DOHAD IN THE CONTEXT OF EPIDEMIOLOGY AND PUBLIC HEALTH

Lynne C. Messer, PhD, MPH

August 12, 2021

DOHaD summer course

Learning objectives

By the end of this talk, you will be able to:

- Understand how DOHaD research is conducted among populations in an epidemiologic context
- Describe how social structure contributes to the patterning of DOHaD-related exposures and outcomes in populations
- Explain how DOHaD may partially explain existing health inequities among population groups in the United States

in the beginning - observational epidemiology

- Lancet, September 1989
  - 5654 men born (1911-1930) in six districts of Hertfordshire, England
  - Complete data on birthweight and breastfeeding
  - Exclusion criteria explained, sex-restriction justified
  - Standardized mortality ratios calculated for three outcomes and overall

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WEIGHT IN INFANCY AND DEATH FROM ISCHAEMIC HEART DISEASE

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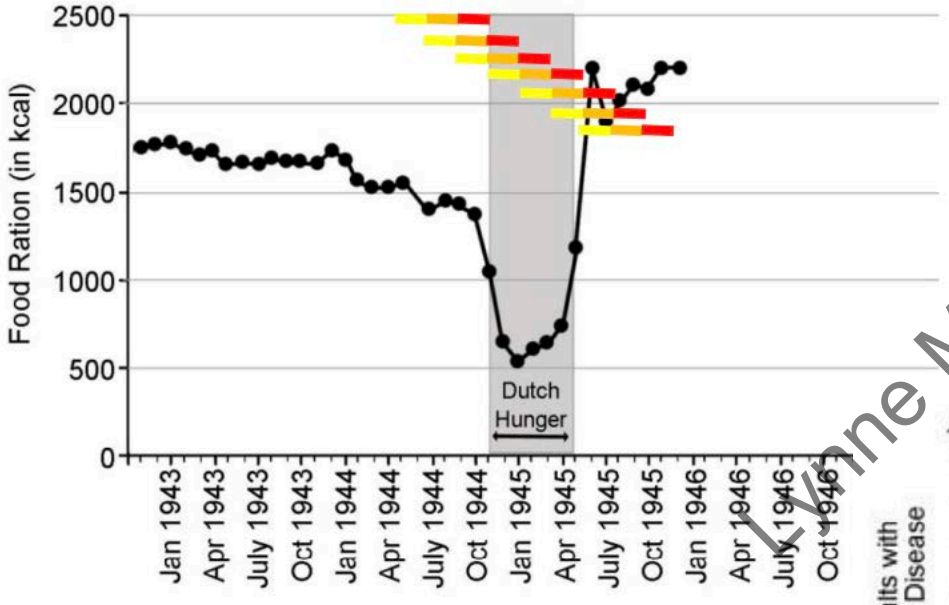
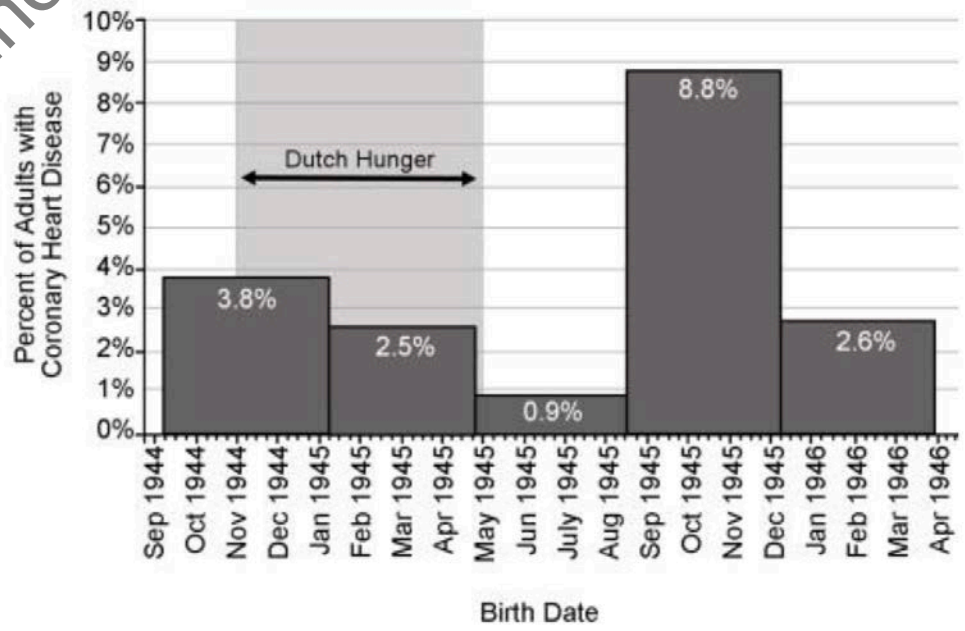
TABLE I—SMRS ACCORDING TO WEIGHT AT ONE YEAR OF AGE AND BIRTHWEIGHT

Weight (pounds)	Cause of death: Ischaemic heart disease	Chronic obstructive lung disease	Lung cancer	All causes
One year old				
⩽18 (n=324)	111 (37)*	129 (6)	98 (11)	89 (85)
19–20 (n=971)	81 (76)	86 (11)	99 (31)	89 (238)
21–22 (n=1850)	98 (163)	41 (9)	87 (48)	85 (405)
23–24 (n=1464)	71 (98)	61 (11)	57 (26)	68 (265)
25–26 (n=769)	68 (49)	52 (5)	97 (23)	73 (150)
⩾27 (n=276)	42 (11)	29 (1)	70 (6)	58 (43)
Birthweight				
⩽5·5 (n=251)	104 (25)	93 (3)	113 (9)	101 (69)
6–6·5 (n=752)	77 (51)	59 (5)	101 (22)	69 (131)
7–7·5 (n=1598)	90 (129)	75 (14)	68 (32)	83 (340)
8–8·5 (n=1757)	85 (141)	50 (11)	85 (47)	80 (380)
9–9·5 (n=868)	62 (53)	69 (8)	67 (19)	70 (170)
⩾10 (n=428)	81 (35)	33 (2)	109 (16)	77 (96)
Total (n=5654)	82 (434)	61 (43)	83 (145)	79 (1186)

*Number of deaths in parentheses. 2·2 pounds = 1 kg.

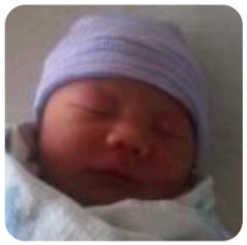
more observational epidemiology - Dutch Hunger Winter

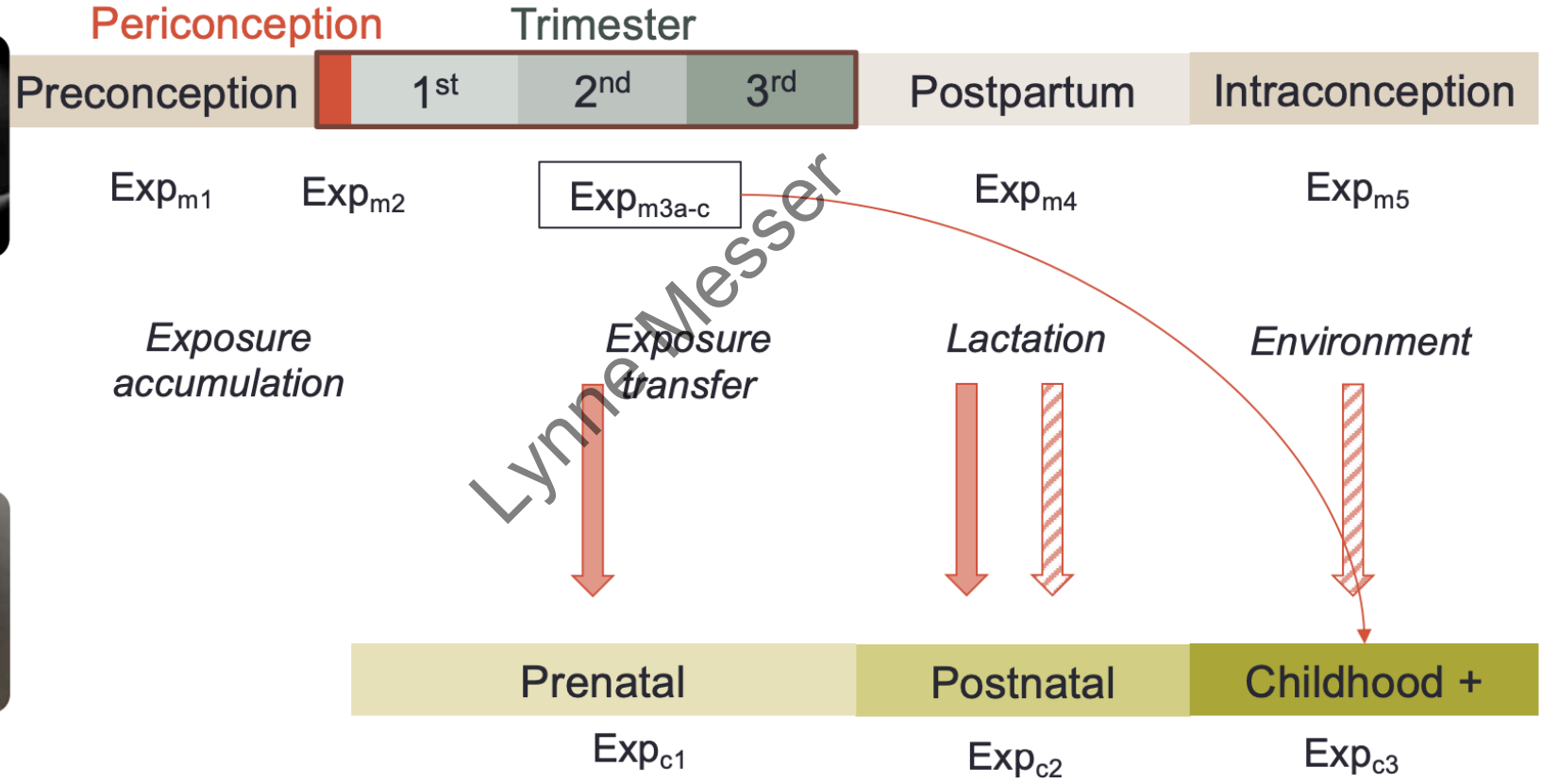




Lumley, 2007
Charbonneau, Moss, Marriott, 2015

how epidemiologists attempt to isolate intrauterine effects





Exp: Exposure (e.g., nutrition, chemical exposure, stress)
Subscripts: m=maternal, c=child at time point 1, 2, etc.

