

Digital Health

Spring 2025

UNIVERSIDAD POLITÉCNICA DE MADRID



#3 Industry Overview: Macrotrends and Innovation

Agenda

- Questions?
- Icebreaker: If you won one million Euros at a casino, what would you do with the money?
- Learning objectives: Discipline literacy; critical analysis skills; applied and integrative learning; and, soft skills
- Students present their admired health system – homework #1 due today
- Lecture; What drives innovation in health care?
- Review and discussion: Macrotrends
- Guest speaker
- Concept map exercise
- Plan Group Project
- Next week: Hospitals, clinics, health providers, electronic medical and health records, personal health records, enterprise computing.

Macrotrends impacting health

- Pandemic challenge
- Aging population
- Cost of drugs and care
- Chronic disease
- Mental health
- Shortage of health professionals
- Obesity
- Globalization
- Climate change
- Immigration
- Urbanization
- Large companies entering medicine
- AI



Macrotrends: Pandemic Challenge

- The declaration of a public health emergency in many countries offered public funding to many initiatives, including digital health start ups in telehealth and remote patient monitoring.
- For example, in Ethiopia, health care workers were reshuffled and health facilities redeployed.
- Elective surgeries cancelled.
- Patients avoid care.
- Supply chain issues.
- Burnout of health professionals.
- Over 5 million lives lost globally.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8968362/>



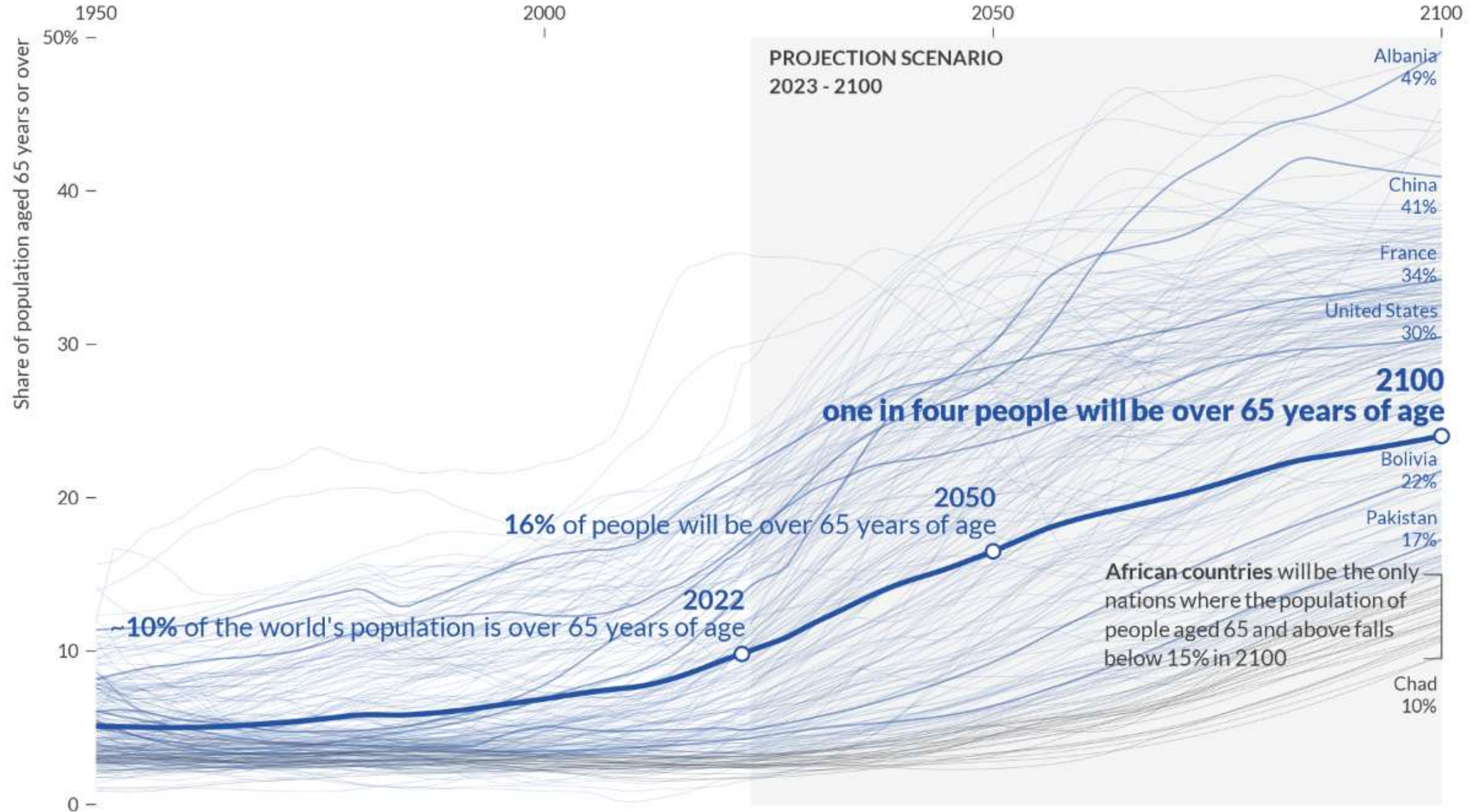
Macrotrends: Aging Population

- The world's older population continues to grow at an unprecedented rate. The pace of population aging is much faster than in the past.
- Today, **10 %** of people worldwide are aged 65 and over.
- <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>



