# Monitoring Socioeconomic Inequalities in Sexually Transmitted Infections, Tuberculosis, and Violence: Geocoding and Choice of Area-Based Socioeconomic Measures—The Public Health Disparities Geocoding Project (US)

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## SYNOPSIS

**Objectives.** To determine which area-based socioeconomic measures, at which level of geography, are suitable for monitoring socioeconomic inequalities in sexually transmitted infections (STIs), tuberculosis (TB), and violence in the United States.

**Methods.** Cross-sectional analysis of public health surveillance data, geocoded and linked to area-based socioeconomic measures generated from 1990 census tract, block group, and ZIP Code data. We included all incident cases among residents of either Massachusetts (MA; 1990 population = 6,016,425) or Rhode Island (RI; 1990 population = 1,003,464) for: STIs (MA: 1994–1998, *n* = 26,535 chlamydia, 7,464 gonorrhea, 2,619 syphilis; RI: 1994–1996, *n* = 4,473 chlamydia, 1,256 gonorrhea, 305 syphilis); TB (MA: 1993–1998, *n* = 1,793; RI: 1985–1994, *n* = 576), and non-fatal weapons related injuries (MA: 1995–1997, *n* = 6,628).

**Results.** Analyses indicated that: (*a*) block group and tract socioeconomic measures performed similarly within and across both states, with results more variable for the ZIP Code level measures; (*b*) measures of economic deprivation consistently detected the steepest socioeconomic gradients, considered across all outcomes (incidence rate ratios on the order of 10 or higher for syphilis, gonorrhea, and non-fatal intentional weapons-related injuries, and 7 or higher for chlamydia and TB); and (*c*) results were similar for categories generated by quintiles and by a priori categorical cut-points.

**Conclusions.** Supplementing U.S. public health surveillance systems with census tract or block group area-based socioeconomic measures of economic deprivation could greatly enhance monitoring and analysis of social inequalities in health in the United States.

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Scant population-based U.S. data exist on socioeconomic gradients in sexually transmitted infections (STIs), tuberculosis (TB), and violence, given an absence of socioeconomic data in the public health surveillance systems for these outcomes.[1,2] Numerous studies nevertheless suggest that economic deprivation—at the individual, household, and community level—increases likelihood of experiencing one of these adverse health events, having it reported to a public health agency, or both.[3–12] Limited evidence likewise indicates that the social patterning of these three discrete outcomes—STIs, TB, and violence—is interlinked by the shared underlying determinant of impoverishment.[13–15] Absent socioeconomic data, however, U.S. public health monitoring systems can neither track socioeconomic inequalities in the occurrence of these deleterious consequences of interpersonal contact nor compare the socioeconomic characteristics of individuals included in their surveillance systems to the rest of the population.

Fortunately, geocoding and use of area-based socioeconomic measures (ABSMs) provides a possible solution to the absence of individual-level socioeconomic data in these U.S. public health surveillance systems.[16–18] In this approach, both cases and the catchment population are classified in relation to their neighborhood socioeconomic characteristics, thereby permitting calculation of rates stratified by the area-based socioeconomic measures. The utility of this approach was first recognized in the 1920s and 1930s, in pathbreaking studies supported by the National Tuberculosis Association, following establishment of the first census tracts in New York City in 1906.[19–23] These investigations assessed people's risk of TB and later other health outcomes in relationship to socioeconomic conditions of their census tracts, also termed "sanitary areas" because of their utility for public health planning.[19–24] One novel insight, as apt now as it was then, is that ABSMs are meaningful data in their own right and should not be conceptualized solely as "proxies" for individual-level data.

Yet, despite a legacy of over 75 years of linking ABSMs with U.S. public health records, to date there exists no standard for use of ABSMs in public health research or surveillance systems.[17,18,24–27] Considering only the recent U.S. literature on STIs, TB, and violence, research has employed an eclectic array of census-derived single-indicator and composite area-based measures, measured at the level of the census block group,[10,28–30] census tract,[31–37] ZIP Code,[7,38–42] and larger "community areas," often defined by local health departments.[43–45] Single-variable measures used include: poverty rate, median household income, low family income, percent in working class or blue-collar occupations, percent unemployed, percent of adults with less than a high school education, crowding, and value of housing units.[7,28,30,32,36,38,39,42,43,45] Composite indices, based on assorted scores summed in diverse ways, have variously combined data on income, education, crowding, occupation, housing tenure, housing cost, unemployment, and public assistance.[29,31,33–35,40,41,44] Although a plurality of measures may be useful for etiologic research, in the case of monitoring, such heterogeneity impedes comparing results across studies, across outcomes, and over time.

The purpose of our study accordingly was to ascertain which ABSMs, at which level of geography, would be most appropriate for monitoring socioeconomic disparities in STIs, TB, and violence in the U.S. These health outcomes, conceptually linked by the common theme of adverse interpersonal contact, are among the set we are analyzing for our Public Health Disparities Geocoding Project, which is seeking to develop recommendations for use of ABSMs across diverse outcomes ranging from birth to death.[46,47] Pertinent a priori considerations include: (*a*) external validity (Do the measures find gradients in the direction reported in the literature, i.e., positive, negative, or none, and across the full range of the distribution?); (*b*) robustness (Do the measures detect expected gradients across a wide range of outcomes?); (*c*) completeness (Is the measure relatively unaffected by missing data?); and (*d*) user-friendliness (How easy is the measure to understand and explain?). Guided by both an ecosocial framework[48] and our related findings for mortality (including homicide) and cancer incidence[46] and for low birthweight and childhood lead poisoning,[47] we additionally hypothesized that stronger socioeconomic gradients in health would be detected by area-based measures of economic deprivation, compared with affluence, with effects more consistent at the block group and census tract, as compared to ZIP Code, level.

## METHODS

**Data sources: health outcomes**

The study base comprised populations and areas in Massachusetts (MA) and Rhode Island (RI) enumerated at or around the 1990 census.[49] STI and TB data were provided by the Massachusetts Department of Public Health (MDPH)[50,51] and the Rhode Island Department of Health (RIDOH);[52,53] violence data, in relation to non-fatal weapons-related injury, were provided by MDPH only[54] (Table 1). Use of these data was approved by all relevant Institutional Review Boards/Human Subjects Committees at the Harvard School of

**Table 1. Study population: cases (1985–1998)[a] and areas (1990), Massachusetts (MA) and Rhode Island (RI)**

| | *Massachusetts* | *Rhode Island* |
|---|---|---|
| *Study base population*[b] | *N* | *N* |
| 1990 population | 6,016,425 | 1,003,464 |
| Sexually transmitted infections[a]: | | |
| Total | 39,144 | 6,403 |
| Chlamydia | 26,535 | 4,773 |
| Gonorrhea | 7,464 | 1,256 |
| Syphilis | 2,619 | 305 |
| Tuberculosis[a] | 1,793 | 576 |
| Non-fatal weapons-related injury[a] | 6,628 | na |

| | *Population size* | | | *Population size* | | |
|---|---|---|---|---|---|---|
| *Areas* | *N* | *Mean (SD)* | *Range* | *N* | *Mean (SD)* | *Range* |
| Block groups | 5,603 | 1,085.4 (665.2) | 5 to 10,096 | 897 | 1,137.7 (670.8) | 7 to 5,652 |
| Census tracts | 1,331 | 4,571.8 (2,080.0) | 18 to 15,411 | 235 | 4,325.3 (1,810.9) | 26 to 9,822 |
| ZIP Codes | 474 | 12,719.7 (12,244.1) | 14 to 65,001 | 70 | 14,335.2 (13,234.8) | 63 to 53,763 |

