

Demography of population health

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Outline

- Introduction
- Implications of mortality declines for population health
- A conceptual framework of population health
- Measures of population health
- Methodological issues in healthy life expectancy
- Key lessons from demographic models of population health
- Conclusions



Introduction

- Demographic regimes of low mortality and low fertility have been in place for the better part of a century in developed countries
- Fertility rates have fallen to near and even below replacement level in many countries
 - Populations with slow or negative growth rates
 - Rapidly advancing age structures (population aging)
 - Japan, South Korea, Germany, Italy, Greece, Bulgaria

Population size

- United Nations: populations of much of Europe and Japan will decline in size over the next five decades
- Countries that attract a relatively large number of immigrants (US, UK, Spain) are projected to maintain or increase population size
 - They will experience less severe population aging

Population aging

- Population aging is a world wide demographic phenomenon
- Less developed countries have also experienced historical trend toward population aging
- Population is aging in a much faster pace in less developed countries than in developed countries

Population health

- Due to population aging, especially because of dramatic declines in mortality at older ages
 - Demographers have been investigating recent trends in population health
 - Especially linkages between mortality, morbidity, and disability
- Investigations of these linkages relates to forecasting demands that an aging population will place on health care and public-pension systems

Key question

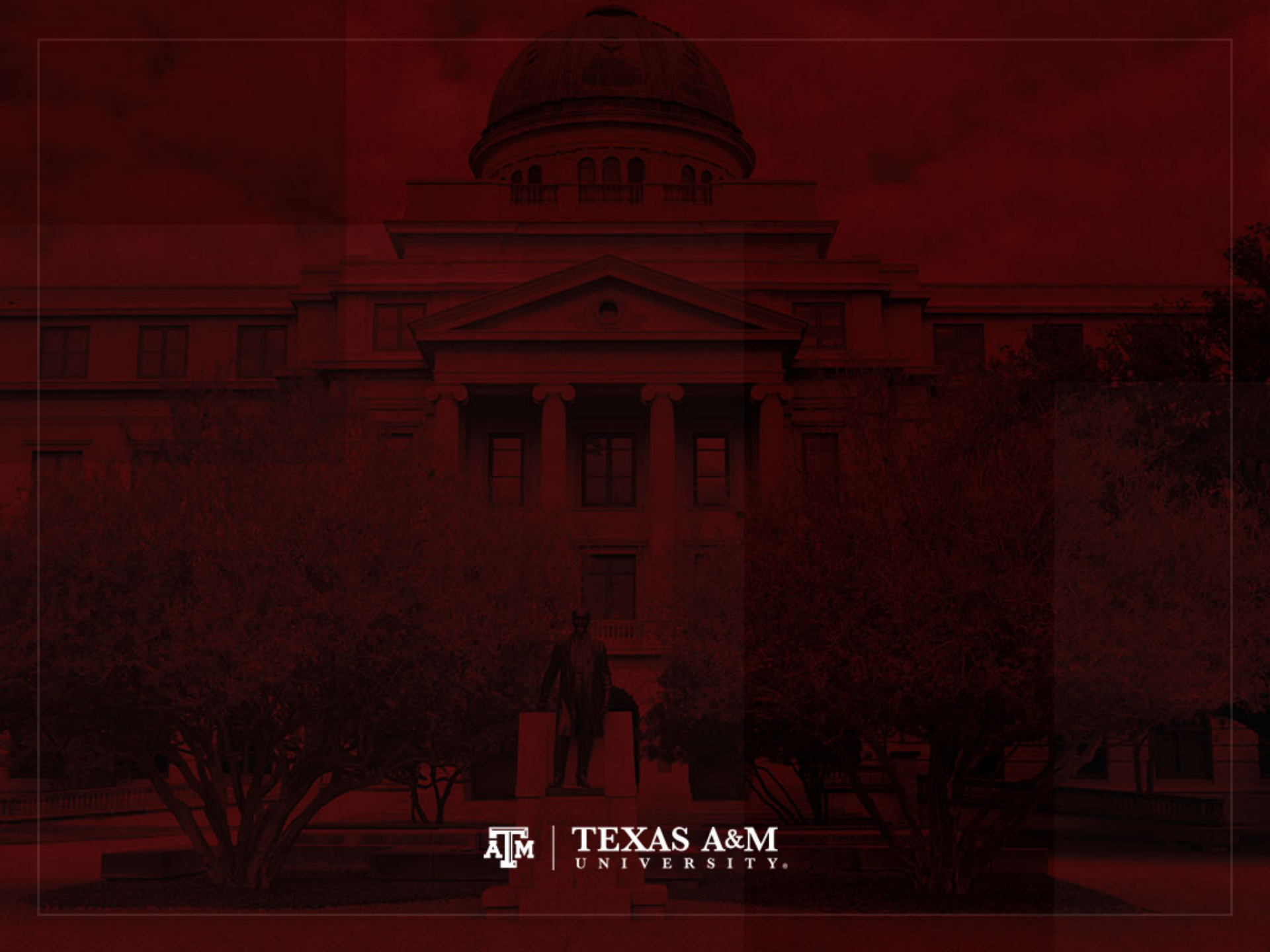
- A key question is whether declining mortality rates in the older population is a sign of declining morbidity and disability rates
- The answer has implications for whether gains in life expectancy at older ages are accompanied by an increase in healthy life expectancy
 - Expected number of years in good health