Janne Boone-Heinonen graphic, 2021

Examples of progress in DOHaD epidemiology domains

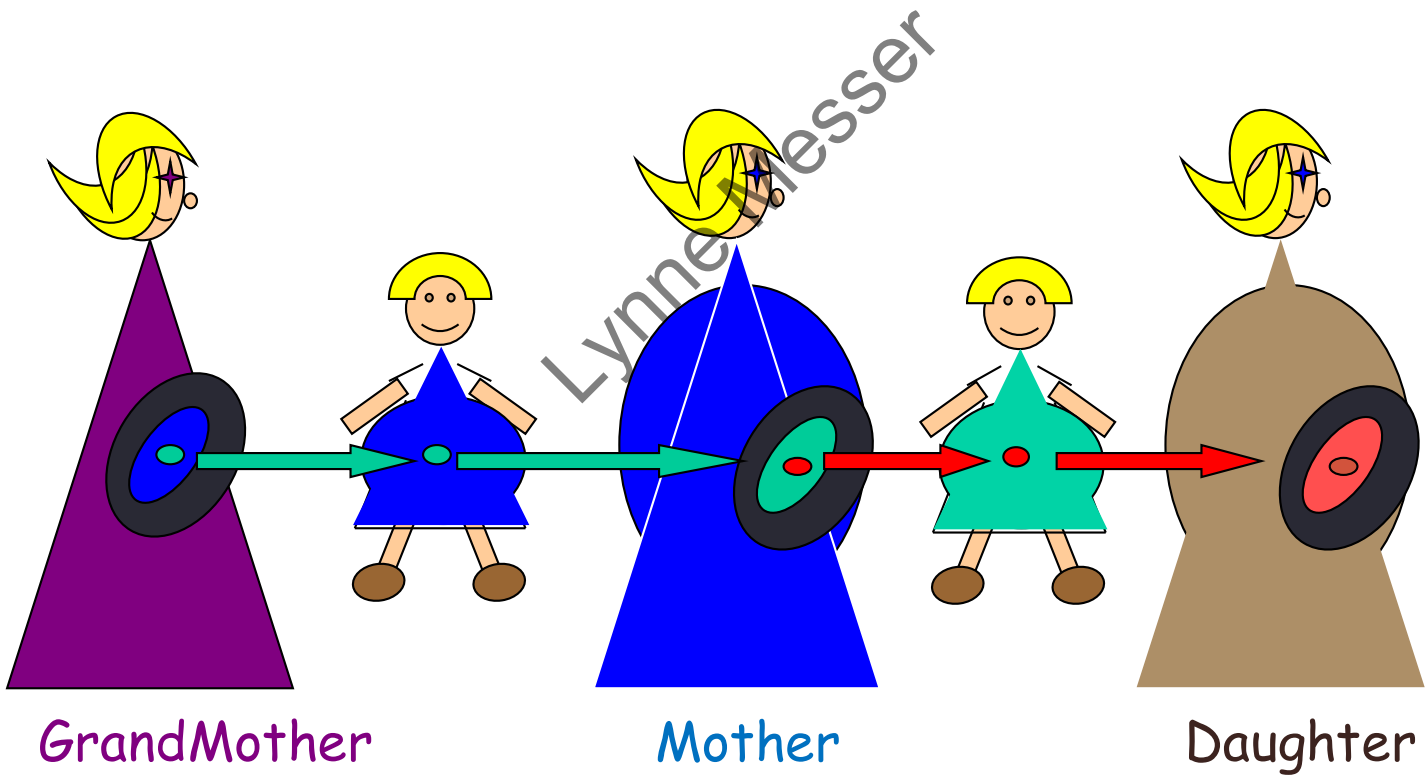
Timing of exposures

Timing of outcomes

Maternal factors	Development proxies	Postnatal factors	Biological mechanism / Behavioral mechanism	Long-term Outcomes
			Intermediate outcomes	
• Diet	• LBW	• BFing	• Epigenetic markers	• CVD
• Environmental	• SGA	• ACEs	• Hormone profiles	• Diabetes
• Stress	• LGA	And more	• Body composition	• Mental health
• High adiposity	And more…		• Other biomarkers	• Cognition
And more…			And more…	• Cancer
				• Asthma
				• Aging
Paternal factors				And more…

how DOHaD has changed epidemiology - obvious example 1

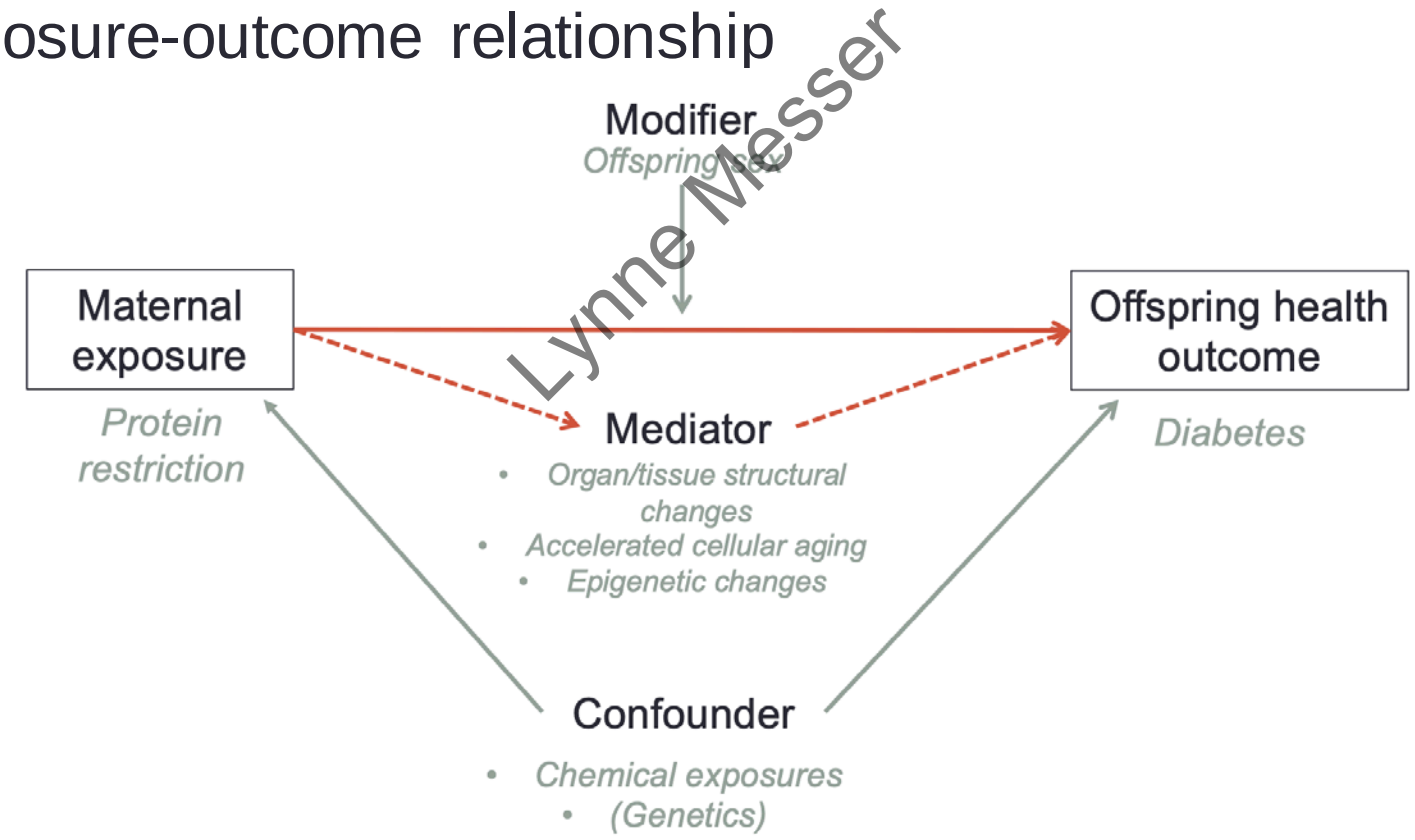
- When “exposure” occurs



Susan Bagby graphic, 2018

how DOHaD has changed epidemiology - obvious example 2

- What constitutes a “mediator” or ”modifier” of an exposure-outcome relationship



Janne Boone-Heinonen graphic, 2021

AND NOW… HOW EPIDEMIOLOGY* COULD INFLUENCE DOHAD

*And by ”epidemiology”, I mean social epidemiology

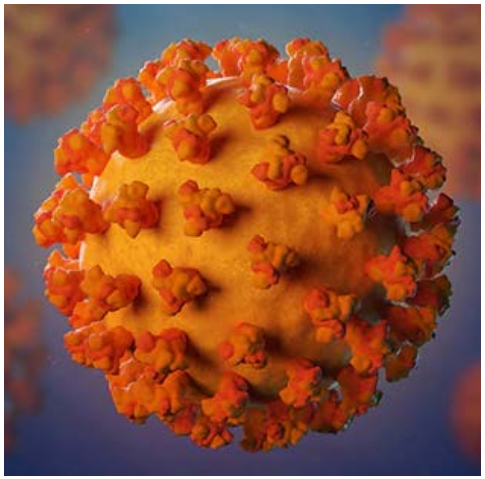
Traditional disease causation

- Individual exposed to some disease-causing factor
- Disease / injury results

Specific exposure

↓

Disease or injury



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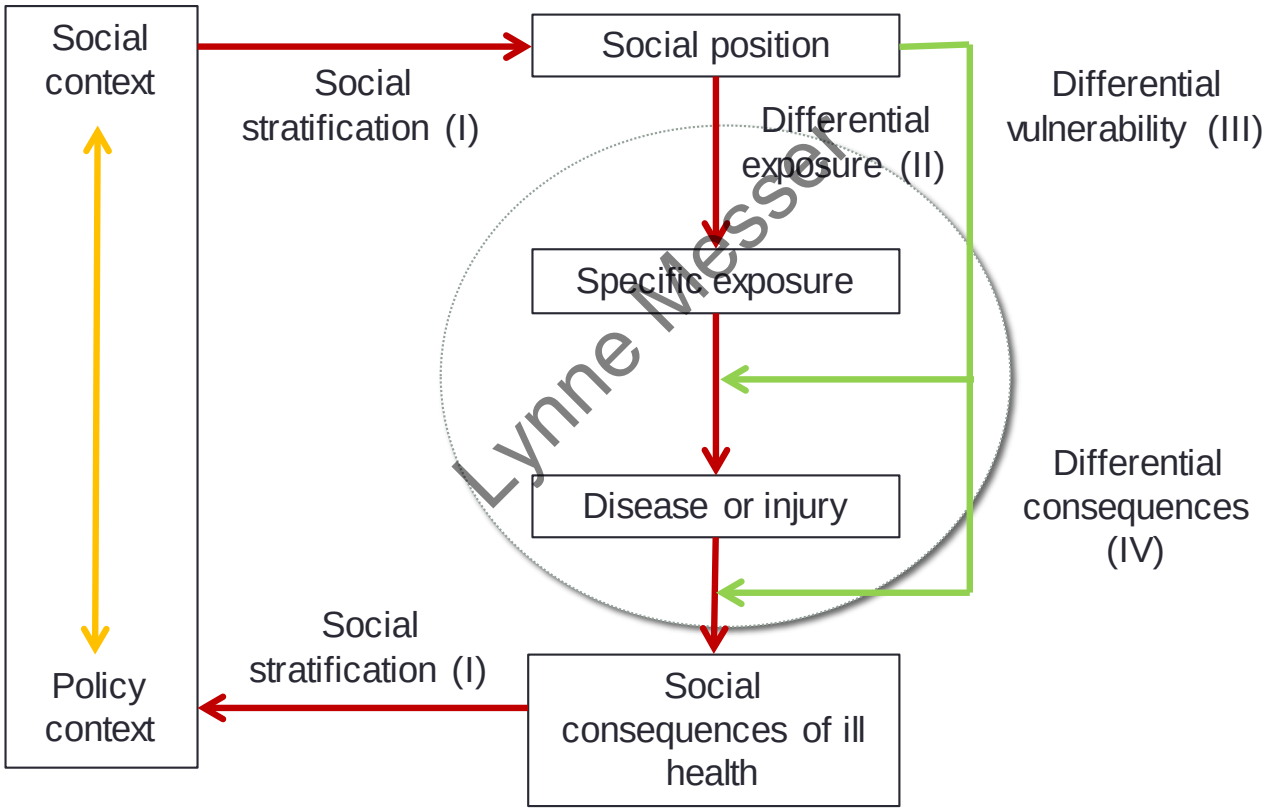
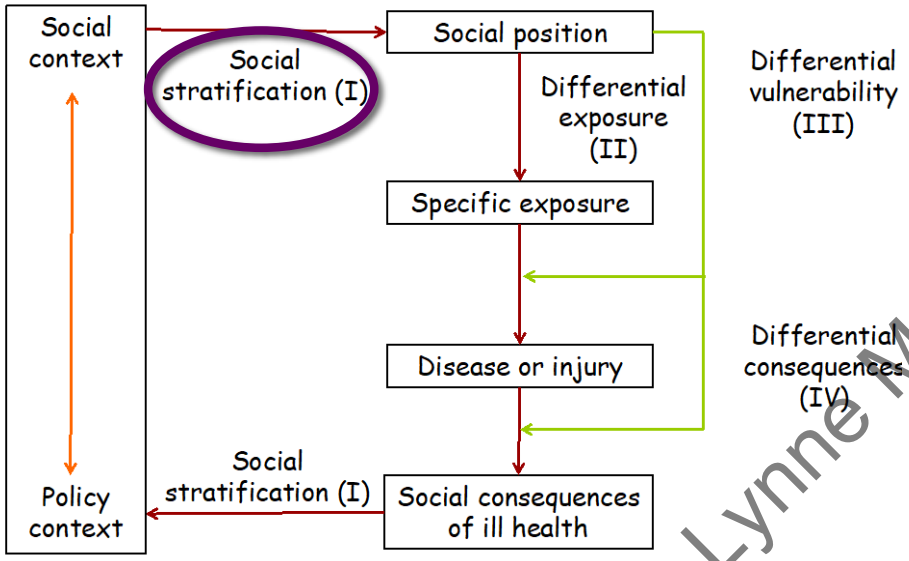
Coronavirus disease 2019