| | *STIs* | | *TB* | | *Non-fatal weapons related injury* | |
|---|---|---|---|---|---|---|
| *Sociodemographic characteristics of cases* | *MA Percent* | *RI Percent* | *MA Percent* | *RI Percent* | *MA Percent* | *RI Percent* |
| Gender: women | 69.5 | 74.8 | 41.7 | 42.5 | 13.4 | na |
| Age (years): <15 | 1.5 | 2.0 | 4.6 | 8.3 | 4.6 | |
| 15–44 | 87.6 | 94.8 | 49.7 | 44.3 | 86.9 | |
| 45–64 | 4.0 | 2.8 | 22.4 | 21.2 | 5.7 | na |
| 65+ | 0.7 | 0.5 | 22.8 | 26.2 | 0.9 | |
| unknown | 6.2 | 0.0 | 0.4 | 0.0 | 2.0 | |
| Race/ethnicity[c]: | | | | | | |
| American Indian | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Asian/Pacific Islander | 2.3 | 0.0 | 29.3 | 20.1 | 1.5 | |
| Black non-Hispanic | 19.4 | 28.1 | 24.8 | 13.2 | 28.0 | |
| Hispanic | 17.3 | 22.7 | na | na | 20.2 | na |
| White non-Hispanic | 25.7 | 45.2 | 31.8 | 49.8 | 38.3 | |
| White Hispanic | na | na | 11.7 | 14.2 | na | |
| Black Hispanic | na | na | 2.1 | 2.8 | na | |
| Other | na | na | na | na | 1.2 | |
| Unknown/missing | 35.1 | 4.1 | 0.3 | 0.0 | 10.7 | |

[a]STI data: MA = 1994–1998; RI = 1994–1996; TB data: MA = 1993–1998; RI = 1985–1994; non-fatal weapons-related injury data: 1995–1997.

[b]In-state residents only.

[c]Racial/ethnic categories employed across the different data sets were not identical; na = not applicable.

SD = standard deviation

Public Health, MDPH, and RIDOH. We restricted analyses to three of the most commonly recorded STIs: chlamydia, gonorrhea, and syphilis; for violence, the MA Weapons-Related Injury Surveillance System (WRISS) provided data on intentional and non-intentional gunshot wounds and intentional stab wounds. In each surveillance system, reporting is mandatory, and data on age, gender and race/ethnicity were obtained by a mixture of self- and observer-report. For all outcomes, to capture the population burden from a monitoring perspective, we analyzed data on cases, rather than individuals, since a given individual could experience the specified outcome more than once during the study period. Years of cases included were selected to ensure an adequate sample size to generate stable rate estimates, using available records containing addresses proximate temporally to the 1990s census.

We obtained the STI data for all cases of new infections recorded among residents of MA from 1994 through 1998 ($n = 40,653$) and of RI from 1994 through 1996 ($n = 6,403$). Cases included in the STI databases for both states were identified and reported to the state health department because they: (*a*) were symptomatic patients; (*b*) sought testing because they were concerned about their exposure (i.e., after unsafe sex); (*c*) received a complete battery of STI tests as part of seeking confidential HIV testing; (*d*) were contacts of active cases; or (*e*) were tested as part of obtaining a routine gynecologic exam.[50,52] The initial MA data set included 39,144 records, excluding cases not geocoded to MA ($n = 989$) and not in the study interval ($n = 520$). The final analytic data set for MA included 36,344 records, additionally excluding cases with an unspecified type of STI ($n = 394$), and missing data on age ($n = 2,406$). For RI, the final analytic data included 6,403 records, none warranting exclusion.

TB cases comprised all cases of new infections recorded among residents of MA from 1993 through 1998 ($n = 1,837$) and of RI from 1985 through 1994 ($n = 576$). Individuals included in the TB databases for both states were identified and reported to the state health department via designated TB clinics and additional health care providers.[51,53] The initial data set for MA included 1,793 records, excluding cases who were not a resident of MA at time of diagnosis ($n = 44$). The final analytic data set for MA included 1,786 records, additionally excluding the 7 cases missing age at diagnosis. The final analytic data set for RI included 576 records, with none warranting exclusion.

We obtained data on new non-fatal weapons-related injury from WRISS, which was expanded from a pilot program in 1994 by MDPH to include all MA acute care hospital emergency departments.[54] Among the 7,724 initial records obtained from WRISS for the period from 1995 through 1997, we excluded 22 for not being a resident of the state at time of diagnosis, 1,074 for either not being in the study time period or having the date of event missing, 655 due to missing data on either intent or type of weapon used, 130 due to missing data for gender, and 72 for missing data on age, yielding 5,571 cases in the analytic data set. Data on whether the injury was intentional or not were obtained from the respondent, if conscious, and otherwise coded as "unknown."

**Data sources: area-based socioeconomic measures**

As described in our prior analyses,[46,47] we obtained 1990 census data for census tracts and block groups from U.S. Bureau of Census Summary Tape File 3A and ZIP Code data from Summary Tape File 3B.[55] The U.S. Bureau of Census defines a census tract, on average containing 4,000 individuals, to be a "small, relatively permanent statistical subdivision of a county . . . designed to be relatively homogeneous with respect to population characteristics, economic status, and living conditions;" its subdivision, the block group, on average containing 1,000 individuals, is the smallest geographic census unit for which census socioeconomic data are tabulated.[56] By contrast, ZIP Codes, on average containing 30,000 individuals, are "administrative units established by the United States Postal Service . . . for the most efficient delivery of mail, and therefore generally do not respect political or census statistical area boundaries."[55] Spanning from large areas cutting across states to a single building or company with a high volume of mail, "carrier routes for one ZIP Code may intertwine with those of one or more ZIP Codes" such that "this area is more conceptual than geographic."[57] Additionally, unlike census tracts and block groups, ZIP Codes are subject to alteration in non-decennial census years: they can be added, eliminated, or have their codes changed or boundaries redefined.[58–60] To geocode to the census block group, tract, and ZIP Code levels, we submitted residential addresses from the mortality and cancer data to a commercial geocoding firm whose accuracy we had previously ascertained was high (96%).[61]

Three considerations guided our development of area-based measures of socioeconomic position (SEP): (1) a priori conceptual definitions of SEP and social class;[17] (2) U.S. and UK evidence emphasizing detrimental effects of material deprivation on health;[2,62–67] and (3) the need for measures that can be meaningfully compared over time and space, so as to permit valid monitoring and contrasts in relation to time period and region.[17,46,47,66,67] As shown in Table 2, the 11 single-variable and 8 composite ABSMs we generated meeting these criteria, at each level of geography for each state, reflected 6 domains of SEP: occupational class, income, poverty, wealth, education, and crowding, premised on the understanding that social class, as a social relationship, fundamentally drives the distribution of these manifest aspects of SEP.[17,46,47]

Among the composite variables, two were U.S. analogues of the UK Townsend[67–69] and Carstairs[66,70] deprivation indices, one used the algorithm for the U.S. Centers for Disease Control and Prevention's (CDC) "Index of Local Economic Resources,"[71] and five were

