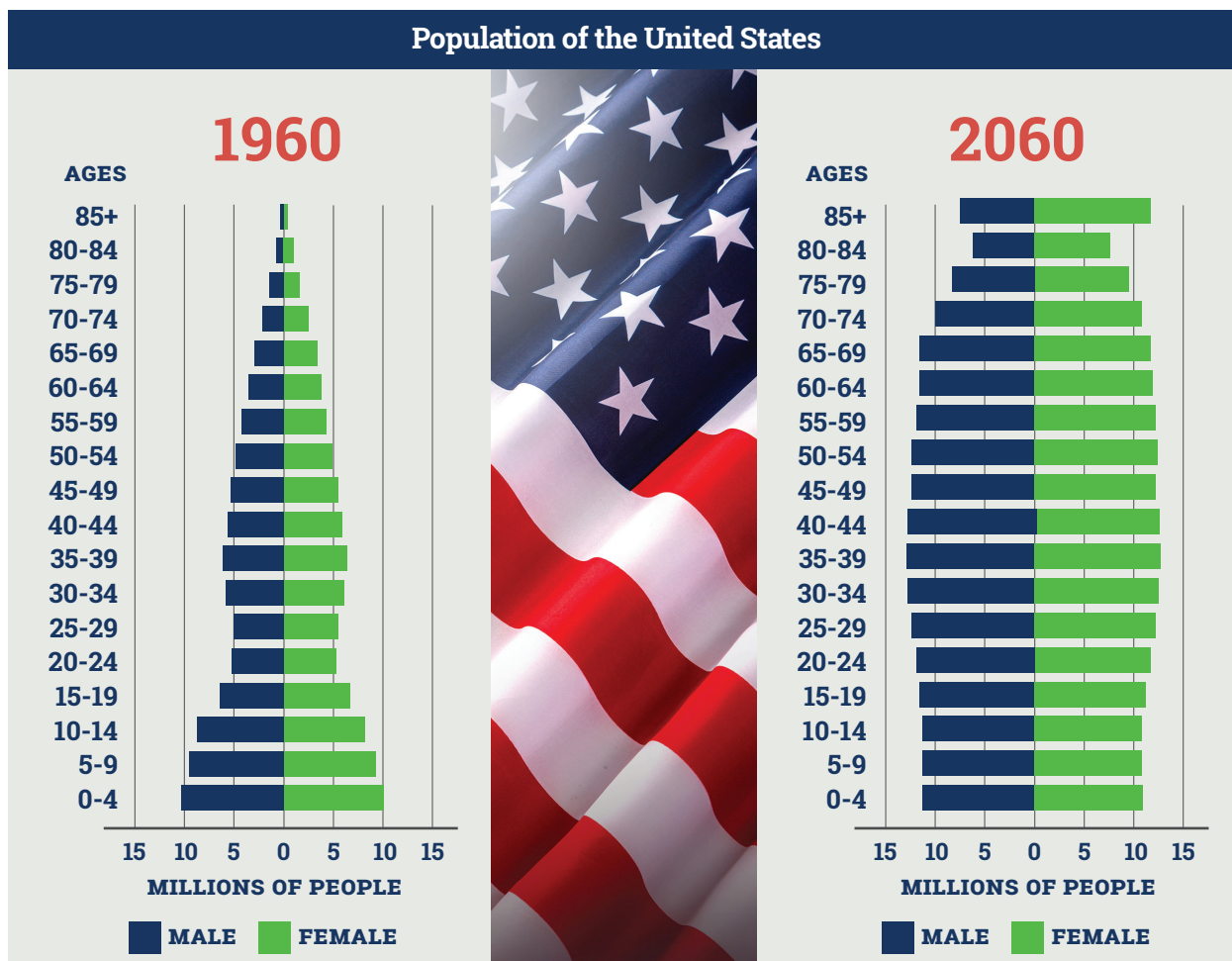
Three in 10 frontline health care workers reported considering no longer working in health care due to Covid-19.¹⁴⁸ Burnout-related resignations are clearly making the pre-pandemic workforce shortage worse.

Demand for health care is growing as the population in the U.S. becomes older and sicker with more chronic disease. As a result, the health care industry remains one of the fastest growing sectors in the U.S. Employment in health care is expected to grow by 16 percent from 2020 to 2030, according to the U.S. Bureau of Labor Statistics. This is well above the average 8 percent growth rate.¹⁴⁹ According to data from the Greater Houston Partnership, health care and social assistance employed an average of 376,089 people in Houston in 2020, accounting for almost one in eight Houston workers. The health care and social assistance

sector is forecast to be a principal growth area for the region.

This growth is primarily driven by an aging population as the entire baby boomer generation, people born between 1946 and 1964, will be over 65 by 2030. At an estimated 73 million people, this generation is the second largest age group, according to the 2020 Census.¹⁵⁰

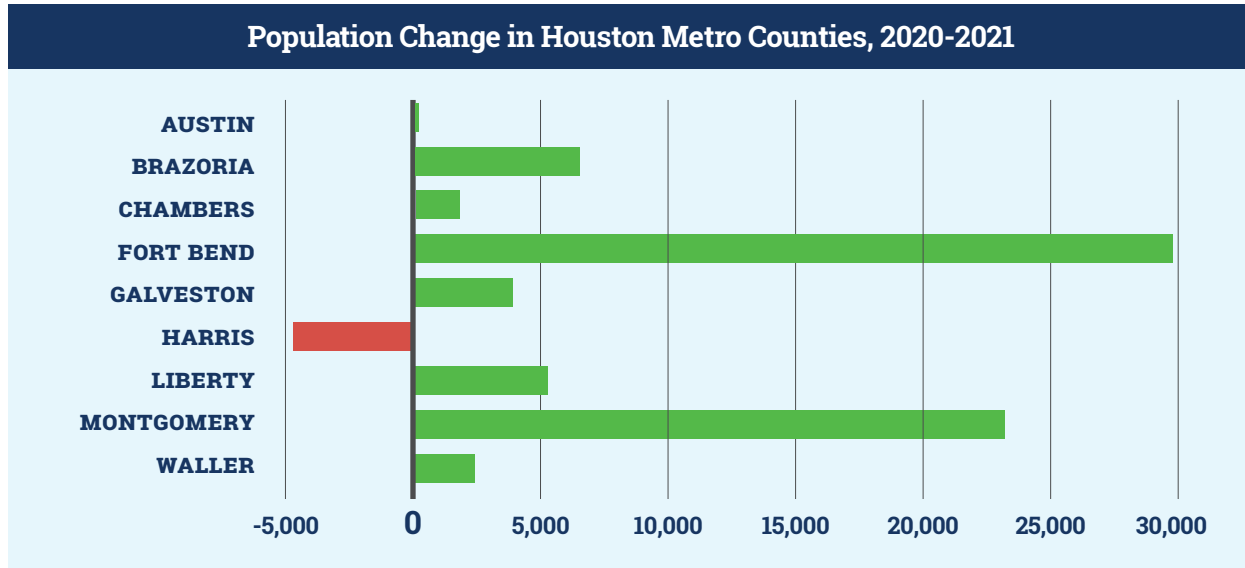
According to a 2021 report from the Greater Houston Partnership, Houston has 175,000 more residents aged 65 and older today than it did five years ago and based on the 2020 Census 11 percent of the Houston MSA is age 65 and over. According to data from the 2018 National Health Interview Survey, 51.8 percent of adults had at least one diagnosed chronic condition and 27.2 percent had multiple chronic conditions.¹⁵¹



Source: U.S. Census

SUBURBAN COUNTIES WILL EXPERIENCE GREATEST GROWTH

The population of the Houston Metropolitan Statistical Area has been growing since the 1960's and is currently at just over 7.2 million people, according to 2020 Census data. Suburban counties outside of Houston, such as Fort Bend County and Montgomery County, are expected to see most of the population growth. The senior population in Fort Bend, the county experiencing the largest population increase, quadrupled between the years 2000 to 2017. The population is also becoming more diverse, leading to unique health needs, according to the 2022 Houston Area Survey conducted by Rice University's Kinder Institute.



Source: Kinder Institute



“The health care staffing shortage is the No. 1 issue affecting health care today.”

—Shane Chen, Chief Operating Officer of Houston's HOPE Clinic, a Federally Qualified Health Center (FQHC).

WORKFORCE SHORTAGE IN THE UNITED STATES

Amid growing demand for health care workers, the U.S. and Houston face a current and projected shortage of people to fill the jobs. The Texas Hospital Association has released multiple written testimonies stressing that severe workforce shortages in the state threaten patient care.

