Social Determinants of Infectious Disease

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Outline

- What is social epidemiology?

- Social patterning of infection
  - Examples

- Implications for prevention

Social Epidemiology

Emerged during the chronic disease era

- Term traced back to a 1950 article by Alfred Yankauer
  - The relationship of fetal and infant mortality to residential segregation: an inquiry into social epidemiology- *American Sociological Review*

- Term increased in the literature after 1969

Krieger, N. *Int J Epidemiol.*2001;30:688-77

Social Determinants

- Social Epidemiology
  - Focus on social conditions that promote or harm health rather than on specific <u>outcomes</u>

- Requires researchers to move from proximate to distal factors

Krieger, N. *Int J Epidemiol.*2001;30:688-77

Social Epidemiology Became a Study of Chronic Diseases

"field of inquiry that regards the role of social and psychological factors in the etiology of chronic diseases"

– Reynaud M. *Rev Epidemiol Sante Publique.* 1987;35:3-19

" a term which has recently come into favor to describe research concerned with social factors in the etiology of chronic disease"

– McQueen DV. *Soc Sci Med.* 1982;16:353-67

The "Gradient" in chronic disease

- Wealthier, more educated people live longer, healthier lives (on average)

- Access to care and traditional behavioral factors do not entirely explain the gradient

Died in 1800's

Every meter in height of the grave, adjusted for year of death:

- 1.93 years (95%CI 1.06-2.80) later age at death for men

- 2.92 years (95%CI 1.76-4.08) later age at death for women

Davey Smith G, Carroll D, Rankin S, Rowan D. Socioeconomic differentials in mortality: evidence from Glasgow graveyards. BMJ 1992;305:1554-1557.

Years of Education and Mortality
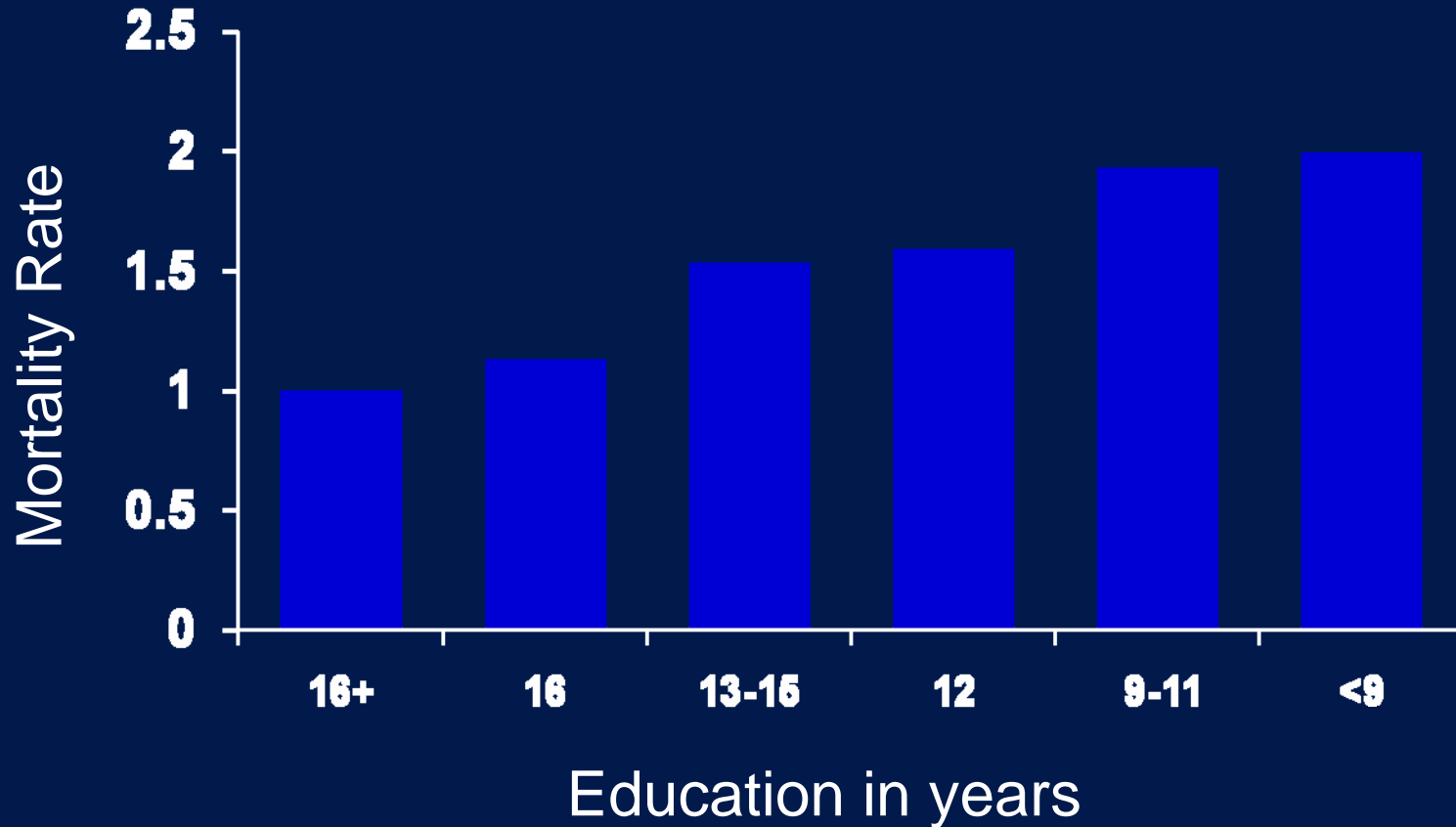
Age-adjusted Relative Risk of Mortality from Cox Models, National Longitudinal Mortality Study (NLMS), ~8 years follow-up time (males)

8

Socioeconomic and psychosocial gradients

- Cardiovascular disease

- Dementia and cognitive impairment

- Physical functioning

- Some cancers
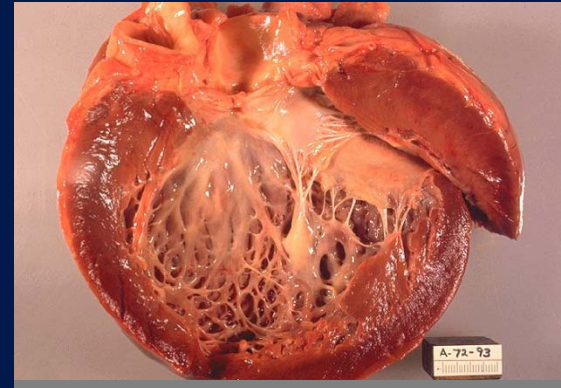
Potential Pathway: Stress?

Lower socioeconomic position (SEP) associated with greater exposure to stressors such as:

- perceived financial strain
- job insecurity
- low job control
- negative life events
- unsafe residential environments
- discriminatory experiences