This exposure – outcome relationship occurs in a larger context



Diderichsen and Hallqvist, 2001

Social stratification -> health



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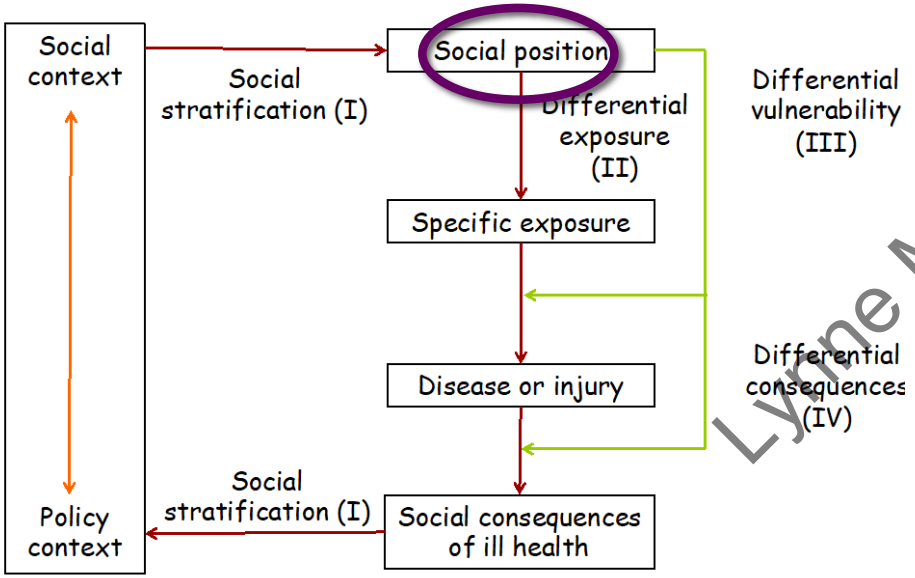
- Social context – immediate physical / social setting; includes engines that generate and distribute power (e.g., education system, labor policies)
- Social stratification - system by which society ranks individuals and groups into those with more or less power

Diderichsen and Hallqvist, 2001

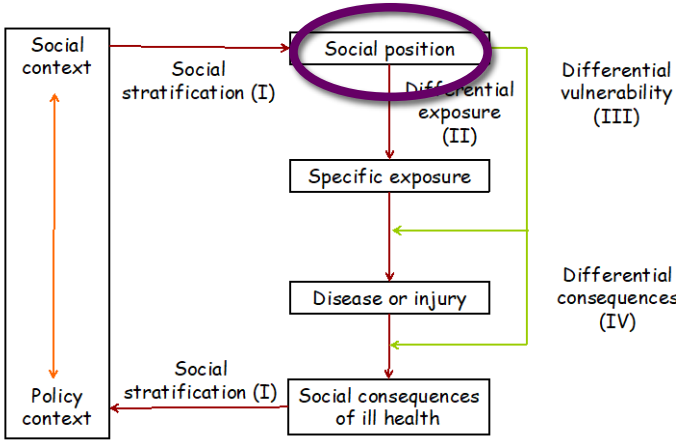
Social position - health



- Social position describes a person's place or standing within society
- Individuals in society defined, in part, by their relationship to social context
- Meaning of one's social position varies by context

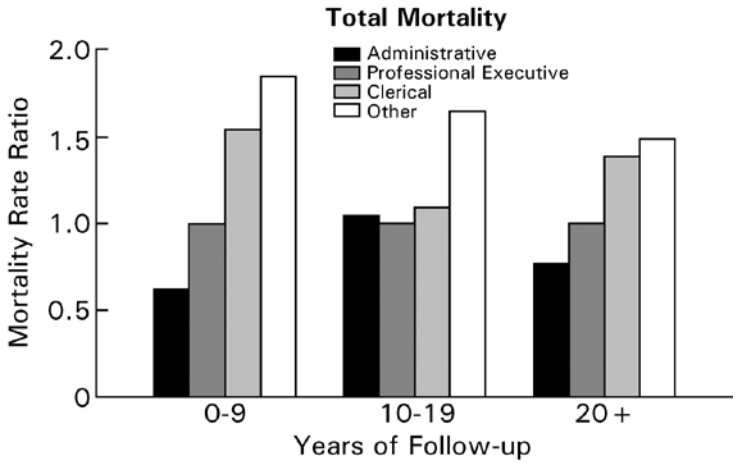
Diderichsen and Hallqvist, 2001

Social position - health, continued



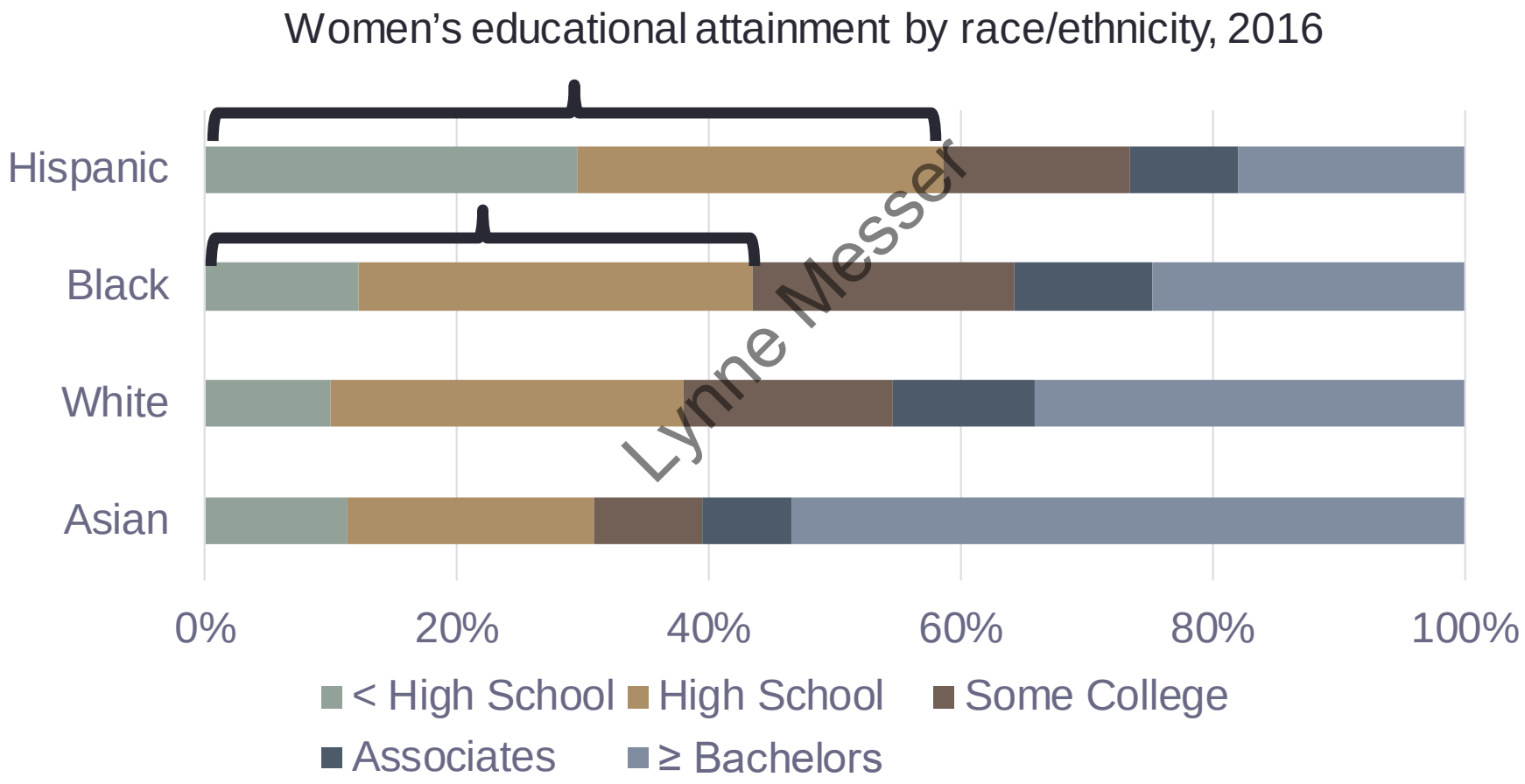
- Even when we think that intrinsic order is fair or tolerable (e.g., job type or educational level), *social position will be associated with health outcomes*

- Social gradients - Whitehall studies of British civil service found robust association between descending job grade and poorer health (Marmot, et al., 1978)



Diderichsen and Hallqvist, 2001

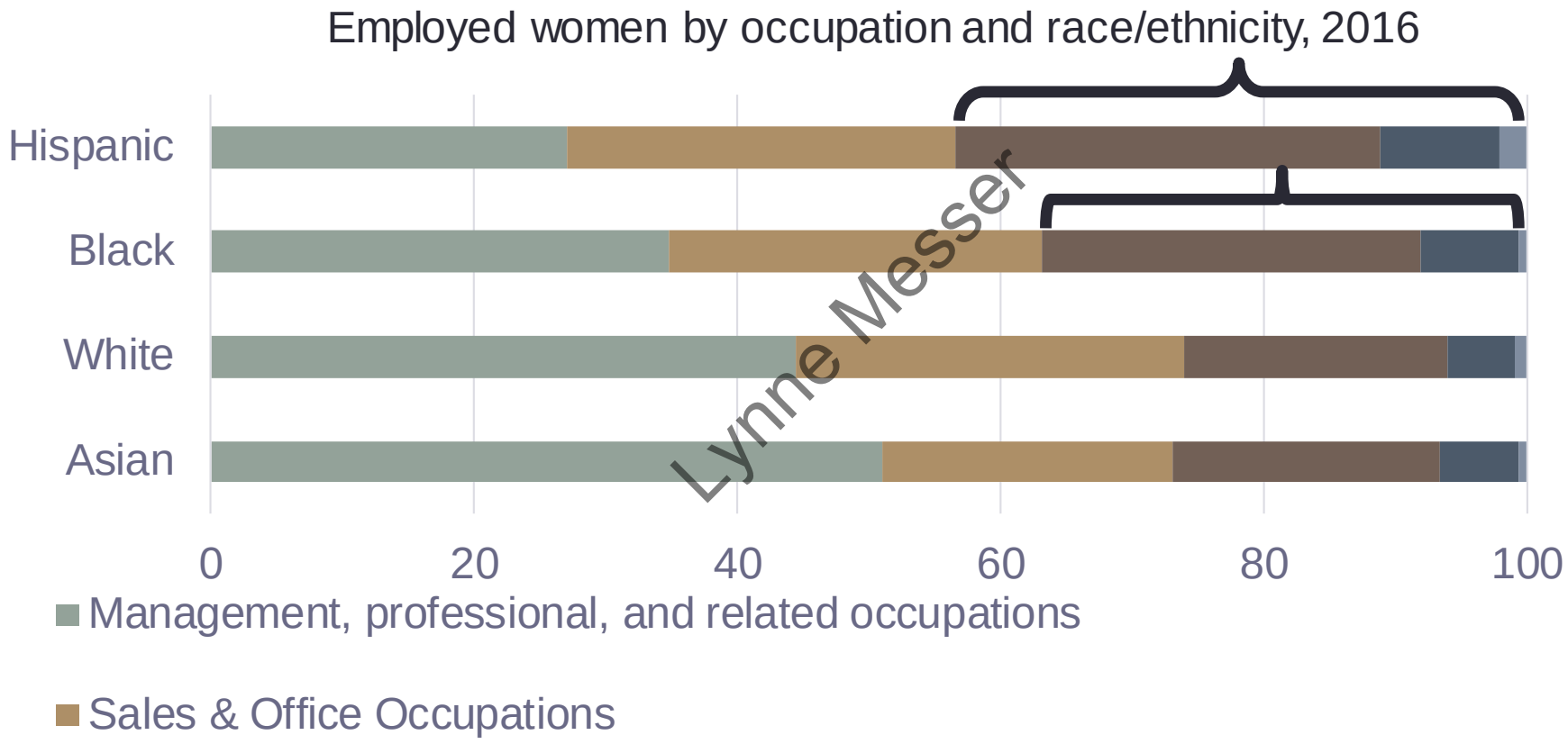
Social position 1: women (& education)