The world's population is aging

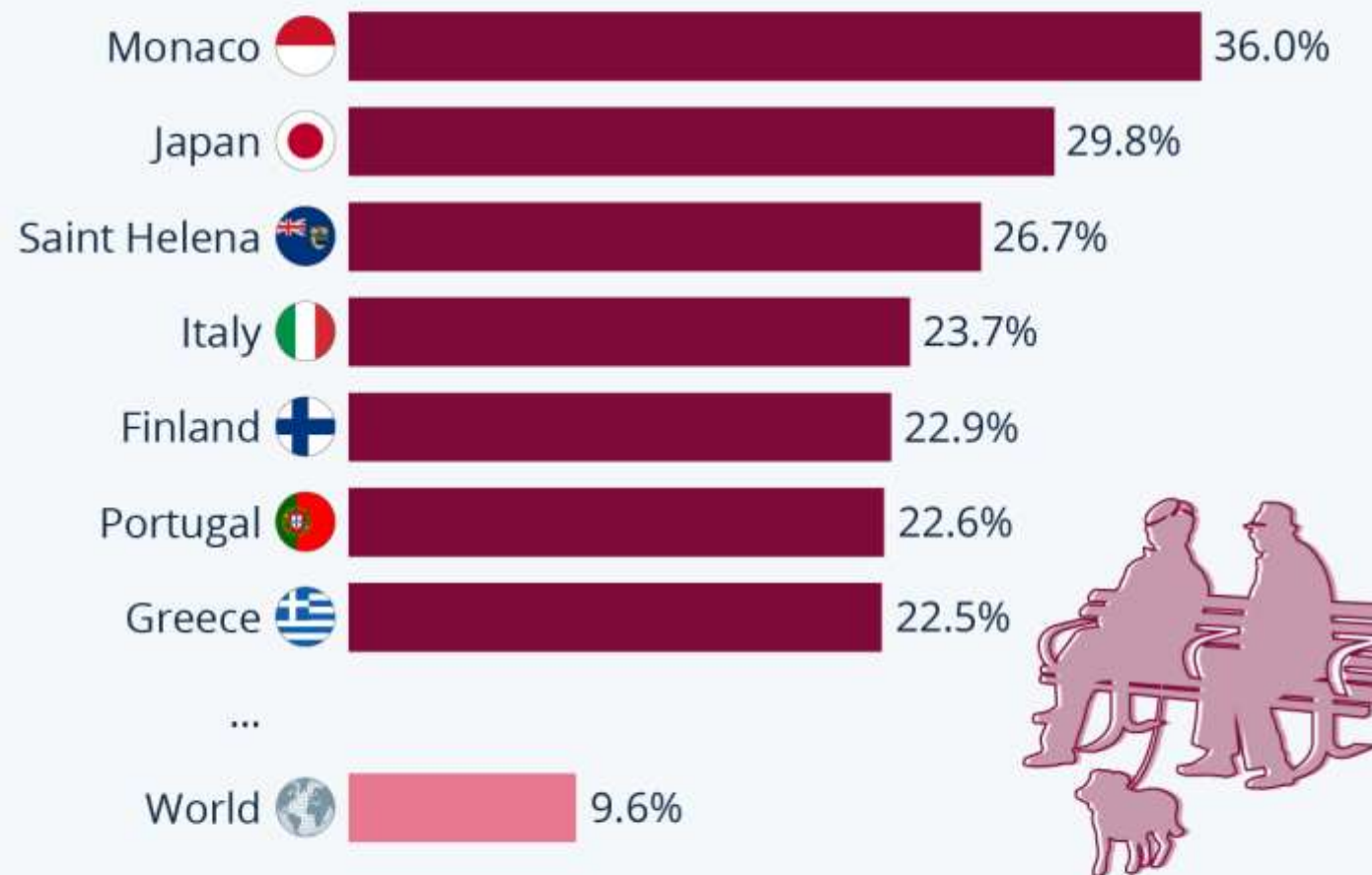
The population of people aged 65 and above is rising in every country, and will continue to do so in the future



Visualization: Pablo Alvarez | Source: United Nations World Population Prospects (2022) (via OurWorldInData.org)

The World's Aging Societies

Estimated share of population aged 65+ in 2021
by country/area



Source: United Nations Population Division



Macrotrends: Aging Population

- All countries face major challenges to ensure that their health and social systems are ready to make the most of this demographic shift.
- In 2050, 80% of older people will be living in low- and middle-income countries.
- Beginning in 2020, the number of people aged 60 years and older outnumbered children younger than 5 years.
- Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12% to 22%.
- [https://www.who.int/news-room/fact-sheets/detail/ageing-and-health#:~:text=By%202030%2C%201%20in%206,will%20double%20\(2.1%20billion\).](https://www.who.int/news-room/fact-sheets/detail/ageing-and-health#:~:text=By%202030%2C%201%20in%206,will%20double%20(2.1%20billion).)

Macrotrends: High costs of drugs



- Global spending on prescription drugs in 2020 was expected to be **\$1.3 trillion**. The U.S. will spend \$350 billion. The spending rate is expected to increase at **3-6%** annually worldwide.
- Mainly because of expensive cancer treatments and increases of prescription drug costs.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7311400/>

Macrotrends: High costs of drugs



- Most pharmaceutical spending per capita: U.S.A., Germany, Canada, Korea, Switzerland, France
- In 2022, U.S. prices across all drugs were 2.78 times higher than comparison countries.
- Most new drugs were available first in the U.S. before being launched in other countries.
- Causes of high drug prices (U.S.): monopoly, research and development, patent laws, lobbying power of pharmaceutical companies, greed.
- <https://aspe.hhs.gov/reports/comparing-prescription-drugs>

U.S. Drug Prices Sky-High In International Comparison

Percentage by which the prices of U.S. prescription drugs surpass those in other selected countries