The U.S. Department of Health and Human Services projects a shortage of more than 3.2 million essential, low-wage health workers in the next five years and a shortage of 140,000 physicians by 2033.¹⁵²

We are seeing workforce shortages in nurses, mental health professionals, primary care physicians, and more.

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149. U.S. Bureau of Labor Statistics. (2022, April 18). *Healthcare Occupations: Occupational Outlook Handbook*. U.S. Bureau of Labor Statistics. Bureau of Labor Statistics.

150. America Counts Staff. (2019, December 10). *2020 Census Will Help Policymakers Prepare for the Incoming Wave of Aging Boomers*. Census.Gov.

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152. AHA. (2021, November). *Fact Sheet: Strengthening the Health Care Workforce* | AHA. American Hospital Association.

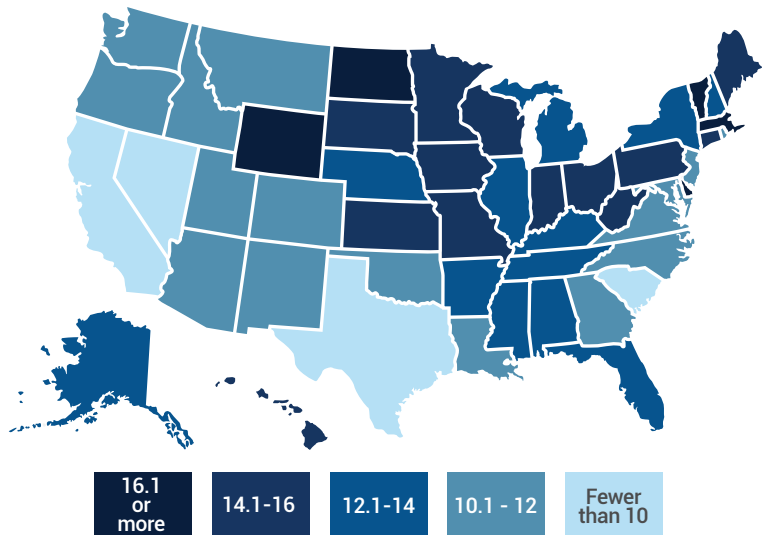
NURSING WORKFORCE SHORTAGE

Currently, Texas has 15,900 fewer nurses than it needs,¹⁵³ a number expected to increase to 57,000 registered nurses by 2032.¹⁵⁴ The U.S., on average, employs 12.06 registered nurses per 1,000 people, but, as of 2020, Texas had 9.6 registered nurses per 1,000 people according to the University of St. Augustine Health Sciences.

Another way to understand how our region is faring on nurses is “location quotient,” a measurement that reflects the concentration of health care employees. Our region has a location quotient of 0.89, below the national average of 1.¹⁵⁵

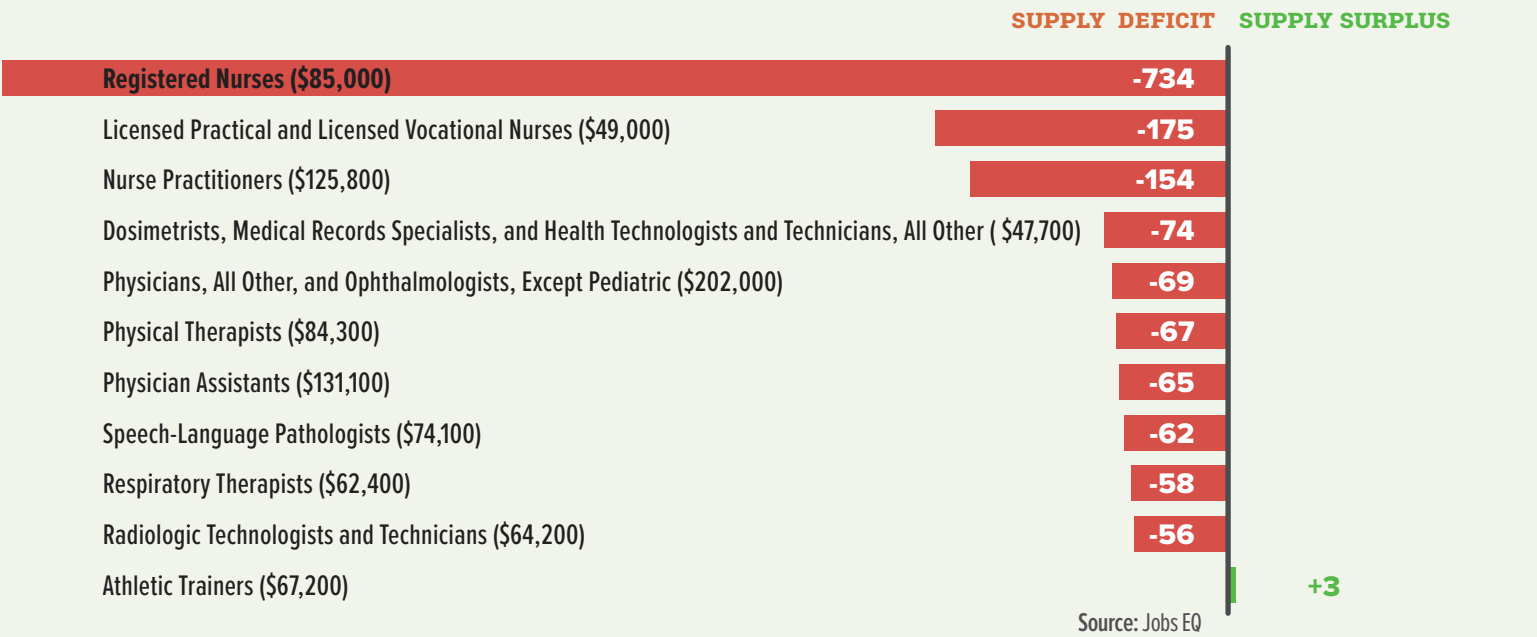
Nationwide, over half a million registered nurses are expected to retire by the end of this year. Dr. Kelli Nations, division chief nurse executive at HCA Houston Healthcare, told us that “The most pressing issue for our hospitals today is the shortage of health care colleagues.”

RN's per 1,000 Population in 2020



Source: University of St. Augustine for Health Sciences

Projected Houston Occupation Gaps by 2032



153. U.S. Department of Health and Human Services. (n.d.). *Supply and Demand Projections of the Nursing Workforce: 2014-2030*. 22.
 154. Texas Health and Human Services. (2020). *Updated Nurse Supply and Demand Projections 2018-2032*. 3.
 155. Jobs EQ. (2022). *Economic Overview: Houston-The Woodlands-Sugar Land, TX MSA*. Retrieved August 2022
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 157. Smiley, R. A., Ruttinger, C., Oliveira, C. M., Hudson, L. R., Allgeyer, R., Reneau, K. A., Silvestre, J. H., & Alexander, M. (2021). The 2020 National Nursing Workforce Survey. *Journal of Nursing Regulation*, 12(1), S1–S96.

IMPACT OF THE PANDEMIC:

Dr. Teresa McIntyre, a research professor in clinical and health psychology at the University of Houston's College of Nursing, is the principal investigator on a Houston-based study, in collaboration with HCA Houston Healthcare Clear Lake/Mainland Hospitals, to examine the effect of Covid-19 care on nurses' stress and well-being and on the workforce shortage.

"Over 90 percent of nurses reported experiencing shortage of staff as a stressor during the COVID-19 pandemic. Other highly endorsed stressors were fear of infection and of infecting others. Personal stressors include disruptions in sleep, lack of resources, pressure of having to take care of children and meals and so on," Dr. McIntyre said. "There were so many things in nurses' personal lives impacted by the pandemic."

CONTRACT NURSES:

During the pandemic, many nurses left their jobs or the profession, spurring hospitals to turn to contract nurses. According to the American Hospital Association (AHA), 95 percent of all health care facilities hired from contract labor firms.

With Covid-19, the median hourly rate of contract nurses tripled from 2019 to 2022, reaching \$148.20/hour, the AHA reported. Those rates were also seen in our region. Jack Frazee, director of government relations and general counsel at the Texas Nurses Association, said that trend "distorted wages in the nursing market, pulled labor out of traditional positions and into traveling positions." He added that nurses in already understaffed rural areas left those jobs for more lucrative contract nursing jobs.