**Table 2. Area-based socioeconomic measures: constructs and operational definitions, using 1990 U.S. census data[40]**

| *Construct* | *Operational definition* | *Census variable* |
|---|---|---|
| A) Occupational class | | |
| 1) Working class[17] | • Percent of persons employed in predominantly working class occupations, i.e., as non-supervisory employees, operationalized as percent of persons employed in the following 8 of 13 census-based occupational groups: administrative support; sales; private household service; other service (except protective); precision production, craft, repair; machine operators, assemblers, inspectors; transportation and material moving; handlers, equipment cleaners, laborers. | P78 |
| 2) Unemployment | • Percent of persons age 16 and older in the labor force who are unemployed (and actively seeking work) | P71 |
| B) Income | | |
| 3) Median household income | • Median household income in year prior to the decennial census (for U.S. in 1989 = $30,056) | P80A |
| 4) Low income[108] | • Percent of households with income <50% of the U.S. median household income (i.e., <$15,000) | P80 |
| 5) High income | • Percent of households with incomes ≥400% of the U.S. median household income (i.e., ≥$150,000) | P80 |
| 6) Gini coefficient | • A measure of income inequality, regarding the share of income distribution across the population, calculated using the standard algorithm employed by the U.S. Census Bureau to extrapolate the lower and upper ends of the income distribution[109,110] | P80, P80A, P81 |
| C) Poverty | | |
| 7) Below poverty | • Percent of persons below federally-defined poverty line, a threshold which varies by size and age composition of the household, and on average equaled $12,647 for a family of 4 in 1989[55] | P117 |
| D) Wealth | | |
| 8) Expensive homes | • Percent of owner-occupied homes worth ≥$300,000 (400% of the median value of owned homes in 1989) | H61 |
| E) Education | | |
| 9) Low: <high school | • Percent of persons, age 25 and older, with less than a 12th grade education | P57 |
| 10) High: ≥four years | • Percent of persons, age 25 and older, with at least 4 years of college | P57 |
| F) Crowding | | |
| 11) Crowded households | • Percent of households with ≥1 person per room | H69, H49 |

*continued on p. 245*

created exclusively for our study. To mirror the skewed population distribution of socioeconomic resources, SEP1 and SEP2 simultaneously combined categorical data on poverty, working class, and either wealth or high income. Factor 1 and Factor 2 were generated at each geographic level by factor analysis using a maximum likelihood approach[72–73] applied to inputs listed in Table 2, using rank values of the census data, rather than impose arbitrary transformations to normalize their often considerably skewed distribution, with tied values assigned an average rank. The two-factor model was selected as the most appropriate description of the underlying factor structure, with correlations between the factors ranging from 0.420 to 0.564 after oblique rotation. Finally, the SEP index—a summed z-score akin to the Townsend index—was generated using inputs identified by the factor analysis.

**Data analysis**

Our analytic plan involved five steps. In Step 1, we assessed the distribution of the data, including the extent of missing data. In Step 2, we calculated age-

**Table 2 (continued). Area-based socioeconomic measures: constructs and operational definitions, using 1990 U.S. census data[40]**

| *Construct* | *Operational definition* | *Census variable* |
|---|---|---|
| G) Composite measures | | |
| 12) Townsend index[67–69] | • UK deprivation measure consisting of a standardized z-score combining data on percent crowding, percent unemployment, percent no car ownership, and percent renters | H69, H49, H40, H8 |
| 13) Carstairs index[66–67,70] | • UK deprivation measure consisting of a standardized z-score combining data on percent crowding, percent male unemployment, percent no car ownership, and percent low social class (U.S. census categories for: transportation and material moving; handlers, equipment cleaners, and laborers; household service). | H69, H49 H40, P78 |
| 14) Index of Local Economic Resources[52] | • A "summary index" based on: "white collar employment, unemployment, and family income" | P78, P71, P107A |
| 15) SEP1 | • A composite categorical variable based on percent < poverty, working class, and expensive homes | (see above) |
| 16) SEP2 | • A composite categorical variable based on percent < poverty, working class, and high income | (see above) |
| 17) factor 1[a] | • A factor pertaining to economic resources; highly correlated with poverty, median household income, home ownership, and car ownership | (see above) |
| 18) factor 2[a] | • A factor pertaining to occupation and education; highly correlated with percent working class, <high school, and ≥four years college | (see above) |
| 19) SEP index | • A summary deprivation measure consisting of a standardized z-score combining data on percent working class, unemployed, <poverty, <high school, expensive homes, and median household income[b] | (see above) |

[a]Variables employed in the factor analysis: percent working class, unemployed, < poverty, home ownership, car ownership, no telephone, expensive homes, < high school education, ≥ four years of college education, household crowding, households with only one room, no kitchen, no private plumbing, and also median household income and proportion of total income in the area derived from interest, dividends, and net rent.

[b]Values for "expensive homes" and "median household income" were reversed before computing z-score so that a higher score on the SEP index would correspond to a higher degree of deprivation.

standardized average annual incidence rates for each outcome stratified by the ABSMs at each level of geography for each state,[74,75] using the Year 2000 standard million[76] and age-specific rates generated for 11 age groups (<1, 1–4, 5–14, 15–24, . . . , 75–84, 85+ years old). The numerators and denominators of these rates consisted of individuals residing in areas identified at the specified level of geography for which data on the specified area-based socioeconomic measure were available. Following standard practice for rates centered around a census,[77,78] we set the total number of person-years in the denominator equal to the population in that socioeconomic stratum enumerated in the 1990 census multiplied by the relevant number of years of observation. Cut-points for categorical ABSMs were based on both their percentile distribution (e.g., quintiles) and a priori considerations (e.g., the federal definition of "poverty areas" as regions where ≥20% of the population is below the U.S. poverty line[79,80]).

In Step 3, we visually inspected and quantified socioeconomic gradients for each outcome using each area-based socioeconomic measure at each level of geography. Following standard U.S. reporting practices,[1,2] we computed the incidence rate ratio (IRR) and rate difference (IRD), comparing rates for people living in areas with the least and most resources; given similar patterns, we report only the IRR. We also calculated the relative index of inequality (RII), a measure of effect that employs data across all strata of the determinant (not just the extremes). As described in Appendix 1, by taking into account both the population distribution of the exposure and the magnitude of the rate ratio detected in each socioeconomic stratum, the

RII thus permits meaningful comparison of gradients across different socioeconomic measures.[81–83] In Step 4, we further restricted analyses to individuals geocoded to all three levels of geography; because observed patterns closely resembled those obtained in Step 3, we report only the former (data not shown, available upon request). In Step 5, we summarized findings across socioeconomic measures and levels of geography, in relation to our previously mentioned a priori considerations regarding external validity, robustness, and completeness of each measure. All analyses were conducted in SAS.[84]

## RESULTS

Overall, among the total 54,544 STI, TB, and non-fatal injury cases for MA and RI, the proportion successfully geocoded to the census block group was 80% and was 99% for both the census tract and ZIP Code. These results were independent of gender, age, and race/ethnicity for the STIs and for the non-fatal weapons related injuries and varied only slightly by these characteristics for TB (data not shown; available upon request). The proportion of areas, at all levels of geography, without the specified socioeconomic measures was also low (<1%), with the exception of measures containing data on wealth (2% to 4% missing) (data not shown, available upon request). Among the 50,880 records geocoded to the ZIP Code level, 5.9% (3,007 records) could not be linked to 1990 census data because their ZIP Codes either were for non-residential sites or else were ZIP Codes created or changed after the 1990 census. This proportion varied by outcome, ranging from a low of 4.8% for the MA STI to a high of 15.8% for the MA TB cases.