Health expectancies & policies

- Understanding health expectancies helps implementing policies to improve quality of life rather than simply improving length of life
- Health expectancies also help monitoring trends in population health
 - Evaluate disparities across population subgroups
 - Target health care policies where they are needed
 - Identify effects of major interventions and policy changes on both the length and quality of life

Mortality, morbidity, disability

- Mortality, morbidity, and disability are not similar concepts
 - It is possible to have declines in mortality and increased in morbidity and disability
- Changes in these individual-level processes combine in complex ways to generate changes in population health
 - We need to understand interactions among these major health processes to understand population health



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Implications of mortality declines for population health

- Life expectancy (as a measure of mortality)
 - It has long been used as a prime indicator of the health of a population
 - It is easy to calculate in life tables
 - It provides cross-national comparisons
- Correspondence between mortality and health changes is not straightforward

Mortality improvement & health

- If mortality improvements occur primarily among persons with health problems/conditions
 - A greater number of people will survive in poor health
 - Higher prevalence of a given health condition in a population (morbidity, disability)
 - It will lengthen years of life with that health condition
- If mortality improves because of delays in the onset of diseases and functional problems
 - Population health will improve
 - Prevalence rates and life expectancy with a health condition will decline



Fatal and nonfatal conditions

- With population aging, chronic and degenerative diseases become more prevalent
 - They are not immediately tied to mortality (e.g., hypertension, arthritis)
 - Co- and multi-morbidity is becoming more common
- To understand how mortality changes influences health, we need to know
 - Where health improvements are happening
 - Changing mix of fatal and nonfatal disease conditions in the population



Socioeconomic changes

- Changes in the socioeconomic characteristics of populations also contribute to uneven changes in disease and disability prevalence in a population
- A range of scientific activities have been designed to measure implications of mortality declines for the health (morbidity, disability) of surviving populations between and within nations

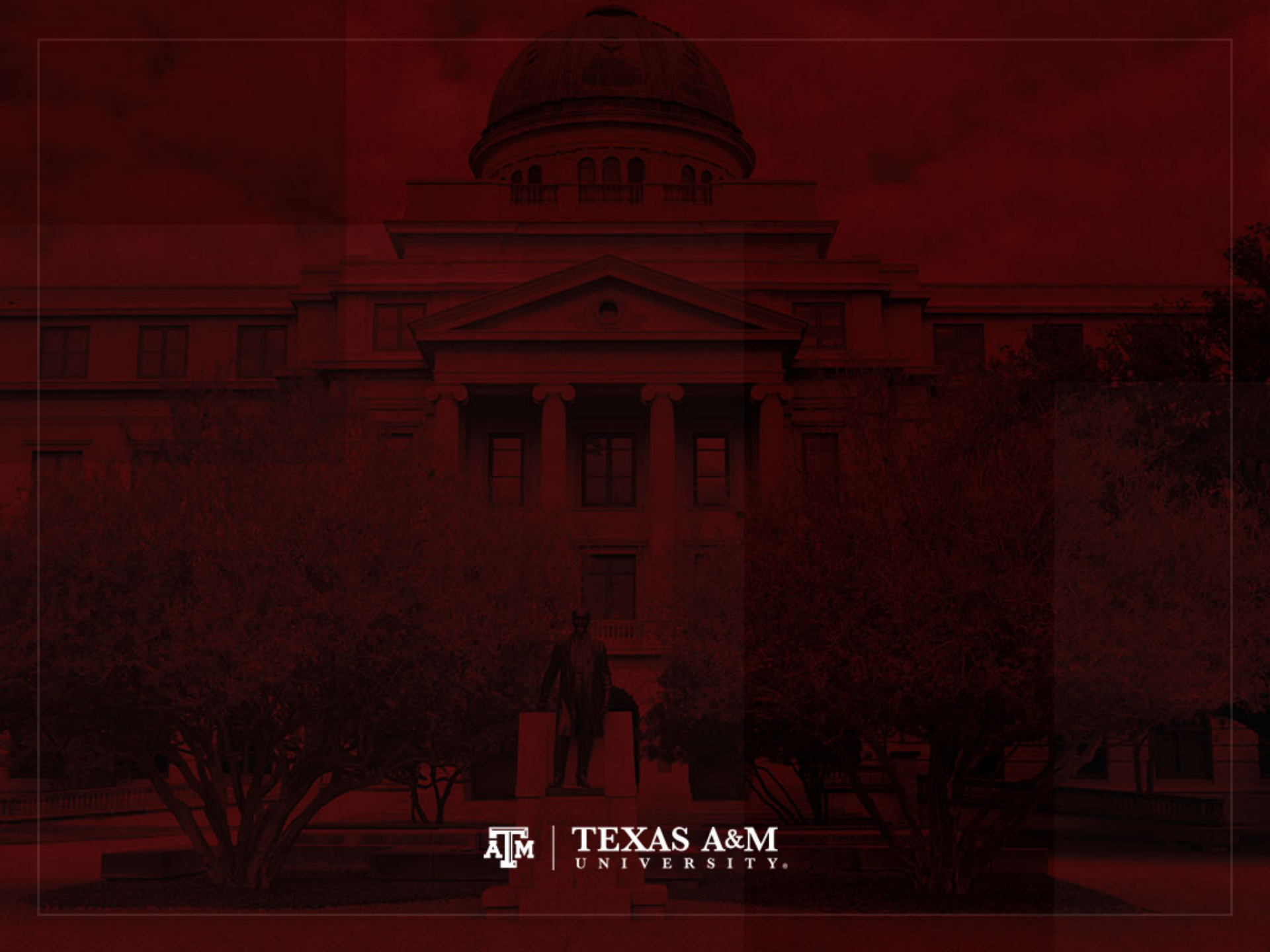
Two major questions

- Does declining mortality over a lengthy historical period signify that members of a population are living longer healthier lives?
 - Is morbidity being compressed in the life span?
- Or do mortality improvements lead to the lengthening of poor health prior to death?
 - Does disability prevalence increase at the same time that mortality rates decline?