Below, we will detail six underlying factors or trends of the nursing shortage: aging workforce, geographical disparities, high turnover rates, lacking education pipeline, workplace violence, and mental health concerns.

AN AGING WORKFORCE:

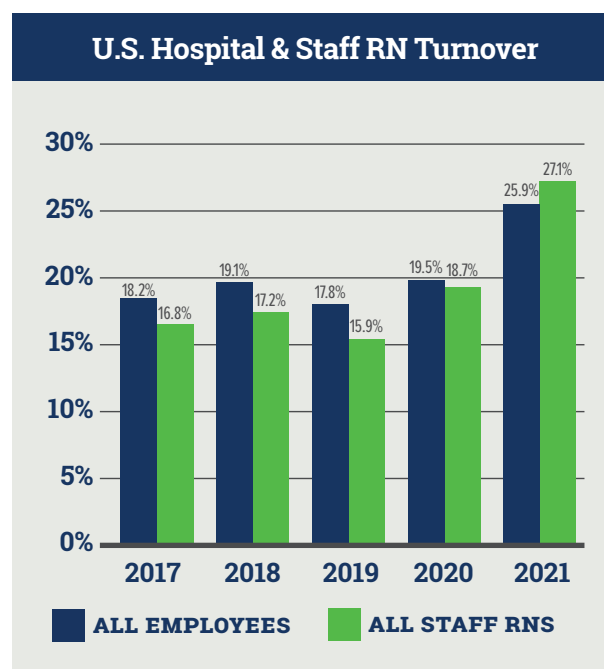
Nearly half of all registered nurses in Texas are over the age of 44, and over a third of all registered nurses are 55 and older.¹⁵⁶ More than one-fifth of nurses plan to retire in the next five years.¹⁵⁷ Dr. McIntyre said Houston's aging workforce is a key factor driving our shortage. Also troubling, she found, "Seniority is a strong factor in determining resilience and coping. Older nurses tend to be more experienced and are able to deal with stressful situations better than young nurses." Younger, less resilient nurses will be left behind, causing them to be more likely to leave their job.

GEOGRAPHICAL DISPARITIES:

Rural communities across Texas are likely to be disproportionately affected by nursing shortages compared with metropolitan areas. Sparsely populated regions already have limited hospital and health care access and their operations are more often underfunded and understaffed.

HIGH TURNOVER RATE:

During the pandemic, the turnover rate of registered nurses reached a high of 27.1 percent in 2021. Nurses often cite stress, pay, and lack of organizational support as the main reasons they leave their jobs. High vacancies can hurt patient outcomes.



Source: NSI Nursing solutions Healthcare Retention and RN Staffing Report

High turnover rates are a problem in Houston, Dr. McIntyre said, explaining: “The biggest predictor of turnover that we have found in our study is perceived organizational support, or the nurse’s perceptions that their organization values their contributions and protects their physical and emotional well-being. The more perceived organizational support, the less likely a nurse is to leave.”

LACK OF AN ADEQUATE EDUCATION PIPELINE:

Despite current and growing needs for nurses, nursing schools cannot take on more students due to their own shortages. The Texas Center for Nursing Workforce Commission data shows 15,700 nursing school applicants were turned away in Texas last year. And while Texas increased the number of nursing graduates by 100 percent in the last decade, we still cannot meet demand.

Nursing schools are facing shortages of faculty. Schools are confronting aging and retiring workforces. In Texas, the average age of nursing faculty is 55. Dr. Kathryn Tart, founding dean of the University of Houston College of Nursing, shared that across the nursing college landscape low faculty pay and retirements are driving shortages. Nursing colleges also need more slots for students to complete clinical rotations via academic-practice partnerships.

Dr. Tart also detailed another issue colleges will have to grapple with. Next year, a new nurse licensing exam, the Next Generation NCLEX, will focus more heavily on clinical judgment and decision-making. The pass rate may drop – at least initially – meaning fewer nurses will pass the exam.

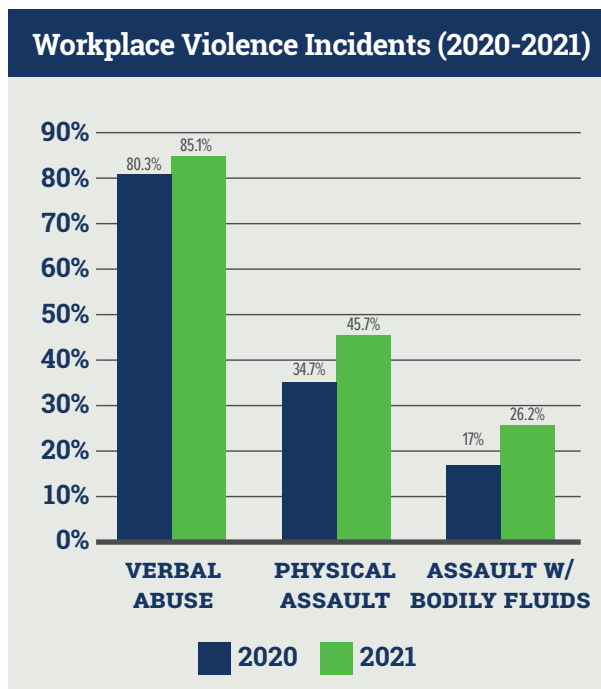
To help build a stronger nursing student pipeline, this year the Texas Workforce Commission allocated \$15 million to create a statewide registered apprenticeship program.

WORKPLACE VIOLENCE:

Workplace violence, an issue before the pandemic, has increased. U.S. Bureau of Labor Statistics says health care workers are four times more likely to experience workplace violence than other occupations. “Health care workers can face physical and psychological harm, which can affect the safety and morale of our colleagues as well as impact patient care. Common injuries sustained by nurses as a result of workplace violence include fractures of the face and extremities,” Dr. Nations said.

“Primarily, the violence comes from patients and their families,” Frazee said. “In hospitals people deal with emotionally challenging circumstances and often the psychological effects of illness. Since (nurses) are often in proximity with patients and their families and are there 24/7, they often bear the brunt of this violence.”

In November 2020, National Nurses United, a union and professional organization, said 20 percent of respondents in its survey reported increased workplace violence during Covid-19.

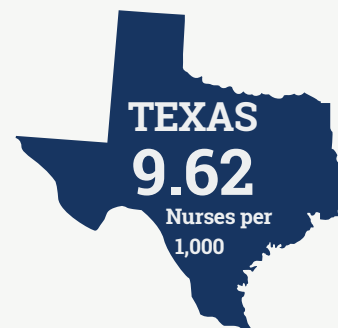


Source: McGuire, Sarayna S., et al. “Impact of the COVID-19 Pandemic on Workplace Violence at an Academic Emergency Department.” *The American Journal of Emergency Medicine*, W.B. Saunders, 23 Sept. 2021

158. Bryant-Genevier, J., Rao, C. Y., Lopes-Cardozo, B., Kone, A., Rose, C., Thomas, I., Orquiola, D., Lynfield, R., Shah, D., Freeman, L., Becker, S., Williams, A., Gould, D. W., Tiesman, H., Lloyd, G., Hill, L., & Byrkit, R. (2021). Symptoms of Depression, Anxiety, Post-Traumatic Stress Disorder, and Suicidal Ideation Among State, Tribal, Local, and Territorial Public Health Workers During the COVID-19 Pandemic—United States, March–April 2021. *MMWR. Morbidity and Mortality Weekly Report*, 70(26), 947–952.
159. McIntyre, T., Welty, L., Love, M., Shani, P., McIntyre, S., & Taylor, P. (2022). Occupational health impact of COVID-19 response on nurses’ well-being and work outcomes at HCA Houston Healthcare Clear Lake and Mainland: Final report. University of Houston College of Nursing.
160. Lasater, K. B., Aiken, L. H., Sloane, D. M., French, R., Anusiewicz, C. V., Martin, B., Reneau, K., Alexander, M., & McHugh, M. D. (2021). Is Hospital Nurse Staffing Legislation in the Public’s Interest?: An Observational Study in New York State. *Medical Care*, 59(5), 444–450.



Total Nurses (2018): 3,956,080
Population (2019): 328,055,000



Total Nurses (2018): 279,000
Population (2019): 28,996,000

Source: Figure taken from Nurse Journal 2022 <https://nursejournal.org/articles/the-us-nursing-shortage-state-by-state-breakdown/>

MENTAL HEALTH CONCERNS:

The stress of the pandemic gravely affected the mental health of health care workers generally and frontline workers such as nurses specifically. The U.S. Department of Health and Human Services reports that as of 2022, over 50 percent of health care workers report at least one symptom of a mental health condition.¹⁵⁸ The UH-HCA Houston Healthcare Clear Lake and Mainland study found that more than 70 percent of the nurses reported headaches, physical exhaustion, difficulty sleeping, and/or overeating.