Tables 3a–3d present data on and comparing incidence rates stratified by each area-based socioeconomic measure, at each level of geography, for the STIs (MA: 3a; RI: 3b), TB (3c), and weapons-related injury (3d). Given similar findings, we present results for selected variables, e.g., we present data only for the categorical but not quintile version of the poverty variable, for SEP1 and not SEP2, and for the SEP index and not Factor 1 or Factor 2. We likewise present in the tables only data for syphilis, not gonorrhea, since both displayed similar patterning by the selected ABSMs (tabular data for gonorrhea available upon request).

**Sexually transmitted infections**

In both states, socioeconomic gradients were, as expected, greatest for syphilis, intermediate for gonorrhea, and lowest for chlamydia (Tables 3a–3b). Within MA, incidence rates for all three types of STIs were highest among cases living in areas with high crowding (syphilis: >55/100,000 for block group and census tract, and >25/100,000 for ZIP Code; gonorrhea: >80/100,000 for block group and census tract, and >50/100,000 for ZIP Code; chlamydia: >200/100,000 for block group and census tract, and >180/100,000 for ZIP Code). Next highest were rates among cases living in areas with high levels of economic deprivation, as measured by poverty (syphilis: >33/100,000; gonorrhea: >60/100,000; chlamydia: >145/100,000) and also by the Townsend index, the SEP index, SEP1, and low education. These measures of economic deprivation consistently detected the strongest socioeconomic gradients, especially at the block group and census tract level (syphilis and gonorrhea: IRR ≥10, RII >20; chlamydia: IRR ≥7, RII >10); the weakest gradients were detected by measures of occupation, wealth, and income inequality. ZIP Code level estimates were variously equal to, lower than, and rarely higher (except for the Gini) than their block group and census tract counterparts. Similar patterns, albeit with higher incidence rates and less steep socioeconomic gradients, occurred for the STIs in RI (Table 3b).

**Tuberculosis**

The same patterning of results was evident for TB (Table 3c). Within MA, TB rates were highest among cases living in areas with high crowding (>20/100,000 for block group, census tract, and ZIP Code), followed again by rates among cases in areas with high levels of economic deprivation (>13/100,000 for: poverty, Townsend index, and SEP1, for block group and census tract). These measures of economic deprivation detected the strongest socioeconomic gradients, especially at the block group and census tract level (IRR: ≥7; RII >15). ZIP Code level estimates for each of these measures, however, were typically lower. Additionally, at all geographic levels, weaker gradients were detected by measures of occupation, wealth, and income inequality (except for the ZIP Code level estimate for the Gini). Patterns detected in RI were similar, albeit accentuated by slightly higher rates of TB among cases in areas with the least economic resources.

**Non-fatal weapons-related injuries**

Among the intentional injuries, accounting for 87.5% of all non-fatal weapons-related injuries, 79.2% were due to stabbing and 20.8% to guns; among the non-intentional injuries, all were due to guns as data are not collected on non-intentional stab wounds. As shown in Table 3d, the ratio of the median rate of intentional to unintentional injuries increased steeply with economic deprivation: it was approximately 12 times

**TABLE 3a–3c. Incidence rates for STIs (chlamydia, gonorrhea, syphilis), tuberculosis, and non-fatal weapons-related injuries stratified by the census block group (BG), census tract (CT), and ZIP Code (ZC) area-based socioeconomic measures[a] for individuals in areas with the least and most resources: average annual age-standardized[b] rates (per 100,000) and age-adjusted comparisons: incidence rate ratio (IRR) and relative index of inequality (RII), with 95% confidence interval (CI), Massachusetts and Rhode Island, 1985–1998**

