

Global Impact of Cancer

Cancer burden, population trends, and disparities

Pathology and cancer epidemiology

Dr Abu Suraih Sakhri

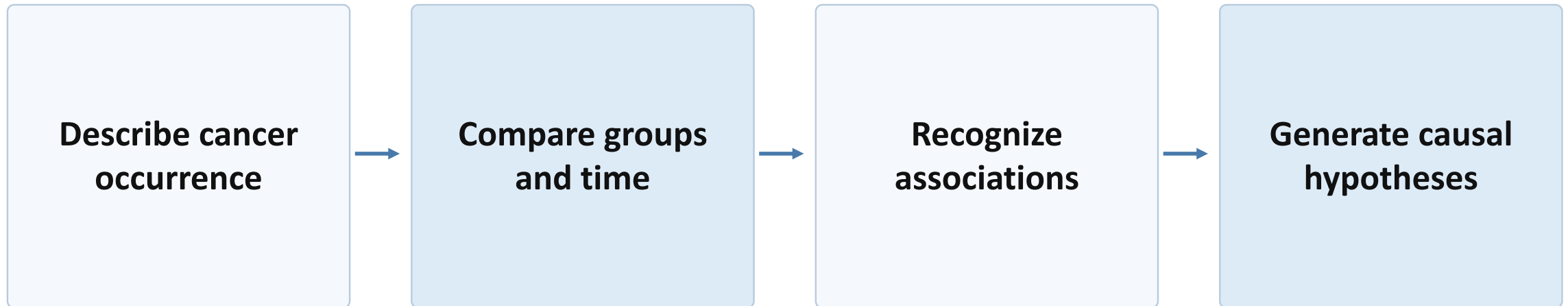
MBBS, MD (Pathology)

www.abusuraihsakhri.com

Learning outcomes

- Distinguish incident cancer cases, cancer deaths, and age-adjusted rates.
- Interpret the worldwide burden and projected demographic pressure reported.
- Compare leading cancer sites and cancer mortality by sex in the U.S.
- Explain major historical mortality trends, screening effects, and inequities.

Why cancer epidemiology matters



Population patterns complement morphological and molecular observations.

Association alone is not proof of causation.

Four dimensions of cancer burden

Occurrence

- New diagnoses within a period
- Relative distribution of tumor sites

Outcome

- Cancer-attributed deaths
- Mortality trends across time

Counts and rates answer different questions.

Incidence is not mortality

Incidence

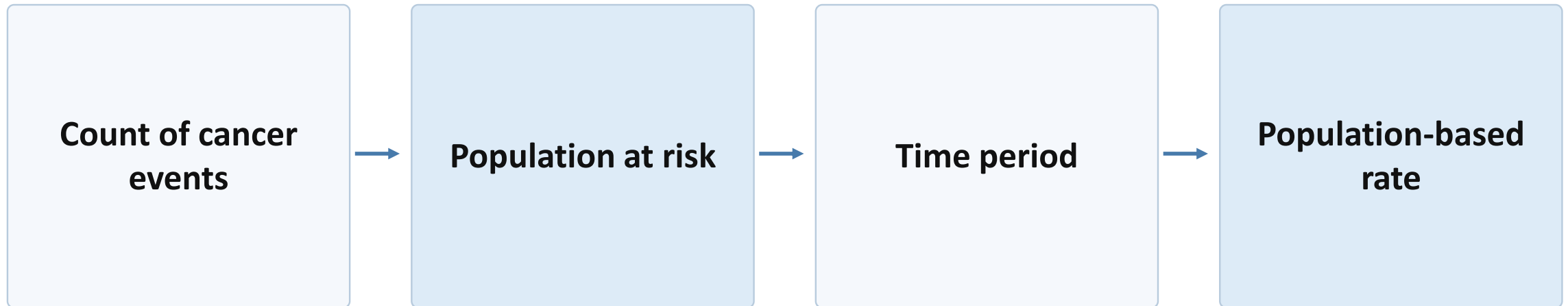
- New cancer diagnoses
- Reflects occurrence and detection
- May rise even if survival improves

Mortality

- Deaths attributed to cancer
- Reflects lethality and clinical care
- Can decline while incidence is stable

Avoid ranking cancer lethality from diagnosis counts alone.

A count needs a population context



Cancer counts describe workload; Rates facilitate comparisons.

What an age-adjusted death rate means

- The textbook expresses age-adjusted cancer mortality as deaths per 100,000 population.
- Adjustment supports comparisons when populations have different age structures.
- A change in deaths can reflect both changing rates and changing population size.
- Specify age-adjustment when interpreting long-run mortality trends.

Age adjustment is not the same as an absolute death count.