BLS Reports, Report 1070, October 2016

Sarah Andrea graphic, 2018

Social position 2 – women's occupation

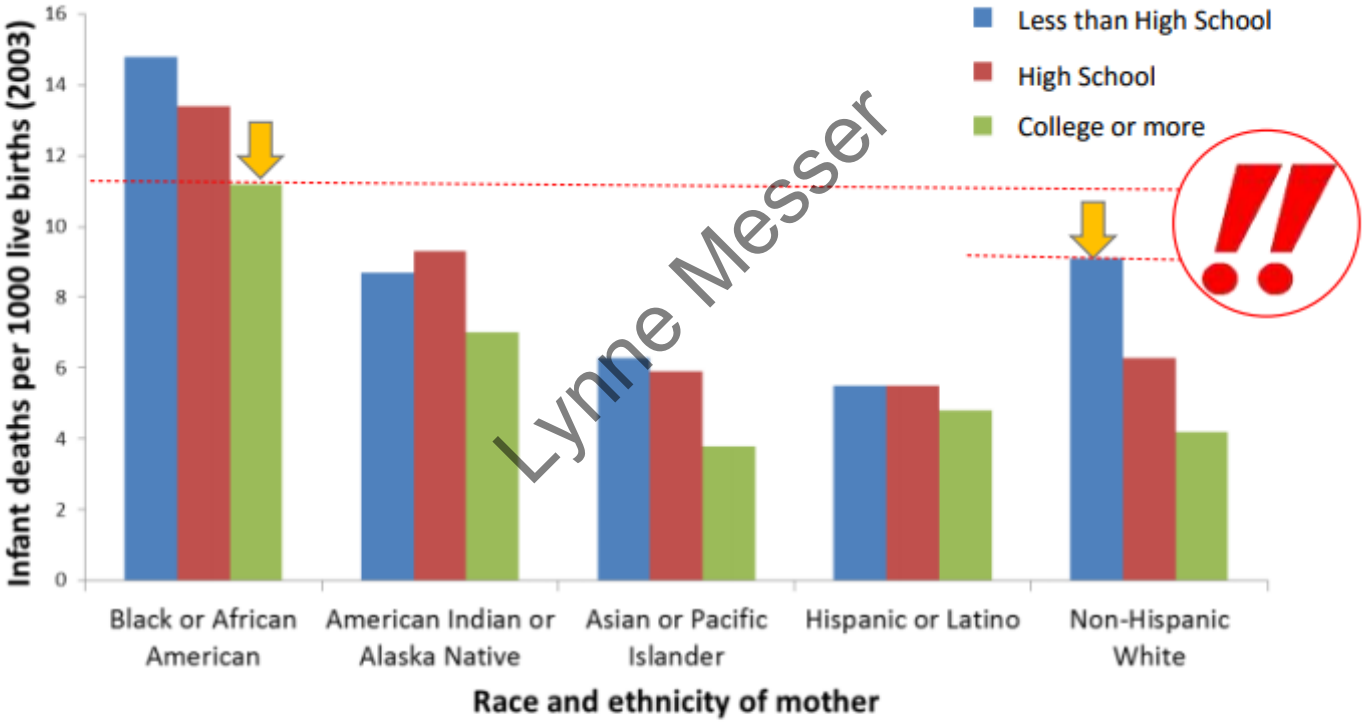


BLS Reports, Report 1070, October 2016

Sarah Andrea graphic, 2018

Consequences of women's social position on infant health

Educational attainment and infant mortality in the US, 2006

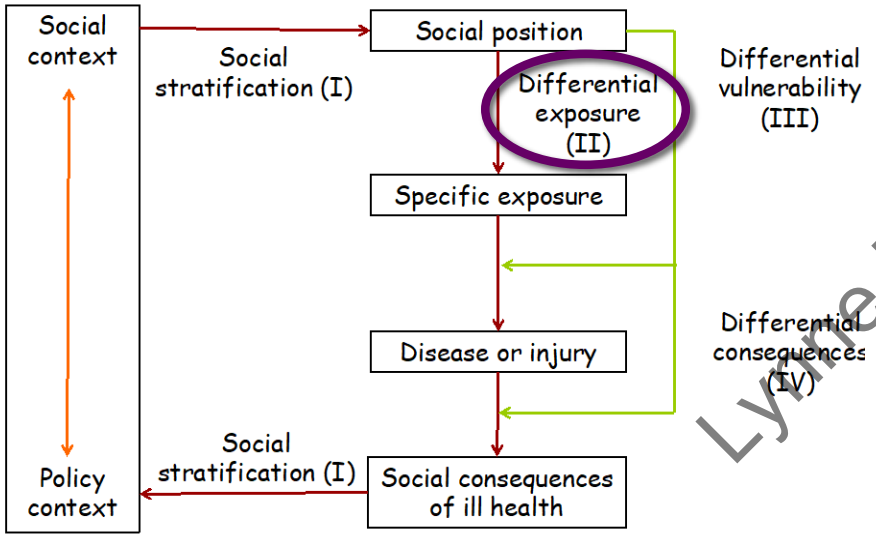


Source: National Center for Health Statistics, Health, United States, 2006, With Chartbook on Trends in the Health of Americans, Hyattsville, MD: 2006

"Measuring Racial Equity: A Groundwater Approach" Austin, Texas. August 17, 2016

Sarah Andrea graphic, 2018

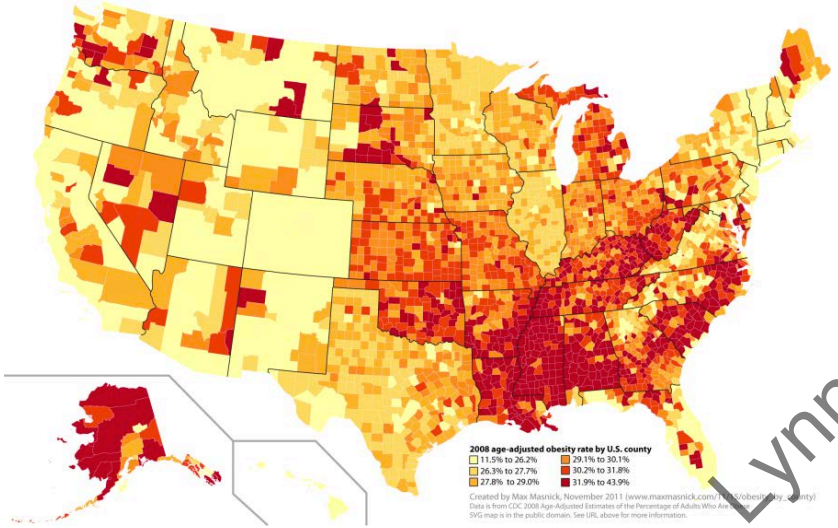
Differential exposure - health

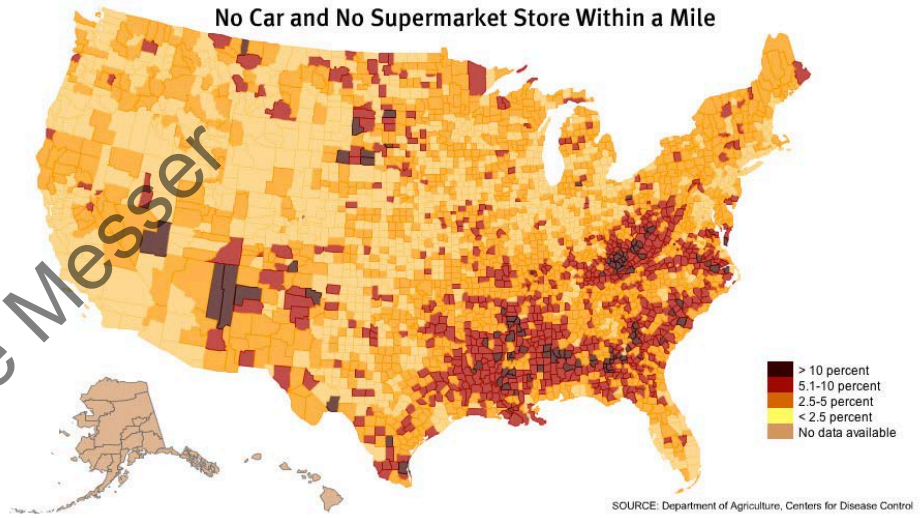


- Differential exposure – exposures vary between social groups by type, amount, duration
  - Dangerous living conditions
  - Dangerous jobs
  - Ability to make healthy choices
  - Greater risk of toxic exposures
- Advantage or disadvantage accumulates over time

Diderichsen and Hallqvist, 2001

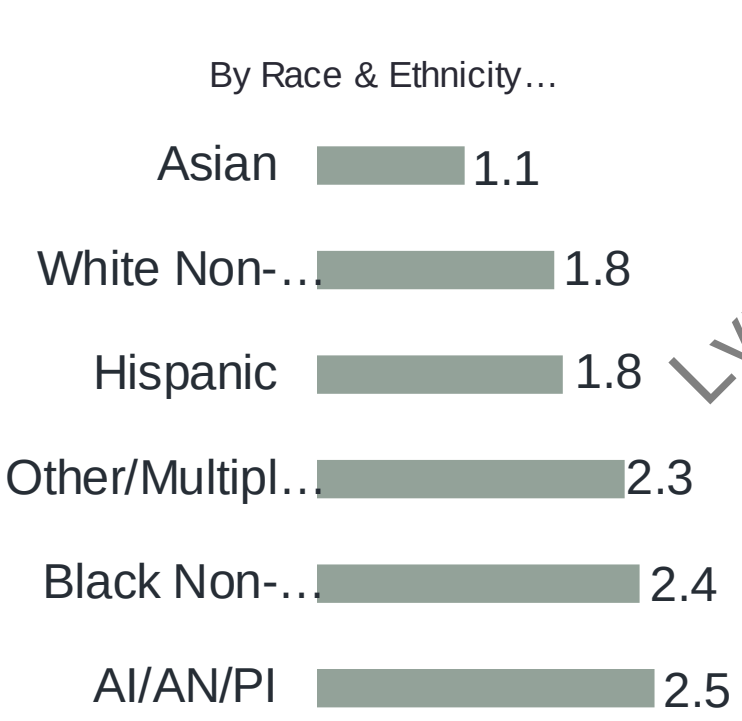
Differential exposure 1 – unhealthy food environments

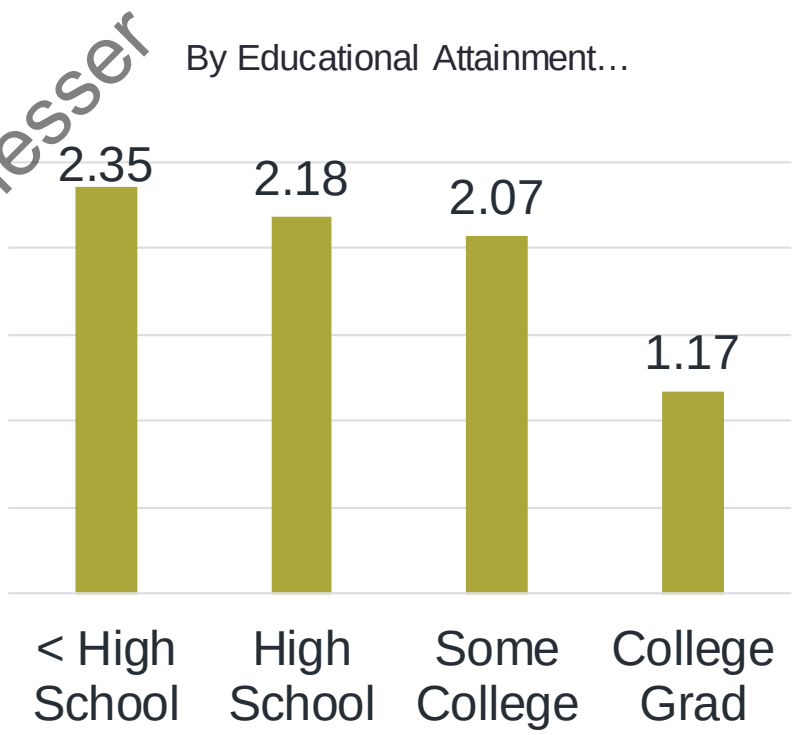




Differential exposure 2 – toxic stress

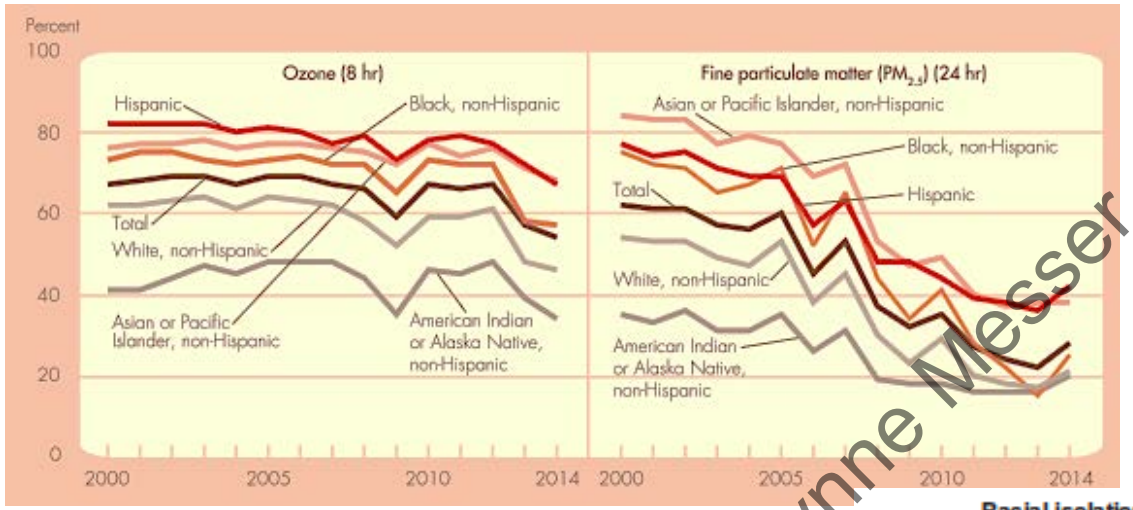
Mean number of stressful life events in the 12 months before delivery, PRAMS 2004-2014