Hypothesized Pathways

Figure from D.N. Khansar et al. (1990) *Immunol. Today* 11:170
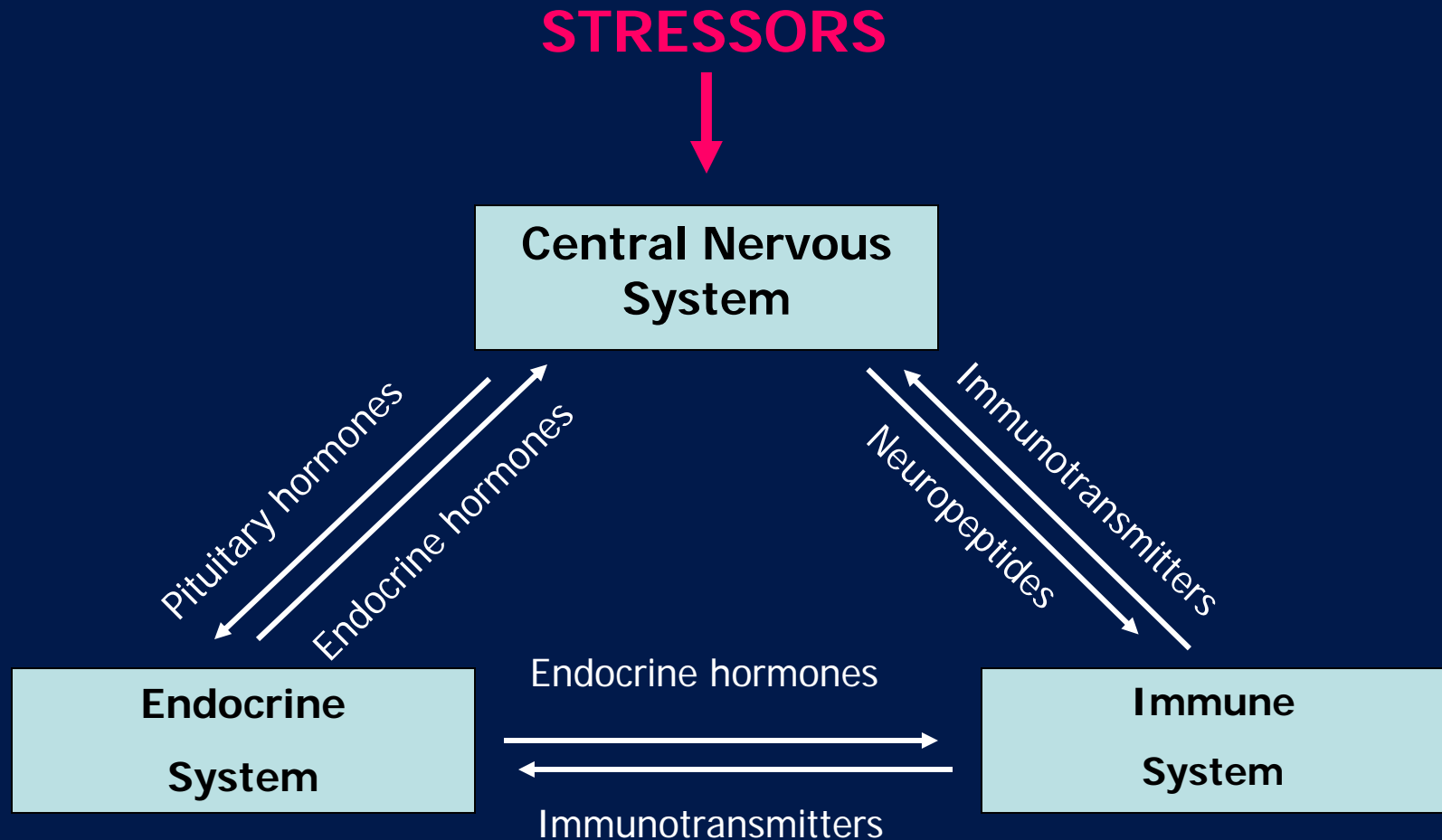
What is the evidence for a relationship between social factors and infection in the US?

Today

- Social, political, behavioral and environmental factors are widely accepted as forces shaping emergence and reemergence of pathogens

Proportion of AIDS Cases among Adults and Adolescents, by Race/Ethnicity and Year of Diagnosis 1985–2003—United States
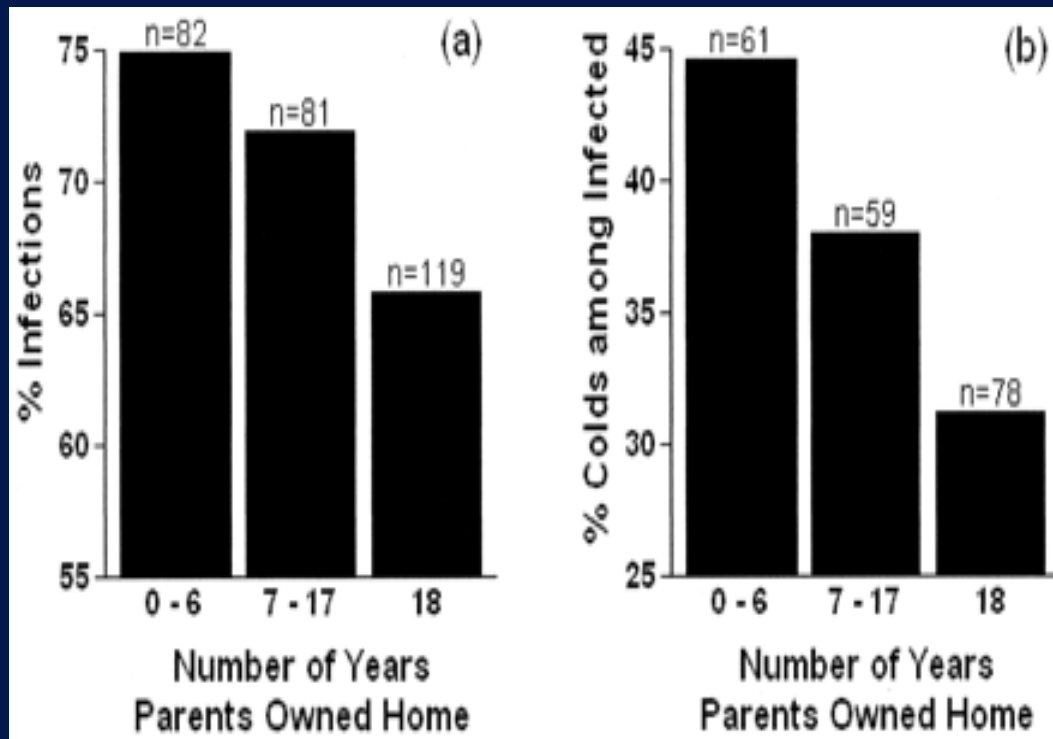
Cases, %

White, not Hispanic

Black, not Hispanic

Hispanic

Asian/Pacific Islander

American Indian/ Alaska Native

Year of diagnosis
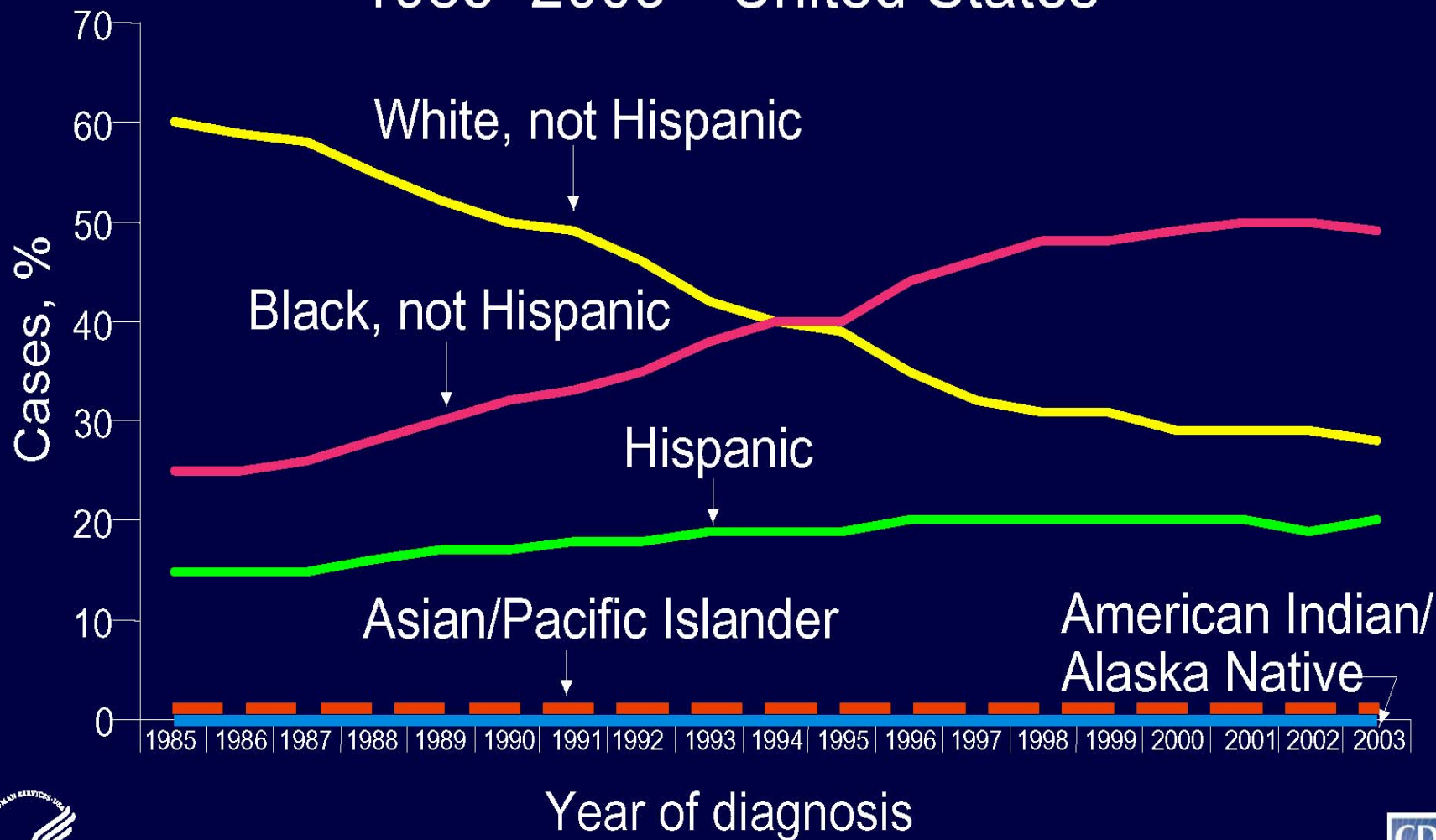
Note. Adjusted for reporting delays.