Absolute burden versus underlying risk

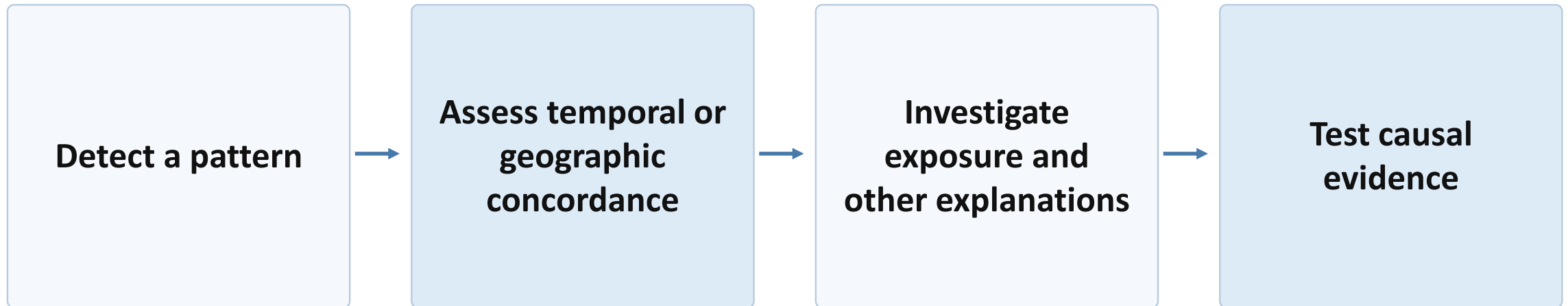
Absolute count	Age-adjusted rate
• Affected by population size • Affected by population age composition • Relevant to health-system capacity	• Standardizes age structure • Useful for temporal comparisons • Does not itself measure total service demand

A falling standardized rate can coexist with a growing total burden.

Read every cancer statistic with its denominator

- Identify geography: Worldwide or U.S.
- Identify sex, age strata, and tumor site.
- Identify calendar year and whether values are observed, estimated, or projected.
- Check exclusions such as nonmelanoma skin cancer and in situ tumors.

How population patterns inform etiology



Smoking–lung cancer and diet–colon cancer as epidemiologic examples.

Avoid treating ecological associations as proof

- Regional differences suggest candidate determinants; They do not identify an individual cause.
- Calendar trends may involve both exposure changes and medical care.
- Health-care access and diagnostic practices can affect measured incidence.
- Use population findings to frame, not replace, causal investigation.

Worldwide cancer mortality burden in 2020

>9.9

Million estimated cancer deaths worldwide

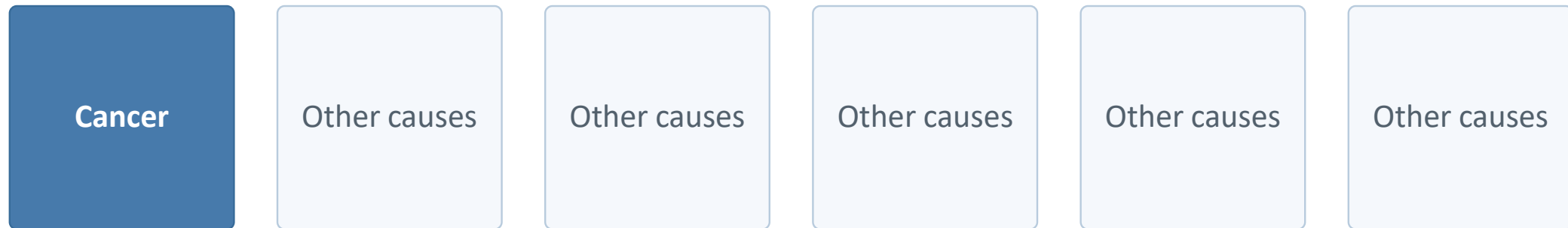
≈1 in 6

Of all deaths were attributed to cancer

Both figures refer to 2020 worldwide estimates.

Interpreting “nearly one in six deaths”

Cancer accounted for nearly one-sixth of all deaths worldwide in 2020.



Schematic approximation of a fraction — not six equally sized epidemiologic populations.

The textbook's worldwide projection for 2030

21.4

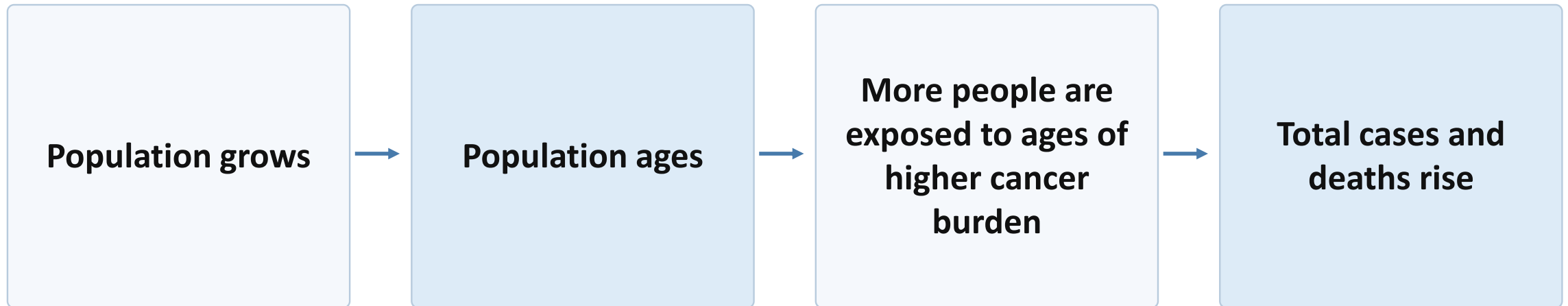
Million new cancer cases projected

13.2

Million cancer deaths projected

These are projections reported, not independently updated surveillance estimates.