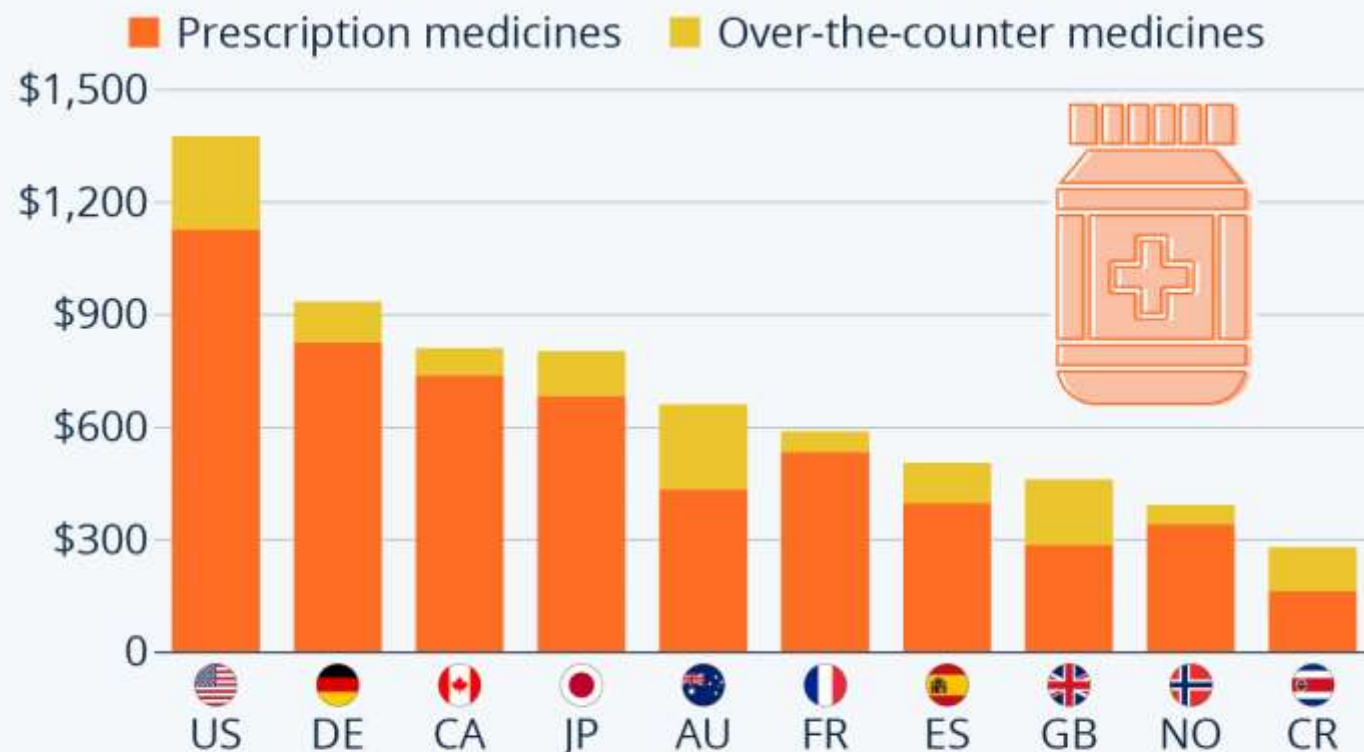
2019-2021 analysis of 2018 prices

Source: Rand Corporation



Americans Spend Much More on Pharmaceuticals

Per-capita expenditure on pharmaceuticals in selected OECD countries in 2019*

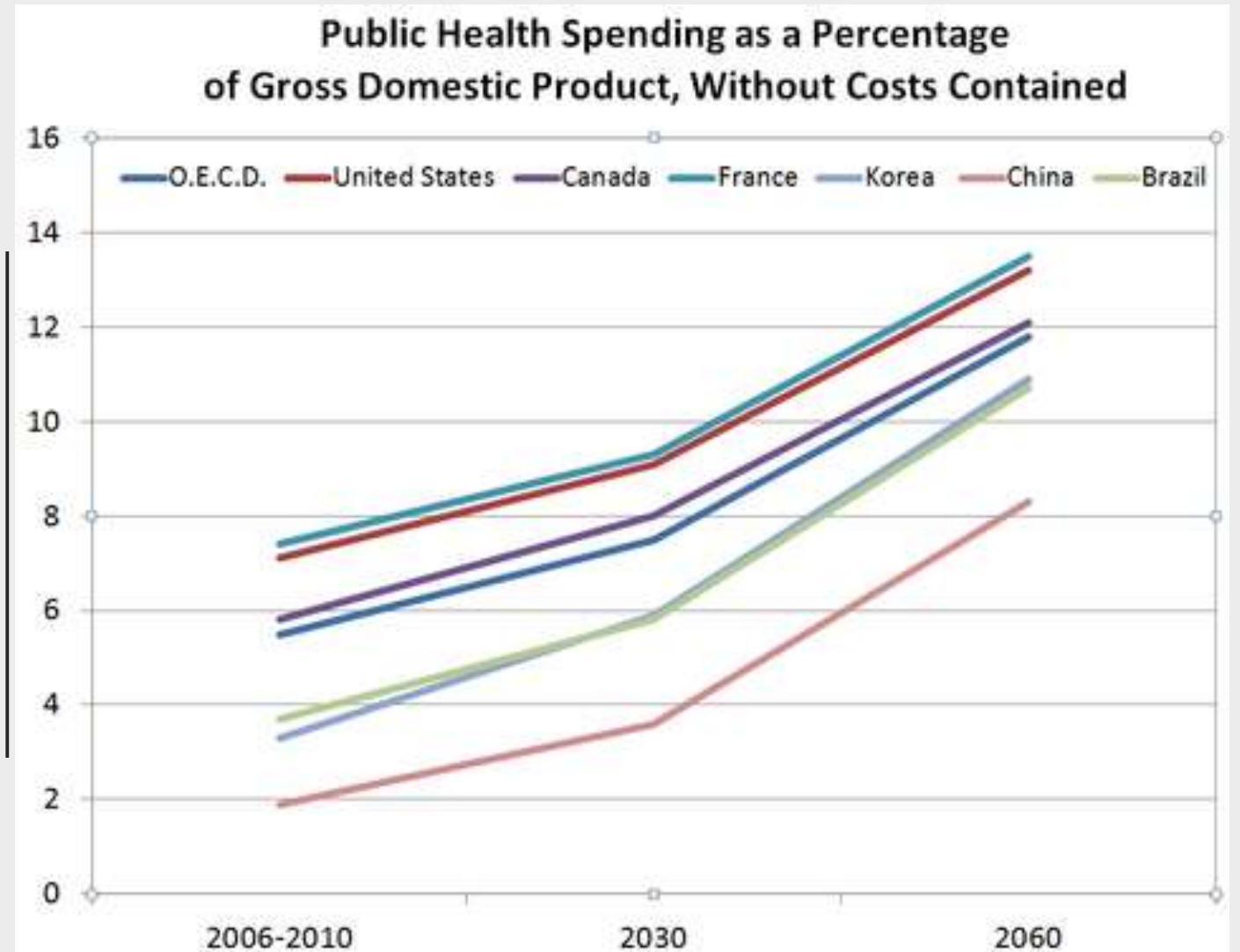


* or latest available. Adjusted for purchasing power parity

Source: OECD



Macrotrends:
Rising cost of
care



Macrotrends: Rising costs of health care

- Because of the pandemic, sharp increases in government spending on health at all country income levels underpinned the rise in health spending to a new high of \$9 trillion (approximately 11% of global GDP).
- Government health spending generally increased and offset declines in out-of-pocket spending.
- Causes: Overuse of care, underuse of prevention, global inflation
- <https://www.who.int/publications/i/item/9789240064911>

Macrotrends: Incidence of chronic diseases



- The number of chronic diseases is rapidly increasing worldwide and is not limited to the developed regions of the world.
- If trends continue by around 2050 chronic diseases such as cardiovascular diseases, cancer, diabetes and respiratory illnesses – will account for 86 per cent of the 90 million deaths each year: a staggering 90 per cent increase in absolute numbers, since 2019.

➤ <https://news.un.org/en/story/2023/05/1136832#:~:text=Despite%20overall%20health%20progress%2C%20WHO,a%20staggering%2090%20per%20cent>



Mental health conditions are widespread



Macrotrends: Mental Health

- In 2010 **970 million people globally were living** with a mental disorder, with anxiety and depression the most common.
- Mental health is determined by a complex combination of individual, social and structural stresses and vulnerabilities.
- Mental and substance use disorders are some of the leading causes of disability and financial loss globally. This increases the risk of suicide and human rights violations.
- Affordable, effective and feasible strategies exist to promote, protect and restore mental health and the need for action is urgent.
- https://www.who.int/health-topics/mental-health#tab=tab_1