Improvements don't happen at the same pace

- Recent evidence indicates that mortality, morbidity, and disability improvements do not necessarily happen at the same pace
- Disability rates are declining more slowly than mortality rates
 - Due to increases in morbidity
 - True in developed and developing countries
 - Differences across population subgroups (e.g., by age, sex, education, income, race/ethnicity)

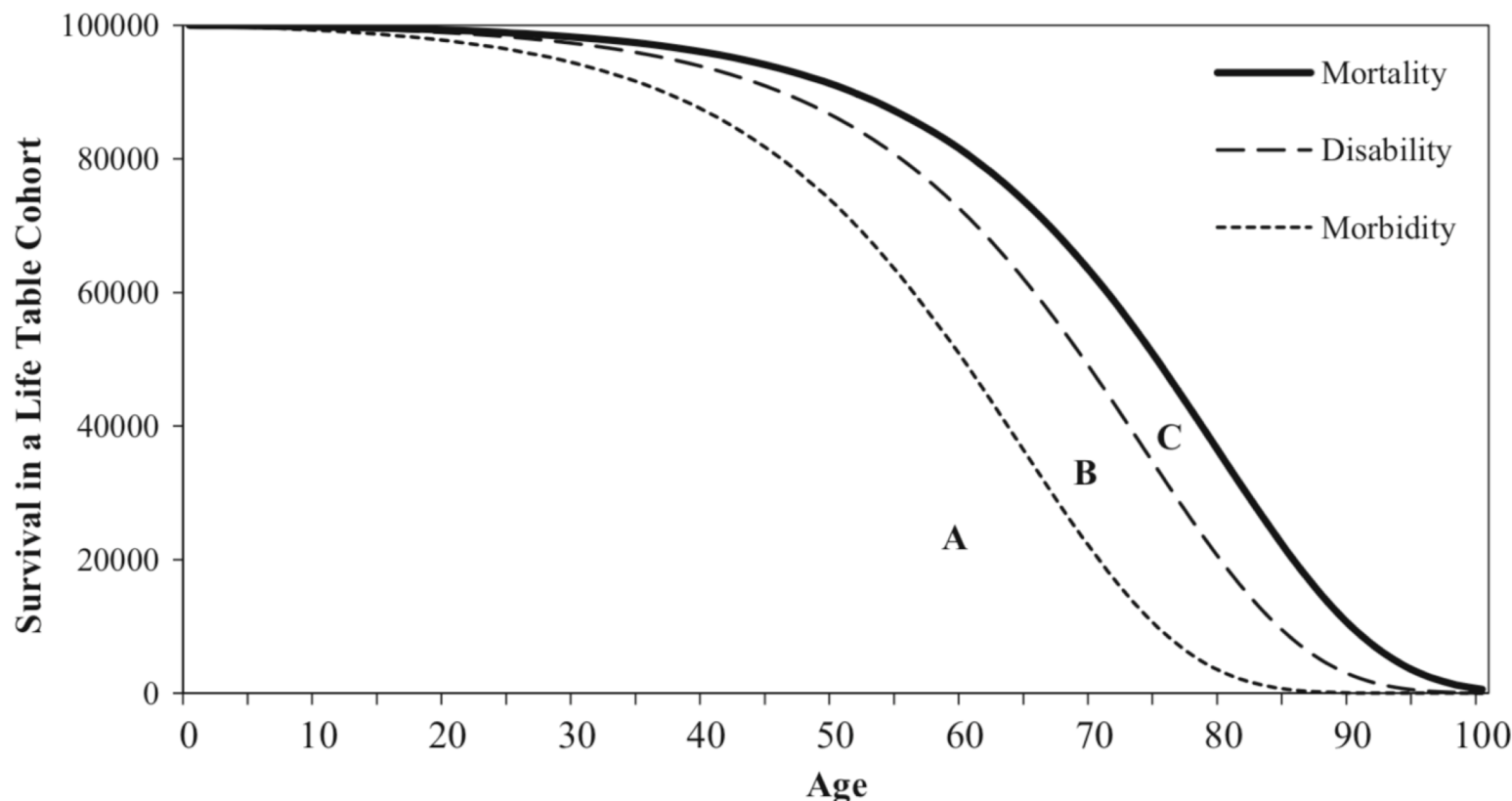


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A conceptual framework of population health

- A conceptual framework of population health was proposed that integrates concepts of morbidity, disability, and mortality
 - The healthy life expectancy framework is based on a life table survival model
 - Overall survivorship is decomposed into the proportion of a cohort that survives without one of three health events (morbidity, disability, death)

Life table framework for a hypothetical population



A: represents probability of being free of morbidity at each age (disease-free person-years)

A and B: represent probability of being free of disability (disability-free person-years)

C: represents probability of being disabled at each age (person-years spent disabled)

B and C: represent person-years lived with a chronic condition (morbidity and disability)