Adult HIV prevalence rate (%) (ages 15-49), log scale
SOURCE: UNAIDS

Gross National Income per capita (PPP $), log scale
SOURCE: World Development Indicators (World Bank)

www.GAPMINDER.org

COLOUR BY REGION
- Arab States
- Central and Eastern Europe
- Central Asia
- East Asia and the Pacific
- Latin America and the Caribbean
- North America and Western Europe
- South and West Asia
- Sub-Saharan Africa

SIZE BY NUMBER OF PEOPLE LIVING WITH HIV
5 000
10 000
25 000
50 000
100 000
250 000

SOURCE: UNAIDS
Italic: size guestimation made by Gapminder
Sudan HIV prevalence Guestimated by Gapminder

500 000
1 000 000
2 500 000

5 000 000

YEAR~ 2001-2003

Childhood Socioeconomics and Colds

■ Ownership from ages 1-9 was a more important marker than adolescence
  ■ Critical period hypothesis?

Figure from: Cohen *et al.* (2004) Childhood socioeconomic status and host resistance to infectious illness in adulthood. *Psychosomatic Med* 66:553-8
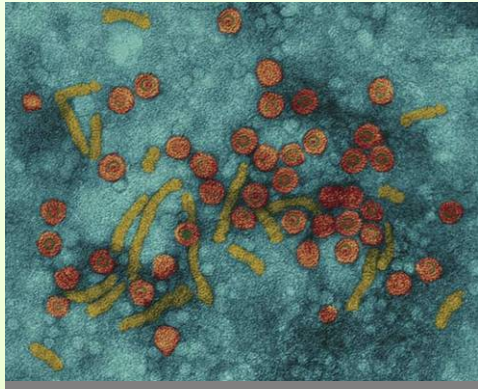
Hepatitis B Virus (HBV)
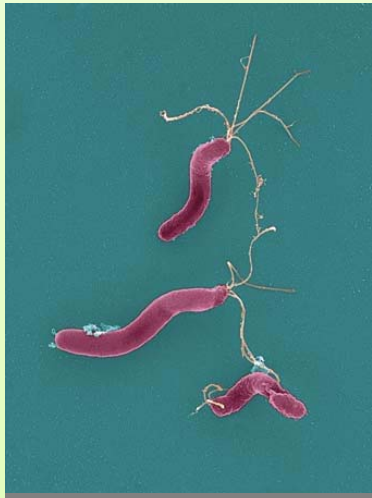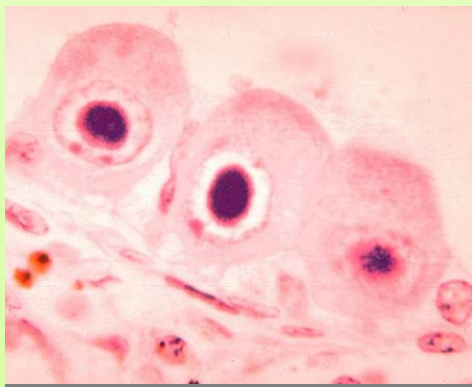
> Hepatocellular carcinoma, Chronic hepatitis

Helicobacter pylori

> Peptic Ulcer Disease, Gastric lymphoma

Cytomegalovirus (CMV)
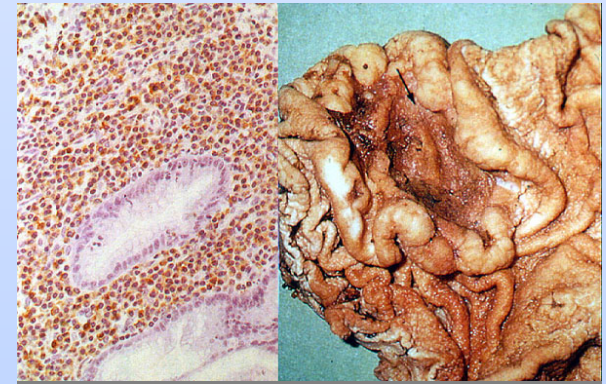
> Post-transplant accelerated atherosclerosis
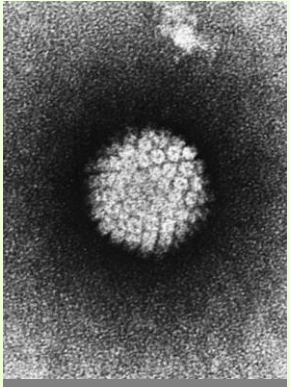
Human Papilloma Virus (HPV) › Cervical Carcinoma
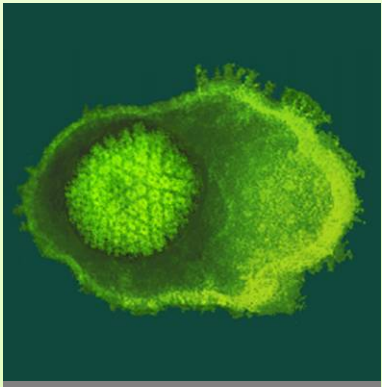
Varicella zoster › Shingles, neuropathy
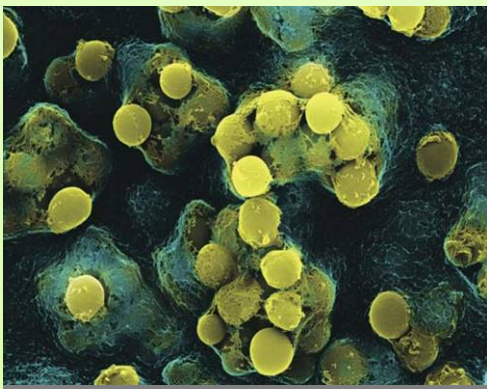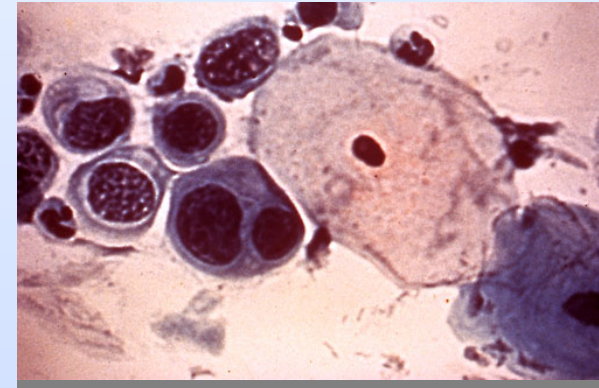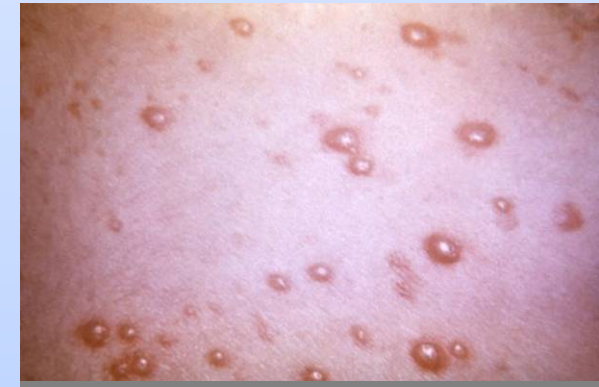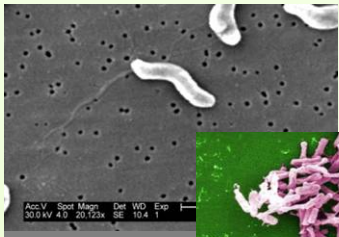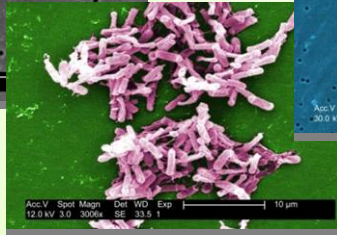
Streptococcus pyogenes › Rheumatic heart disease
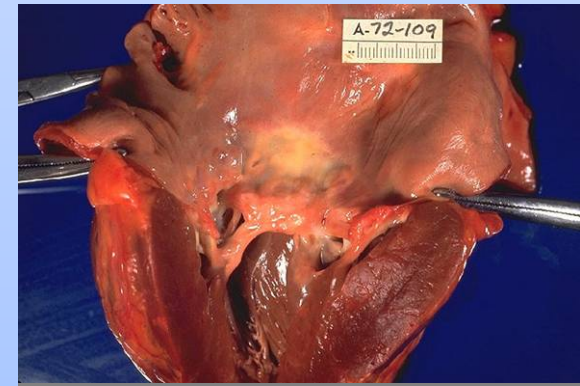
Implicated Pathogens
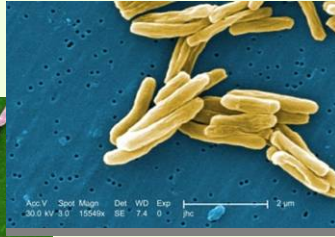
Clostridium