Why projected global counts increase



Population growth and aging as the stated drivers.

These figures are projections, not observed 2030 outcomes.

A projection is not a measured outcome

Estimate for 2020

- Global deaths: Over 9.9 million
- Cancer: Nearly one in six deaths

Projection for 2030

- New cases: 21.4 million
- Deaths: 13.2 million

Do not plot these unlike metrics as one continuous time series.

Three constraints on interpreting projections

- The projected value refers to a future calendar year relative to its modeling assumptions.
- The textbook explicitly emphasizes demographic drivers, not a quantified change in intrinsic cancer risk.
- New cases and cancer deaths have different denominators and clinical meanings.
- A historical projection should not be relabeled as a current global estimate.

Worldwide burden and U.S. Site patterns

Worldwide

- 2020 cancer death burden
- 2030 projected cases and deaths
- Population growth and aging

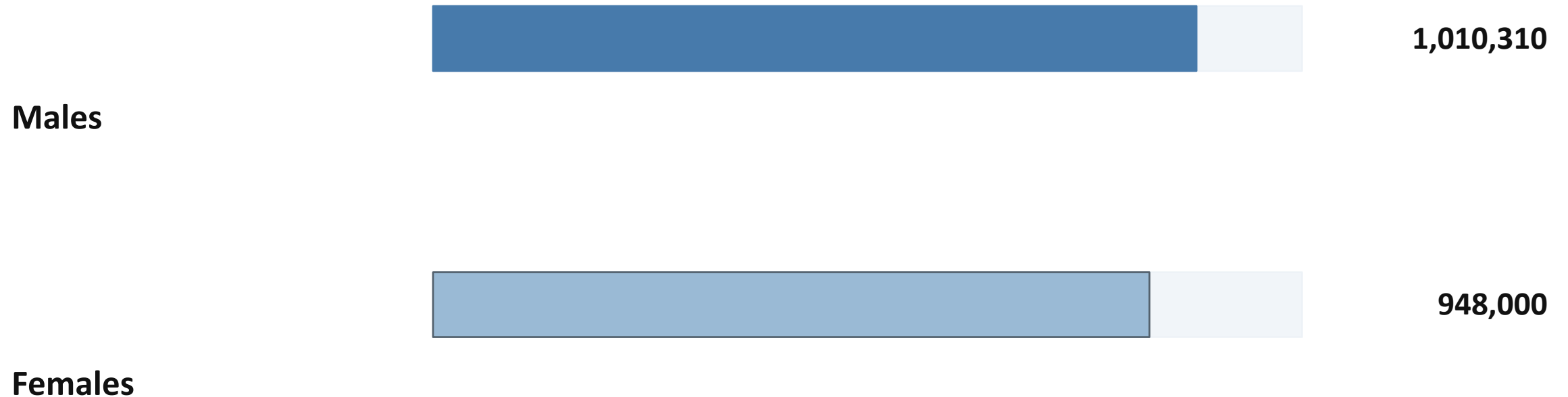
United States

- 2023 sex-stratified diagnoses
- 2023 sex-stratified mortality
- Historical age-adjusted rates

Do not combine worldwide and U.S. Totals as if they share one denominator.

Estimated new U.S. Cancer diagnoses in 2023

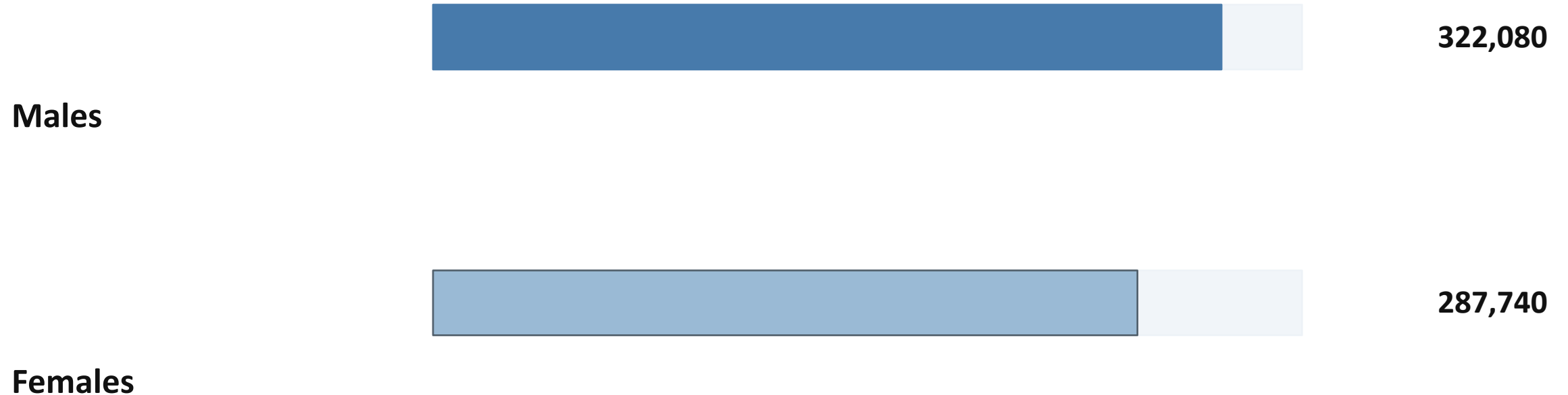
New cases, United States, sex-stratified