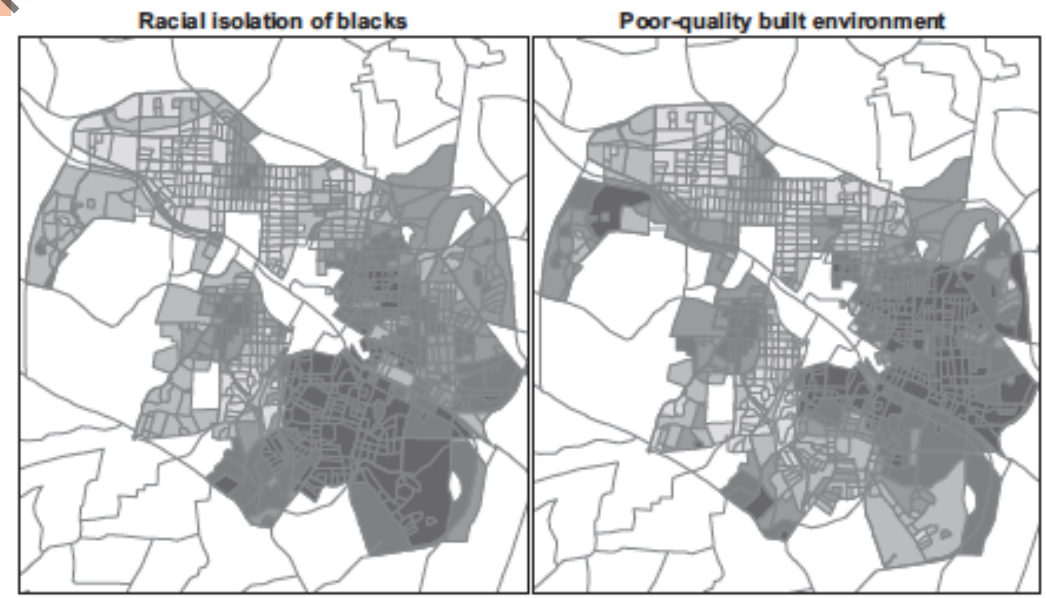


Survey-weighted; Analysis by SBA

Differential exposure 3 – unhealthy physical environments

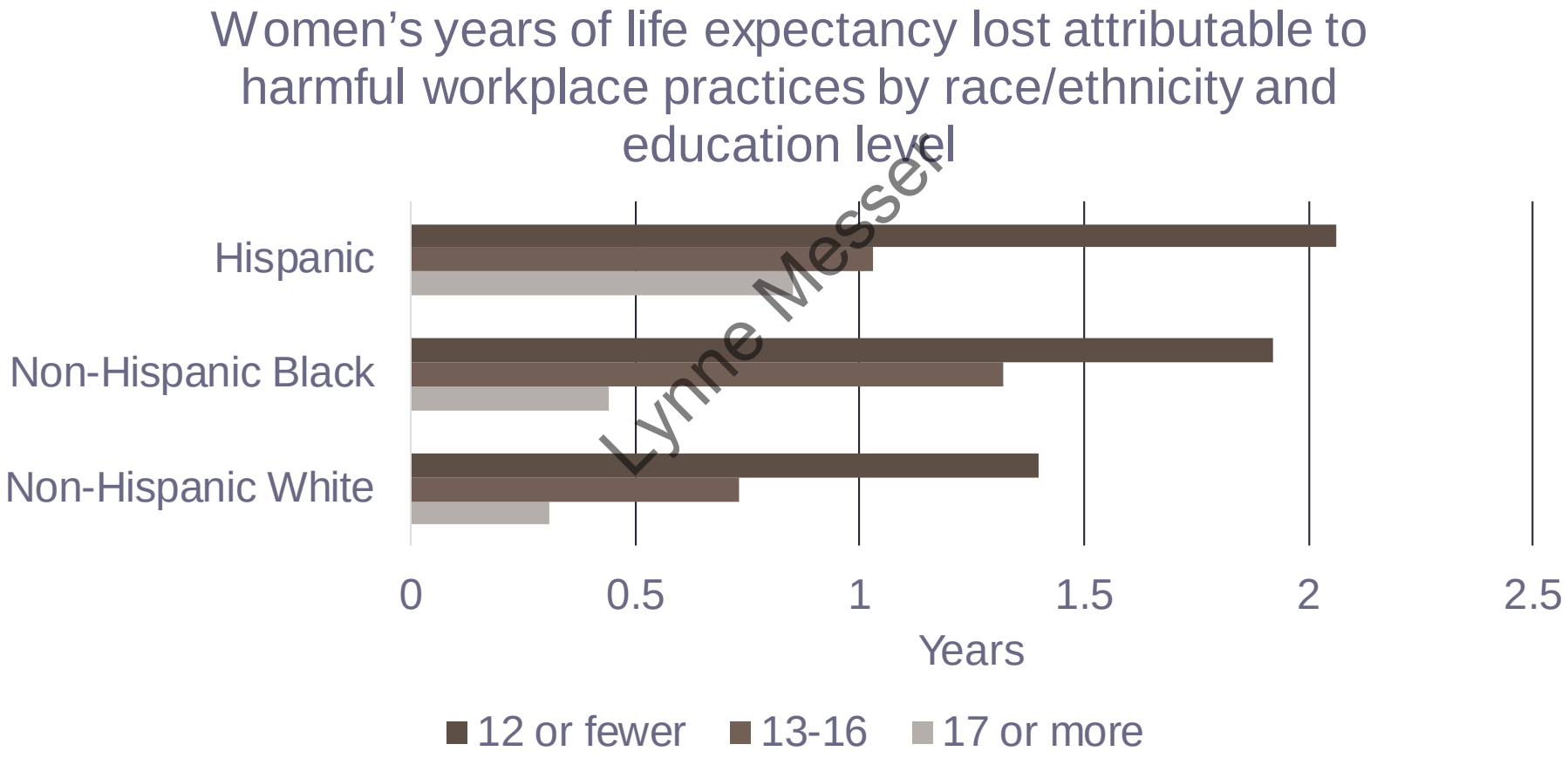


EPA, AQS, 2014



Anthopolos, Kaufman, Messer, Miranda; (2015); Epidemiology; 25(3): 397-405

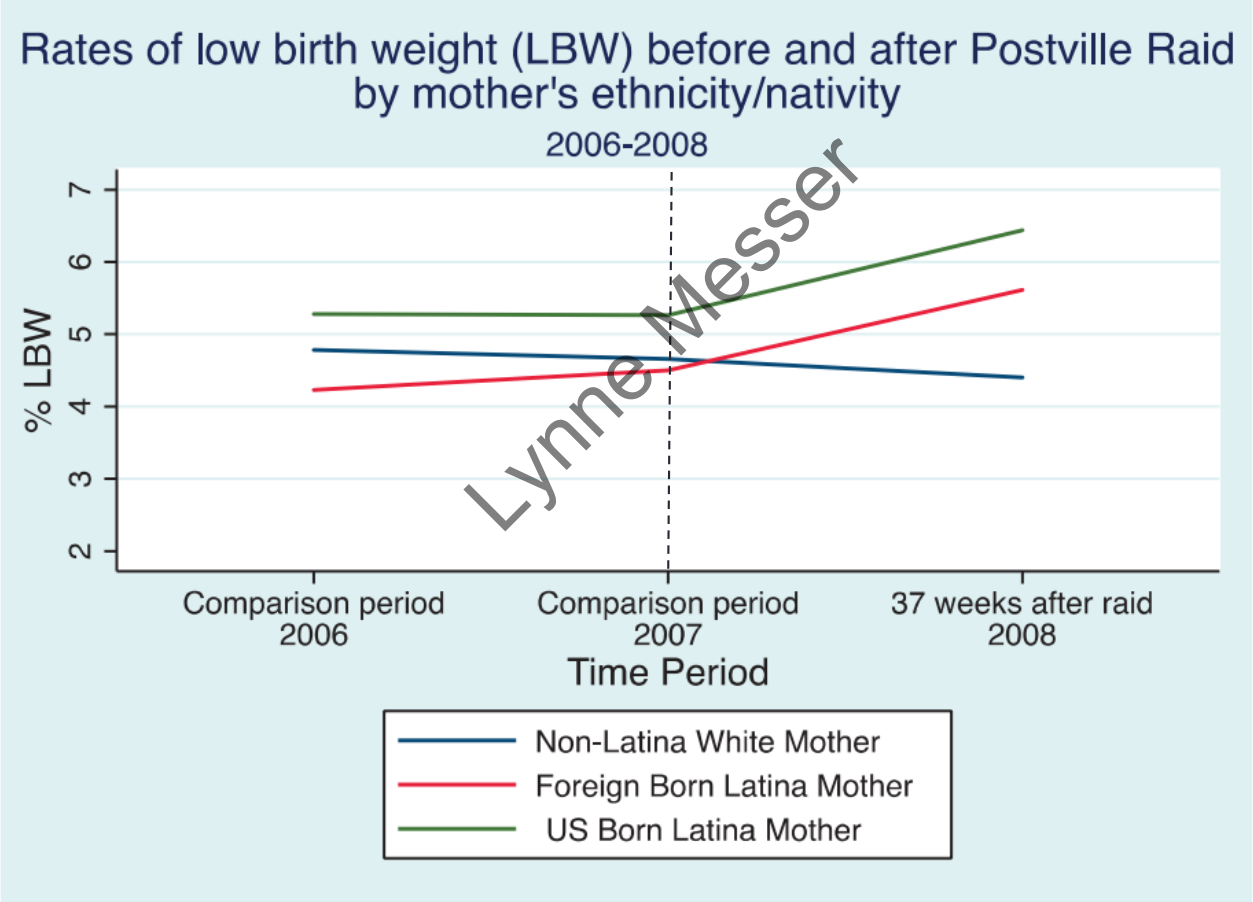
Consequences of differential exposures on women's health



Health Aff (Millwood). 2015 Oct;34(10):1761-8.