C. jejuni
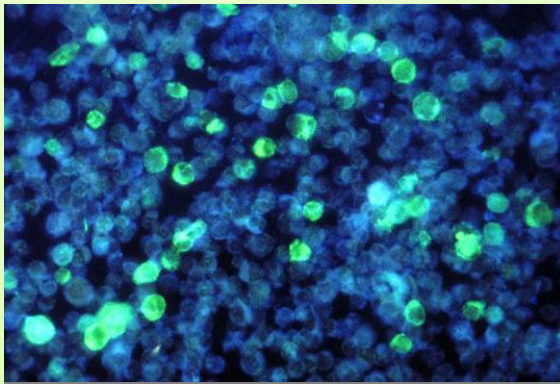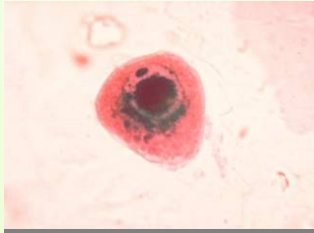
Mycobacterium paratuber
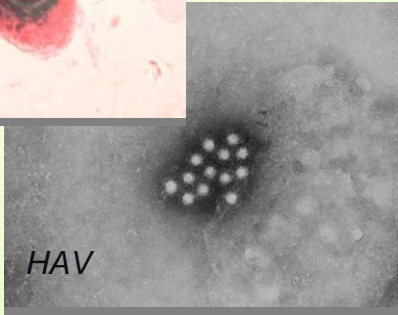
❯ **Crohn's disease**
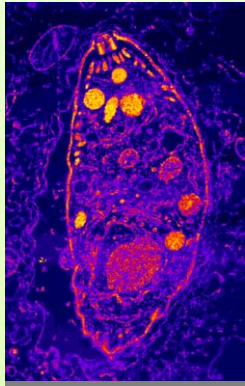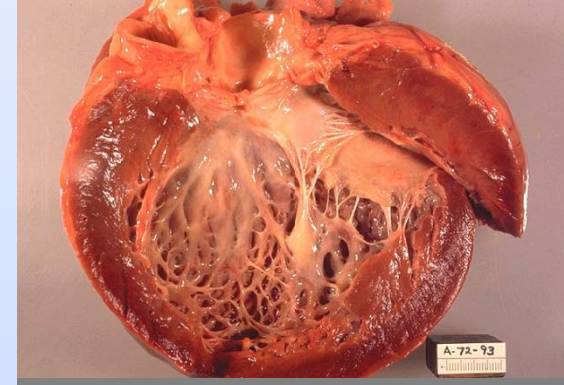
HTLV-1, EBV

EBV

❯ Chronic Fatigue Syndrome

CMV

HAV

Cytomegalovirus (CMV), Herpes Simplex Virus (HSV), *Chlamydia pneumoniae*, *Helicobacter pylori,* periodontal bacteria, hepatitis A virus (HAV)
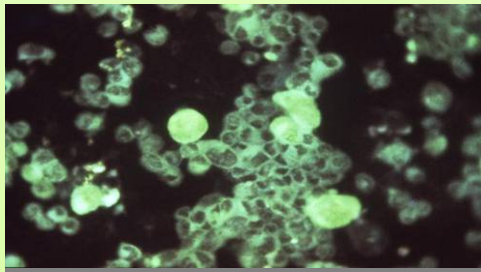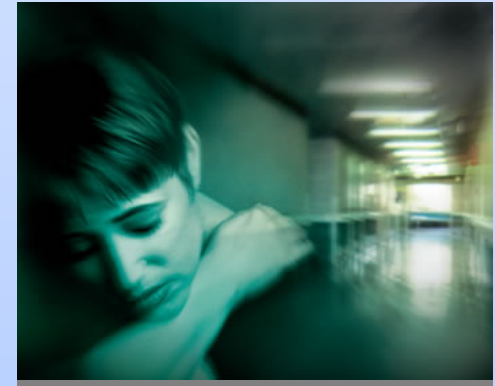
> Cardiovascular disease

Toxoplasma gondii

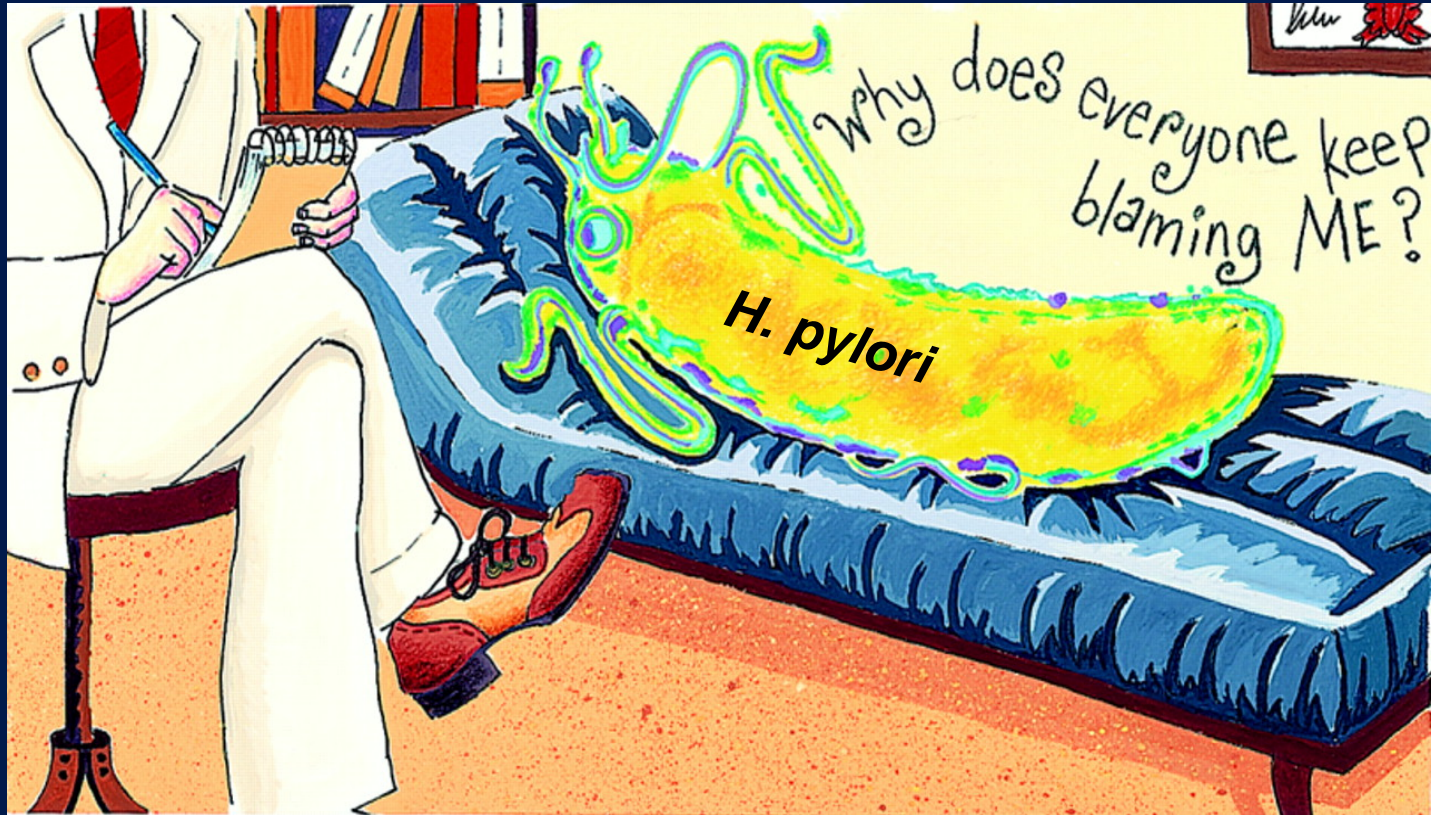*Toxoplasma gondii*, HSV-2, CMV, prenatal exposure to viruses/influenza