Numbers are estimated new cases and exclude the categories stated in Fig. 7.16.

Estimated U.S. Cancer deaths in 2023

Cancer deaths, United States, sex-stratified



Unlike the diagnosis panel, this panel represents mortality.

What the two 2023 U.S. Totals describe

1,958,310

Combined estimated new cases across
males and females

609,820

Combined estimated cancer deaths across
males and females

Derived arithmetic sums; New cases and deaths are different events and must not be divided to estimate individual case fatality.

Why deaths divided by new cases is misleading

Diagnosed during 2023

Died during 2023

Not necessarily the same individuals or diagnosis years

Annual deaths / annual diagnoses is NOT a patient-level survival estimate.

Male cancer diagnosis pattern in the source

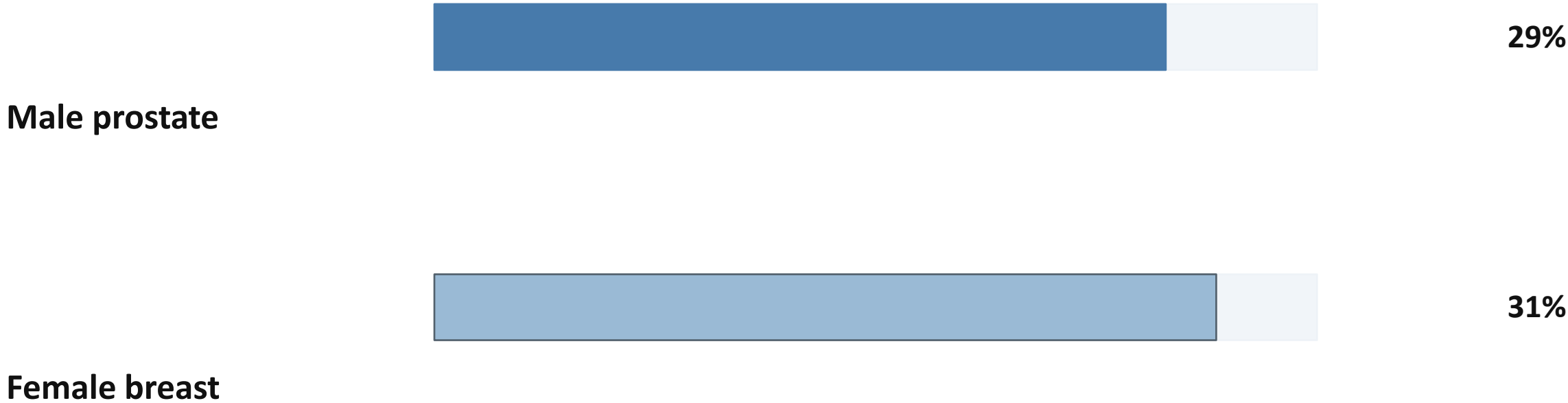
- Prostate is the leading site in the U.S. Male incidence list.
- Lung and bronchus contribute a major share of male diagnoses.
- Colon and rectum are also prominent among male new cases.
- Site frequencies should be interpreted within the male denominator.

Female cancer diagnosis pattern in the source

- Breast is the leading site among U.S. Female diagnoses.
- Lung and bronchus remain prominent among female new cases.
- Colon and rectum are another major component of female incidence.
- The profile differs from the ranking for female cancer deaths.

Dominant sites in sex-specific new diagnoses

Percentage of new diagnoses in 2023



Shares are within each sex and should not be added to a combined percentage.