Sarah Andrea graphic, 2018

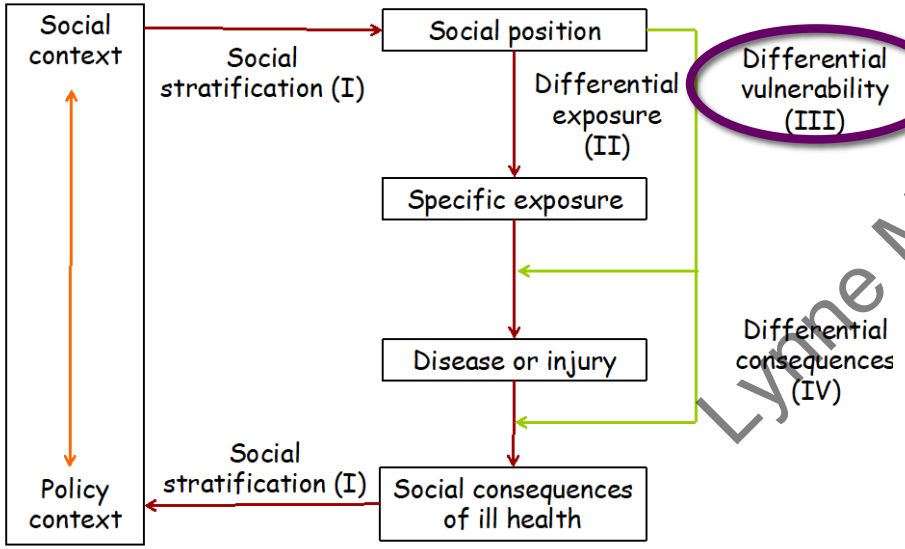
Consequences of differential exposures on infant health



International Journal of Epidemiology, 2017, 839–849

Sarah Andrea graphic, 2018

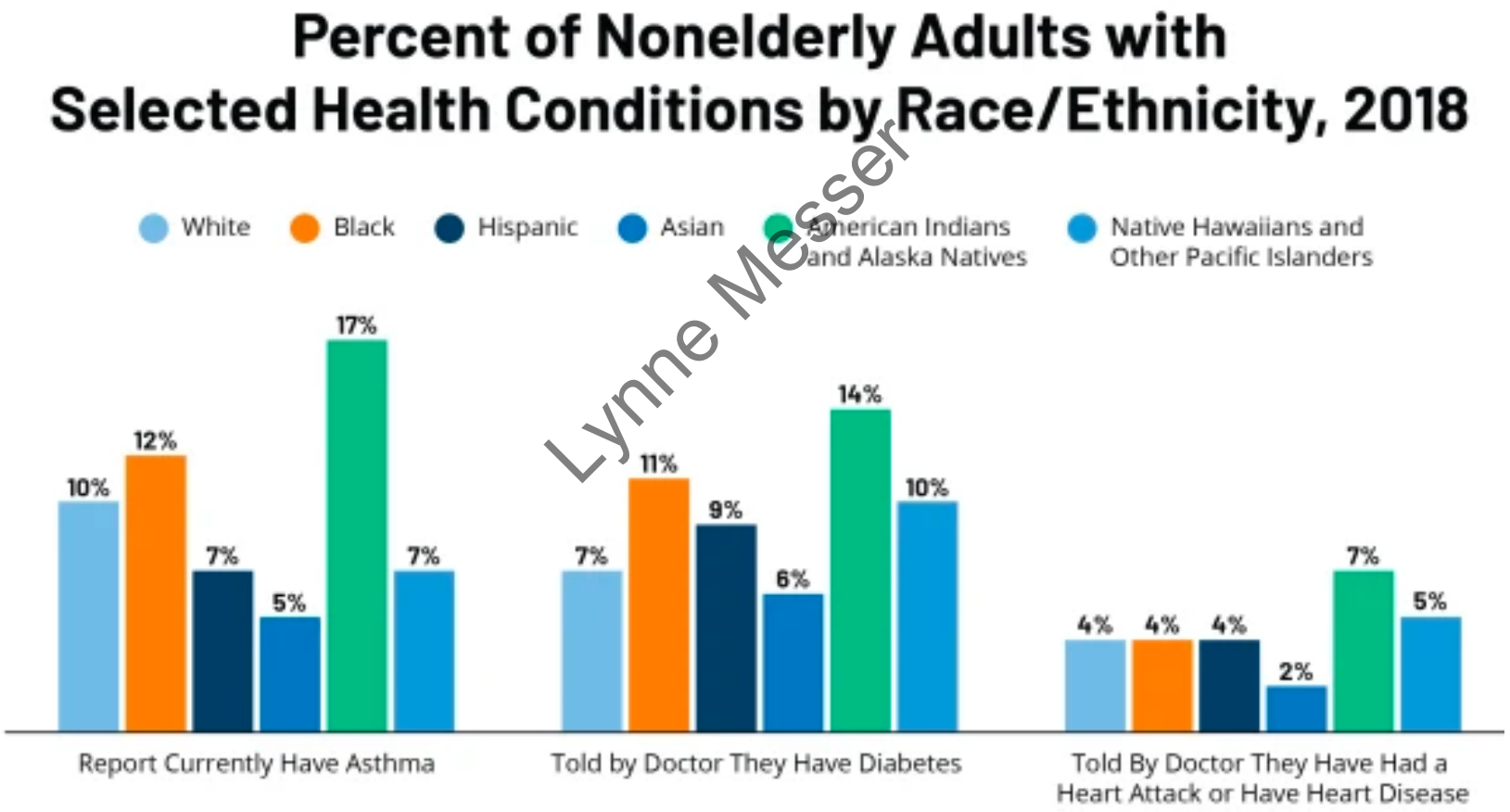
Differential vulnerability - health



- Differential vulnerability – health impact of adverse exposure dependent on other factors
- Even if risk factor equally distributed, health impacts may be unevenly distributed due to underlying vulnerabilities
- Vulnerabilities may also reflect differences between social groups in biological defenses (e.g., fetal programming)

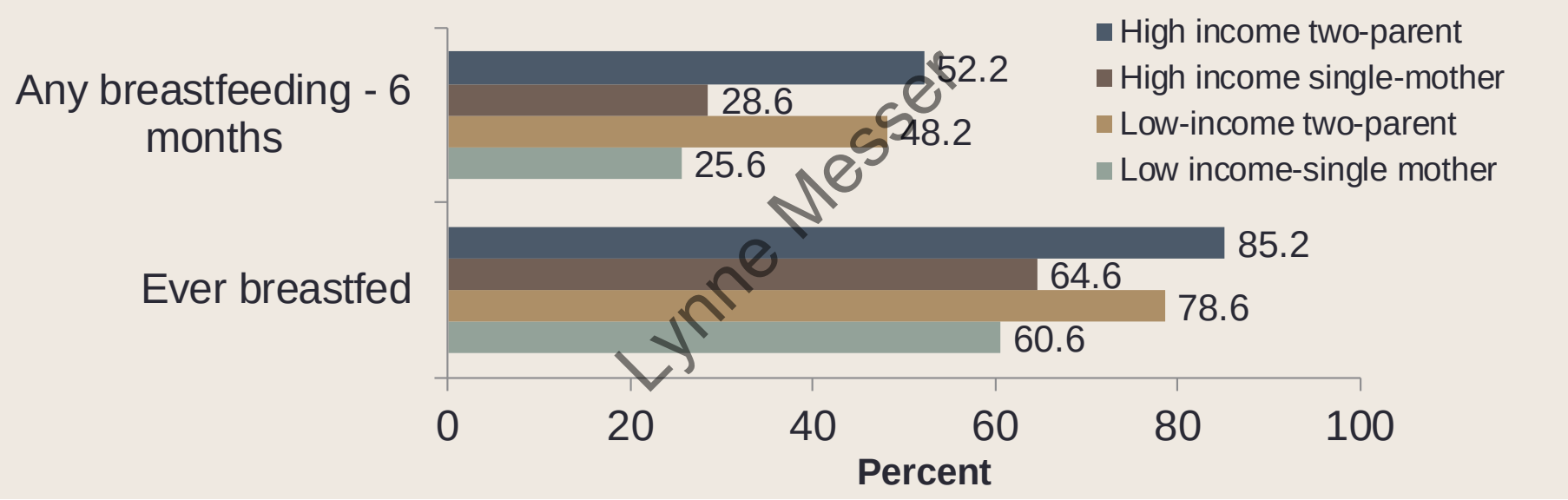
Diderichsen and Hallqvist, 2001

Differential vulnerability 1 – comorbidities by race/ethnicity



Kaiser Family Foundation, 2020

Differential vulnerability 2 – infant breastfeeding by income

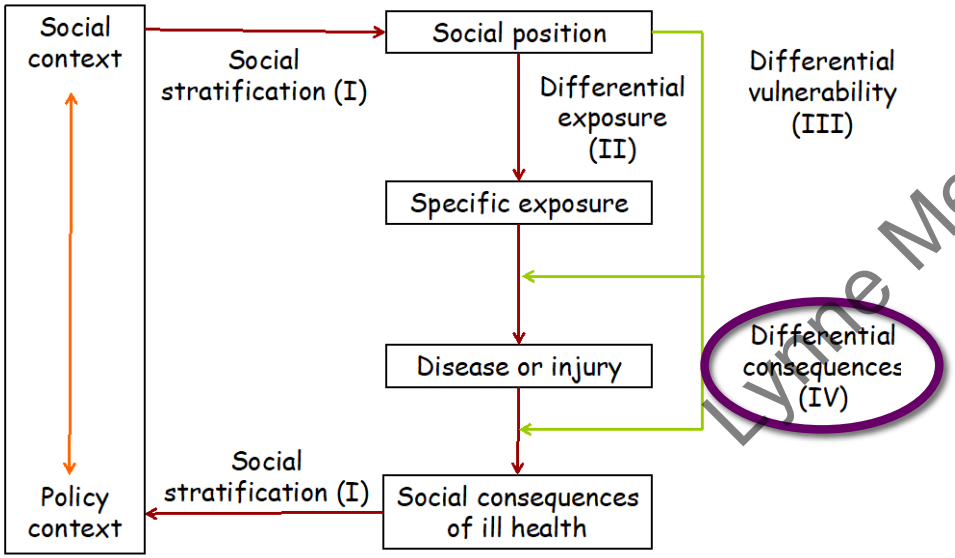


Barriers to breastfeeding: one of the first missed opportunities to develop healthy eating practices and food preferences

Janne Boone-Heinonen graphic, 2021

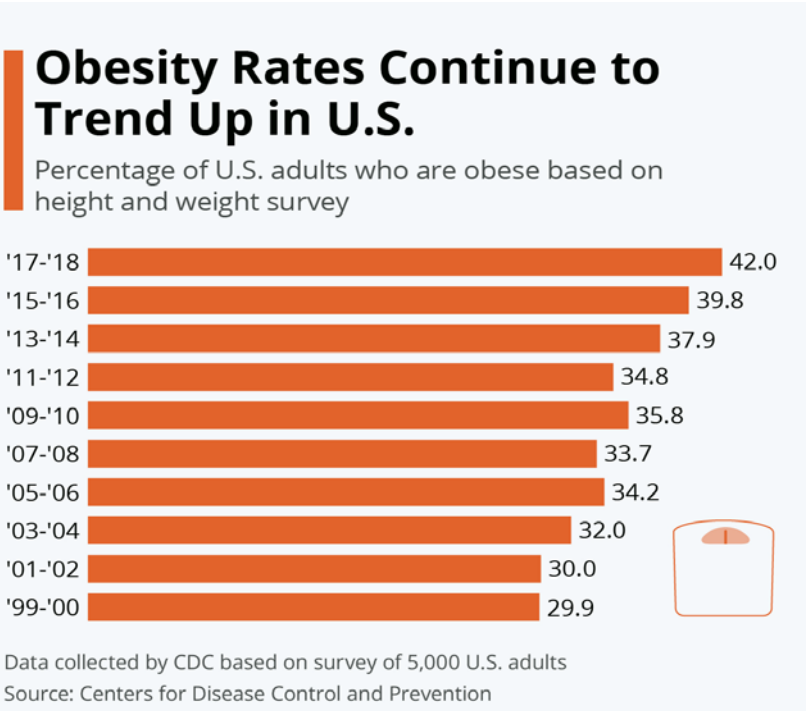
Kim & Gallien (2014) Mat & Child Nutr.