**Table 3a: Sexually transmitted infections, Massachusetts (1994–1998)**

| | | *Rate: least resources* | | | *Rate: most resources* | | | *IRR (95% CI): least/most* | | | *RII (95% CI)* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Health outcome* | *Area-based socioeconomic measure* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* |
| Chlamydia | Working class (categorical) | 113.2 | 143.7 | 115.9 | 28.3 | 43.6 | 33.5 | 4.0 (3.4, 4.7) | 3.3 (2.9, 3.8) | 3.5 (2.9, 4.2) | 6.0 (5.6, 6.3) | 4.7 (4.5, 4.9) | 6.1 (5.8, 6.5) |
| | Median household income (quintile) | 125.8 | 150.2 | 129.5 | 17.0 | 29.1 | 21.6 | 7.4 (6.2, 8.9) | 5.2 (4.5, 5.9) | 6.0 (5.1, 7.1) | 11.7 (11.0, 12.5) | 8.0 (7.6, 8.5) | 10.8 (10.2, 11.4) |
| | Poverty (categorical) | 146.8 | 173.7 | 182.2 | 25.4 | 32.8 | 26.9 | 5.8 (5.2, 6.5) | 5.3 (4.8, 5.9) | 6.8 (6.0, 7.6) | 12.1 (11.4, 12.9) | 10.0 (9.5, 10.5) | 11.7 (11.1, 12.4) |
| | Gini (quintile) | 98.1 | 132.5 | 121.1 | 32.6 | 36.3 | 27.8 | 3.0 (2.6, 3.5) | 3.7 (3.2, 4.2) | 4.4 (3.6, 5.3) | 4.5 (4.2, 4.7) | 4.9 (4.6, 5.1) | 6.9 (6.6, 7.3) |
| | Wealth (categorical) | 64.6 | 81.6 | 86.6 | 29.1 | 48.6 | 43.7 | 2.2 (1.9, 2.6) | 1.7 (1.5, 1.9) | 2.0 (1.7, 2.3) | 5.3 (4.9, 5.8) | 2.7 (2.6, 2.9) | 4.7 (4.4, 5.0) |
| | Crowding (categorical) | 216.4 | 254.2 | 183.3 | 40.8 | 53.7 | 47.0 | 5.3 (4.4, 6.4) | 4.7 (3.7, 6.1) | 3.9 (1.4, 10.5) | 11.4 (10.7, 12.2) | 11.6 (11.0, 12.3) | 16.2 (15.3, 17.2) |
| | Low education (categorical) | 158.4 | 166.8 | 168.3 | 23.5 | 34.7 | 27.8 | 6.8 (6.0, 7.6) | 4.8 (4.3, 5.4) | 6.0 (5.3, 7.0) | 13.8 (13.0, 14.7) | 8.8 (8.3, 9.3) | 11.9 (11.3, 12.6) |
| | Townsend index (quintile) | 138.8 | 172.1 | 119.9 | 19.6 | 31.8 | 23.9 | 7.1 (5.9, 8.5) | 5.4 (4.7, 6.2) | 5.0 (4.0, 6.2) | 16.0 (15.0, 17.1) | 10.2 (9.7, 10.8) | 11.6 (10.9, 12.4) |
| | Index of Local Economic Resources (quintile) | 143.7 | 183.1 | 154.9 | 20.1 | 35.8 | 27.7 | 7.1 (6.1, 8.4) | 5.1 (4.5, 5.8) | 5.6 (4.9, 6.4) | 14.0 (13.1, 14.9) | 9.2 (8.8, 9.7) | 12.7 (12.0, 13.4) |
| | SEP1 (categorical) | 169.2 | 192.2 | 170.9 | 22.0 | 42.4 | 33.7 | 7.7 (6.1, 9.6) | 4.5 (3.9, 5.3) | 5.1 (4.0, 6.3) | 9.0 (8.4, 9.6) | 6.3 (6.0, 6.7) | 7.1 (6.7, 7.5) |
| | SEP Index (quintile) | 139.8 | 178.4 | 136.3 | 18.4 | 33.3 | 28.3 | 7.6 (6.4, 9.1) | 5.4 (4.7, 6.1) | 4.8 (4.1, 5.6) | 16.0 (15.0, 17.1) | 9.9 (9.4, 10.4) | 11.8 (11.1, 12.5) |
| | Median value | 139.8 | 172.1 | 136.3 | 23.5 | 35.8 | 27.8 | 6.8 | 4.8 | 5.0 | 11.7 | 8.8 | 11.6 |
| Syphilis | Working class (categorical) | 17.7 | 24.6 | 18.3 | 2.7 | 4.5 | 2.9 | 6.7 (4.1, 10.9) | 5.5 (3.6, 8.4) | 6.2 (3.5, 11.2) | 11.8 (10.0, 14.0) | 9.5 (8.2, 11.0) | 9.7 (8.3, 11.4) |
| | Median household income (quintile) | 22.5 | 26.0 | 20.2 | 1.1 | 2.3 | 1.8 | 20.8 (10.5, 41.5) | 11.4 (7.1, 18.4) | 11.5 (6.5, 20.6) | 47.0 (38.6, 57.3) | 26.8 (22.7, 31.7) | 27.8 (23.3, 33.2) |
| | Poverty (categorical) | 33.4 | 40.3 | 41.3 | 1.6 | 2.3 | 1.9 | 20.4 (13.5, 30.8) | 17.9 (12.3, 25.9) | 21.6 (14.2, 33.0) | 114.8 (92.8, 141.9) | 76.3 (63.6, 91.6) | 75.9 (62.9, 91.6) |
| | Gini (quintile) | 16.0 | 22.8 | 19.1 | 2.6 | 2.5 | 2.1 | 6.2 (3.7, 10.3) | 9.2 (5.7, 14.8) | 9.0 (4.4, 18.5) | 11.0 (9.3, 13.1) | 17.5 (14.9, 20.6) | 24.0 (20.1, 28.7) |
| | Wealth (categorical) | 8.2 | 9.6 | 10.6 | 3.6 | 5.4 | 4.8 | 2.3 (1.4, 3.7) | 1.8 (1.2, 2.7) | 2.2 (1.5, 3.4) | 7.7 (5.9, 10.1) | 2.5 (2.1, 3.0) | 5.2 (4.3, 6.4) |
| | Crowding (categorical) | 57.3 | 62.5 | 26.2 | 3.8 | 4.7 | 4.2 | 15.2 (9.1, 25.3) | 13.3 (7.0, 25.0) | 6.3 (0.3, 115.6) | 76.6 (65.1, 90.1) | 87.6 (75.6, 101.4) | 94.6 (81.2, 110.2) |
| | Low education (categorical) | 27.0 | 27.4 | 27.5 | 1.8 | 3.1 | 2.3 | 15.4 (10.0, 23.7) | 8.8 (6.1, 12.8) | 12.0 (7.6, 18.8) | 46.8 (38.6, 56.8) | 22.6 (19.3, 26.6) | 33.5 (28.2, 39.9) |
| | Townsend index (quintile) | 29.4 | 37.6 | 20.2 | 1.0 | 3.1 | 1.8 | 30.4 (13.9, 66.2) | 12.0 (7.9, 18.3) | 11.0 (5.2, 23.3) | 297.6 (229.9, 385.3) | 86.7 (71.6, 105.0) | 76.6 (61.2, 95.9) |
| | Index of Local Economic Resources (quintile) | 23.9 | 30.9 | 23.9 | 1.6 | 2.9 | 1.8 | 15.1 (8.6, 26.5) | 10.8 (7.1, 16.4) | 13.0 (7.6, 22.0) | 53.7 (43.9, 65.7) | 30.3 (25.6, 35.9) | 34.4 (28.7, 41.3) |
| | SEP1 (categorical) | 34.1 | 43.4 | 46.5 | 1.9 | 4.3 | 3.0 | 17.5 (8.6, 35.8) | 10.1 (6.2, 16.3) | 15.5 (8.0, 30.0) | 35.5 (29.4, 43.0) | 22.6 (19.2, 26.6) | 20.0 (17.0, 23.7) |
| | SEP Index (quintile) | 23.8 | 30.1 | 20.4 | 1.3 | 3.1 | 2.0 | 17.8 (9.4, 33.8) | 9.6 (6.3, 14.7) | 10.1 (5.8, 17.7) | 76.4 (61.0, 95.6) | 30.2 (25.5, 35.9) | 31.3 (26.0, 37.7) |
| | Median value | 23.9 | 30.1 | 20.4 | 1.9 | 3.1 | 2.3 | 15.2 | 10.1 | 11.0 | 47.0 | 26.9 | 31.3 |