A core set of sites dominates cancer burden

High-frequency sites

- Lung and bronchus
- Female breast and prostate
- Colon and rectum

Textbook's synthesis

- Together represent >50% of U.S. Diagnoses
- Also >50% of U.S. Cancer deaths
- Distribution differs by sex and endpoint

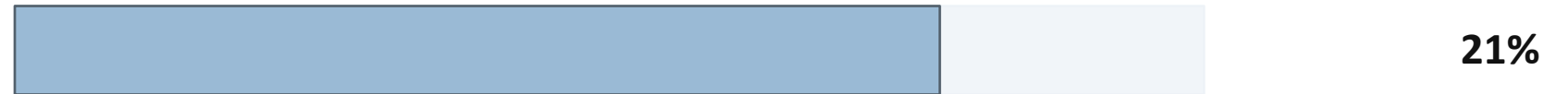
Concentration of burden suggests where population-level prevention and care may matter most.

Lung cancer and 2023 U.S. Mortality

Percentage of cancer deaths within each sex



Males: Lung



Females: Lung

Mortality fractions are cancer-death shares, not lung cancer case-fatality risks.

Cancer incidence and mortality rankings can diverge

Frequent diagnoses

- Breast cancer: High incidence in females
- Prostate cancer: High incidence in males

Prominent mortality

- Lung cancer: Prominent in both sexes
- Mortality distribution reflects more than diagnosis frequency

The leading cancer by diagnoses need not be the leading cancer by deaths.

Why site-specific rankings deserve separate panels

- A diagnosis panel answers which cancers arise most frequently.
- A mortality panel answers which cancers cause the most deaths.
- Neither identifies individual prognosis without further follow-up data.
- Annual counts alone cannot separate stage, treatment, and disease biology.

The female breast–lung paradox

Breast carcinoma

- Occurs about 2.5 times as often as lung carcinoma in women, per Robbins.
- Most frequent new female cancer diagnosis.

Lung carcinoma

- Causes more female cancer deaths than breast carcinoma.
- Lung is a leading category in the death panel.

Incidence and mortality measure different features of cancer burden.

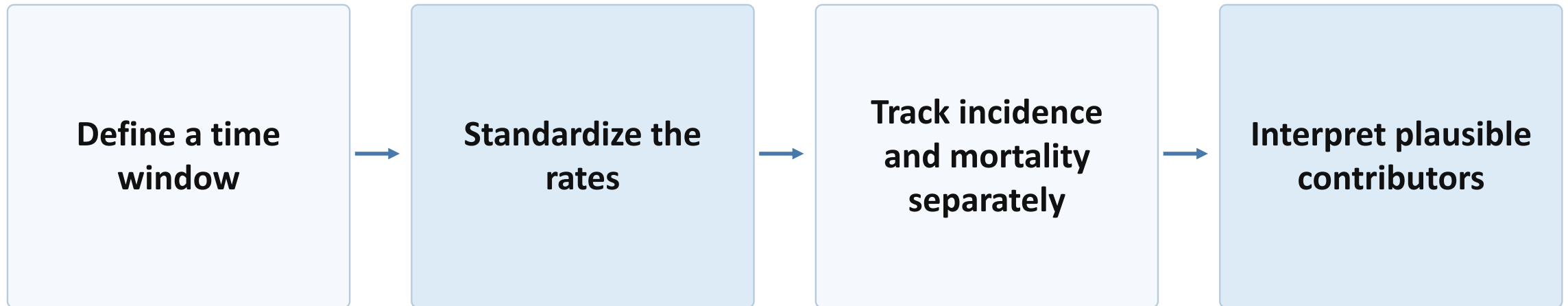
How to read the 2023 figure exclusions

- The source excludes basal cell and squamous cell carcinomas of the skin.
- In situ carcinomas are excluded, except urinary bladder.
- The figure stratifies totals by males and females.
- These design choices define the scope of comparisons and totals.

Why the “all other sites” category matters

- Cancer occurs across many organs beyond the leading listed sites.
- A residual category prevents a site-ranking figure from appearing exhaustive.
- The combined category does not represent one biological cancer entity.
- Never compare a pooled residual category with a specific tumor type as if equivalent.

From burden description to trend analysis



The historical U.S. Series is reported using age-adjusted cancer death rates.

Historical background: Trends were not always favorable

- Age-adjusted cancer death rates increased during the last 50 years of the twentieth century.
- The described subsequent improvement began on different dates for males and females.
- A single long-run trend can therefore hide an important directional reversal.
- Always define both interval and endpoint when reporting change.

Cancer incidence stabilized in the U.S.

Males

- Incidence stable since 1995 account.
- Stability concerns rates, not necessarily absolute new-case counts.