> Schizophrenia, Dementia

CMV

Social Patterning of *H. pylori*

Social Patterning of *H. pylori:* importance of childhood

23
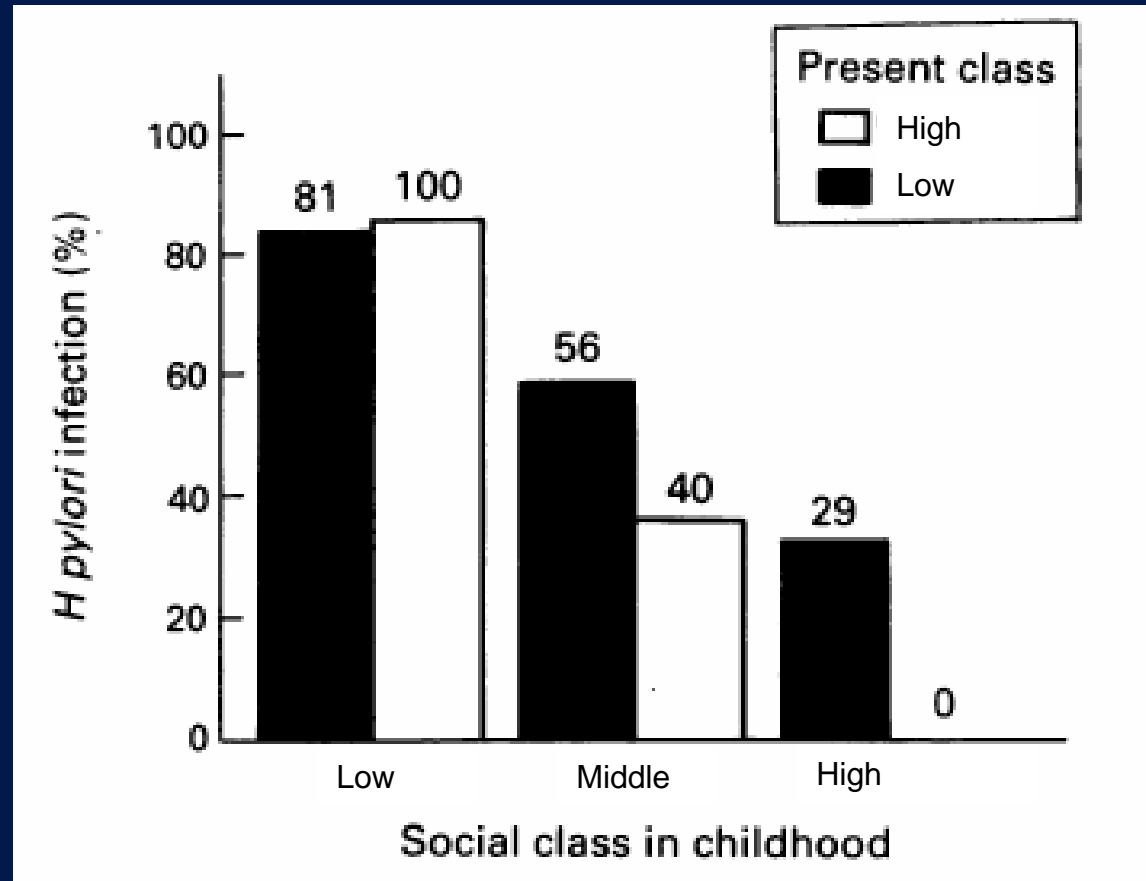
Prevalence of HPV among US Women (N=1,921) ages 14-59
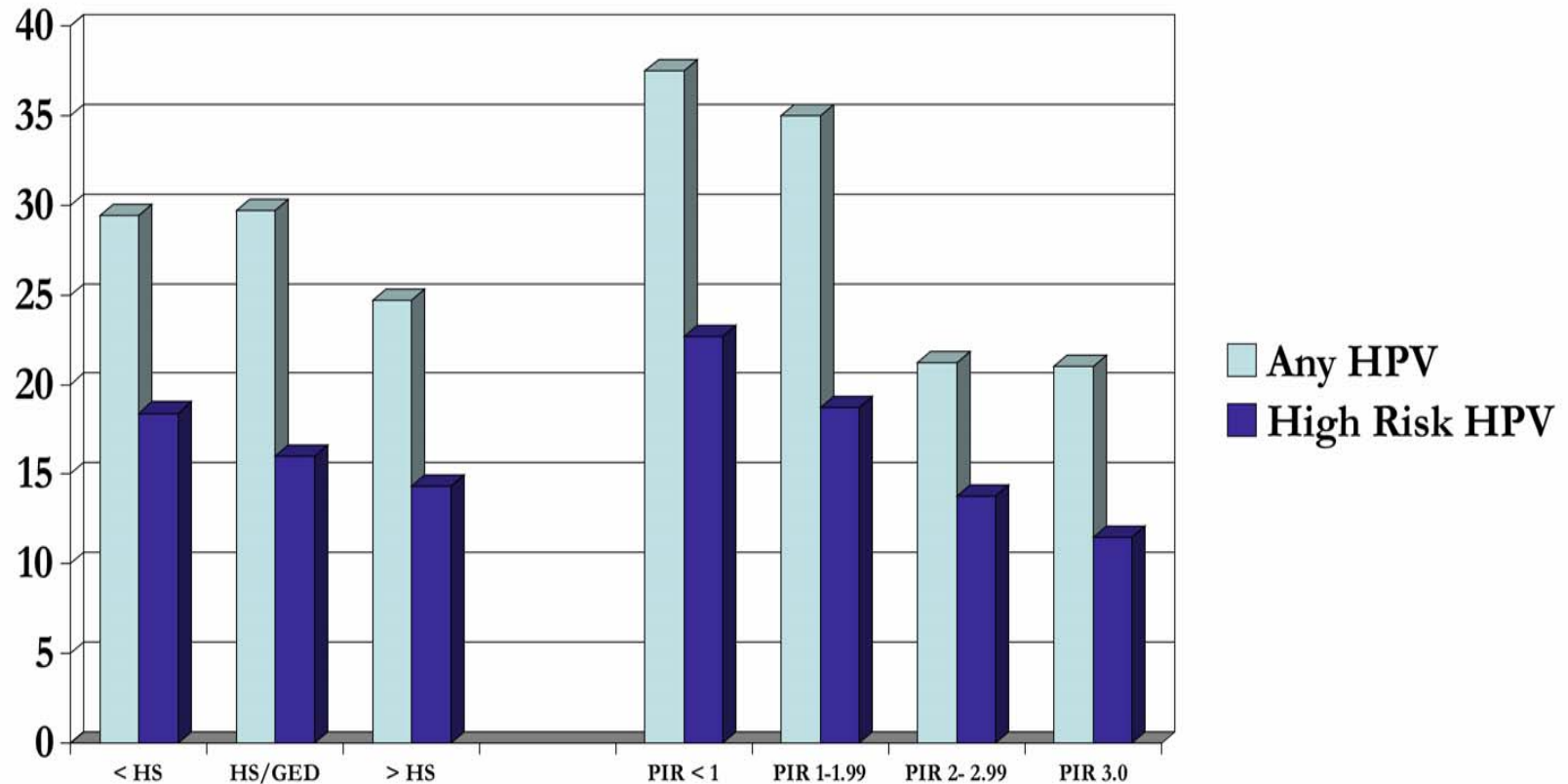
Age Adjusted Prevalence of Infection by Education, NHANES
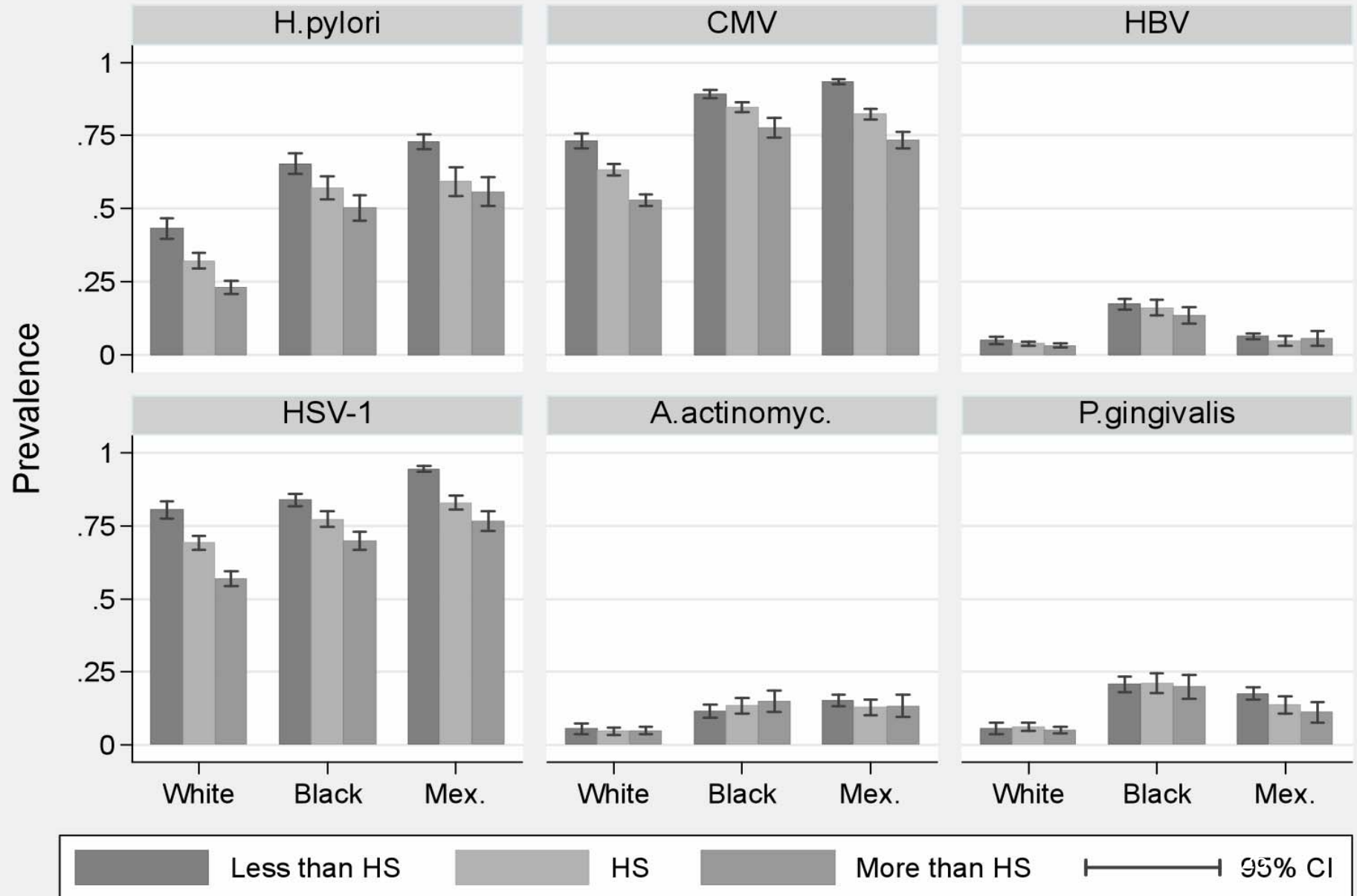
Zajacova, Dowd and Aiello (2009) Socioeconomic and race/ethnic patterns in persistent infection burden among US adults. *Journal of Gerontology: Medical Sciences*