**Table 3b. Sexually transmitted diseases, Rhode Island (1994–1996)**

| Health outcome | Area-based socioeconomic measure | Rate: least resources | | | Rate: most resources | | | IRR (95% CI): least/most | | | RII (95% CI) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BG | CT | ZC | BG | CT | ZC | BG | CT | ZC | BG | CT | ZC |
| Chlamydia | Working class (categorical) | 241.3 | 277.6 | 353.2 | 60.3 | 57.1 | 75.9 | 4.0 (2.6, 6.3) | 4.9 (2.9, 8.1) | 4.7 (2.8, 7.9) | 8.1 (7.1, 9.2) | 8.9 (7.9, 10.1) | 12.8 (11.2, 14.5) |
| | Median household income (quintile) | 322.4 | 366.6 | 279.6 | 46.2 | 45.2 | 31.7 | 7.0 (4.9, 9.9) | 8.1 (5.7, 11.6) | 8.8 (5.0, 15.6) | 13.5 (11.8, 15.4) | 33.3 (29.2, 38.0) | 17.3 (15.0, 19.9) |
| | Poverty (categorical) | 319.1 | 354.6 | 421.7 | 63.3 | 63.8 | 55.5 | 5.0 (4.0, 6.4) | 5.6 (4.3, 7.2) | 7.6 (5.3, 10.9) | 9.4 (8.3, 10.6) | 10.5 (9.2, 11.9) | 14.8 (13.0, 16.9) |
| | Gini (quintile) | 174.2 | 211.3 | 236.4 | 71.2 | 64.1 | 38.4 | 2.5 (1.8, 3.4) | 3.3 (2.4, 4.5) | 6.2 (2.8, 13.7) | 2.9 (2.6, 3.3) | 3.7 (3.3, 4.1) | 7.0 (6.2, 7.9) |
| | Wealth (categorical) | 146.0 | 157.9 | 166.2 | 45.7 | 55.1 | 68.1 | 3.2 (1.8, 5.8) | 2.9 (1.7, 4.9) | 2.4 (1.5, 3.9) | 5.5 (4.4, 6.9) | 13.9 (11.3, 17.0) | 7.1 (5.9, 8.5) |
| | Crowding (categorical)[c] | 534.0 | 558.3 | 528.3 | 96.4 | 99.1 | 96.5 | 5.5 (3.8, 8.0) | 5.6 (3.2, 9.9) | 5.5 (4.1, 7.3) | 13.3 (11.7, 15.1) | 15.5 (13.6, 17.6) | 18.9 (16.6, 21.6) |
| | Low education (categorical) | 300.1 | 326.7 | 309.6 | 43.6 | 46.6 | 53.1 | 6.9 (5.0, 9.5) | 7.0 (4.8, 10.2) | 5.8 (4.1, 8.2) | 13.2 (11.6, 15.0) | 11.8 (10.4, 13.4) | 11.9 (10.5, 13.5) |
| | Townsend index (quintile) | 317.8 | 372.0 | 226.0 | 48.1 | 58.2 | 44.2 | 6.6 (4.6, 9.5) | 6.4 (4.6, 8.8) | 5.1 (2.4, 10.8) | 14.2 (12.4, 16.2) | 14.6 (12.8, 16.6) | 12.2 (10.6, 14.0) |
| | Index of Local Economic Resources (quintile) | 355.7 | 381.0 | 290.3 | 51.3 | 56.6 | 54.7 | 6.9 (5.0, 9.6) | 6.7 (5.0, 9.1) | 5.3 (4.0, 7.1) | 12.5 (11.0, 14.1) | 29.0 (25.5, 32.9) | 13.3 (11.6, 15.2) |
| | SEP1 (categorical) | 434.7 | 456.4 | 455.6 | 45.7 | 55.3 | 75.5 | 9.5 (4.9, 18.4) | 8.3 (4.5, 15.0) | 6.0 (3.5, 10.3) | 11.9 (10.5, 13.5) | 26.8 (23.7, 30.3) | 14.4 (12.7, 16.4) |
| | SEP Index (quintile) | 350.9 | 381.4 | 279.2 | 45.9 | 49.6 | 60.3 | 7.7 (5.4, 10.8) | 7.7 (5.5, 10.7) | 4.6 (3.2, 6.7) | 17.6 (15.3, 20.1) | 17.2 (15.1, 19.7) | 14.3 (12.5, 16.4) |
| | Median value | 319.1 | 366.6 | 279.6 | 48.1 | 56.6 | 55.5 | 6.6 | 6.4 | 5.5 | 12.4 | 14.6 | 13.3 |
| Syphilis | Working class (categorical) | 19.0 | 22.8 | 34.5 | 2.1 | 3.5 | 4.3 | 9.1 (0.9, 97.5) | 6.4 (0.6, 68.6) | 8.0 (0.5, 120.9) | 38.5 (20.5, 72.2) | 21.3 (12.6, 36.0) | 49.4 (28.0, 87.2) |
| | Median household income (quintile) | 29.4 | 30.6 | 22.5 | 1.6 | 1.4 | 4.8 | 18.0 (3.0, 107.6) | 22.7 (3.2, 159.8) | 4.7 (1.0, 21.3) | 111.1 (57.0, 216.5) | 48.7 (27.7, 85.7) | 58.7 (31.1, 110.9) |
| | Poverty (categorical) | 33.2 | 37.1 | 45.7 | 2.0 | 3.7 | 3.3 | 16.9 (4.7, 60.4) | 10.1 (3.6, 27.9) | 13.8 (3.5, 54.3) | 83.4 (44.4, 156.6) | 33.6 (19.9, 56.7) | 49.1 (28.3, 85.1) |
| | Gini (quintile) | 12.9 | 19.4 | 20.0 | 2.4 | 2.4 | 1.3 | 5.4 (0.9, 31.7) | 7.9 (1.6, 38.5) | 15.2 (0.3, 839.0) | 6.6 (4.1, 10.8) | 11.8 (7.2, 19.1) | 21.7 (12.6, 37.3) |
| | Wealth (categorical) | 8.8 | 10.4 | 11.3 | 1.3 | 3.4 | 2.9 | 6.6 (0.1, 362.8) | 3.1 (0.2, 40.1) | 3.9 (0.3, 53.8) | 15.3 (4.8, 48.3) | 6.3 (2.9, 13.7) | 16.3 (7.2, 37.1) |
| | Crowding (categorical)[c] | 96.4 | 147.5 | 82.0 | 4.0 | 5.1 | 5.0 | 24.4 (7.2, 82.3) | 28.7 (6.6, 124.9) | 16.4 (6.5, 41.4) | 86.4 (52.2, 143.1) | 72.8 (45.8, 115.8) | 81.8 (51.0, 131.2) |
| | Low education (categorical) | 25.4 | 30.8 | 26.7 | 1.2 | 1.2 | 1.2 | 21.0 (2.6, 169.2) | 25.5 (1.9, 341.1) | 21.7 (2.0, 238.6) | 93.2 (47.7, 182.2) | 51.6 (29.1, 91.5) | 45.4 (25.6, 80.6) |
| | Townsend index (quintile) | 30.3 | 35.2 | 18.2 | 1.4 | 4.1 | 9.6 | 21.4 (2.8, 166.8) | 8.5 (2.6, 28.1) | 1.9 (0.4, 8.7) | 234.7 (109.4, 503.2) | 54.5 (30.8, 96.3) | 30.8 (16.7, 57.0) |
| | Index of Local Economic Resources (quintile) | 30.3 | 35.0 | 24.3 | 1.5 | 4.8 | 3.3 | 19.7 (3.3, 116.4) | 7.3 (2.5, 21.5) | 7.3 (2.1, 25.3) | 97.8 (50.3, 190.1) | 36.0 (21.0, 61.7) | 34.3 (19.4, 60.5) |
| | SEP1 (categorical) | 43.0 | 43.4 | 50.1 | 1.3 | 4.5 | 4.3 | 32.5 (0.6, 1819.6) | 9.7 (0.7, 130.8) | 11.7 (0.8, 178.2) | 72.5 (39.6, 133.0) | 40.9 (24.6, 67.8) | 70.6 (42.2, 118.1) |
| | SEP Index (quintile) | 31.9 | 33.8 | 22.5 | 1.1 | 4.0 | 5.3 | 28.1 (3.1, 252.8) | 8.4 (2.5, 27.6) | 4.2 (1.1, 16.2) | 231.1 (107.6, 496.2) | 43.9 (25.2, 76.5) | 45.7 (24.8, 84.2) |
| | Median value | 30.3 | 33.8 | 24.3 | 1.5 | 3.7 | 4.3 | 19.6 | 8.5 | 8.0 | 86.4 | 40.8 | 45.7 |