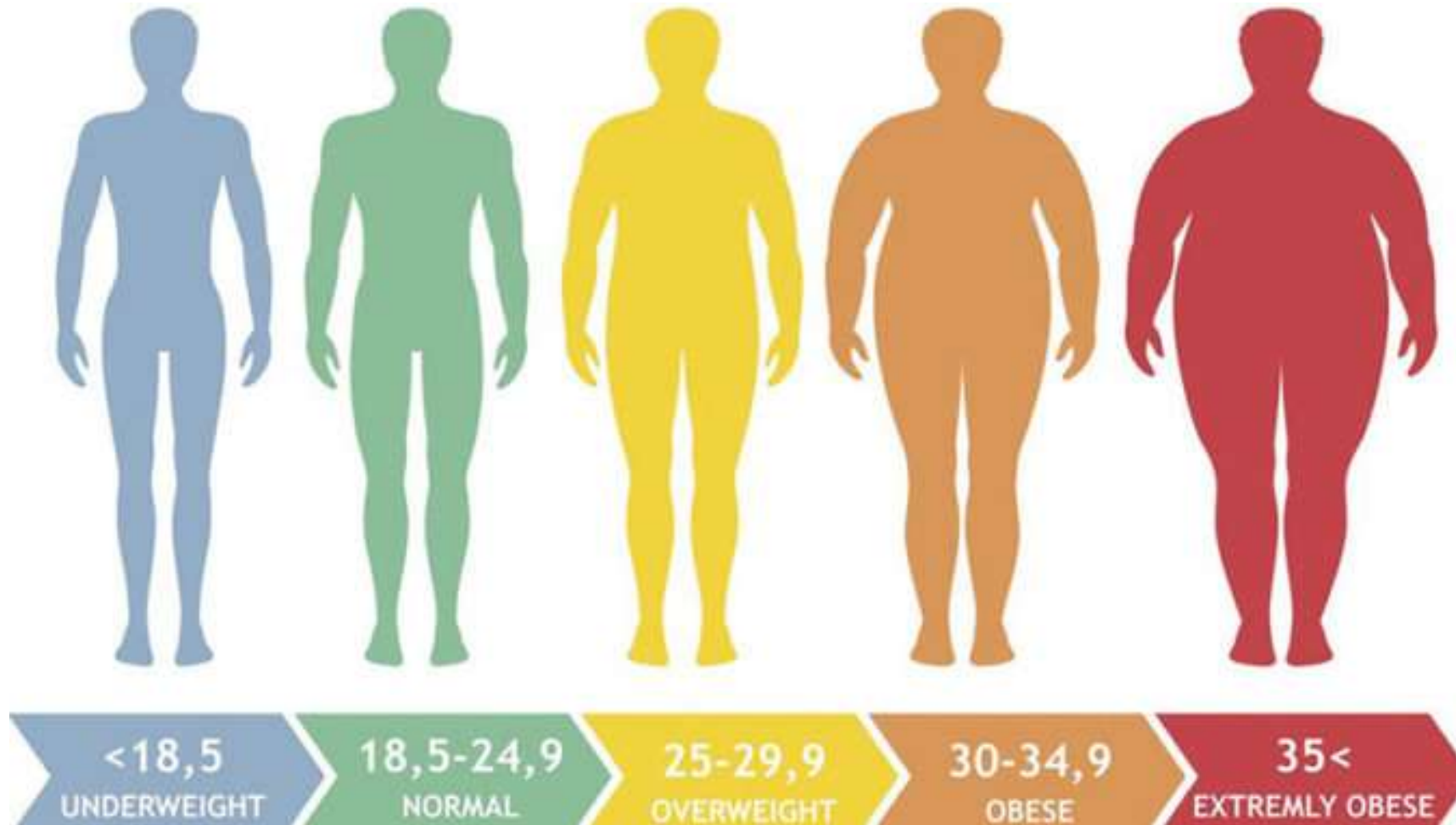
Macrotrends: Shortage of health professionals

- Exacerbated by the pandemic, many countries do not have the health care workers required to deliver quality health care.

Macrotrends: Shortage of health professionals

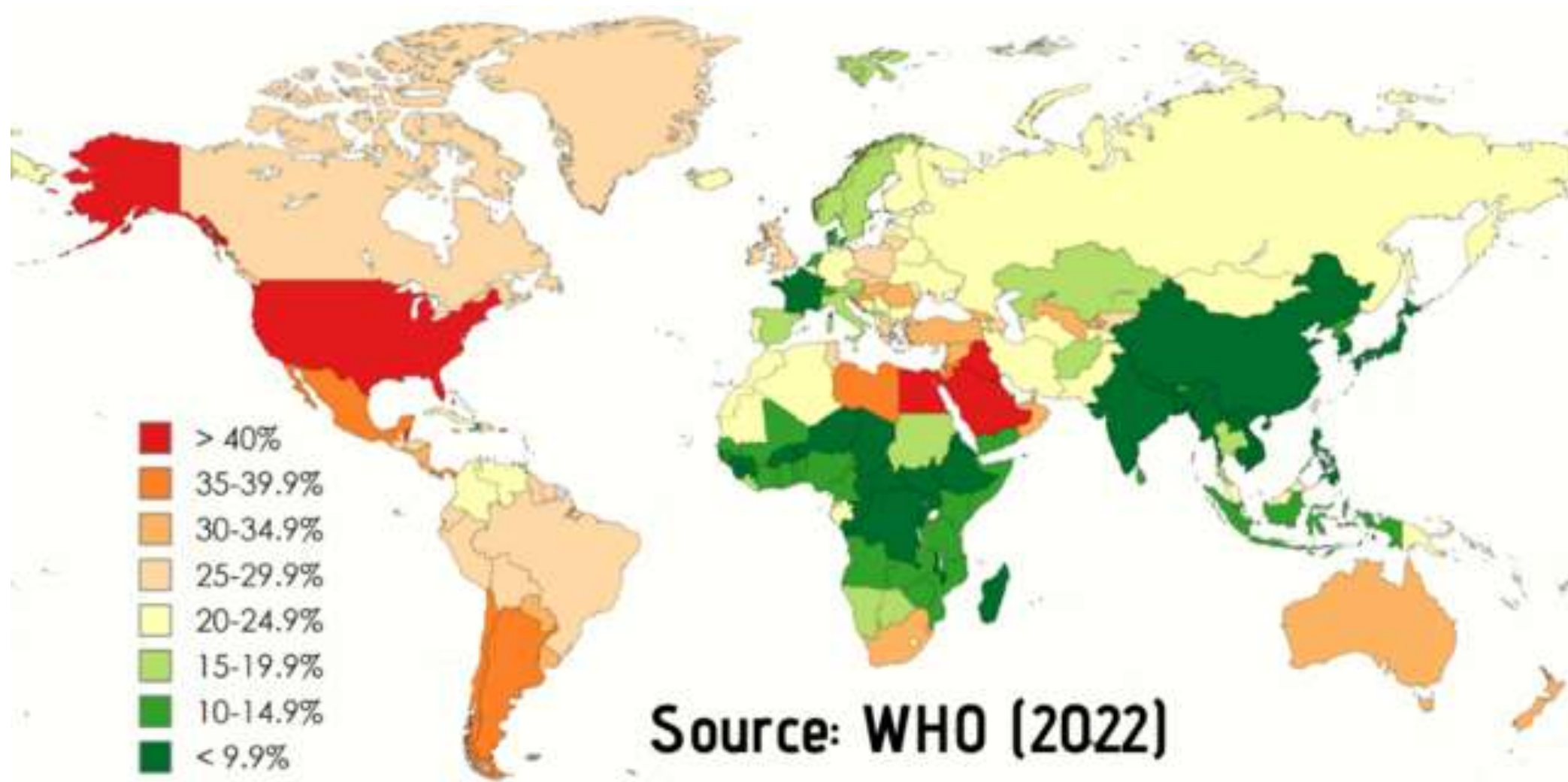
- In 2020, the global workforce stock was 29.1 million nurses, 12.7 million medical doctors, 3.7 million pharmacists, 2.5 million dentists, 2.2 million midwives and 14.9 million additional occupations, tallying to **65.1 million health workers**.
- It was not equitably distributed with a 6.5-fold difference in density between high-income and low-income countries. The projected global health workforce size by 2030 is **84 million health workers**.
- The shortage is primarily in low and middle-income countries. Urgent and extreme action is needed now to improve recruitment and retention.
- <https://gh.bmj.com/content/7/6/e009316>