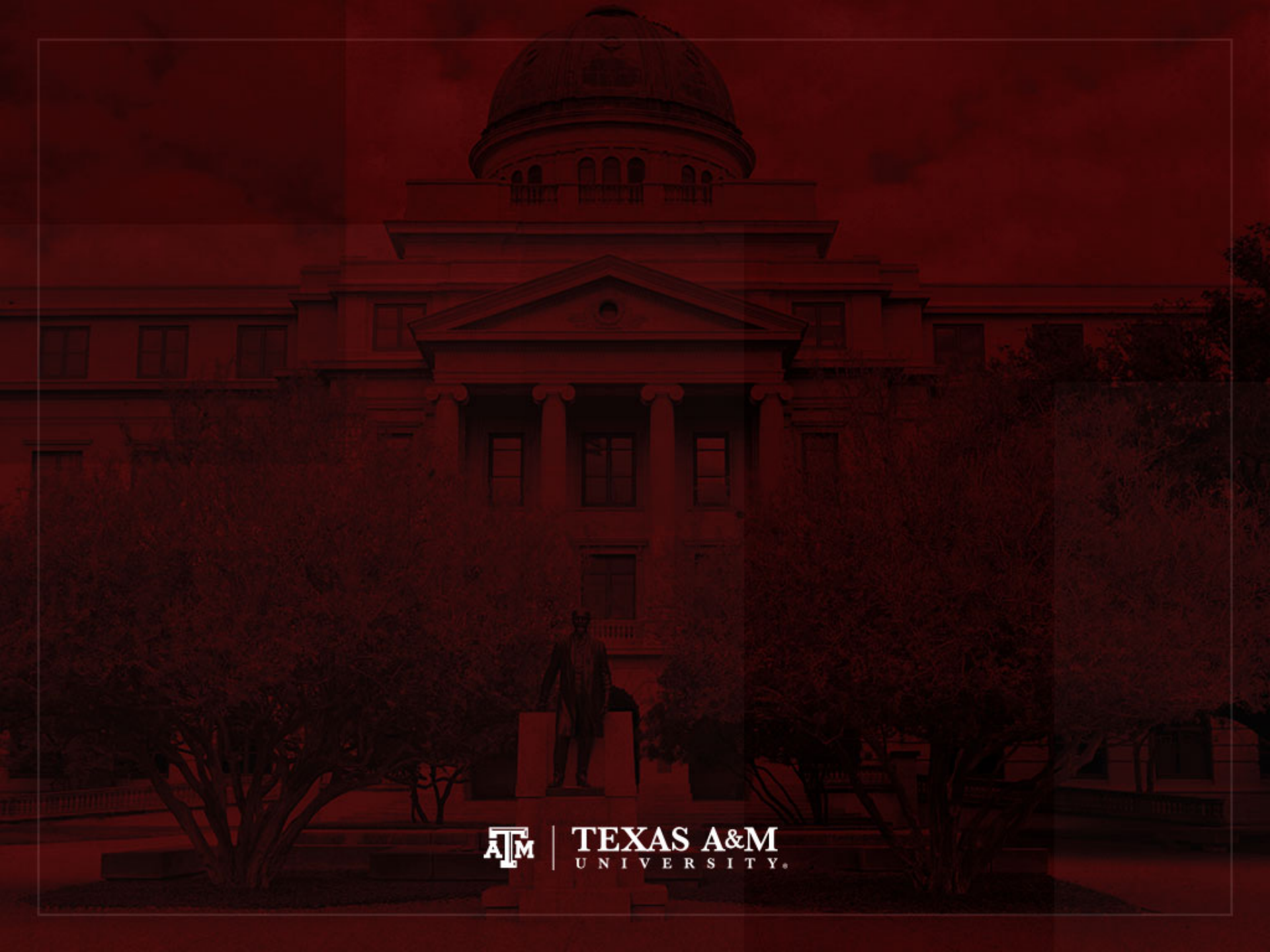
Indicators from the framework

- This life table model developed the general summary measure of healthy life expectancy
 - Length of time that an average individual can expect to be healthy
- Three population health indicators
 - Total life expectancy
 - Disability-free life expectancy
 - Disease-free life expectancy

Interpreting health indicators

- Health indicators can be interpreted to understand implications of public health policies
- We can investigate how disease-free and disability-free life expectancies change as total life expectancy grows
 - Whether declines in mortality lead to the expansion or compression of morbidity and disability
 - Whether different population groups have similar or different survival, morbidity, and disability experiences
 - Whether these experiences vary through time





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Measures of population health

- Health is a complex concept denoting well-being free from disability and disease, and mental, physical, and emotional problems
- The main ways to measure population health through the life table model are primarily based on concepts from the World Health Organization
 - International Classification of Impairments, Disabilities, and Handicaps (ICIDH)

Disablement process

- “Disablement process” shows the effects that chronic and acute conditions have on the functioning of specific body systems and on people’s abilities to act in necessary, usual, expected and personally desired ways in their society

Beginning of disablement

- Disablement process typically begins with the onset of a chronic disease that may have a cascading effect
 - Loss of physical or mental function
 - Impaired mobility, restrictions in various body motions or strength, loss of short-term memory
- Start of disability
 - When functional problems make it difficult or impossible to perform routine social activities



Disablement and mortality

- Conceptualization of disablement corresponds to the idea that individual aging refers to changes in structure and function
 - This conceptualization lacks direct correspondence between disablement and mortality
- Mortality reflects the aging process of changes in structure and function, but it does not define the aging process