## Table 3c. Tuberculosis (TB): Massachusetts (1993–1998) and Rhode Island (1985–1994)

| | | *Rate: least resources* | | | *Rate: most resources* | | | *IRR (95% CI): least/most* | | | *RII (95% CI)* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Health outcome* | *Area-based socioeconomic measure* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* |
| TB: MA | Working class (categorical) | 8.3 | 10.8 | 2.0 | 3.1 | 3.8 | 2.9 | 2.7 (1.7, 4.3) | 2.8 (1.8, 4.5) | 0.7 (0.3, 1.9) | 3.8 (3.2, 4.6) | 3.3 (2.8, 3.9) | 1.8 (1.5, 2.1) |
| | Median household income (quintile) | 10.7 | 11.3 | 7.1 | 1.8 | 2.2 | 1.7 | 5.8 (3.4, 10.0) | 5.1 (3.1, 8.4) | 4.2 (2.3, 7.7) | 9.6 (7.9, 11.6) | 9.1 (7.6, 10.9) | 6.6 (5.4, 8.0) |
| | Poverty (categorical) | 14.5 | 16.1 | 13.1 | 2.1 | 2.1 | 1.7 | 6.8 (4.6, 10.1) | 7.7 (5.1, 11.5) | 7.6 (4.7, 12.3) | 15.5 (12.8, 18.8) | 17.6 (14.6, 21.2) | 13.8 (11.3, 17.0) |
| | Gini (quintile) | 7.9 | 10.1 | 7.7 | 2.5 | 2.5 | 1.2 | 3.2 (1.9, 5.4) | 4.1 (2.5, 6.7) | 6.4 (2.5, 16.1) | 4.3 (3.6, 5.2) | 5.5 (4.6, 6.6) | 8.3 (6.8, 10.2) |
| | Wealth (categorical) | 4.9 | 5.4 | 4.6 | 2.9 | 3.8 | 3.6 | 1.7 (1.0, 2.8) | 1.4 (0.9, 2.2) | 1.3 (0.8, 2.0) | 4.0 (3.0, 5.2) | 2.1 (1.7, 2.6) | 2.0 (1.6, 2.5) |
| | Crowding (categorical) | 20.7 | 26.5 | 34.7 | 3.2 | 3.4 | 3.0 | 6.6 (3.1, 13.7) | 7.8 (3.3, 18.7) | 11.6 (1.4, 96.4) | 18.4 (15.2, 22.4) | 26.9 (22.4, 32.3) | 16.1 (13.1, 19.8) |
| | Low education (categorical) | 11.6 | 11.3 | 6.5 | 2.5 | 2.7 | 2.2 | 4.7 (3.1, 7.2) | 4.2 (2.7, 6.5) | 3.0 (1.6, 5.6) | 8.0 (6.6, 9.6) | 7.1 (5.9, 8.5) | 5.5 (4.6, 6.7) |
| | Townsend index (quintile) | 13.1 | 15.4 | 8.1 | 1.8 | 1.9 | 1.4 | 7.4 (4.2, 13.0) | 7.9 (4.8, 13.2) | 5.6 (2.5, 12.4) | 24.5 (19.8, 30.4) | 22.4 (18.4, 27.3) | 16.6 (13.2, 21.0) |
| | Index of Local Economic Resources (quintile) | 10.4 | 11.8 | 7.3 | 2.3 | 2.8 | 2.1 | 4.5 (2.8, 7.2) | 4.2 (2.7, 6.5) | 3.4 (2.1, 5.6) | 8.3 (6.8, 10.0) | 6.9 (5.8, 8.2) | 5.4 (4.5, 6.6) |
| | SEP1 (categorical) | 14.3 | 16.3 | 2.9 | 2.5 | 3.3 | 2.8 | 5.8 (3.0, 11.2) | 4.9 (2.8, 8.6) | 1.0 (0.2, 4.9) | 8.1 (6.6, 9.9) | 7.5 (6.2, 9.0) | 3.5 (2.9, 4.4) |
| | SEP Index (quintile) | 10.7 | 11.8 | 6.8 | 2.1 | 2.8 | 2.1 | 5.1 (3.0, 8.6) | 4.3 (2.7, 6.7) | 3.3 (1.9, 5.7) | 9.8 (8.0, 12.0) | 7.5 (6.2, 9.0) | 5.5 (4.5, 6.7) |
| | Median value | 10.7 | 11.8 | 7.1 | 2.4 | 2.7 | 2.1 | 4.9 | 4.3 | 3.4 | 8.3 | 7.5 | 5.5 |
| TB: RI | Working class (categorical) | 10.4 | 12.9 | 16.1 | 2.7 | 3.3 | 5.4 | 3.9 (1.3, 12.0) | 3.9 (1.1, 13.6) | 3.0 (0.8, 11.4) | 12.2 (8.5, 17.5) | 14.5 (10.2, 20.8) | 19.7 (13.6, 28.6) |
| | Median household income (quintile) | 14.1 | 16.4 | 12.1 | 1.5 | 2.1 | 1.6 | 9.3 (3.3, 26.8) | 7.9 (3.1, 20.3) | 7.6 (1.6, 36.4) | 20.6 (14.3, 29.8) | 22.5 (15.6, 32.6) | 32.4 (21.3, 49.2) |
| | Poverty (categorical) | 17.1 | 19.7 | 21.5 | 2.3 | 2.2 | 1.7 | 7.3 (3.7, 14.6) | 8.8 (4.3, 17.9) | 12.8 (4.3, 37.6) | 18.8 (13.2, 26.8) | 22.5 (15.7, 32.3) | 31.3 (21.5, 45.5) |
| | Gini (quintile) | 6.8 | 9.7 | 11.7 | 3.1 | 2.0 | 1.4 | 2.2 (0.9, 5.7) | 4.9 (1.7, 13.7) | 8.6 (0.6, 112.6) | 3.0 (2.2, 4.1) | 5.1 (3.7, 7.0) | 12.7 (8.8, 18.3) |
| | Wealth (categorical) | 5.7 | 6.2 | 6.5 | 2.2 | 3.2 | 4.2 | 2.5 (0.5, 12.0) | 2.0 (0.5, 7.5) | 1.6 (0.5, 5.2) | 8.3 (4.2, 16.2) | 7.2 (4.1, 12.7) | 9.2 (5.4, 15.5) |
| | Crowding (categorical)[c] | 42.3 | 58.5 | 30.3 | 3.3 | 3.2 | 3.5 | 12.7 (4.8, 33.6) | 18.1 (5.1, 63.7) | 8.8 (4.0, 19.7) | 30.3 (21.6, 42.5) | 52.5 (37.7, 73.2) | 37.2 (26.4, 52.5) |
| | Low education (categorical) | 13.1 | 14.7 | 12.3 | 1.8 | 2.2 | 2.3 | 7.1 (2.8, 18.5) | 6.7 (2.3, 19.4) | 5.4 (2.0, 14.7) | 18.3 (12.6, 26.6) | 18.2 (12.6, 26.2) | 17.0 (11.7, 24.6) |
| | Townsend index (quintile) | 15.4 | 17.9 | 10.1 | 2.0 | 2.4 | 2.1 | 7.8 (2.9, 20.9) | 7.6 (3.3, 17.7) | 4.9 (0.7, 34.5) | 27.4 (18.7, 40.3) | 24.8 (17.1, 36.0) | 21.0 (13.9, 31.8) |
| | Index of Local Economic Resources (quintile) | 16.6 | 17.1 | 12.8 | 2.0 | 2.9 | 2.3 | 8.4 (3.4, 20.4) | 5.9 (2.8, 12.5) | 5.7 (2.4, 13.2) | 20.3 (14.1, 29.3) | 16.4 (11.5, 23.4) | 18.9 (13.0, 27.6) |
| | SEP1 (categorical) | 19.4 | 22.8 | 22.0 | 3.1 | 3.8 | 5.4 | 6.3 (1.5, 26.0) | 5.9 (1.4, 24.7) | 4.1 (1.0, 16.0) | 20.8 (14.5, 29.9) | 25.6 (18.0, 36.3) | 27.0 (18.9, 38.6) |
| | SEP Index (quintile) | 15.8 | 17.2 | 12.1 | 1.8 | 2.2 | 2.6 | 8.6 (3.2, 23.2) | 7.8 (3.2, 19.1) | 4.7 (1.6, 13.7) | 28.2 (19.1, 41.7) | 21.1 (14.7, 30.4) | 26.3 (17.5, 39.4) |
| | Median value | 15.4 | 17.1 | 12.3 | 2.2 | 2.4 | 2.3 | 7.3 | 6.7 | 4.9 | 20.3 | 21.1 | 21.0 |