Macrotrends: Obesity worldwide



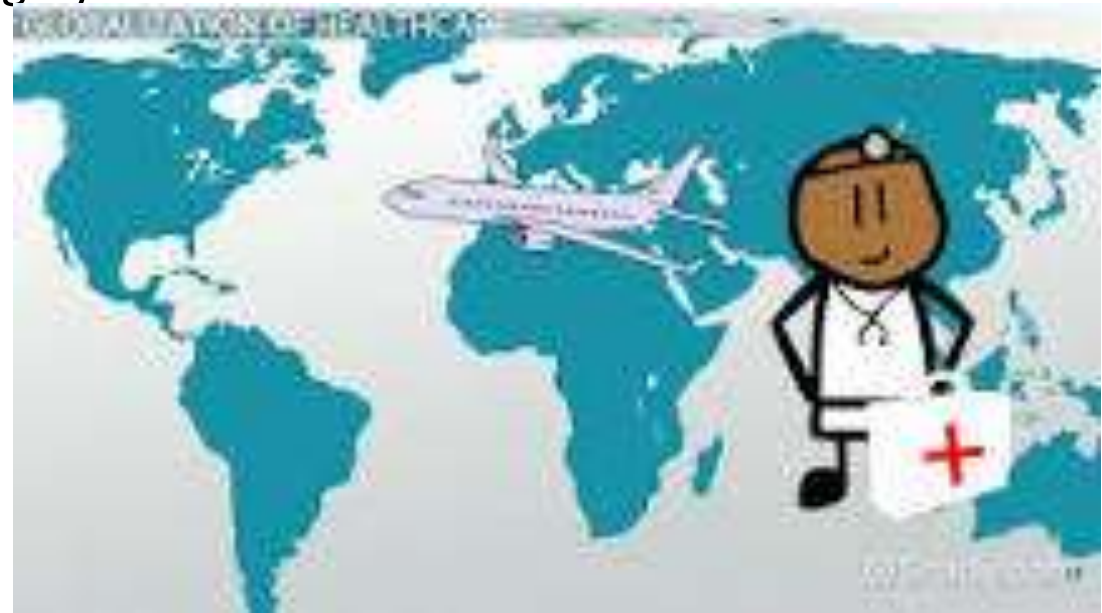
Macrotrends: Obesity worldwide

- Worldwide obesity has more than doubled since 1990, and adolescent obesity has quadrupled.
 - In 2022, more than 2.5 billion adults, 18 years and older, were overweight or obese.
 - In 2022, 1 in 8 people in the world were obese.
 - In 2022, 37 million children under the age of 5 were overweight.
 - Most of the world's population live in countries where being overweight or obese kills more people than being underweight.
 - Is obesity preventable?
- <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>



Macrotrends: Globalization

- Globalization – collaborative exchange of ideas, knowledge, medicines, research and care internationally.
 - Example – Gates Foundation distributing and developing vaccines to prevent the global burden of epidemics especially in Africa
 - Example – Medical tourism
 - Costa Rica especially dentistry and plastic surgery
 - 9 Billion \$ industry in India





Macrotrends: Globalization

- Interaction and integration among people, companies, and governments worldwide
- Global communications
- Travel
- Trade agreements
- Flow of ideas
- Spread of disease
- <https://vittana.org/19-advantages-and-disadvantages-of-globalization>

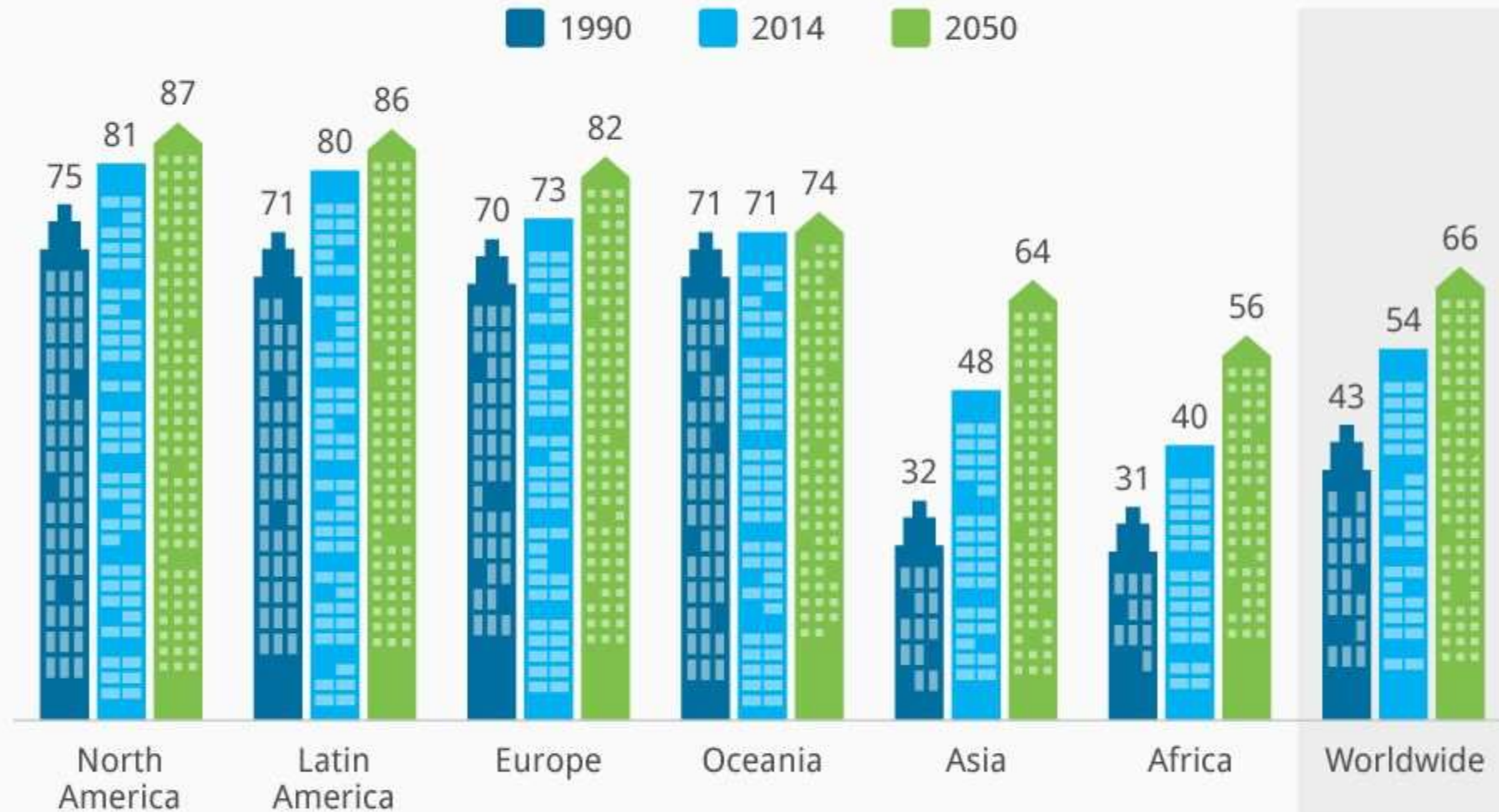
Macrotrends: Climate change



- Causing catastrophic harm to health because of warming of the planet and extreme weather events.
- Disruption of the food supply chain. increases in zoonoses. changing patterns of vector-borne diseases. worsening air and water quality. disruption in access to healthcare delivery, rising mental health issues, humanitarian crises.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10016220/#:~:text=Robust%20early%2Dwarning%20systems%20that,cause%20disruption%20of%20medical%20services.>