CMV immune response by Age and Education, NHANES

CMV immune response by Age and Income, NHANES
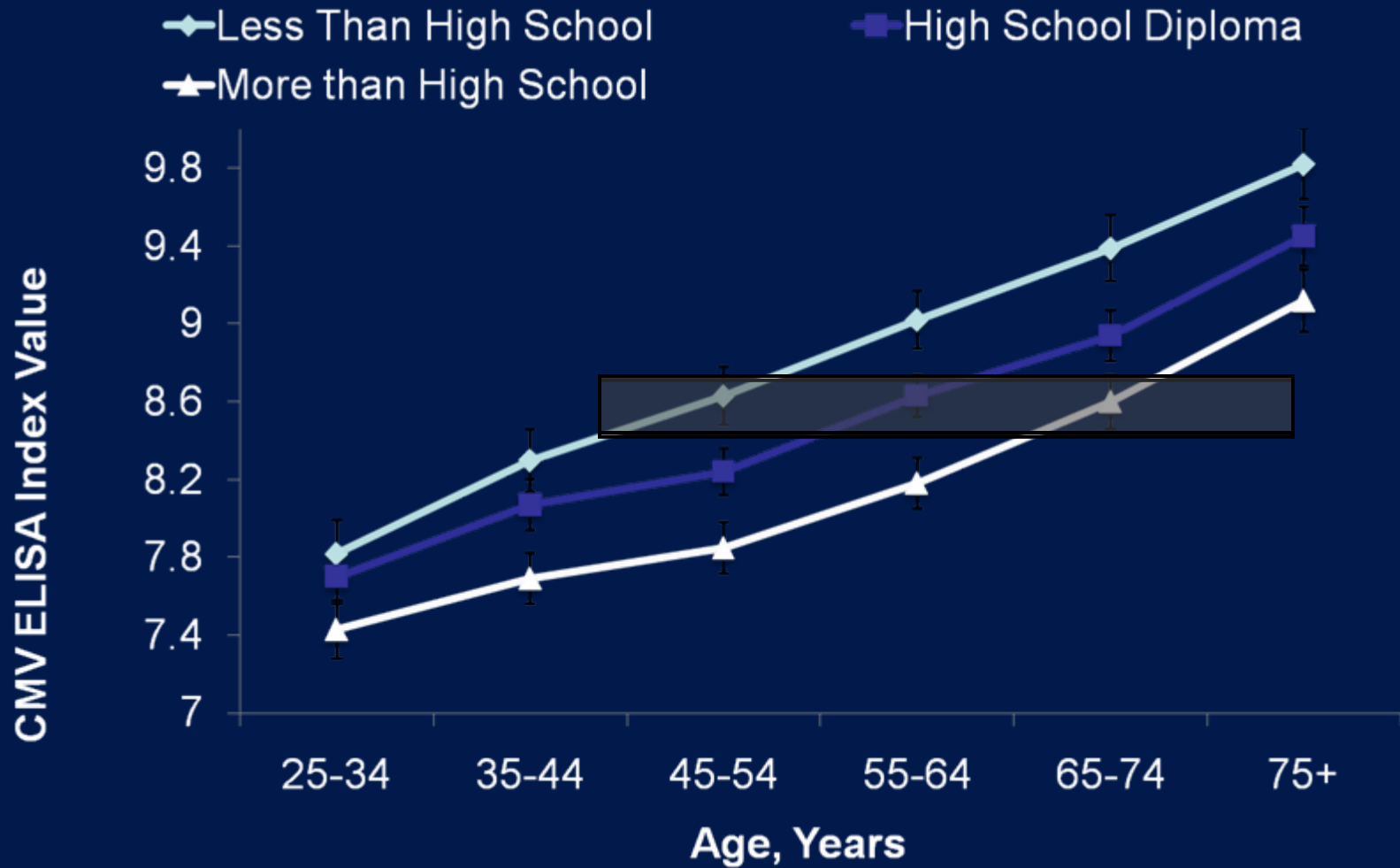
*Adjusted for race/ethnicity, education, and sex. Censored regression of log family income: slope=-0.25 (0.07), p <0.01