Measuring healthy life expectancy

- The disablement framework has resulted in a class of measures for describing the health of a population
- Different measures of healthy life expectancy
 - Different operational definitions
 - They partition life expectancy into the years lived in different health states
- Total life expectancy is uniform in the underlying process (mortality)



Disease-free life expectancy

- Disease-free life expectancy is the expected number of years the average person in a population would expect to live free of disease
 - Or a specific disease depending on the model
 - If current patterns of morbidity and mortality were to continue over time

Disability-free life expectancy

- Disease-free life expectancy is the expected number of years of life free of a chronic health condition that limits the routine social activities
- Disability can be defined in terms of
 - Household management, measured by instrumental activities of daily living (IADL)
 - Managing money, using telephone, preparing meals...
 - Ability to provide basic self-care, measured by activities of daily living (ADL)
 - Toileting, bathing, dressing, eating, in and out of bed...
 - Ability to perform major social roles (e.g., paid work)

Health adjusted life expectancy

- Health adjusted life expectancy (HALE) measures health by adjusting life expectancy according to weights assigned to particular health states
 - It tries to identify the gap between life in perfect health and life where individuals have ill health
 - The weights for health states range from zero (dead) to one (perfect health)
- Weighting systems are controversial
 - As a result, HALE has been less frequently used



Use of HALE

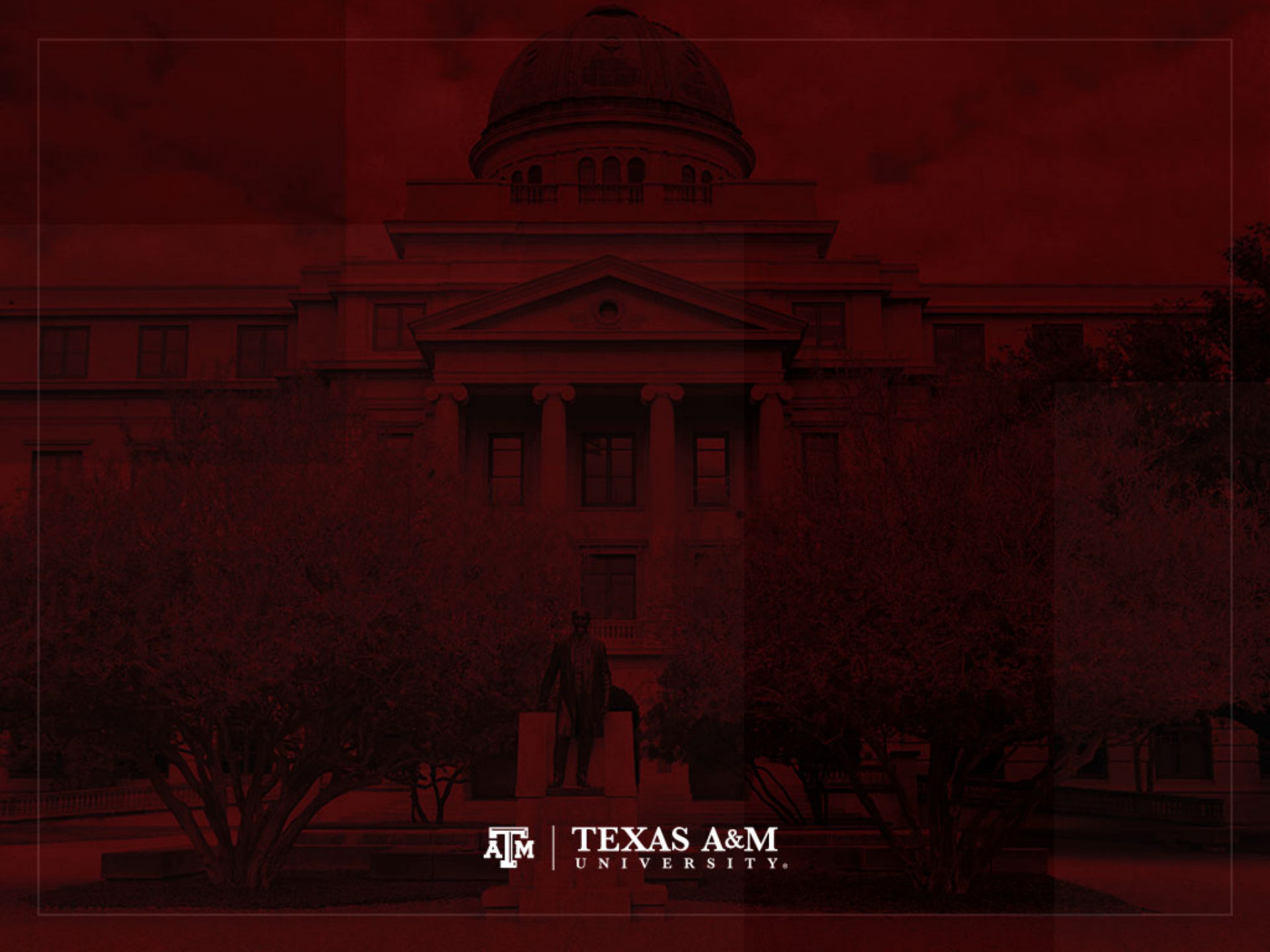
- However, health-adjusted life expectancies have become a useful policy tool in evaluating the burden of disease internationally
 - HALEs have been used to measure the burden of illness consequences of eliminating particular diseases from the population
 - Eliminating diabetes would increase total and disability-free life expectancy by about 3 years in Ontario, Canada (Manuel, Schultz 2004)
 - Eliminating cancer would increase Japanese total life expectancy by more than 3 years and disability-free life expectancy by about 1 year (Hashimoto et al. 2012)