The virus triggered stressors included fear of infection, staffing shortages, and disruptions to personal life. Dr. McIntyre said that more than 90 percent of the Houston-based nurses interviewed reported experiencing multiple and elevated levels of these stressors. The study found nurses reported significant levels of stress, anxiety, depression, and burnout.¹⁵⁹ Those directly responsible for Covid-19 patients were more at-risk for these symptoms than other nurses.

POTENTIAL SOLUTIONS:

Given that nursing shortages can lead to a range of worse outcomes for patients, it is important for government and health care leaders to do what they can.¹⁶⁰ State lawmakers have tried to tackle the issue. For example, in 2001, the legislature passed the Nursing Shortage Reduction Program, which is ongoing and sends funds to nursing education programs. The Texas Nurses Association has called for more funding and tweaks to the program.

We offer the following suggestions for graduating and retaining nurses, based on current research and our discussions with experts.

Producing More Nurses

1. Work with younger students to build a pipeline to nursing school.
2. Increase clinical spots for nursing students.
3. Invest in nursing schools by adding staff and classrooms.
4. Find legislative solutions to bring in nurses from abroad.

Improving Nurse Retention

1. Implement regulatory and hospital-level changes to improve workplace safety and security.
2. Allow for more flexible work hours.
3. Create hospital-level mental health and wellness programs.
4. Teach and foster a culture of self-care in all levels of nursing education.

OTHER SHORTAGES

The health care workforce shortage – and the fallout from Covid-19– is not, of course, limited to nurses. Below we will touch on mental health providers and primary care doctors.

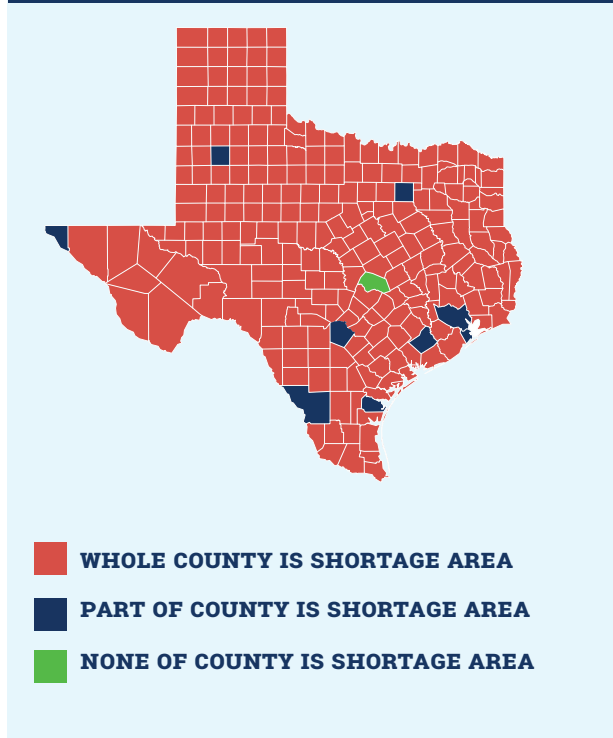
Only 32.9 percent of the need for **mental health professionals** is met in Texas.¹⁶¹ Health Professional Shortage Areas are designated by federal health officials using the ratio of available psychiatrists compared to the number of necessary psychiatrists. Across the county, there are 433 such shortage areas, with more than half of Texas residents living in a shortage area.

In addition, among states, Texas ranks second to last, with just 133 mental health professionals per 100,000 residents in 2021. Kara Hill, of Mental Health America, noted: “The behavioral health sector has shortages in behavioral health providers, and it is one of the biggest issues facing health care. We need to grow the workforce in number and diversity while becoming innovative in the way we use behavioral health providers to create an environment that will address the range of needs equitably. It is also crucial that we equip primary care providers to be able to identify, diagnose, treat, and manage patients with common mental health conditions they are seeing in the office every day. Integrated behavioral health can expand access by pairing equipped primary care and behavioral health providers to work together productively.”

Primary care physicians are vital to the functioning of a health care system. In 2018, the American Association of Medical Colleges projected physician demand to grow faster than supply, largely due to population growth and aging. It projected a physician shortage of 54,000-139,000 by 2033. The primary care physician shortage is projected to be between 21,400-55,200 by 2033.¹⁶²

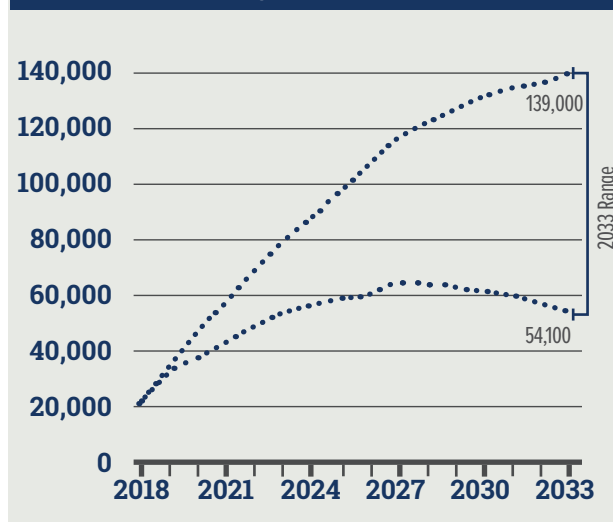
Using the location quotient indicator mentioned earlier, the Houston MSA, at 0.83, falls below the national average of 1.

Mental Health Professional Shortage Areas



Source: data.HRSA.gov, July 2022

U.S. Total Projected Physician Shortfall Range 2018-2033



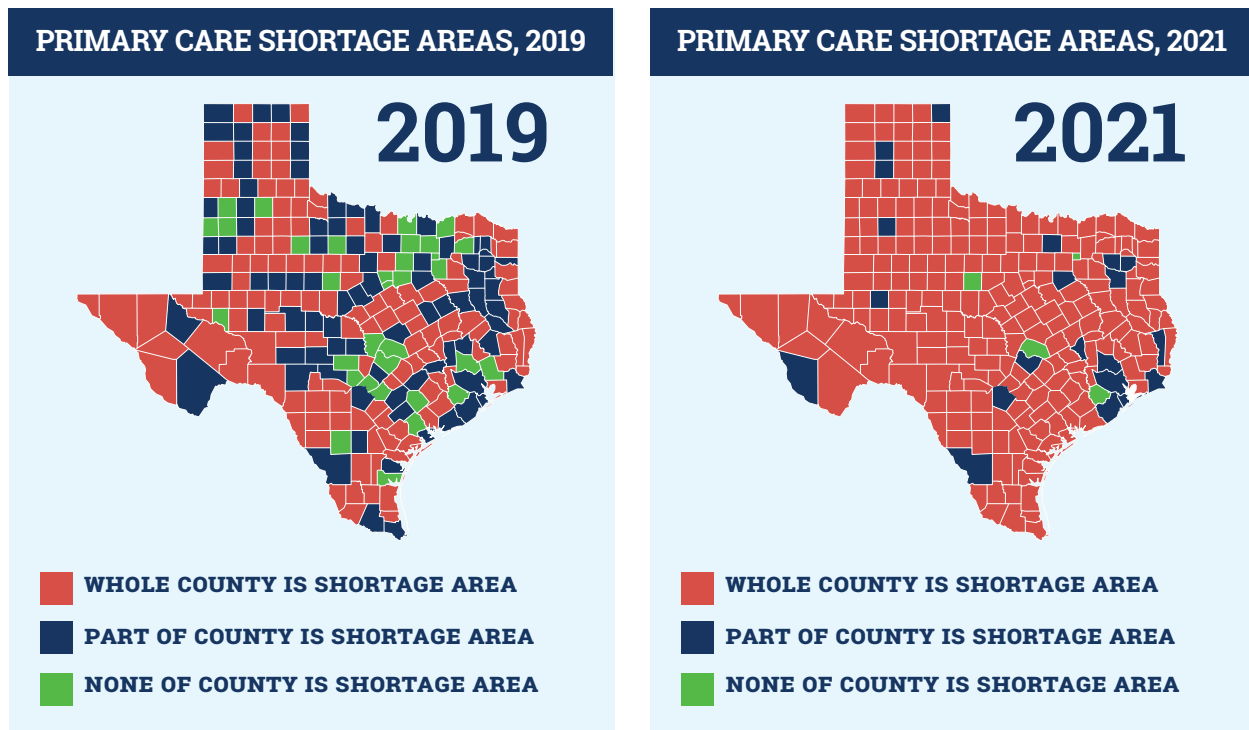
Source: Association of American Medical Colleges Report from 2020

161. Understanding Houston. (n.d.). *Mental Health*. Understanding Houston. Retrieved August 25, 2022

162. Heiser, S. (2020, June 26). New AAMC Report Confirms Growing Physician Shortage. AAMC.

163. Liao, K., & Sypher, K. (2021, December 21). *Rural Health and Hospitals: A Focus on Texas*. APM Research Lab.

Texas has been hit hard by the ongoing primary care physician shortage. In 2019, 129 Texas counties were designated as a primary care shortage area. By 2021, this number had increased to 228 counties.¹⁶³ "Our region," said Dr. Stephen Spann, founding dean of the Tilman J. Fertitta Family College of Medicine at University of Houston and vice-president for medical affairs, "is not immune from a shortage."