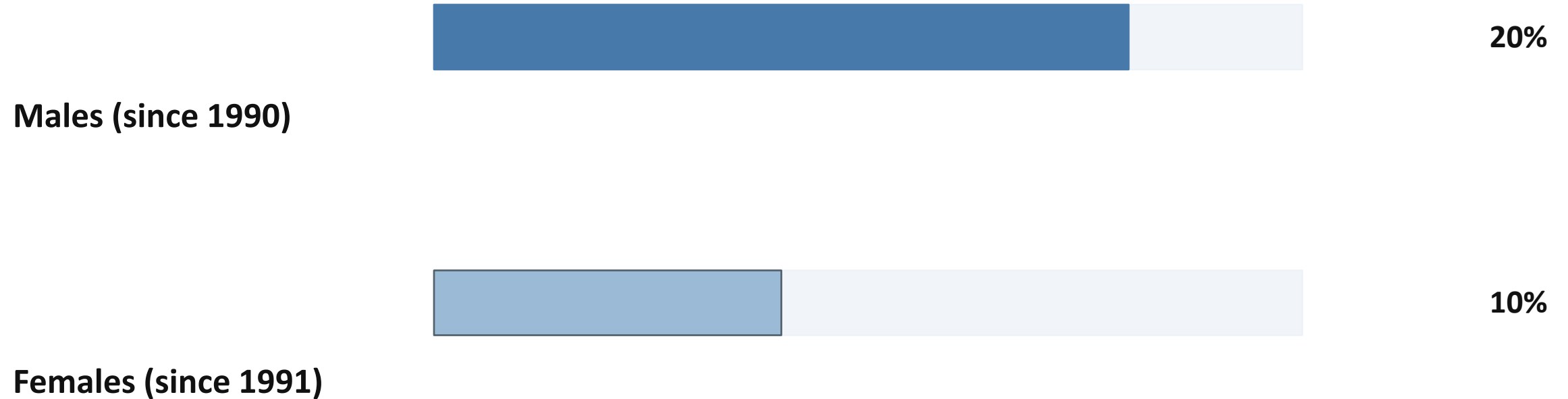
Females

- Incidence stabilized in 1995 account.
- Sex-specific trend requires its own denominator.

Stabilized incidence does not imply that cancer mortality ceased to change.

Reported decline in cancer death rates

Approximate reduction in sex-specific cancer death rates



Historical approximate percent declines as stated by Robbins; Not a comparison of current national rates.

The incidence–mortality decoupling

Incidence observation

- Male and female cancer incidence both stabilized around 1995.
- Incidence measures newly diagnosed cancer.

Mortality observation

- Death rates declined beginning in 1990–1991.
- Reduced deaths can reflect prevention, detection, and treatment.

A stable incidence rate can coexist with improving mortality.

Cancer mortality change is site-dependent

- Improvements in specific cancers contribute disproportionately to total population change.
- Changes in disease exposure can alter future lung cancer mortality.
- Detection and treatment can reduce deaths for selected sites.
- The total mortality trend is an aggregate of heterogeneous cancer types.

Which cancers drove the male mortality decline?

About 80% of the reported male cancer mortality decline



Principal contributing sites:

Lung

Prostate

Colorectal

Share of the decline — not the share of all cancer deaths.

Which cancers drove the female mortality decline?

About 60% of the reported female cancer mortality decline



≈60%

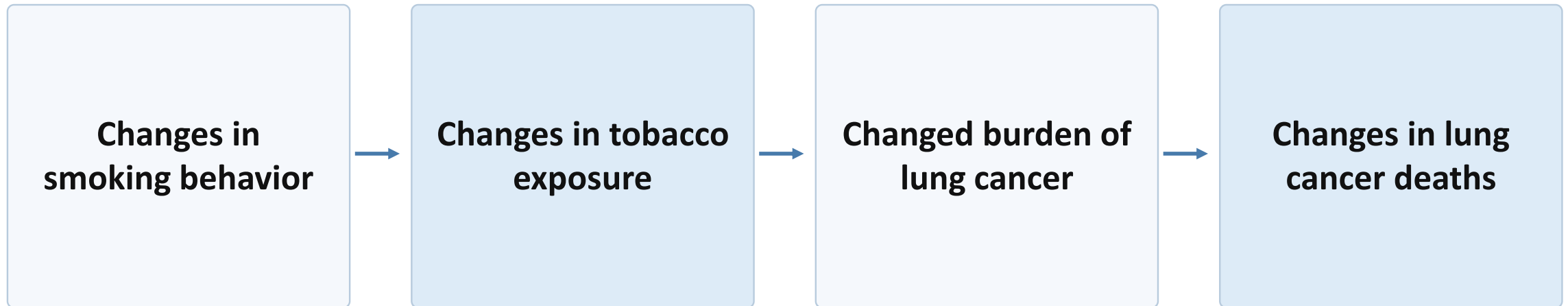
Principal contributing sites:

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Share of the decline — not the share of all cancer deaths.