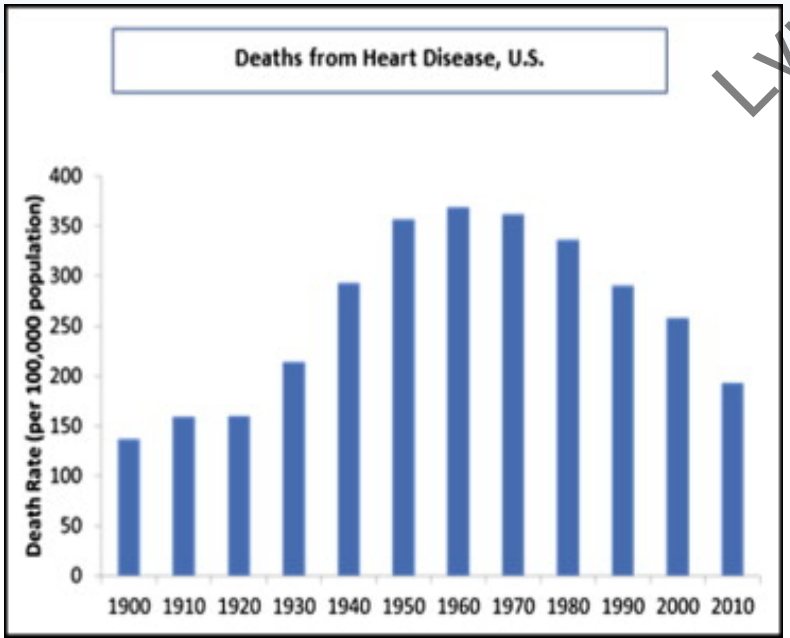
Differential consequences - health

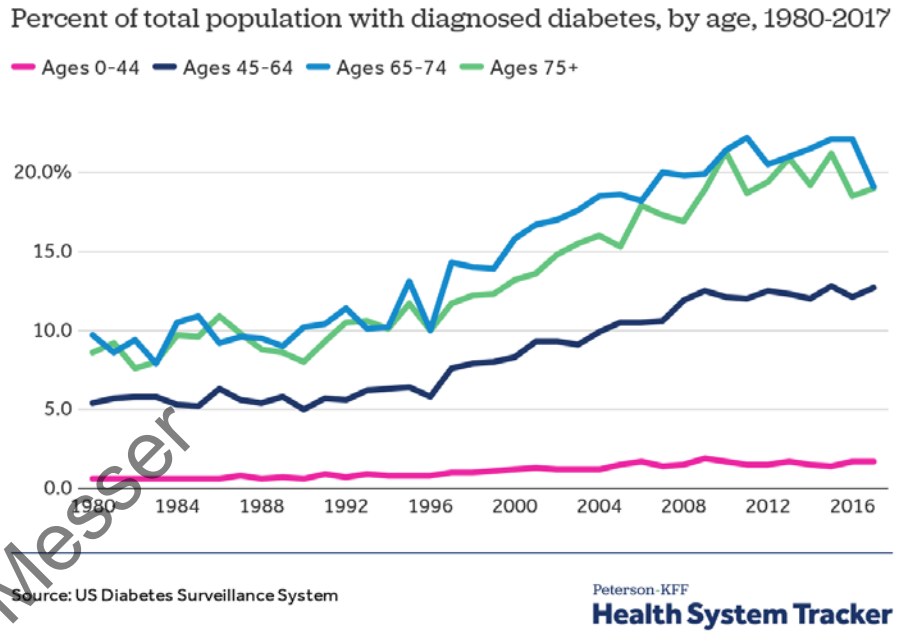


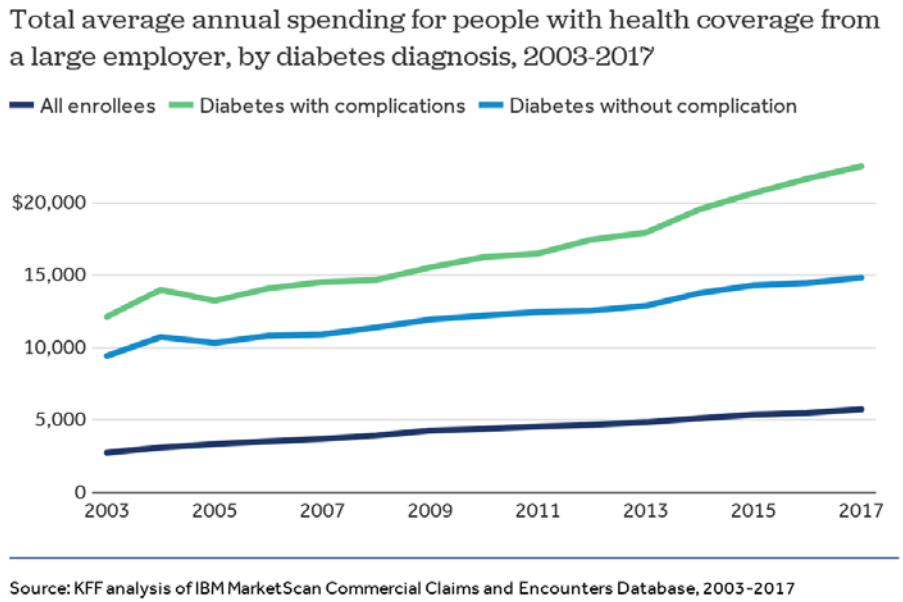
- Social stratification affects one's ability to prevent illness and cope with disease or injury
- Consequences include social and economic costs of disease
- Direct and indirect costs of healthcare and income forgone due to morbidity borne by families

Diderichsen and Hallqvist, 2001

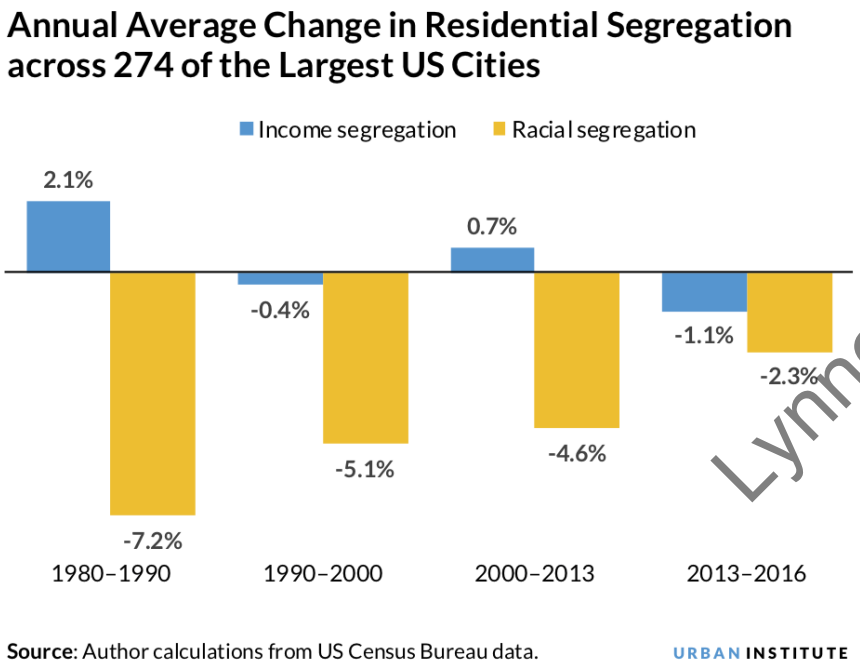








Adverse exposures perpetuated via residential segregation



- Nationally, racial segregation levels going down
  - Gentrification
  - Fewer single race identities

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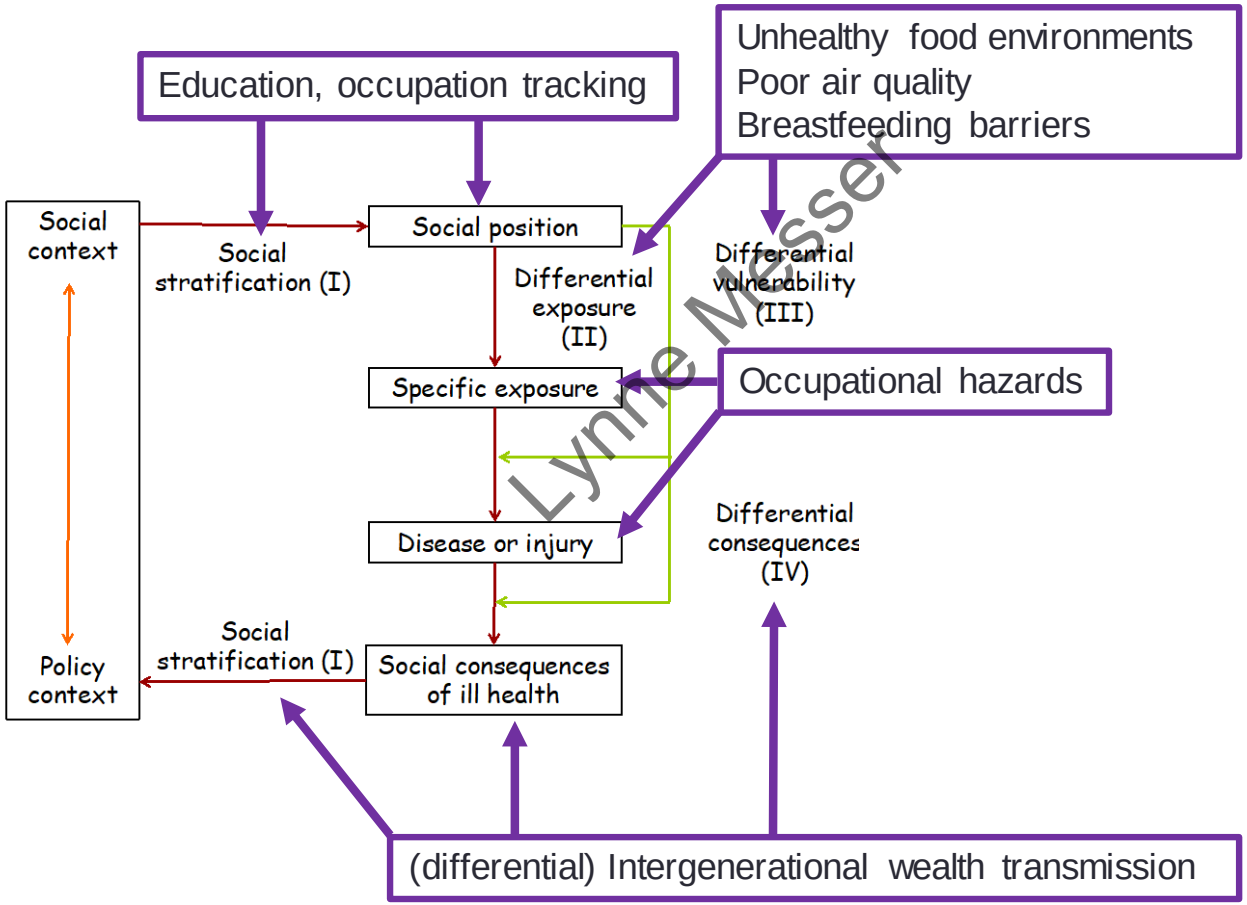
Table 1. Segregation in the Nation's 10 Largest Metropolitan Areas, 2000–2010

	Dissimilarity		Isolation	
	2000	2010	2000	2010
New York	68.7	64.7	47.6	42.4
Los Angeles	58.4	54.5	26.8	22.0
Chicago	77.9	71.9	65.9	57.5
Dallas-Ft. Worth	53.7	47.5	30.4	23.4
Philadelphia	67.0	62.6	50.5	44.6
Houston	56.0	47.8	34.0	24.3
Washington	59.7	56.1	44.0	39.1
Miami	63.6	58.1	42.8	37.7
Atlanta	61.0	54.1	45.4	37.8
Boston	62.6	57.6	32.0	26.8

social construction of intergenerational health inequities

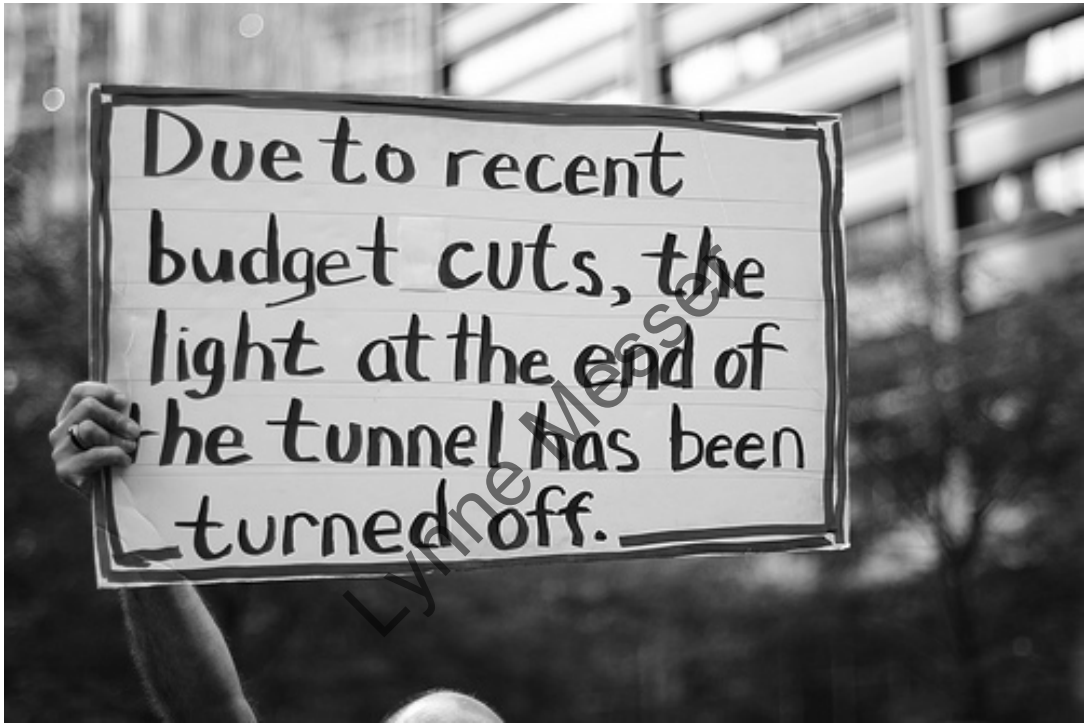


epidemiology enables DOHaD researchers to see our fishbowl

At a population level

Differential distribution of adverse exposures results from

- racism
- sexism
- classism
- etc.


