Childhood Socioeconomic S a . and Ho Re i ance o Infec io Illne in Ad l hood

Sheldon Cohen, PhD, William J. Doyle, PhD, Ronald B. Turner, MD, Cuneyt M. Alper, MD, and David P. Skoner, MD

Objective: Low childhood socioeconomic status (SES) is a risk factor for adult morbidity and mortality primarily attributable to cardiovascular disease. Here, we examine whether childhood SES is associated with adult host resistance to infectious illness, and

studied in 10 groups and were paid $800 for their participation. The study protocol was approved by the institutional review boards of the University of Pittsburgh School of Medicine and Carnegie Mellon University, and informed consent was obtained from each volunteer.

Experimental Plan

Volunteers underwent medical screenings and were excluded if they had a history of psychiatric illness, major nasal or otological surgery, asthma or cardiovascular disease, had abnormal urinalysis, CBC or blood enzymes, or were pregnant, currently lactating, seropositive for HIV, or on regular medication. Specific serum antibody titer to the challenge virus, demographics, weight, and height were assessed at screening and SES, perceived stress, and personality characteristics were assessed during the 6 weeks between screening and virus exposure.

During the first 24 hours of isolation (before viral exposure), volunteers had a nasal examination and a nasal lavage. Baseline symptoms, nasal mucociliary clearance, and nasal mucus production were assessed. Volunteers were excluded at that point if they had signs or symptoms of a cold. If a viral pathogen was isolated from the nasal lavage, the data from the subjects were excluded from analysis.

Then, subjects were given nasal drops containing 100 to 300 $TCID_{50}$ of 1 of 2 rhinovirus types (RV39 [N = 228] or RV23 [N = 106]). The isolation continued for 5 additional days. On each day, volunteers reported their respiratory symptoms, were assessed for nasal mucociliary clearance and nasal mucus production, and nasal lavage samples were collected for virus culture. Approximately 28 days after virus exposure, blood was collected for

the regression coefficient, its standard error, and probability level are re-

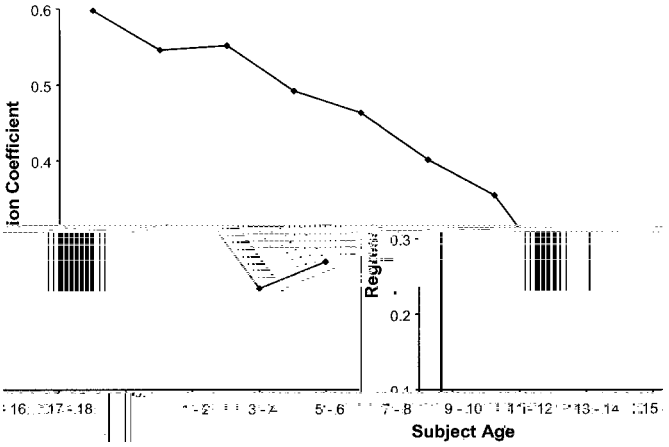

Figure 1. Adjusted effect size (regression coefficient) for the associations between parental home ownership and adult susceptibility to colds at different ages (2-year ranges) during childhood and adolescence.

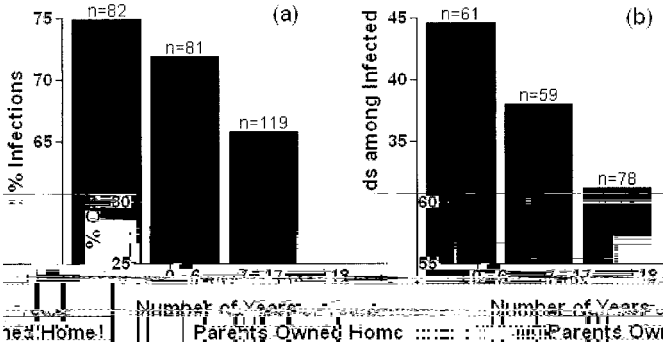

Figure 2. Adjusted (for standard controls) incidences of infection (a) and clinical illness among infected volunteers (b) as a function of years of parental home ownership (tertiled) when the subjects were aged 0 to 18 years.

coefficients in the figure were all significant (p ▫ .05) except for 15–16, and 17–18 years of age. Then we fit a stepwise logistic regression, forcing in the standard control variables in the first step and allowing the 9 2-year span variables to step in. Only the 1- to 2-year variable entered the equation (b ▫ ▫ 0.60 [▫ 0.17], p ▫ .001), suggesting not only that this is the largest effect, but also that once this infancy variable is entered, additional information does not improve the prediction.

We also conducted an analysis to more carefully examine whether *change* in parental home ownership between childhood and adolescence affected susceptibility. Median splits were used to create groups low and high for years of parental home ownership at 1–9 and at 10–18 years. We then created 4 categories representing patterns of change between childhood and adolescence: low at 1–9/low at 10–18 (N ▫ 96), low/high (N ▫ 46), high/low (N ▫ 9), and high/high (N ▫ 131). Analyses using these categories resulted in odds ratios of 3.2 for low/low [CI 1.54, 6.85], 3.2 for low/high [CI 1.39, 7.29], 1.2 for high/low [CI 0.21, 6.93], and 1 for high/high. Reanalysis dropping the high/low group (small N) yielded similar results (3.4 [CI of 1.62–7.31] for low/low; 3.3 [CI 1.41, 7.55] for low/high; and 1 for high/high).