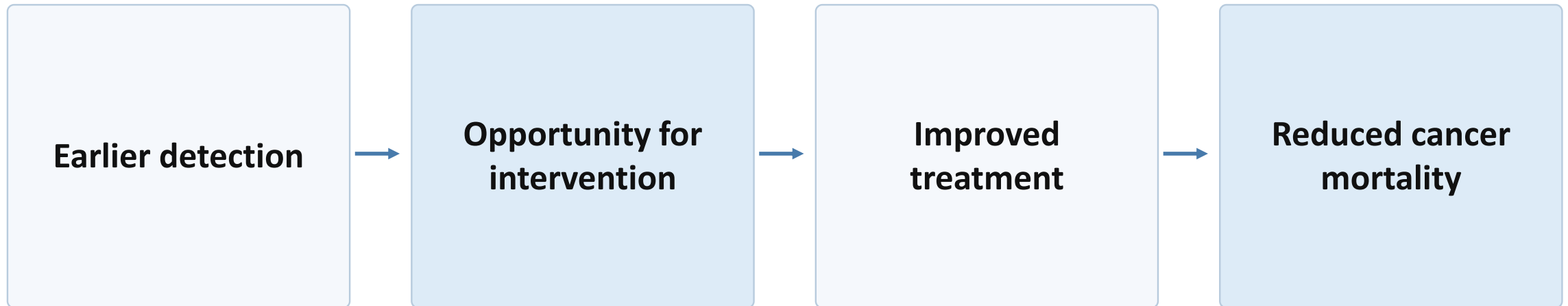
Tobacco use and lung cancer mortality



Robbins explicitly attributes reduced lung cancer deaths to reduced use of tobacco.

Population trend concordance supports, but does not alone establish, causal attribution.

Detection and treatment: Mortality consequences



Improved detection and treatment as drivers for colorectal, breast, and prostate cancer mortality reductions.

Prevention differs from improved cancer care

Exposure change

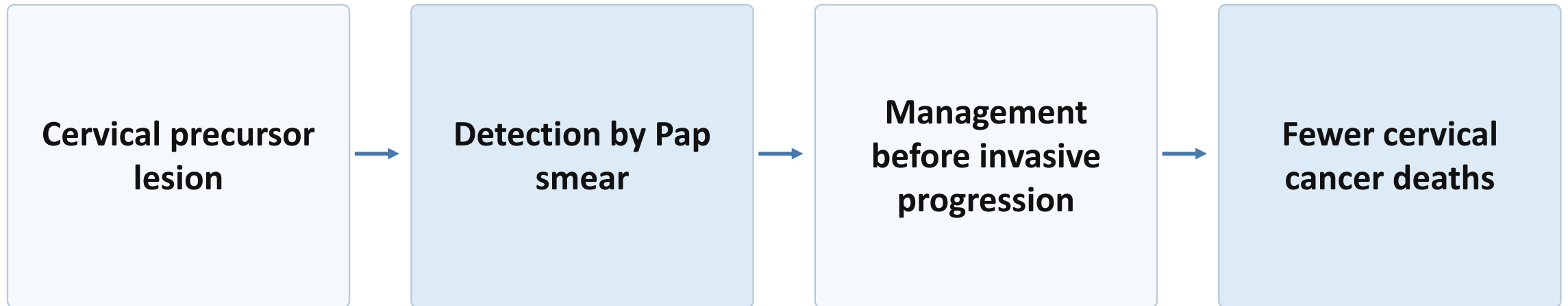
- Reduced tobacco use limits exposure to a carcinogen.
- May change future occurrence of an exposure-related cancer.

Improved care

- Detection identifies lesions earlier.
- Therapy changes outcomes after disease is found.

Different pathways can contribute to the same mortality trend.

The Pap smear and cervical cancer mortality



The marked decline in cervical cancer deaths in high-resource countries largely to cervical cytology.

Why cervical screening changed outcomes

- The Pap smear can identify precursor lesions before progression to invasive cancer.
- It can also identify early cancers at a more curable stage.
- The source reports a sharp decline in cervical cancer deaths in highly resourced countries.
- This is an example of pathology informing population screening.

Precursor detection versus early cancer diagnosis

Precursor lesion

- Abnormality precedes invasive disease.
- Recognition creates an opportunity to prevent progression.

Early invasive cancer

- Disease is already present.
- Recognition may permit effective curative intervention.

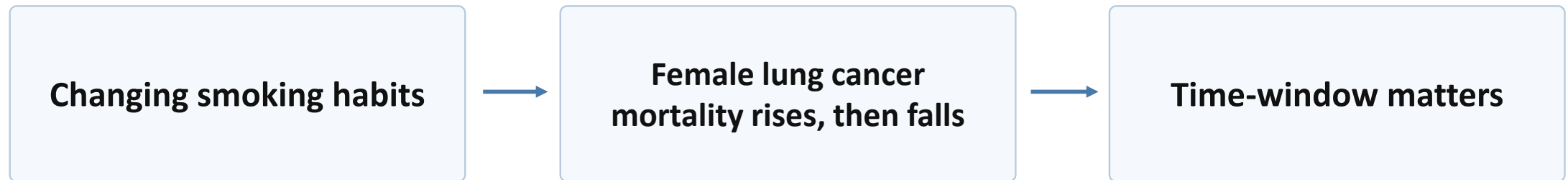
Both pathways can reduce cervical cancer mortality, by different mechanisms.

Female lung cancer mortality reversed direction

- A substantial rise in female lung cancer death rates during 1990–2004.
- Rates then declined in subsequent years.
- The source relates both phases to changes in smoking habits.
- The direction of a trend depends critically on the chosen period.