Due to recent budget cuts, the light at the end of the tunnel has been turned off.
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- Mitigation of gestationally-primed vulnerabilities
  - physical activity effects
  - dietary modifications
- Remediation
  - stricter environmental regulations
  - improved food environments
- Revolution
  - wage equity between women and men
  - reparations for slavery and lands stolen from American Indians

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thank you

questions?

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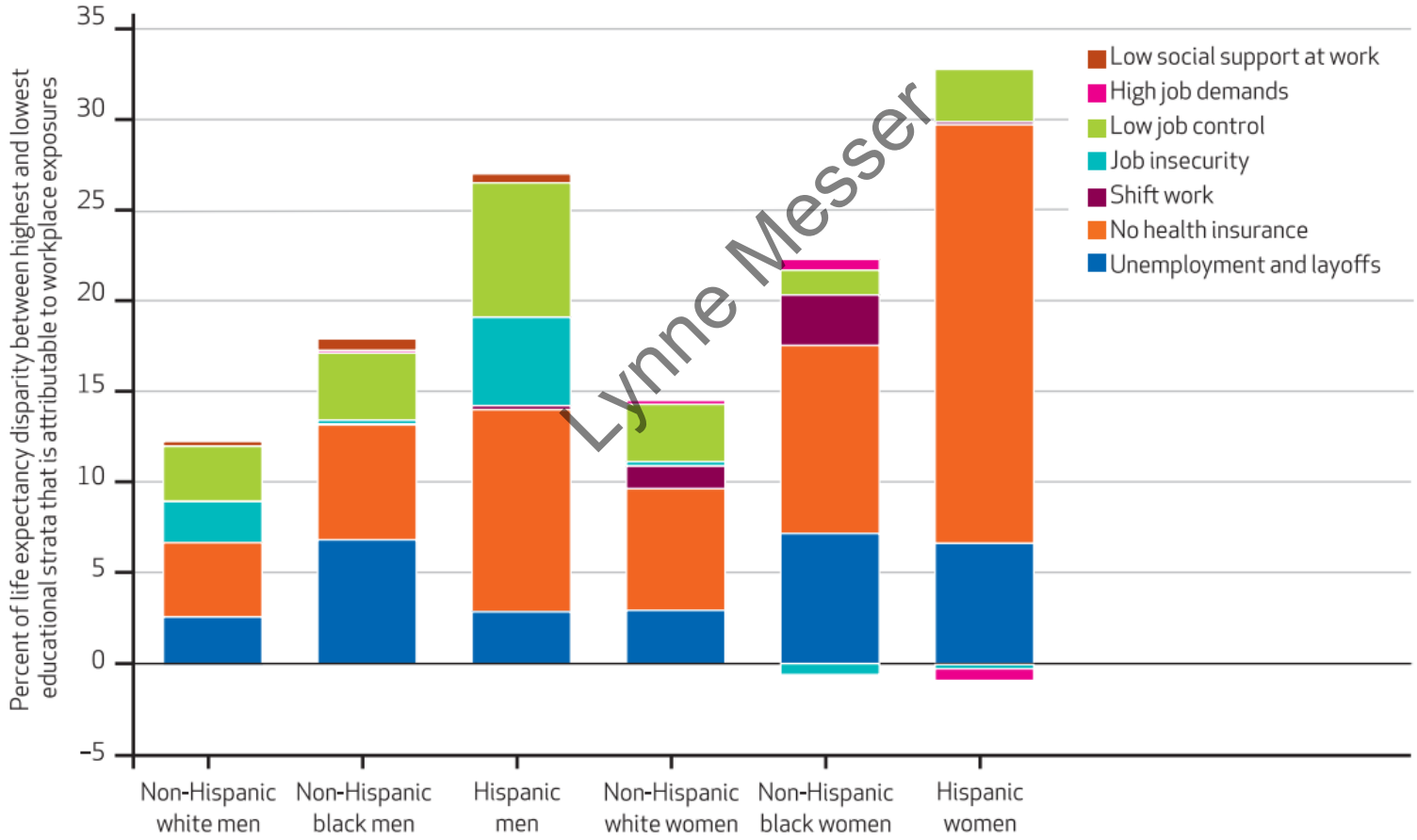
EXTRA SLIDES

EXHIBIT 3

Percentage Of Life Expectancy Disparity Between The Highest And Lowest Educational Strata Attributable To Ten Distinct Workplace Exposures, By Demographic Group

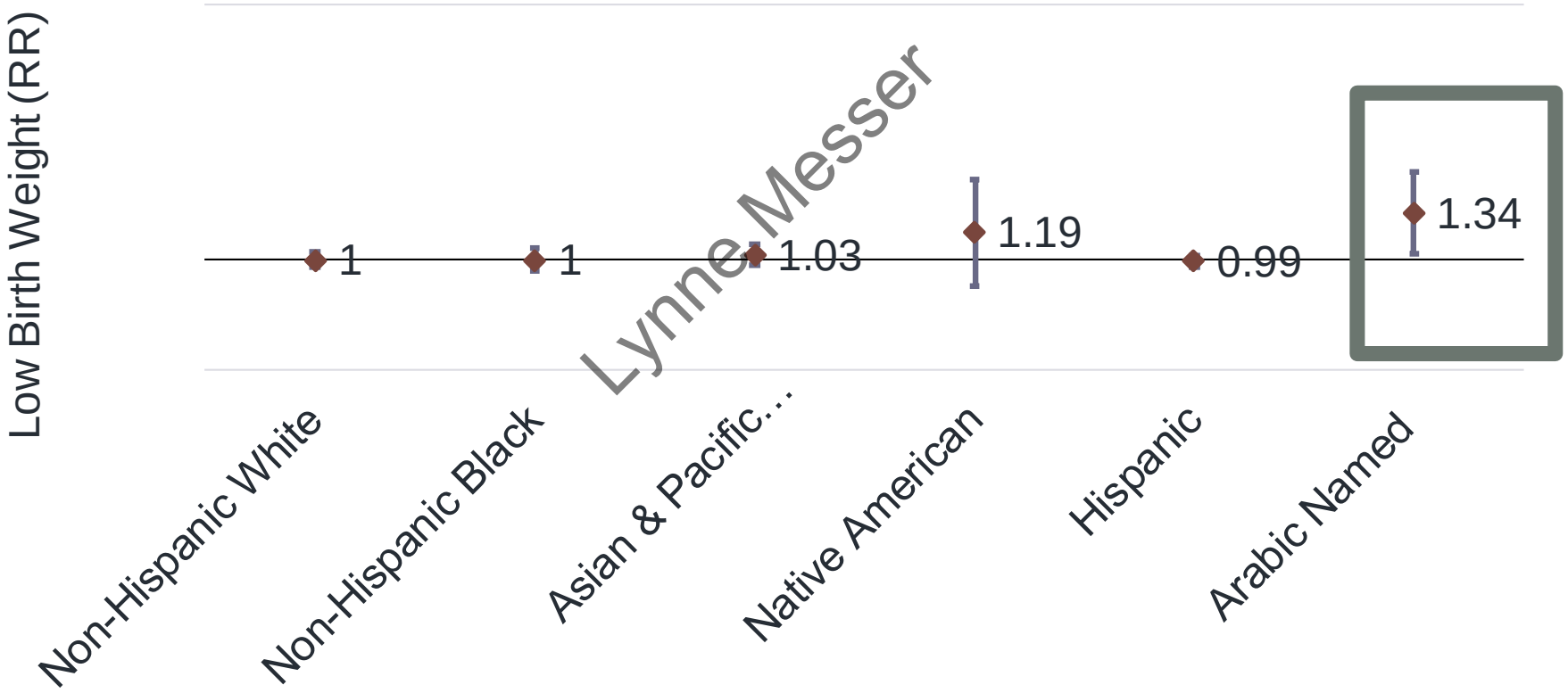


Health Aff (Millwood). 2015 Oct;34(10):1761-8.

LBW among singleton infants in CA;January 2000–June 2001

Demography. 2006 Feb;43(1):185-201.

Relative Risks of LBW among singleton infants during October 2001–March 2002, compared with October 2000–March 2001



Demography. 2006 Feb;43(1):185-201.

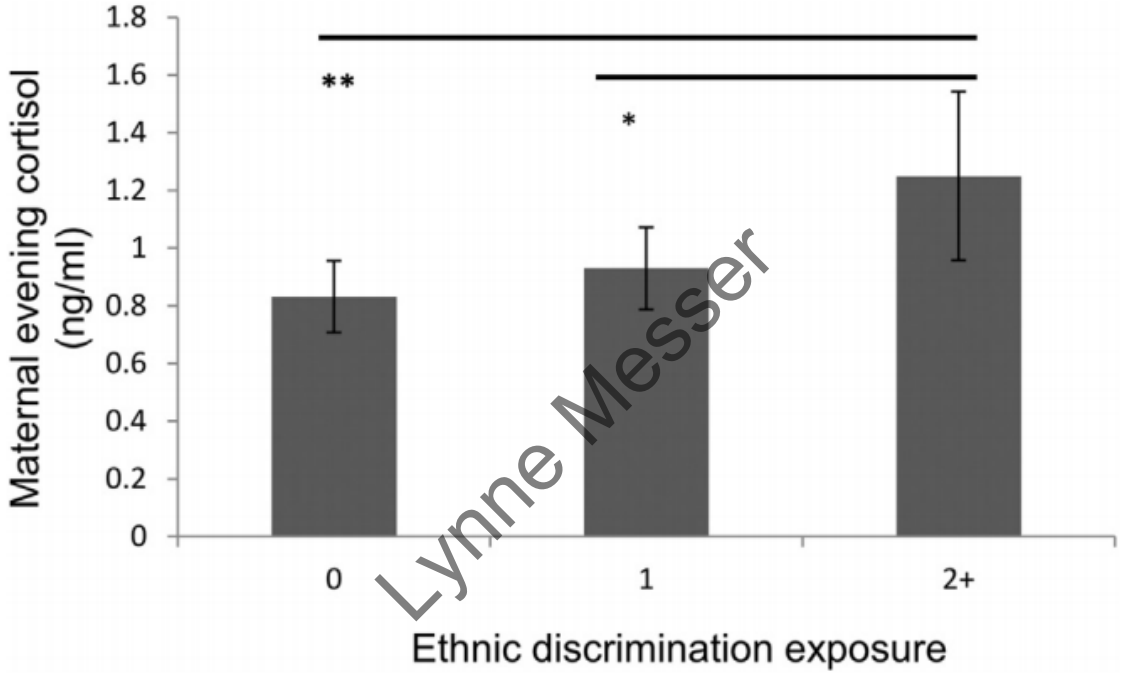


Fig. 1. Relationship between number of reported exposures to ethnic discrimination maternal evening cortisol in late pregnancy (figure presents mean and 95% CI) (** = $P < 0.001$; * = $P < 0.01$).

Soc Sci Med. 2015 Mar;128:36-42. doi: 10.1016/j.socscimed.2015.01.003. Epub 2015 Jan 6.