Disability adjusted life expectancy

- Disability adjusted life expectancy (DALE) identifies the expected years of healthy life
 - It estimates total expected life expectancy
 - Subtracted by the weighted years of ill-health according to severity
- World Health Organization ranks countries based on DALE
 - Years lost to disability are higher in developing countries than in developed countries
 - These limitations affect children and young adults in higher proportions in developing countries





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Methodological issues in healthy life expectancy

- A life table model generates health expectancies
 - They are subject to constraints and assumptions
 - It is hard to compare estimates of healthy life expectancies across studies
- Thus, we focus on
 - Relative proportion of life that is healthy or unhealthy
 - Consistency of group differences (sex, race/ethnicity)

Comparisons of healthy life expectancy

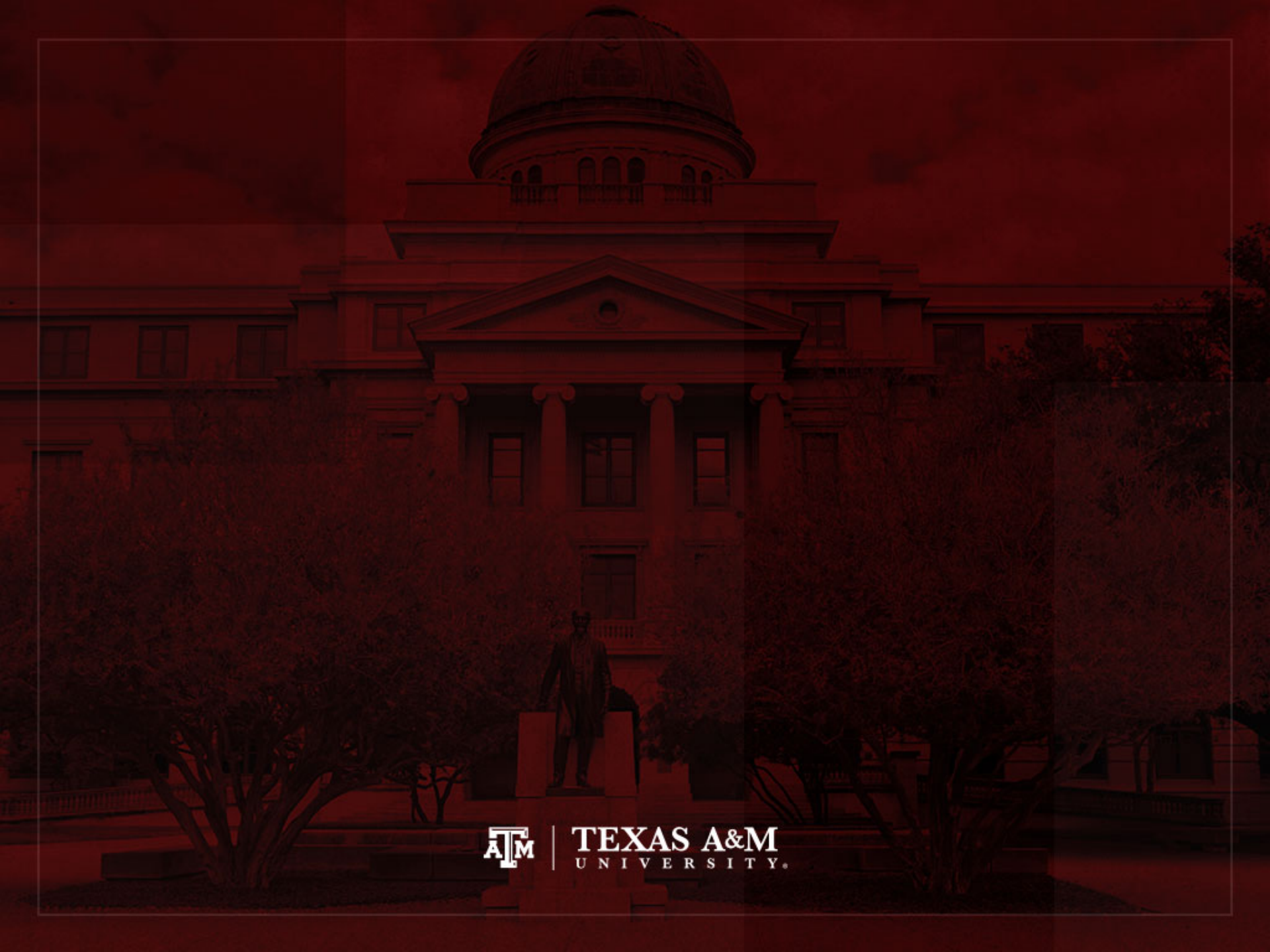
- Comparisons across studies are a challenge
 - Differences in study design and measurement
 - Operational definitions of health measures
 - Various methods used to calculate health expectancies
 - Lack of consistent, high quality, and nationally representative data for a lengthy time period
- Several research groups have made efforts to harmonize study designs and measures

Longitudinal data

- Longitudinal panel data develop healthy life expectancy measures reflecting the complexity of age-related changes in health
 - National Long-Term Care Survey (NLCTS)
 - Survey of Income and Program Participation (SIPP)
 - National Health and Aging Trends Study (NHATS)
 - Health and Retirement Survey (HRS)
- Estimation of changes in morbidity and disability
 - They reveal that as persons age, they not only experience the onset of disability, but they also recover from disability