54% of the World's Population Now Lives in Cities

% of the population living in urban areas



Source: United Nations

Macrotrends: Climate Change and Urbanization

- Global temperature increase
- Shifting weather patterns
- Reducing greenhouse gases
- Converting to renewable energy sources
- <https://www.un.org/en/sections/issues-depth/climate-change/>



Climate change

Health risk

Vulnerability factors

- Demographic
- Geographical
- Biological factors & health status
- Sociopolitical
- Socioeconomic
- Health system capacity
- Gender & equity

Climate-related hazards

- Extreme weather events
- Heat
- Sea level rise
- Air pollution
- Vector distribution & ecology
- Water scarcity
- Reduced food production

Exposure

- People & communities
- Health workforce
- Infrastructure
- Energy systems
- Water systems
- Food systems
- Health systems

Environmental threats
and GHG emissions

Health outcomes



Injury and mortality
from extreme
weather events



Heat-related
illness



Respiratory
illness



Water-borne diseases
and other water-related
health impacts



Zoonoses



Vector-borne
diseases



Malnutrition
and food-borne
diseases



Noncommunicable
diseases (NCDs)



Mental and
psychosocial
health



Impacts on
health care
facilities



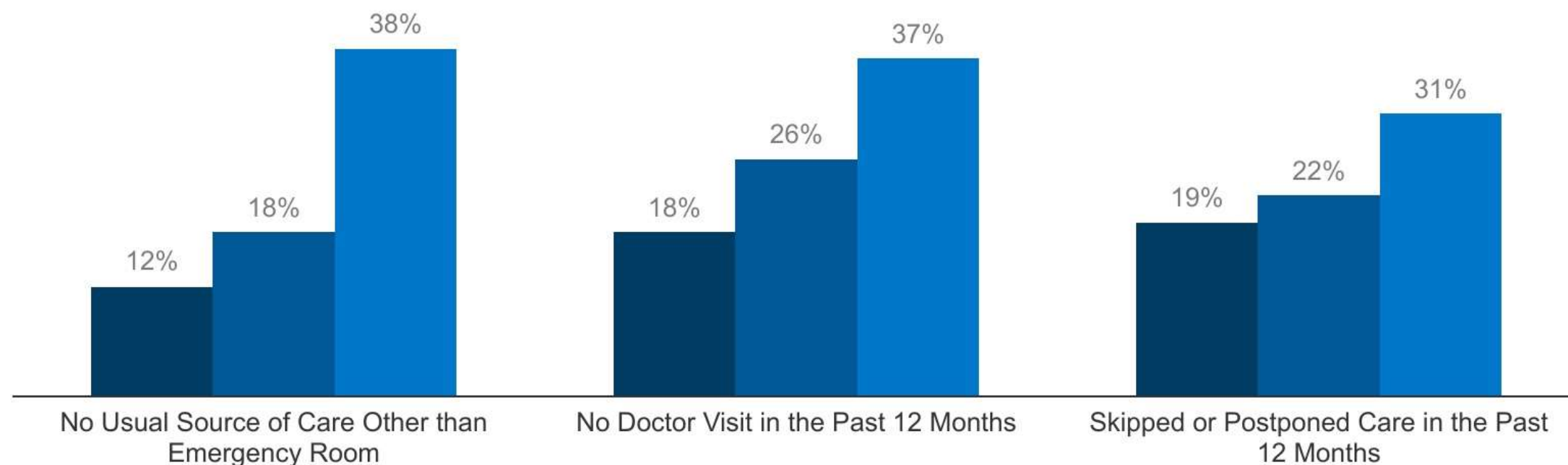
Effects on
health systems

Macrotrends: Immigration and Urbanization

- In the U.S., typically, immigrants do not have health insurance and use less health care services. (11 million people)
 - European countries have aspirations for equitable care between migrants and non-migrants but disparities continue because of access and legal challenges. (5-8 million people)
 - Urbanization has improved public health by reducing death rates and increasing life expectancy at birth according to one WHO study. However, urban development can magnify the risk of environmental hazards such as flash flooding and greater air pollution.
-
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9852986/>

Health Care Access and Use among Immigrant Adults by Immigration Status, 2023

■ Naturalized Citizens ■ Lawfully Present Immigrants ■ Likely Undocumented Immigrants



NOTE: All differences between likely undocumented immigrants and lawfully present immigrants/naturalized citizens are statistically significant at $p < 0.05$. Difference in doctor's visit in the past 12 months between lawfully present immigrants and naturalized citizens also is statistically significant at $p < 0.05$.

SOURCE: KFF/LA Times Survey of Immigrants (April 10 - June 12, 2023)

KFF

Macrotrends impacting technology

- Mobile phones
- Large companies getting involved – Amazon, Apple, Google, Facebook, Microsoft
- Machine learning and artificial intelligence
 - Availability of R&D funding
 - Lower barriers to entrepreneurship
 - Regulatory and government changes
 - Others?