Dowd, J.B and A.E. Aiello (2009) Socioeconomic differentials in immune response. *Epidemiology*
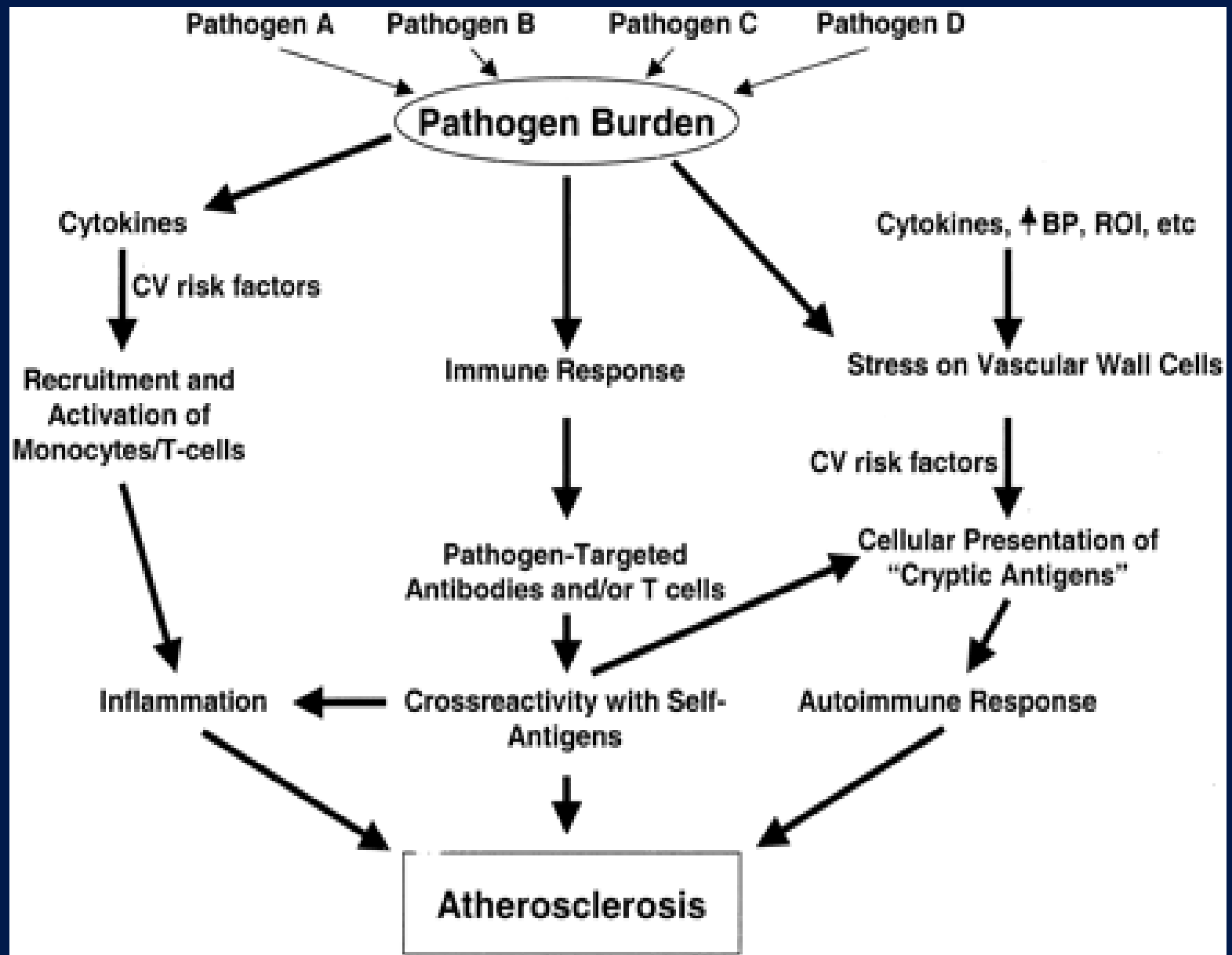
Figure From: Epstein, SE. (2002) The multiple mechanism by which infection may contribute to atherosclerosis development and course. *Circulation Research.* 90:204

Pathogen Burden by Race and Education, NHANES
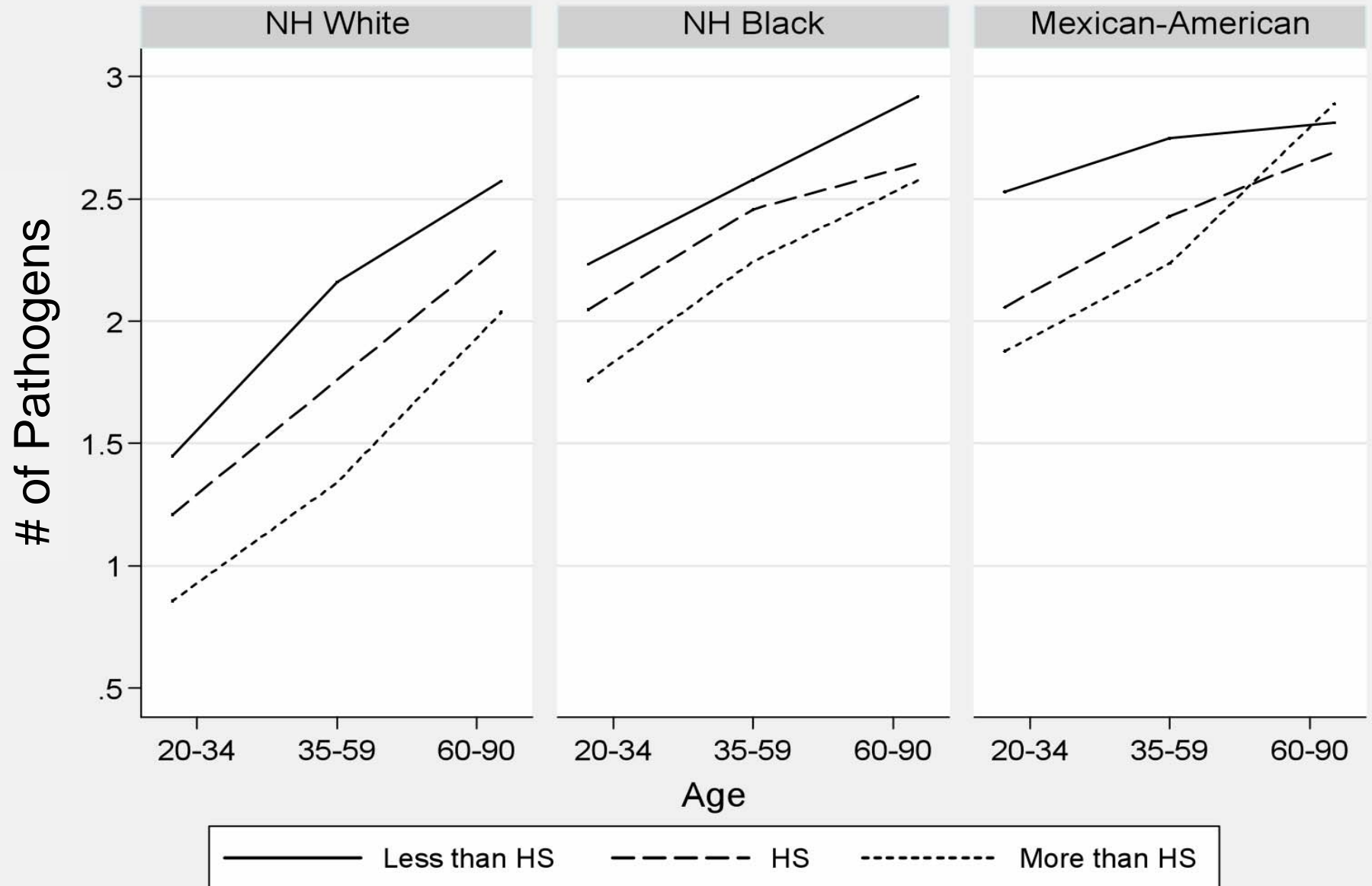