Expanding data collection

- Longitudinal surveys are expanding the field of population health inquiry to include performance assessments
 - Grip strength
 - Cognitive impairment
 - Biomarkers of disease



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Key lessons from demographic models of population health

- The relation between morbidity, disability, and mortality is complex and not always obvious
 - An individual may contract a fatal disease condition but need not die from that cause
 - For some diseases such as heart disease, individuals may live with the disease for many years before death
 - Disability is not necessarily a permanent condition, nor is it one that inevitably precedes death

More findings

- Disability is associated with both fatal and nonfatal chronic conditions
 - Severe disability is not necessarily the final stage of poor health prior to death
- Death is **not** always the outcome of a developmental process
 - Wherein individuals contract a fatal condition
 - The condition induces functional problems and disability
 - The condition results in death in advanced stages



Variations by subgroups

- This complexity carries over to population subgroup differences in the processes defining population health
 - Sex
 - Race/ethnicity
 - Education

Variations by sex

- Sex appears to affect mortality and disability in the opposite directions
 - Women live longer than men
 - Women live more years with functional problems

Variations by race/ethnicity

- Blacks and Whites did not differ significantly in terms of heart disease onset (Hayward et al. 2000)
- Blacks' mortality was substantially higher among persons already with heart disease
- Blacks' excess heart disease mortality is more a consequence of their greater risk of fatal consequences of heart disease
 - Rather than Blacks' higher rates of disease onset

Variations by education

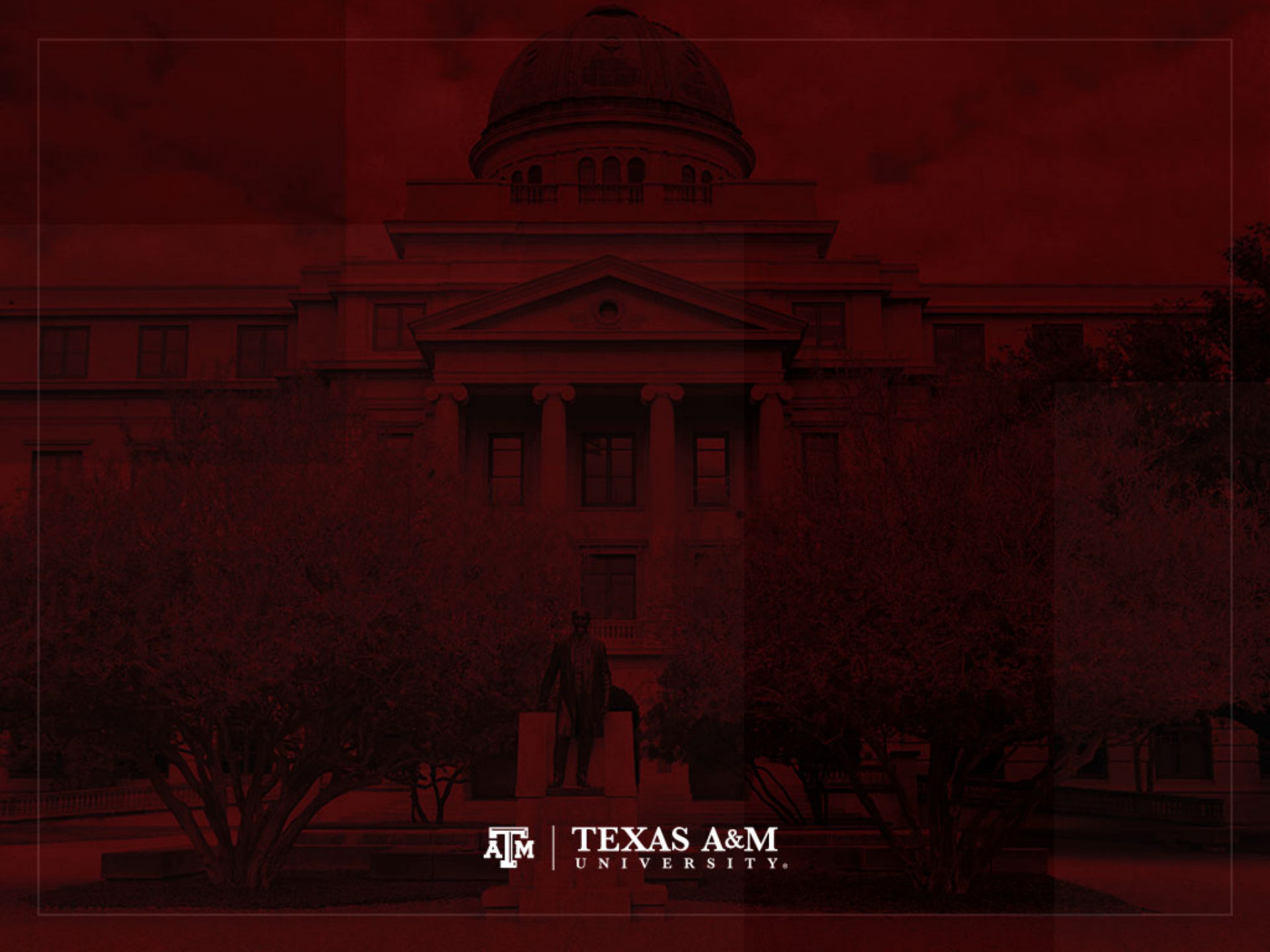
- Education is associated with an increase of both total life and disability-free life
 - Compression of the period of life with functional problems
 - Educational disparities in morbidity, disability, and mortality are widening
- Less educated persons appear to have
 - Higher rates of disability onset
 - Higher rates of death among persons without functioning problems
 - Once functioning problems occur, there is less evidence of an educational effect on mortality