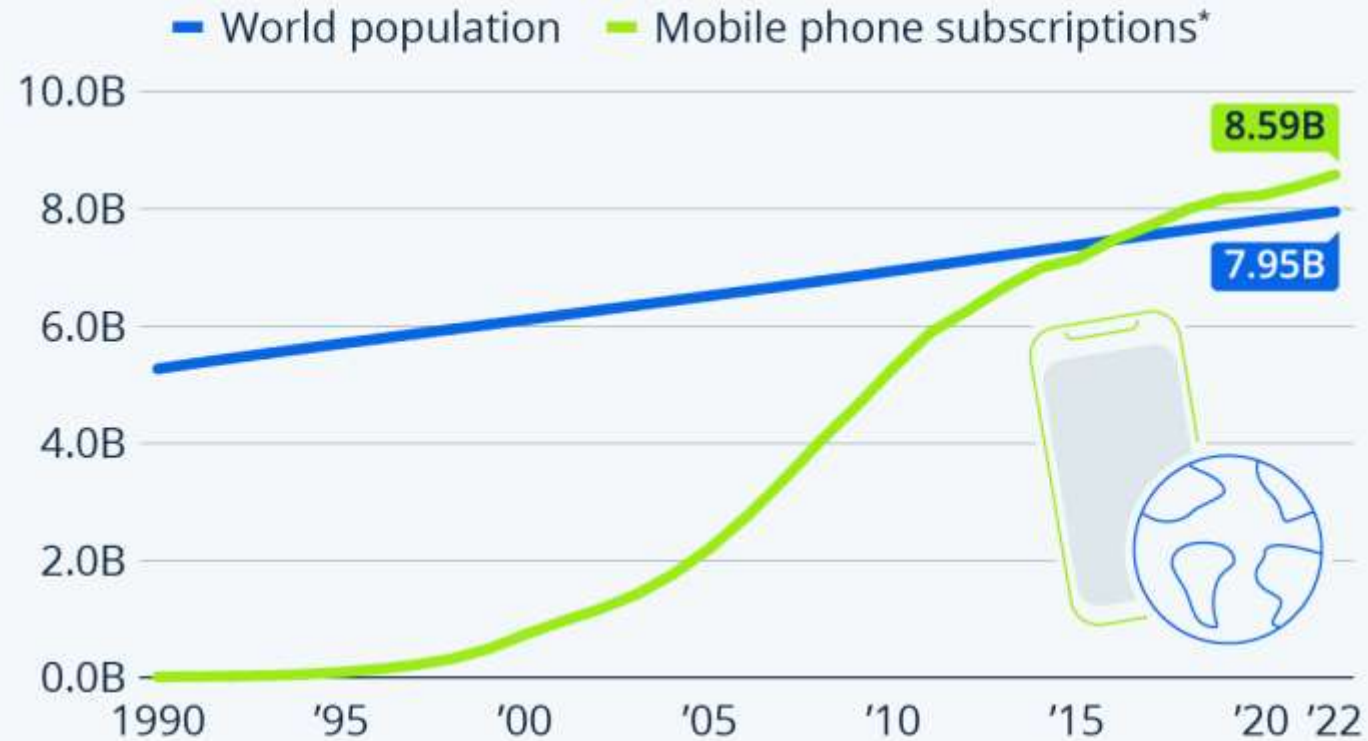


Macrotrends: Ubiquitous mobile phones

- Over 50 years since the very first mobile phone call.
- There were more than 8.58 billion mobile subscriptions in use worldwide in 2022, compared to a global population of 7.95 billion.
- The number of mobile devices is expected to reach **18.22 billion by 2025**.
- <https://www.weforum.org/agenda/2023/04/charted-there-are-more-phones-than-people-in-the-world/#:~:text=According%20to%20the%20International%20Telecommunication,billion%20halfway%20through%20the%20year.>

More Phones Than People

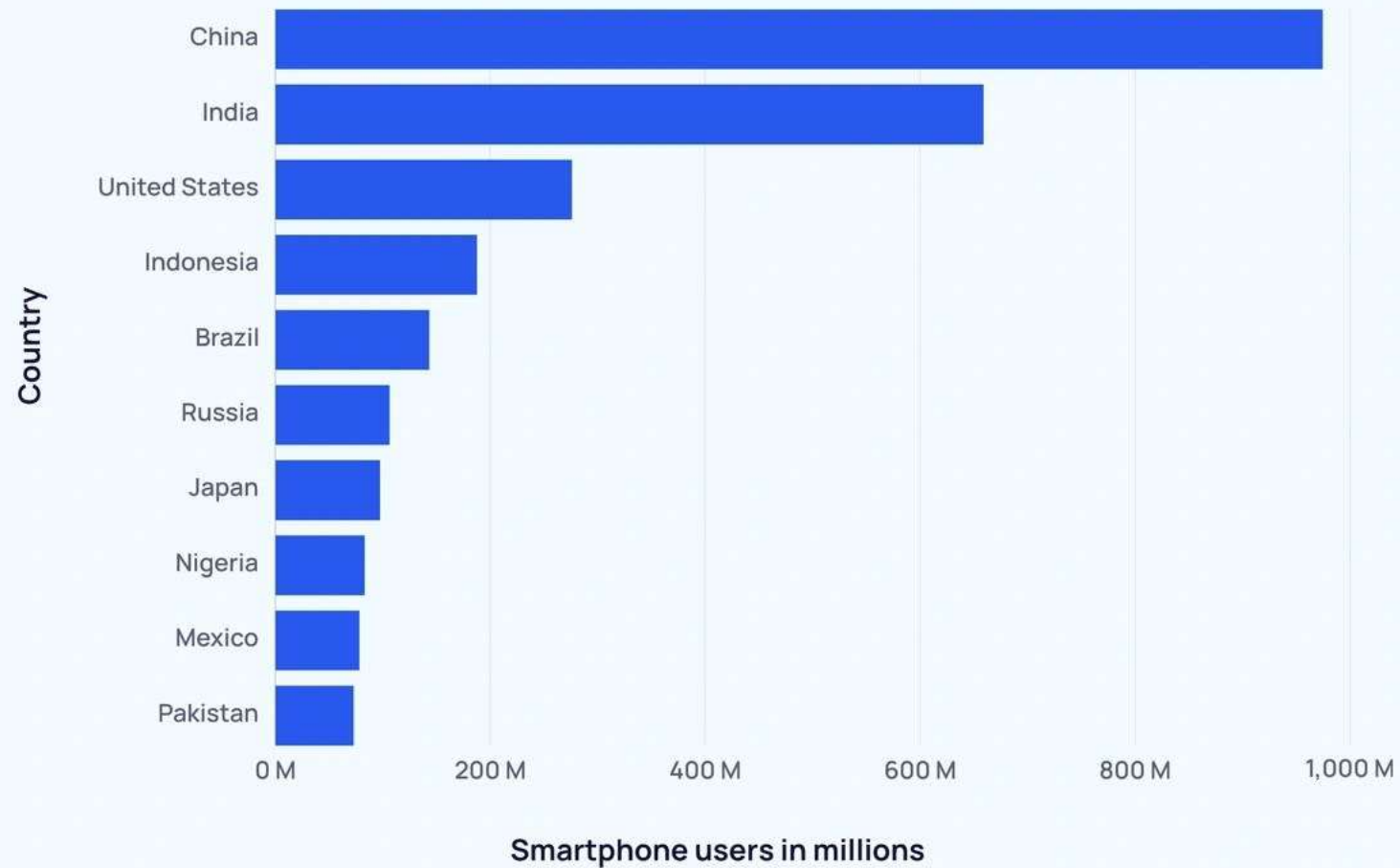
Estimated number of mobile-cellular phone subscriptions vs. world population estimates



* includes postpaid and active prepaid subscriptions that offer voice communications; excludes subscriptions via data cards or USB modems, radio paging and telemetry services

Sources: ITU, World Bank, UN Population Division

Active smartphone users by country



<https://explodingtopics.com/blog/smartphone-stats>

Macrotrends: Large companies involved in health care

- GoogleHealth: <https://health.google/the-check-up/#latest-events>
 - (2min) <https://health.google/the-check-up/#latest-events> (10 min)
- Amazon: Prime one medical, Amazon pharmacy, Amazon clinic.
 - Have a tooth ache?
 - <https://health.amazon.com/>
- Apple:
 - **HealthKit (2014)** provides a central repository for health and fitness data on iPhone and **Apple Watch**.
 - **ResearchKit (2015)** helps medical researchers gather robust data for studies.
 - **CareKit (2016)** is an open source framework for developing apps, by creating dynamic care plans and tracking symptoms.
 - **Glimpse** – patient information data-gathering and medical data management
- Facebook: <https://www.facebook.com/Health/>

Macrotrends: AI in healthcare

(much more discussion later in the course)



- Announcements just this past week....
- Agentic AI –automate tasks but make autonomous decisions to meet established goals
 - Open AI, Google, DeepSeek
 - NVIDIA and IQVIA – automation in clinical research workflows
 - Vantiq – Agentic AI for ICU capacity management, equipment availability and care team coordination.
 - Sword Health – AI agent, Phoenix, leads digital physical therapy sessions

Macrotrends: AI in Healthcare (much more discussion later in the course)

- Uses: Disease detection, personalized treatment plans, automate processes, clinical decision support tools, drug discovery and development, improve the accuracy of medical imaging analysis, eg, identify abnormalities in CT scans, X-rays, and MRIs.