Changing smoking habits: A time-pattern model

Qualitative pattern only — no numeric historical series reconstructed



Do not infer an exact exposure–response lag from this excerpt.

The role of social determinants in cancer outcomes

Upstream determinants

- Socioeconomic circumstances
- Access to screening and health care
- Other environmental and cultural differences

Observed patterns

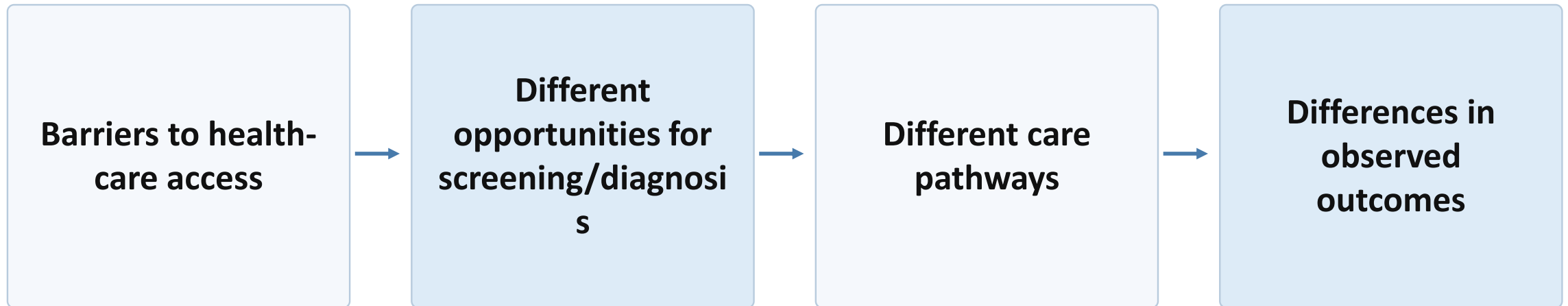
- Incidence can differ between groups
- Outcomes can differ between groups
- Differences need causal evaluation

Disparities require structural and clinical interpretation, not biological essentialism.

Race is not a discrete biological variable

- Robbins explicitly rejects interpreting race as a discrete biological category.
- Cancer disparities across racial and ethnic groups are largely linked to social determinants of health.
- Health-care access and socioeconomic conditions are named examples.
- Population categories should not be treated as substitutes for a causal exposure.

How unequal access can shape outcomes



Access to health care is explicitly cited among the social determinants contributing to disparities.

Diagram is a conceptual teaching model, not a quantified mediation analysis.

Inherited susceptibility is a separate dimension

- The source acknowledges hereditary contributors to cancer risk in some populations.
- It names increased breast and ovarian cancer risk in women of Ashkenazi Jewish descent.
- The cited mechanism is a higher frequency of germline BRCA1 and BRCA2 variants.
- This specific genetic example does not establish race as a biologically discrete category.

Disentangling group differences

Contextual drivers

- Health-care access
- Socioeconomic circumstances
- Environmental and cultural exposures

Specific hereditary factors

- Defined susceptibility alleles
- Germline BRCA1 or BRCA2 variants in a specified group
- Not a general explanation for all disparities

Environmental and inherited contributions must be assessed rather than assumed.

Application: High incidence versus high mortality

A female cancer is the most frequent diagnosis, but another cancer causes more deaths. What does this demonstrate?

- A. Annual case counts are equivalent to lethality
- B. Incidence and mortality rankings can differ
- C. Screening always increases deaths

Application: Interpret a falling mortality rate

A cancer death rate falls while incidence is stable. Which inference is best supported?

- A. Cancer has been eradicated
- B. Improved outcomes may coexist with stable occurrence
- C. The population necessarily became younger

Application: An observed population disparity

Cancer outcomes differ across two racialized population groups. What should be examined first?

- A. Race as a fixed biological mechanism
- B. Access, socioeconomic conditions, and specific exposures
- C. A presumed universal inherited defect

Application: Interpret a 2030 figure

Robbins gives 13.2 million cancer deaths for 2030. Which description is accurate?

- A. Directly observed worldwide deaths in 2030
- B. The textbook's projected worldwide deaths
- C. U.S. Deaths during 2023

Integrated interpretation: Cancer burden is multidimensional

- Global totals reveal a major and potentially growing service burden.
- Incidence and mortality must be reported separately by site, sex, and time.
- Historical mortality improvement reflects a mixture of prevention and better care.
- Disparity analysis requires attention to social determinants and selected inherited risks.

Reference and provenance

Primary teaching source

Robbins, Cotran & Kumar: Pathologic Basis of Disease. 11th ed. Chapter 7, “Neoplasia,” section “Epidemiology of Cancer” → “Global Impact of Cancer,” pp. 244–246.

Statistical reference within that source

Figure 7.16: U.S. cancer incidence and mortality by sex and tumor site, 2023. Values on these slides are historical textbook estimates and projections.