Source: Texas2036.org

Among the factors driving the shortage: burnout, especially caused by Covid-19, retirement, fewer medical students pursuing primary care, not enough medical school seats, and not enough postgraduate training positions.

Students may not choose primary care as they feel the field is undervalued and fear poor reimbursement rates or pay for the services provided. Pay is the most often cited reason for not pursuing primary care, as the average medical student graduates with \$200,000 in debt.

Houston, like other regions, must train and graduate more primary care physicians to help improve local health outcomes. To address this, Tilman J. Fertitta Family College of Medicine focuses on primary care physicians. Through the program students learn to address factors that contribute to health, including social determinants, and about the importance of preventative and equitable care.

In sum, as our population both grows and ages, our work force shortages will only increase. To ease the shortage, community, health, and business leaders must take deliberate steps.

CONCLUSION: THE ROLE OF HEALTH CARE IN HOUSTON'S ECONOMY

Health care is a significant economic driver in our region. Addressing the workforce shortage is crucial for realizing our economic potential. Exciting developments in health technology promise improved efficiencies and outcomes. Great growth potential lies in the developing life sciences sector. Continuing current efforts in talent development, corporate incentives, and marketing of Houston's strengths as a life sciences hub will allow our area to achieve the economic growth modeled in the next section.

Model: The Health Care Sector of 2036



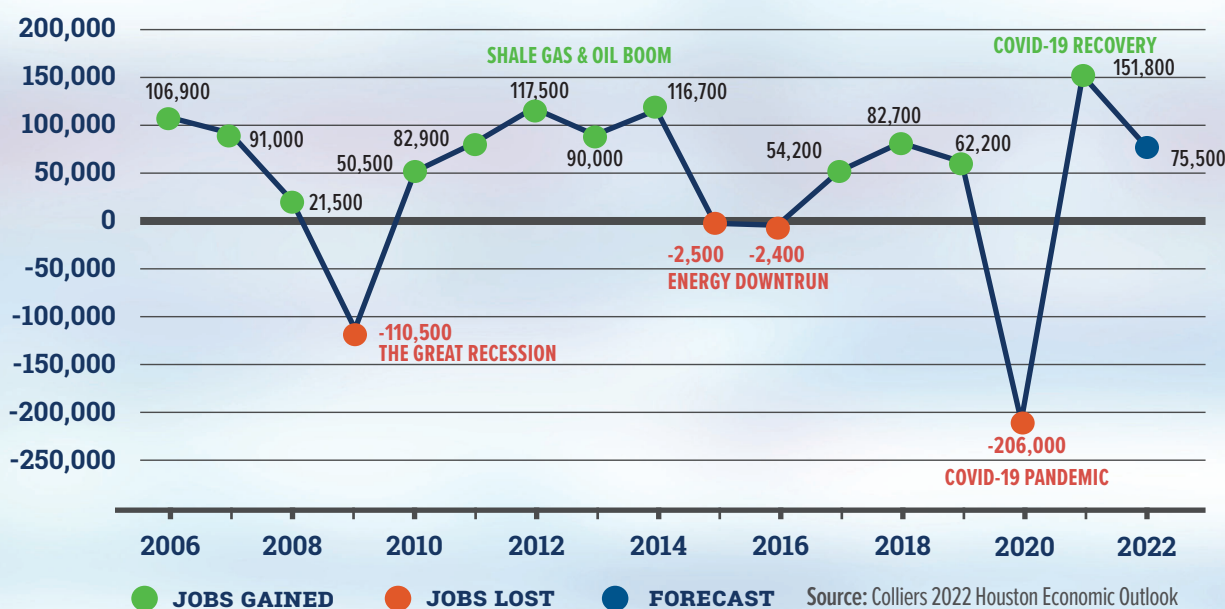
The health care landscape has changed more in the past two years than we could have imagined. Drastic job losses have been followed by a rapid economic recovery. The net effect is that growth rates in most industries appear to be slightly lower when you factor 2020 and 2021 into the mix.

The last two years are likely an anomaly, but economic models are still important tools to guide us through uncertainty. Looking forward at the potential impact of various scenarios can help direct attention and resources toward opportunities. We sought to

understand if the past two years altered the economy in ways that would shift the possible economic outcomes we presented previously and change our recommendations.

In short, our updated modeling shows that while exact employment and GDP scenario projections have been altered, as expected, they are the same directionally as two years ago. Workforce shortages continue to pose a risk to GDP growth, while investments in the life sciences industry offer an outside opportunity for regional economic growth.

Houston Employment Trends



In the Center for Houston's Future's 2020 report, we projected the potential economic effects of changes in the workforce and investments in Greater Houston's health care sector. We selected 2036 – the 200th anniversary of both Houston and Texas – as a milestone date for different scenarios. In this report, we revisited the scenarios to see how they have been altered by events of the past two years.

We shaped our model based on academic literature, expert interviews, and focus groups with health care leaders. This revealed that the past two years have only reinforced the facts and experiences behind the workforce shortage and life sciences investment scenarios. We took this opportunity to refine the model for these scenarios.

The rapid technology adoption scenario we used two years ago proved more complex. Covid-19 expedited technology adoption, which appears to be spurring improved patient outcomes and hospital efficiency in some cases. But we have seen no concrete evidence that it has reduced the number of health care workers required to provide that care. Because we do not have a clear sense at this point, we do not model the rapid technology adoption scenario here as we did two years ago.

A note about the model refinement: Center for Houston's Future's 2020 report, "Houston's Economic Future: Health Care," projected baseline employment to be 595,554 in 2036. Running that same projection with our revised model, we see an anticipated employment growth of 594,884. This tells us that the revised model is comparable to the old model. Going forward all projection values will be based on the revised model.

The data from our model shows that the events of the past two years did not change the underlying conclusions of the last report. Investing in life sciences will have a greater impact on GDP than other health service areas due to the high-multiplier nature of these jobs. Workforce shortages will negatively impact GDP growth, in addition to the health of our community.

KEY FINDINGS FROM OUR MODEL INCLUDE:

- ▶ Health care continues to be the uncontested leader in fueling employment growth for the region. At the current rate of growth, we expect to see **247,000 direct jobs (493,000 total jobs) added in Houston's health care sector from 2021 to 2036, a 68 percent increase.** This projection, however, is contingent on enough qualified workers to fill these jobs.
- ▶ Addressing the health care work force shortage would **protect \$14 billion in GDP** in 2036. In other words, failing to invest in health service workers will reduce Houston's employment by 158,000 jobs when indirect and induced jobs are included.
- ▶ The region can transform the health care sector into an engine of economic growth by cultivating so-called "high-multiplier" life sciences jobs. Our modeling finds that developing a burgeoning life sciences hub in Houston would **add \$40 billion to the region's economy by 2036.**

SCENARIOS

We revisited three scenarios for the region's health care sector and modeled the resulting effects on regional employment and GDP in 2036. The scenarios were selected to illustrate how many of the key drivers and disruptions shaping the health care industry discussed earlier in the report will shape the region's economic future. Information on our model approach and the assumptions we used is detailed in the methodology section of the appendix.



BASELINE SCENARIO: Using baseline data from 2014 to 2021, our first scenario projects what might happen if growth in our health care sector proceeds at the same pace and in the same way over the next 14 years. As a continuation of status quo trends, this case extrapolates the historical rate of technology adoption in the industry and assumes moderate growth in life sciences enterprises.