Interactions

- How major population subgroups (age, gender, race/ethnicity, education) combine to differentiate population health processes?
 - Black women have both an earlier onset and faster accumulation of functional limitations compared to all other groups
 - Black women spend proportionally more years disabled than do others
 - There is also a growing racial and educational inequality in disability-free life expectancy





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Conclusions

- Demographic models of population health combining morbidity, disability, and mortality are a scientific response to population aging in developed nations
- Concerns about whether longer life signals better or worse health have led to
 - Population health monitoring systems
 - Expanding body of research

Health expectancy research

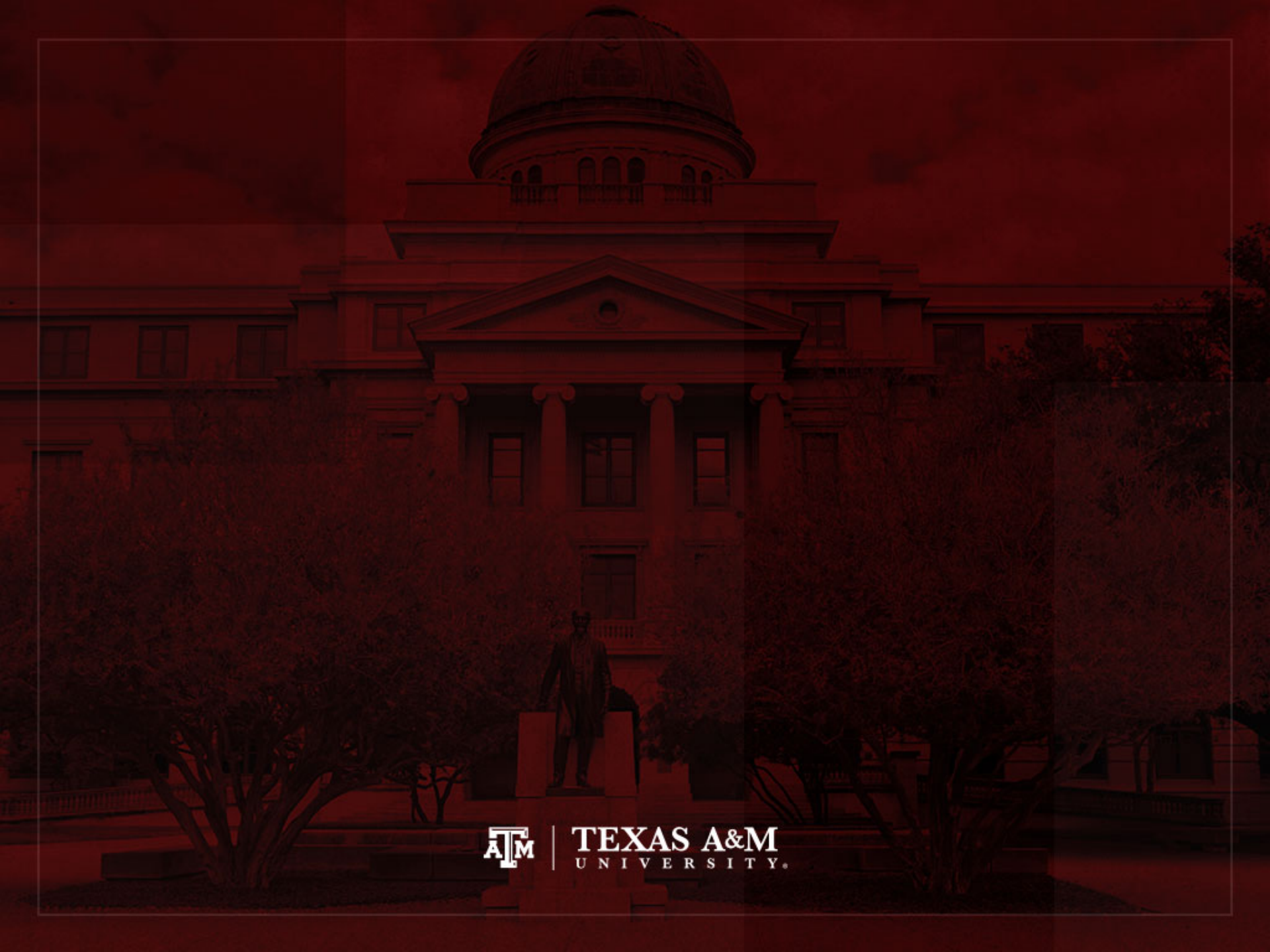
- Health expectancy research has contributed significantly to the current understanding of the recent trends in population health
 - Chronic disease, disability, and self-perceived health, do not necessarily move in the same direction at the same time
 - Rising disability is not necessarily a signal of the failure of policies aimed at enhancing population health
 - Socioeconomic inequality within countries is leading to increased variation in health across population subgroups



References

Poston, Dudley L. (Ed.). 2019. Handbook of Population. Cham: Springer. Chapters 32 (pp. 839–858), 33 (pp. 859–874).





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