Zajacova, Dowd and Aiello (2009) Socioeconomic and race/ethnic patterns in persistent infection burden among US adults.
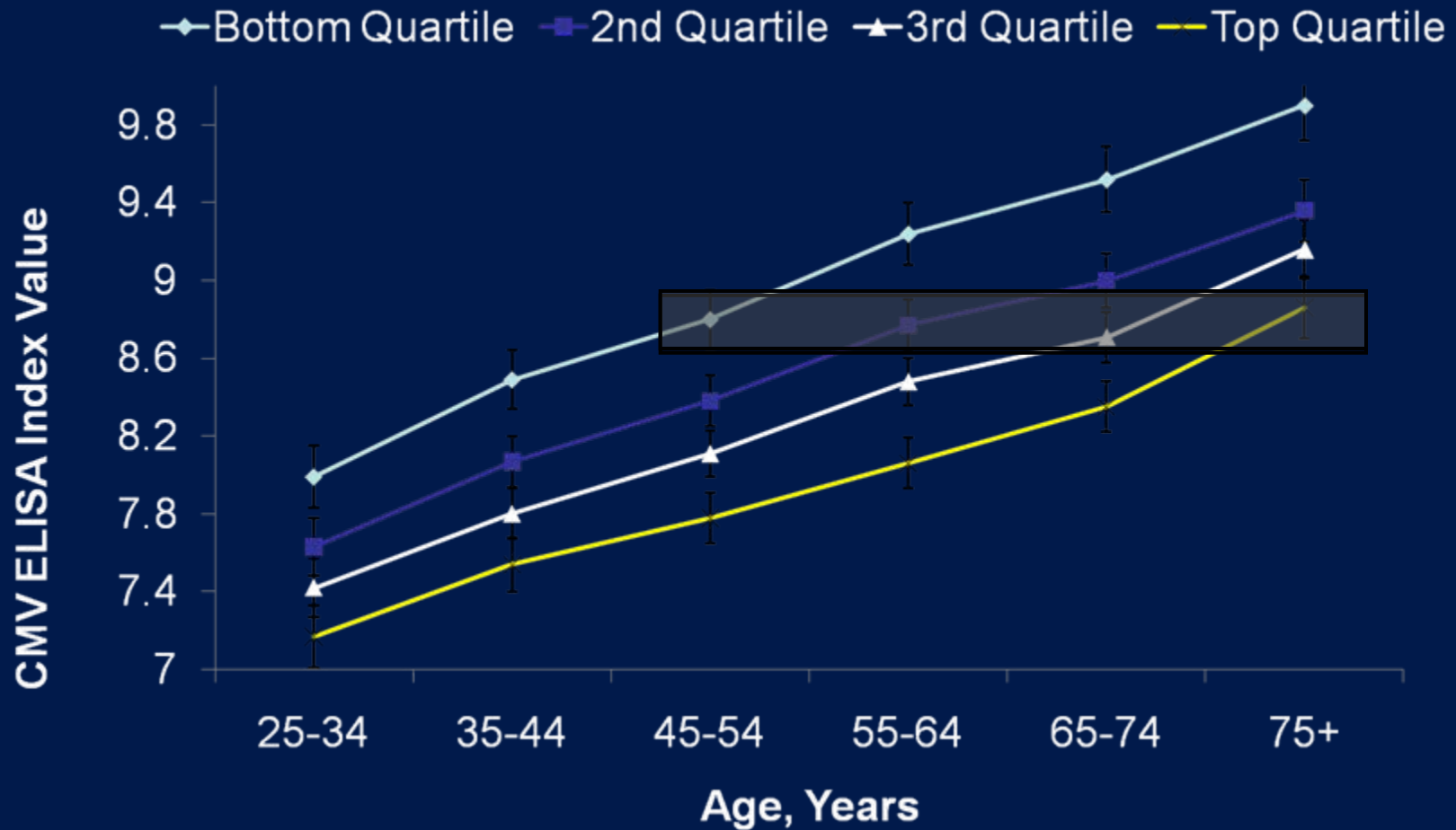*Journal of Gerontology: Medical Sciences*

Disparities in A H1N1

- Race/ethnic disparities in infection
  - Boston Public Health

- Race/ethnic disparities in medic treatment
  - Chicago and Boston

- Prevention measures? Vaccines, antivirals, NPIs?

Dynamics of infection

- My disease status affects your disease status
  - Not independent units

  - Reproductive number
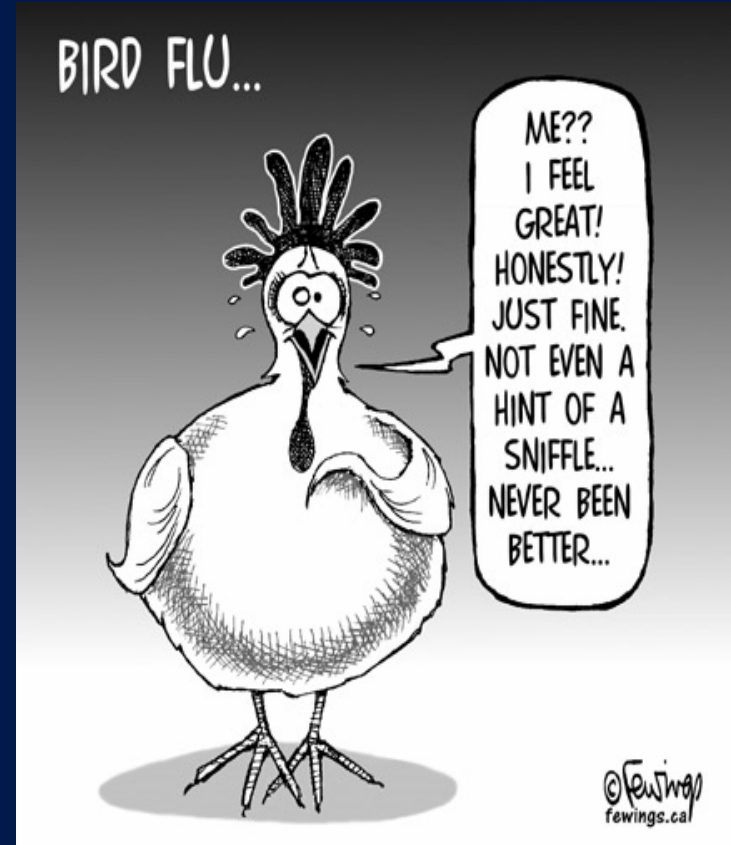
Reproductive number R_0

- "Are zero" or "are-naught"
  - From general population theory

- R_0 = expected number of secondary infectious cases that one infectious host will produce during his or her infectious period in a large population that is completely susceptible

Reproductive number R_0 Formula

$R_0 =$ Number of **contacts** per unit time

c

X

Probability of transmission per contact

p

X

Mean **duration** of infectiousness

d

Public Health Standpoint and R_0

- For an epidemic to occur in a susceptible population $R_0 > 1$

- If $R_0 < 1$ an average case will not reproduce itself

- Caveat: since it is an average it is possible to have an $R_0 < 1$ with a case that causes more than one infective case.
  - A sustaining outbreak is very unlikely

CMV in ages 12-49 in US

Variable	Reproductive Ratio	Average Age at Infection
Entire US	1.7	28.6
Male	1.7	28.0
Female	1.6	29.1
NH Black	4.1	16.3
Mexican American	3.7	17.5
NH White	1.6	29.3
Income Low	2.7	21.9
Income Mid	1.9	26.7
Income High	1.6	28.9

* Primary CMV infections per 100 seronegative persons per year
Table from: Colugnati FA, Staras SA, Dollard SC, Cannon MJ. BMC Infect.Dis. 2007. 7:71.

Immunization and R_0

- Immunization can be used to reduce the number of susceptible individuals

- What fraction do we need to vaccinate so that we produce enough immune whereby infective people are no longer able on average to infect one other person?
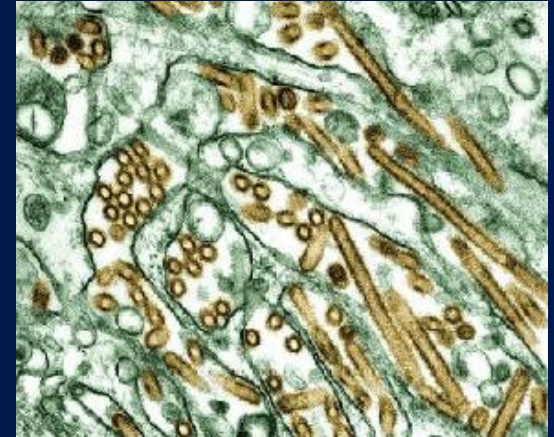
Immunization and R0

- Assume R0 = 2 for CMV in US population
  - Fraction (f) that needs to be immunized before the age of first infection is
    - f = 1- (1/ R0)
    - 1- (1/2)= 50%

- A higher R0 requires immunization of a higher fraction to eliminate transmission
    - Implications for SEP and race/ethnic groups

Conclusions

Strong SEP differentials in many infections in the US

    – Affect wages, schooling, education attainment, occupational attainment

- Disparities affect disease dynamics leading to persistence in disparites over time and space in susceptible groups

Graphic: Want to help stop the spread of H1N1 influenza? Yes, you can! Courtesy of Ben Heine

Conclusions Cont.

- Some evidence to suggest a role for psychosocial factors in immune response

- Targeting interventions at social and biological level
  - Vaccinations?
  - Reducing poverty, improving living standards, nutrition, and lowering stress

Social and environmental patterning

"If two susceptible subjects are exposed to equal doses of the same germ, and one develops infection while the other does not, the factor governing the development of the infection clearly lies outside the germ."

Stewart, GT. Limitations of the germ theory. *Lancet*. 1968 May 18;1(7551):1077-81

Thank You and Acknowledgements

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