Macrotrends: AI in Healthcare

- Example: Reading mammograms
 - In Sweden, a study of 80,000 women at Lund University undergoing AI-supported mammography resulted in 20% more cancers detected and a 44% decrease in workload.
 - [AI-supported mammography screening is found to be safe | Lund University](#)
 - [https://www.thelancet.com/journals/lanonc/article/PIIS1473-3045\(22\)00208-X/abstract](https://www.thelancet.com/journals/lanonc/article/PIIS1473-3045(22)00208-X/abstract)
- Example: AI-powered virtual assistants to personalize medical experiences
 - AIDAVA (2 min) [virtual assistant AI medical - Google Search](#)
 - https://www.google.com/search?q=virtual+assistant+AI+medical&rlz=1C1JZAP_enUS848US849&oq=virtual+assistant+AI+medical&gs_lcrp=EgZiaHJvbWUvBggAEEUYOTIHCAEQIRigATIHCAIQIRigATIHCAMQIRigATIHCAOOIRigATIHCAUQIRigAdIBCiE3OTA4aiBqMTWoAgiwAgE&sourceid=chrome&ie=UTF-8#fnctate-ive&vld=cid:c5d18ch2_vid:oRLB7iBDYnw,st:0
 - <https://docus.ai/ai-health-assistant>

Macrotrends: AI in Healthcare (more later)



American neurotechnology company that has developed and implantable brain-computer interface (BCI).

The company implanted a (BCI) device named Telepathy in a quadriplegic human (dislocated C4 and C5 spinal vertebrae) and subsequently the patient was able to control a computer mouse and control music and play games.

<https://www.bing.com/videos/riverview/relatedvideo?&q=telepathy+neuralink+patient+use&&mid=2A8B21FB6DA31E088A402A8B21FB6DA31E088A40&&FORM=VRDGAR>



Macrotrends: AI in Healthcare

(much more discussion later in the course)

- **Challenges:** Informed consent to use data and data confidentiality and privacy, training clinicians to understand risks and benefits, bias, oversight, workforce displacement.
- AI could perpetuate unfair biases if not trained with diverse data sets, eg researchers have noted medical imaging applications that have done a worse job at detecting skin cancer in dark-skinned patients.
 - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10224020/>
- Similarly, algorithms trained with gender imbalanced data do worse at reading chest X-rays for an underrepresented gender.
 - <https://pubs.rsna.org/doi/full/10.1148/ryai.230060#:~:text=Conclusion,be%20unsafe%20for%20clinical%20applications.>

Summary Things to Know

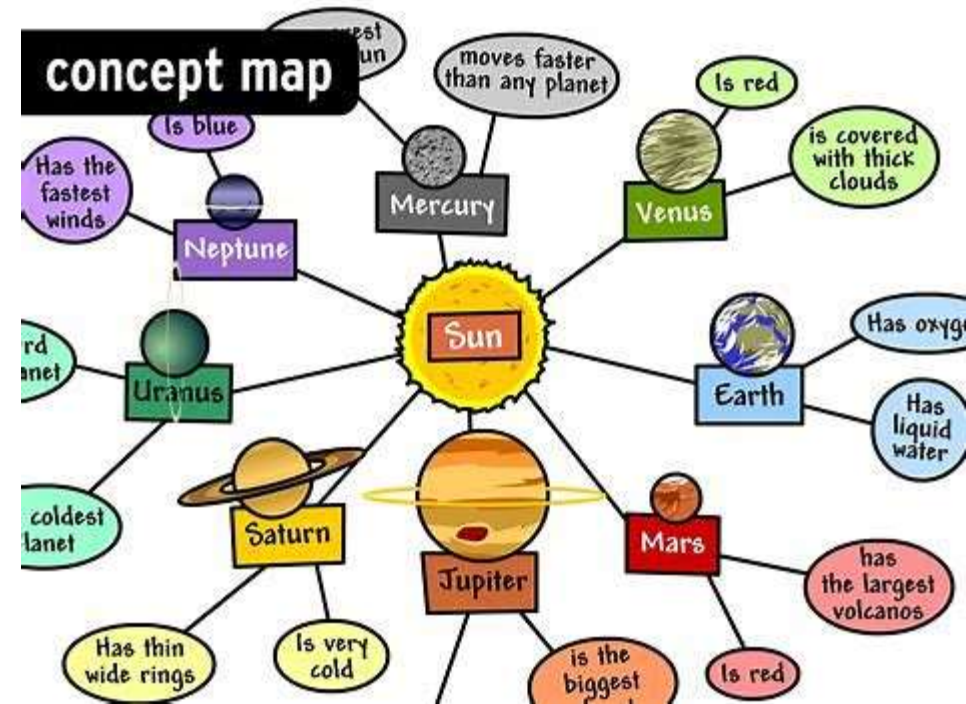
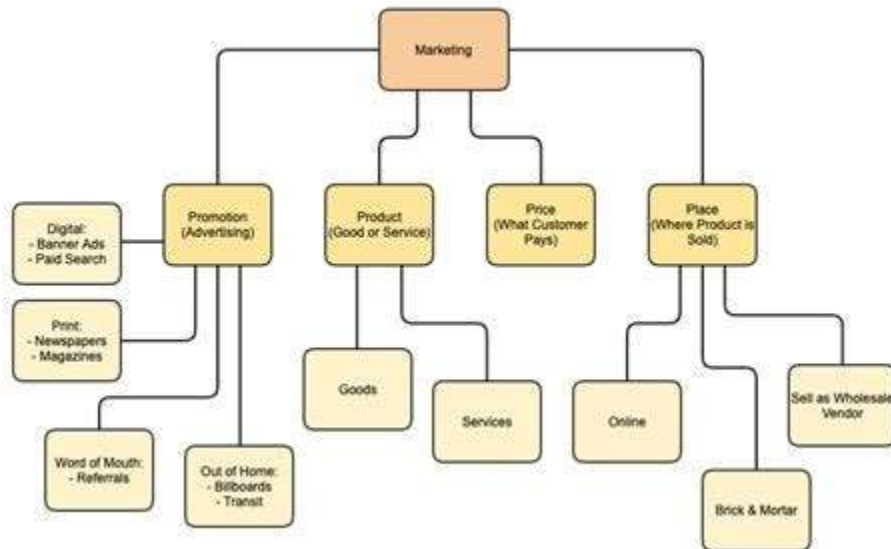
- Explain drivers of innovation in healthcare around the world
- How do macrotrends impact health technology – are they positive or negative?



summary

Concept Map – votes and prizes for the winner

- There are so many factors influencing innovation in health care technology; create a chart, a map, a diagram, a puzzle or other creative way to display the terms.



Group Project



- Assemble your team!
- Brainstorm your topic (see the 6 ideas in the syllabus)
- Assign roles (research, presentation)
- Determine timeline
- Ready, set, go.
- Presentations on April 28, 300 points of your grade

Next week

➤ Read journal article:

- GPT-4 in a Cancer Center, NEJM AI 2024; 1(4)