WORKFORCE SHORTAGE SCENARIO: This case depicts a future in which the region's health care service industry fails to develop a pipeline to meet workforce needs and faces a severe shortage of workers. We presume a 20 percent drag on employment growth. Here, one in every five health care service jobs that would normally be filled will go unhired.



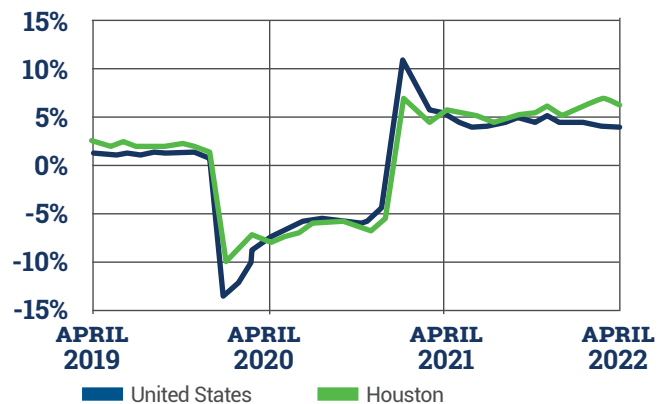
LIFE SCIENCES THRIVE SCENARIO: Life sciences includes businesses focused on biopharmaceuticals and medical devices. This scenario presumes most of the region's health care sector grows at historical rates, but we will also nurture a robust life sciences hub, which creates substantial economic value.

EMPLOYMENT FORECAST

To assess the economic outlook for the region's health care sector, we first review health care hiring historically and extrapolate those trends through 2036. In the past two years, overall employment has changed drastically, but by the end of 2021, employment had nearly returned to normal.

Employment Trends U.S. and Houston MSA

April 2019 - April 2022



Source: U.S. Bureau of Labor Statistics

Preliminary numbers from the Texas Workforce Commission show that by early 2022, aggregate job losses were fully recovered.

Looking back, we see job growth rates across all industries in Houston from 2012 – 2021 were 12 percent. Health care growth remained stable at 25 percent, while life sciences growth was at 77 percent.

That said, the life sciences industry is a fraction of the size with around 5,000 employees compared to health services with 358,979 employees, according to the Texas Workforce Commission. Smaller industries are more sensitive to fluctuations than larger ones, but industry experts agree that life sciences growth is likely to continue to be strong in the next several years, given the investments and interest in this sector.

When looking at industry employment growth, it is important to consider the ripple effects in an economy from not only the direct jobs but also the jobs

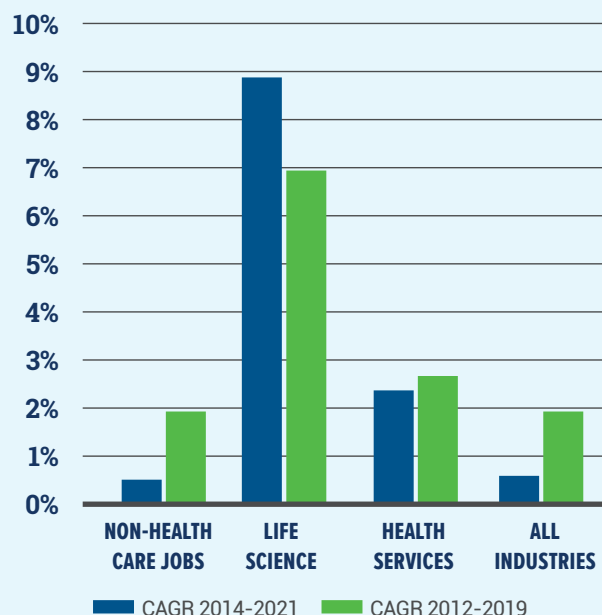
created to support that industry. For instance, a job in biopharmaceuticals will create a demand for supplies to create that pharmaceutical, or indirect jobs. The employees in those direct and indirect positions will then spend money on things like lunch and dry cleaning, creating induced jobs. The number of indirect and induced jobs varies by industry. These are known as job multipliers. Jobs that create more indirect and induced positions are “high multiplier jobs.” The indirect and induced job calculations for this model were provided by the IMPLAN platform.

Under the **baseline scenario**, we expect direct health care employment to increase by 247,000 jobs, with an additional 108,000 indirect and 138,000 induced jobs for a total employment increase of 493,000 jobs. This represents a 68 percent growth in direct jobs. This scenario assumes we have the workforce available to fill these positions.

A **labor shortage scenario** would restrict this employment growth such that total employment would rise by 335,000 jobs compared to the baseline growth of 493,000 jobs. These figures are below the 2019 projection of 465,000 jobs added in a workforce shortage scenario. This is likely because the health care workforce shortage has been exacerbated by the immense strain the Covid-19 pandemic has placed on this group of workers.

The life sciences sector has continued to grow over the past two years while most other sectors saw reductions in both jobs and GDP. The **life sciences thrive scenario** continues to show impressive growth potential for our region with an additional 643,000 jobs in 2036. If we break that down, there will be 284,000 jobs added by direct employment, 163,000 jobs by indirect employment, and 196,000 jobs added by induced employment. This scenario has a larger proportion of indirect and induced jobs than the baseline scenario.

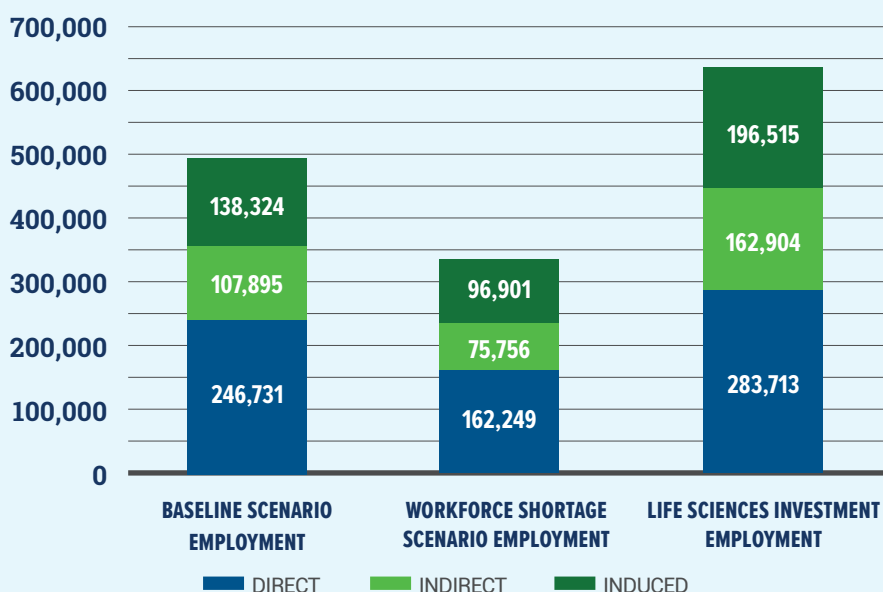
Houston MSA Job Growth Rates by Industry



Source: Center for Houston's Future analysis of JobsEQ data

The models in this report are based on the compound annual growth rate (CAGR) from the 2012 – 2019 period. We chose this CAGR for both the 2019 data and the 2021 data because it avoids distortion from the anomalous contraction in 2020 and explosive growth in 2021. We did also run the model with the 2014 – 2021 CAGR applied to 2021 employment numbers and found that it does not alter the trends discussed here. Output from that model can be found at www.futurehouston.org.

2036 Incremental Health Care Employment by Scenario Houston MSA



Source: Center for Houston's Future

GDP FORECAST

Gross Domestic Product (GDP) is a widely accepted measure of economic activity. We project the 2036 effect on the region's GDP under each of the three scenarios by calculating the economic value added by a typical health care worker in each health care field.

The GDP or value add for the Houston MSA fell between 2019 and 2020 from \$509.3 billion to \$488.2 billion but is expected to recover in 2021. The local GDP numbers will not be released until December 2022 and cannot be included here.