The association of parental home ownership with cold incidence could reflect a decreased risk of infection and/or a decreased risk of clinical illness in infected persons (29,30). Years of parental home ownership was associated with lesser likelihood of both infection (b ▫ ▫ 0.08 [▫ 0.03], p ▫ .005; OR ▫ 3.3 [CI 1.4, 7.9], 1.6 [CI 0.8, 3.5], 1, Figure 2a) and clinical colds in infected subjects (b ▫ ▫ 0.05 [▫ 0.02, p ▫ .04; OR ▫ 3.1 [CI 1.4, 7.3], 2.5 [CI 1.2, 5.4], 1, N ▫ 198; Figure 2b).

In previous papers, we reported that greater extraversion and agreeableness (37) and greater PES (34) were associated with less risk of experimental colds in this sample. To ensure that parental home ownership was not a marker of these or other dispositional characteristics, we reanalyzed the data set adding the Big 5 factors and PES to our standard control variables. Even with this very conservative analysis, parental home ownership still predicted cold incidence (b ▫ ▫ 0.06 [▫ 0.02], p ▫ .01; OR ▫ 3.5 [CI 1.6, 7.9], 2.4 [CI 1.1, 5.0], 1). Finally, in previous studies we have found that psychological stress predicted risk of colds (30,40). To be sure that parental home ownership was not a marker of current (adult) levels of perceived stress, we reanalyzed the data adding the PSS to the equation. Parental home ownership still predicted cold incidence (b ▫ ▫ 0.07 [▫ 0.02], p ▫ .003; OR ▫ 3.9 [CI 1.8, 8.8], 2.8 [CI 1.3, 5.8], 1).

DISCUSSION

The risk in adults for developing a common cold when exposed to a rhinovirus decreased with the number of years their parents owned their homes during the subject's childhood. This relation was independent of prechallenge immunity, age, body mass, race, sex, virus type, and month of exposure. The effect was substantial with an adjusted odds ratio of developing a cold of 3.8 when comparing the lowest to highest tertile of years of parental home ownership. Moreover, the risk of colds increased in a dose–response fashion with decreasing years of home ownership and occurred in both those with and without prechallenge antibody to the virus and across both virus types (see Table 1).

Similar to previous findings for cardiovascular and periodontal health (14), upward mobility in adolescence did not moderate the increased cold risk of low, early childhood SES. Moreover, exposure during infancy (1–2 years) was able to account for the entire effect of parental home ownership. These results support an early exposure hypothesis and are consistent with the hypothesis that there is a critical period confined to in utero exposure or to exposure in infancy (43). However, the data supporting the infant exposure hypothesis is subject to an alternative explanation. Parental home ownership during infancy (1–2 years of age) is strongly associated with the total number of years of parental home ownership (r ▫ 0.77 for years of home ownership between 1 and 18 years of age and r ▫ 0.88 between 1 and 9 years of age, p ▫ .001 in both cases), which as noted earlier is a strong predictor of colds. If early exposure is key, SES related early environmental influences on childhood respiratory function such as air pollution, lead exposure, and damp housing (9,44) or more

of early life and adult socioeconomic factors to adult morbidity in the Whitehall II Study. J Epidemiol Community Health 2001;55:301–7.
15. Chen E, Matthews KA, Boyce WT. Socioeconomic differences in children's health: how and why do these relationships change with age? Psychol Bull 2002;128:295–329.
16. Power C, Manor O, Fox J. Health and class: the early years. London: Chapman and Hall; 1991.
17. Kuh D, Hardy R, Langenberg C, Richards M, Wadsworth MEJ. Mortality in adults aged 26–54 years related to socioeconomic conditions in childhood and adulthood: post war birth cohort study. BMJ 2002;325:1076–80.
18. Rosvall M, Ostergren PO, Hedblad B, Isacsson SO, Janzon L, Berglund G. Life-course perspective on socioeconomic differences in carotid atherosclerosis. Arterioscler Thromb Vasc Biol 2002;22:1704–11.
19. Lawlor DA, Ebrahim S, Davey-Smith G. Socioeconomic position in childhood and adulthood and insulin resistance: cross sectional survey using data from British Women's Heart and Health Study. BMJ 2002; 325:805.
20. Lynch JW, Kaplan GA, Cohen RD, Kauhanen J, Wilson TW, Smith NL, Salonen JT. Childhood and adult socioeconomic status as predictors of mortality in Finland. Lancet 1994;343:524–7.
21. Lynch JW, Kaplan GA, Salonen JT. Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse. Soc Sci Med 1997;44:809–19.
22. Cohen S. Social status and susceptibility to respiratory infections. In: Adler NE, Marmot MM, McEwen BS, Stewart J, editors. Socioeconomic status and health in industrial nations: social, psychological, and biological pathways. New York: New York Academy of Sciences; 1999. p. 246–53.
23. Gupta S, Camm AJ. Chlamydia pneumoniae, antimicrobial therapy and coronary heart disease: a critical overview. Coron Artery Dis 1998;9: 339–43.
24. Kraft M, Cassell G, Pak J, Martin R. Mycoplasma pneumoniae and chlamydia pneumoniae in asthma: effect of clarithromycin. Chest 2002; 121:1782–8.
25. Butel J. Viral carcinogenesis: revelation of molecular mechanisms and etiology of human disease. Carcinogenesis 2000;21:405–26.
26. Tyrrell D, Fiedler M. Cold wars: the fight against the common cold. New York: Oxford University Press; 2002.
27. Farr BM, Gwaltney JM Jr, Hendley JO, Hayden FG, Naclerio RM, McBride T, Doyle WJ, Sorrentino JV, Riker DK, Proud D. A randomized controlled trial of glucocorticoid prophylaxis against experimental rhinovirus infection. J Infect Dis 1990;162:1173–7.
28. Doyle WJ, McBride TP, Swarts JD, Hayden FG, Gwaltney JM Jr. The