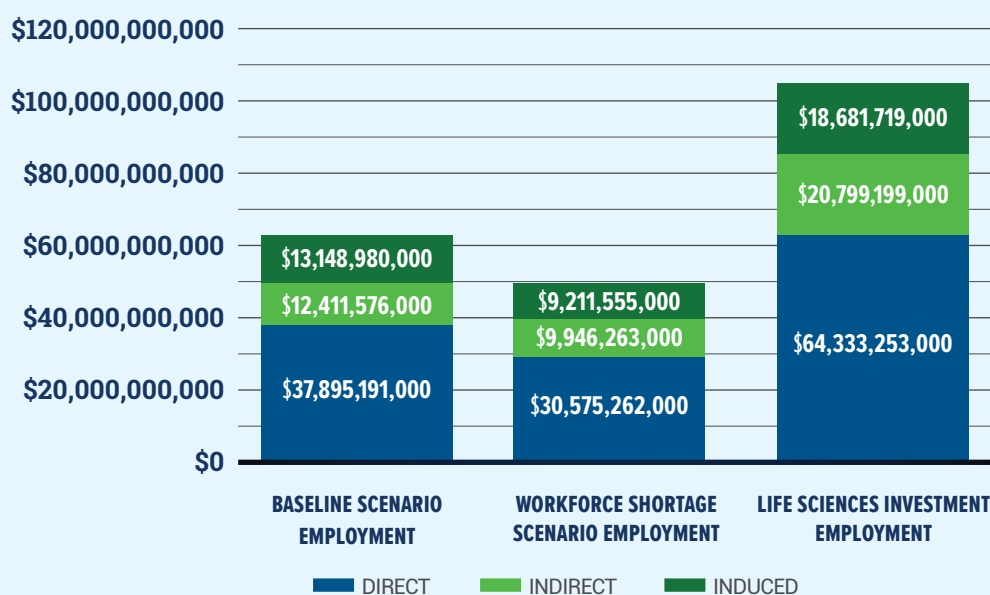
A key dynamic in the health care sector's economic influence on the overall economy lies in how different health care jobs have widely diverse levels of economic impact. This is true across industries.

For every new dollar of earnings in an industry, the amount of compensation across an economy

varies widely. All value-add calculations and earnings multipliers for this model were provided by the IMPLAN platform. Growing the jobs with large employment multipliers and a greater value added per job will result in greater contributions to the region's economy. A review of the life sciences industry in Boston and San Diego indicates that life sciences jobs have employment multipliers of around 2.4 percent compared to a 1.6 percent multiplier for health services. The impact of these multipliers is shown by the range of GDPs in the three scenarios we model.

Visionary leaders in Houston laid the groundwork for a strong health care sector when they formed the Texas Medical Center. This tradition of strategic investments continues with projects like TMC Helix Park. The chart here depicts the change in regional GDP associated with each of the three scenarios. For context, the health care sector contributed \$25.5 billion to Houston's regional GDP in 2020.¹⁶⁴

2036 Incremental Health Care GDP by Scenario Houston MSA



Source: Center for Houston's Future

164. Bureau of Economic Analysis. (n.d.). *Gross Domestic Product (GDP) by County and Metropolitan Area: GDP in Current dollars (CAGDP2)*. Retrieved August 11, 2022



The updated **baseline scenario** projections show the health care sector would add \$38 billion in direct value add by 2036, and \$25 billion in indirect and induced GDP for a total of \$63 billion in added GDP assuming all jobs can be filled.

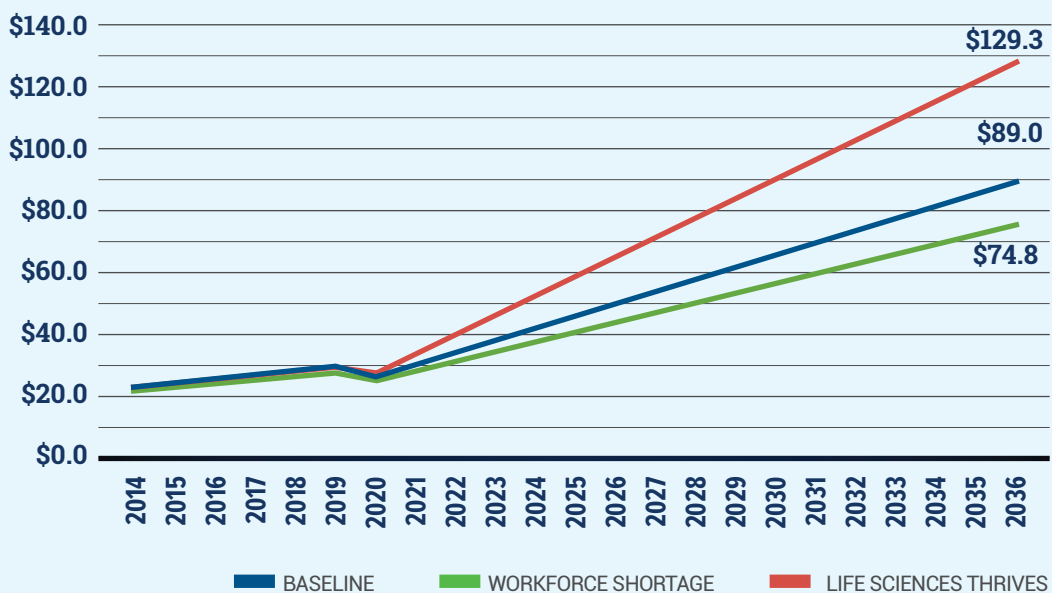


In the **workforce shortage scenario**, our updated modeling suggests the health care sector would add \$30 billion in direct GDP and \$49 billion in total GDP in 2036, which is 22 percent (\$14 billion) less than the baseline case. This is consistent with the projections from 2019 but more pronounced.



The thriving **life sciences scenario** is projected to add \$104 billion in total GDP, a 63 percent boost (\$40 billion) over the baseline case. Given that the Houston region's overall 2020 GDP was \$488 billion, the economic effect of the life sciences scenario would be equivalent to growing today's economy by 21 percent.

Houston MSA Health Care Contribution to GDP in Billions of Dollars



Source: Center for Houston's Future

Conclusions and Recommendations

Covid-19 gravely impacted our region's health and wellness the past two years. Many of the factors and trends we discussed in our 2020 report were highlighted and expedited. Health disparities that have driven poor health outcomes among certain Houstonians were evident in our rates of Covid-19-related deaths and infections. Existing issues with chronic disease, maternal health, and mental health worsened. And health care workforce shortages have only been exacerbated.

Yet, Houston has shown itself to be resourceful in the face of adversity. The adoption of health care technologies, expedited by the urgency of the pandemic, enabled improved efficiencies across the medical system. And innovations in the life sciences sector both locally and worldwide enabled treatment and eventual vaccinations for Covid-19.

The health care sector in Houston remains an essential pillar of Greater Houston's economy, providing more jobs than any other industry and ensuring our region's vitality. Most importantly, this sector works to keep the population healthy. As the World Bank says: "The impact of health on GDP is substantial—an extra year of life expectancy is estimated to raise a country's per capita GDP by about 4 percent."

We have an opportunity to leverage the lessons from the past two years to improve our health care system. This will require collective action from health care and business leaders. We encourage the region's business, civic, and health care stakeholders to build on collaborations of the past two years to address the following:

IMPROVE HEALTH AND HEALTH EQUITY

- ▶ Support policies to improve health, including the expansion of Medicaid; increased funding for safety net organizations, psychiatric facilities, and behavioral health resources; increased price transparency; and adoption of care models that better align incentives with outcomes to reduce wasteful spending in the health care system.
- ▶ Support programs that address social determinants of health, such as the Texas Accountable Community Health Initiative, the Memorial Hermann Community Resource Centers, and the Health Equity Collective, in their efforts to create the technical and human infrastructure to coordinate care equitably across organizations.

ADVANCE HEALTH TECHNOLOGY

- ▶ Health care organizations can continue to adopt technology that improves care.
- ▶ Entrepreneurs can analyze and leverage a wealth of health data from the state's new All-Payer Claims Database, as well as Greater Houston Health Connect, to create solutions for health care problems.
- ▶ Entrepreneurs can combine our technology, health, and data strengths to lead the nation in digital health innovation.

ADDRESS HEALTH CARE WORK FORCE BURNOUT AND SHORTAGE

► Retain talent:

- Businesses can stand behind efforts to address workplace violence in medical facilities. These efforts include increased mental health and security resources and legal consequences for offenders.
- Health care organizations can increase retention by creating a culture of self-care including protected lunch hours and break times, spaces to disconnect and decompress, self-care activities for staff, promoting activities to reduce stigma around mental health care, and increasing employee assistance program benefits.

► Develop the pipeline:

- Businesses can support increased public and/or private funding for faculty positions in nursing colleges and financial support for nursing students.
- Businesses can support legislation to allow open health care positions to be filled by talent from abroad.
- Hospitals can increase participation in clinical rotations and provide more preceptors for nursing students.

PREPARE FOR THE FUTURE

- Businesses, medical institutions, and government agencies can expand on the collaboration and communication spurred by Covid-19 to work on priority health issues.
- Businesses and government agencies can support and engage with the new Texas Epidemic Public Health Institute to help create a comprehensive state preparedness and response plan.

GROW OUR LIFE SCIENCES ECOSYSTEM

- The business community can continue to support programs to provide hands-on training for all levels of life sciences employees, from CEOs to lab techs, in order to translate vast research capabilities into life-enhancing and life-saving solutions for patients.
- The business community can facilitate collaboration between early-stage venture capital firms and investors to expand the pipeline of startup companies in Houston.
- Civic leaders can support incentive programs and share our strengths as a life sciences powerhouse to the world. Houston and Texas have a wealth of research facilities, academic institutions, and medical centers. And Houston has a uniquely dense and diverse patient base for research and clinical trials. The proximity of these resources lends itself to opportunities and efficiencies that cannot be found elsewhere.

INCREASE COLLABORATION BETWEEN THE REGION'S HEALTH CARE SYSTEM AND EMPLOYERS

- As we did in 2020, we recommend the creation of an employer-health care sector coalition to work on the issues raised in this report.
 - A possible model to consider is the Dallas Medical Resources organization, which connects businesses, community, and health care leaders to inform and educate members about the region's health care infrastructure and services.
 - Another model worth considering is Chicago's West Side United organization, which brings together businesses, health care institutions, residents, government agencies, and faith-based institutions to actively work to make their neighborhoods "stronger, healthier and more vibrant places to live."

In this report, we have explored issues and potential solutions surrounding Houston's health care systems. One theme reappears throughout: Collaboration makes us stronger. By working together across geographies and stakeholder groups, we can find and scale promising initiatives. Our region is rich in opportunities. Center for Houston's Future sees enormous potential for our community to shape a healthy and prosperous future.

Model Methodology

ASSUMPTIONS

Baseline Scenario – Direct job growth in health services and life sciences industries will continue at a historic growth rate.

Workforce Shortage Scenario – Direct job growth in health services will decrease by 20 percent of the historic growth rate, the life sciences sector grows at the baseline rate.

Life Sciences Thrives Scenario – Direct job growth in the life sciences industries will increase by 50 percent of the historic growth rate, health services grow at the baseline rate.

PROCESS

Identify baseline economic data and trends - We examined historical data on employment from 2007 to 2021 for selected health care industries from the Quarterly Census of Employment and Wages and JobsEQ to assess how different industries comprising Houston's health care sector have grown in recent history. CAGRs for employment were calculated for each health care sub-industry represented by NAICS code. These CAGRs were used to project direct employment out to the year 2036. These projected employment numbers were input into IMPLAN by sub-industry as the basis of I/O or Economic Impact Analysis of the baseline scenario.

Validate scenarios and forecast employment - In addition to the baseline case, we designed two scenarios. For the 'workforce shortage' scenario, we looked at increases in open positions in the health services sector and interviews with leaders in medical and mental health to support the assumption of a 20 percent decrease in the available workforce. For the 'life sciences thrive' scenario, we looked at the early-stage growth in the life sciences sectors in San Diego and Boston to support the assumption of a 50 percent increase in life sciences jobs.

Assess economic impact - The projected employment numbers from the three scenarios were input into IMPLAN by sub-industry as the basis of I/O or economic impact analysis. IMPLAN provided the appropriate multiplier data to calculate the economic impact of the three scenarios. The employment multiplier measures the number of direct jobs, indirect jobs (those that are generated by supporting the industry), and induced jobs (originating from the additional spending from new direct and indirect employees). Value-added multipliers describe the overall economic result of one dollar of value added in the target industry.

MODEL REFINEMENTS

The scenarios consider health care to include two segments: (1) local health services, which range from hospitals to doctors' offices to substance abuse clinics; and (2) life sciences, which is made up of medical device manufacturing, and biopharmaceutical manufacturing. For this report, we have aligned these segments with the U.S. Cluster Mapping Project, a national economic development initiative led by Harvard Business School Professor Michael Porter through the Institute for Strategy and Competitiveness. We also refined our calculations to a more granular level to increase the accuracy of our model. To ensure consistency, we ran the refined model against both the years from the prior report (2012 – 2019) and our current period (2014-2021) and compared the results. The original report projected baseline employment to be 595,554 in 2036. Running that same projection with our revised model, we see an anticipated employment growth of 594,884. This tells us that the revised model is comparable to the old model. Going forward all projection values will be based on the revised model. All assumptions remain consistent with the 2020 report.

DEFINITION OF TERMS

Employment Numbers - All employment numbers for 2012 – 2021 were provided by JobsEQ based on NAICS industry codes.

Geography - Data in this model is focused on the Houston Metropolitan Statistical Area (MSA) which is comprised of the following counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller.

GDP - The term GDP (gross domestic product) as we use it in this report refers to the value added to our region or a measure of the contribution to GDP. Value add is a substantial portion of output, as it includes labor income (LI), other property income (OPI), and taxes on production and imports (TOPI). Gross domestic product (GDP) is a monetary measure of the market value of all the final goods and services produced in a specific time period by countries.

Growth Rate - 2036 employment numbers were based on the Compound Annual Growth Rate (CAGR) from 2012 – 2019. This rate was applied to both the 2019 data for the original projections and the 2021 employment data for new projections. This treatment avoids distortion from the anomalous contraction in 2020 and explosive growth in 2021. We did also run the model with the 2014 – 2021 CAGR applied to 2021 employment numbers and found that it does not alter the trends discussed here. Output from that model can be found at www.futurehouston.org.

Industry - For this report, we are defining the health care industry as health services and life sciences as defined by the U.S. Cluster Mapping Project. This includes the following NAICS Codes – Health Services: Dental Laboratories (339116), Pharmacies and Drug Stores (446110), Home Health Equipment Rental (532283), Offices of Physicians, Mental Health Specialists (621112), Offices of Physicians (except Mental Health Specialists) (621111), Offices of Dentists (621210), Specialty (except Psychiatric and Substance Abuse) Hospitals (622310), Offices of Chiropractors (621310), Offices of Podiatrists (621391), Offices of All Other Miscellaneous Health Practitioners (621399), Offices of Optometrists (621320), Offices of Mental Health Practitioners (except Physicians) (621330), Offices of Physical, Occupational and Speech Therapists, and Audiologists (621340), HMO Medical Centers (621491), Kidney Dialysis Centers (621492), Freestanding Ambulatory Surgical and Emergency Centers (621493), All Other Outpatient Care Centers (621498), Family Planning Centers (621410), Outpatient Mental Health and Substance Abuse Centers (621420), Medical Laboratories 621511, Diagnostic Imaging Centers (621512), Home Health Care Services (621610), Blood and Organ Banks (621991), All Other Miscellaneous Ambulatory Health Care Services (621999), Psychiatric and Substance Abuse Hospitals (622210), Residential Intellectual and Developmental Disability Facilities (623210), Nursing Care Facilities (Skilled Nursing Facilities) (623110), General Medical and Surgical Hospitals (622110), Assisted Living Facilities for the Elderly (623312), Continuing Care Retirement Communities (623311), Residential Mental Health and Substance Abuse Facilities (623220), Other Residential Care Facilities (623990); Biopharmaceuticals: Medicinal and Botanical Manufacturing (325411), Pharmaceutical Preparation Manufacturing (325412), In-Vitro Diagnostic Substance Manufacturing (325413), Biological Product (except Diagnostic) Manufacturing (325414); Medical Devices: Optical Instrument and Lens Manufacturing (333314), Surgical and Medical Instrument Manufacturing (339112), Surgical Appliance and Supplies Manufacturing (339113), Dental Equipment and Supplies Manufacturing (339114), Ophthalmic Goods Manufacturing (339115).

Input-Output Model - The input-output model used for this study is provided by IMPLAN. The IMPLAN modeling system combines the benchmark input-output accounts of the U.S. Bureau of Economic Analysis with other data to construct quantitative models of trade flow. IMPLAN provides the multipliers to allow us to examine the effects of a change in one economic activity to estimate the outcome on a region's economy (impact analysis). Impacts are expressed in 2022 dollars and event inputs are modeled on the 2019 data year.

NAICS - North American Industry Classification System. NAICS is a system of industrial classification developed and used by the U.S., Canada, and Mexico for grouping establishments by similarity of production process.

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