**Table 3d. Non-fatal weapons, related injury: intentional ($n$ = 5759 cases) and unintentional ($n$ = 479 cases), Massachusetts only; 1995–1997)**

| | | *Rate: least resources* | | | *Rate: most resources* | | | *IRR (95% CI): least/most* | | | *RII (95% CI)* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Health outcome* | *Area-based socioeconomic measure* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* | *BG* | *CT* | *ZC* |
| Non-fatal weapons, related injury: Intentional | Working class (categorical) | 59.4 | 72.7 | 60.1 | 8.4 | 8.7 | 6.0 | 7.1 (5.0, 10.1) | 8.4 (5.8, 12.1) | 10.0 (6.1, 16.1) | 12.3 (10.9, 13.9) | 13.8 (12.3, 15.5) | 15.1 (13.4, 16.9) |
| | Median household income (quintile) | 67.9 | 76.8 | 60.5 | 5.0 | 5.9 | 4.2 | 13.5 (9.0, 20.5) | 12.9 (8.9, 18.8) | 14.3 (8.8, 23.0) | 28.4 (24.9, 32.5) | 27.7 (24.4, 31.4) | 28.1 (24.6, 32.1) |
| | Poverty (categorical) | 82.2 | 90.2 | 89.9 | 8.2 | 7.9 | 6.7 | 10.0 (7.8, 12.8) | 11.4 (8.8, 14.7) | 13.5 (10.0, 18.2) | 29.6 (25.9, 33.7) | 32.6 (28.7, 37.0) | 33.2 (29.1, 37.8) |
| | Gini (quintile) | 46.1 | 58.6 | 52.8 | 10.6 | 9.8 | 6.1 | 4.3 (3.1, 6.0) | 6.0 (4.4, 8.1) | 8.6 (5.1, 14.6) | 6.9 (6.2, 7.8) | 9.7 (8.6, 10.8) | 13.3 (11.8, 15.1) |
| | Wealth (categorical) | 28.8 | 33.0 | 35.2 | 8.6 | 8.2 | 8.2 | 3.3 (2.2, 5.0) | 4.0 (2.7, 6.0) | 4.3 (2.9, 6.4) | 11.2 (9.1, 13. 7) | 7.3 (6.2, 8.6) | 10.9 (9.3, 12.9) |
| | Crowding (categorical) | 110.1 | 107.6 | 16.6 | 16.2 | 17.8 | 19.4 | 6.8 (4.7, 9.9) | 6.0 (3.5, 10.4) | 1.0 (0.0, 55.2) | 19.9 (17.6, 22.4) | 25.6 (22.8, 28.6) | 25.4 (22.6, 28.5) |
| | Low education (categorical) | 84.6 | 83.0 | 87.4 | 7.3 | 7.2 | 6.2 | 11.6 (8.9, 15.2) | 11.5 (8.6, 15.3) | 14.1 (10.1, 19.5) | 31.2 (27.4, 35.5) | 28.7 (25.4, 32.5) | 33.4 (29.4, 37.9) |
| | Townsend index (quintile) | 73.5 | 85.3 | 54.4 | 5.6 | 7.0 | 5.5 | 13.2 (8.6, 20.4) | 12.2 (8.5, 17.5) | 9.9 (5.6, 17.5) | 45.3 (39.2, 52.4) | 39.3 (34.3, 44.9) | 40.9 (35.1, 47.7) |
| | Index of Local Economic Resources (quintile) | 73.5 | 92.4 | 70.6 | 5.6 | 7.2 | 5.1 | 13.1 (9.0, 19.2) | 12.8 (9.2, 17.7) | 13.9 (9.3, 20.9) | 32.0 (27.9, 36.6) | 33.7 (29.6, 38.2) | 37.1 (32.4, 42.4) |
| | SEP1 (categorical) | 97.6 | 103.3 | 98.7 | 5.0 | 7.8 | 5.9 | 19.4 ( 11.0, 34.2) | 13.2 (8.6, 20.5) | 16.7 (9.6, 29.3) | 23.3 (20.4, 26.6) | 24.7 (21.9, 27.9) | 20.5 (18.0, 23.2) |
| | SEP Index (quintile) | 72.9 | 89.9 | 62.6 | 4.8 | 6.0 | 4.8 | 15.3 (9.9, 23.7) | 14.9 (10.2, 21.8) | 13.2 (8.3, 20.9) | 43.8 (37.8, 50.7) | 41.0 (35.9, 46.9) | 41.6 (36.0, 48.0) |
| | Median value | 72.9 | 83.0 | 60.5 | 7.3 | 7.2 | 6.0 | 11.7 | 11.5 | 13.2 | 28.4 | 27.7 | 28.1 |
| Non-fatal weapons, related injury: Unintentional | Working class (categorical) | 1.0 | 1.3 | 1.7 | 0.3 | 0.6 | 0.4 | 3.4 (0.4, 26.3) | 2.2 (0.4, 12.8) | 4.3 (0.5, 40.1) | 2.7 (1.5, 4.8) | 2.4 (1.4, 4.3) | 4.7 (2.6, 8.6) |
| | Median household income (quintile) | 1.1 | 1.0 | 1.2 | 0.6 | 0.6 | 0.6 | 1.9 (0.4, 8.6) | 1.6 (0.4, 7.5) | 2.0 (0.5, 8.6) | 2.1 (1.2, 3.7) | 1.9 (1.1, 3.3) | 2.6 (1.5, 4.6) |
| | Poverty (categorical) | 1.2 | 1.2 | 1.2 | 0.7 | 0.7 | 0.7 | 1.7 (0.5, 6.1) | 1.8 (0.5, 6.9) | 1.8 (0.4, 7.5) | 1.4 (0.8, 2.6) | 2.0 (1.1, 3.5) | 1.9 (1.1, 3.4) |
| | Gini (quintile) | 0.9 | 0.9 | 0.8 | 0.8 | 0.9 | 0.7 | 1.2 (0.3, 5.1) | 1.0 (0.2, 4.0) | 1.1 (0.2, 6.3) | 1.6 (0.9, 2.9) | 1.1 (0.6, 1.9) | 1.3 (0.8, 2.3) |
| | Wealth (categorical) | 0.9 | 1.0 | 1.0 | 0.7 | 0.6 | 0.5 | 1.3 (0.3, 5.8) | 1.6 (0.3, 8.1) | 2.0 (0.4, 11.6) | 1.8 (0.8, 3.8) | 1.8 (0.9, 3.7) | 2.6 (1.3, 5.3) |
| | Crowding (categorical) | 0.9 | 1.5 | 3.8 | 0.7 | 0.8 | 0.8 | 1.3 (0.0, 34.1) | 1.9 (0.0, 104.2) | 5.1 (1.2, 21.5) | 2.3 (1.0, 5.2) | 2.6 (1.2, 5.8) | 4.2 (2.0, 8.7) |
| | Low education (categorical) | 1.1 | 1.0 | 2.0 | 0.6 | 0.7 | 0.6 | 2.0 (0.5, 9.0) | 1.5 (0.3, 7.6) | 3.5 (0.8, 16.4) | 3.0 (1.7, 5.5) | 2.5 (1.4, 4.3) | 3.5 (2.0, 6.3) |
| | Townsend index (quintile) | 1.0 | 1.1 | 1.0 | 0.7 | 0.9 | 0.5 | 1.4 (0.3, 6.1) | 1.2 (0.3, 5.0) | 1.8 (0.3, 12.5) | 1.5 (0.8, 2.6) | 1.3 (0.8, 2.3) | 1.4 (0.8, 2.5) |
| | Index of Local Economic Resources (quintile) | 1.2 | 1.3 | 1.5 | 0.5 | 0.6 | 0.5 | 2.5 (0.5, 11.5) | 2.3 (0.5, 9.8) | 2.8 (0.6, 12.1) | 2.6 (1.5, 4.7) | 3.0 (1.7, 5.3) | 4.2 (2.3, 7.5) |
| | SEP1 (categorical) | 1.4 | 1.8 | 4.0 | 0.4 | 0.6 | 0.4 | 3.8 (0.3, 43.6) | 3.0 (0.4, 21.1) | 10.6 (0.9, 129.2) | 3.1 (1.7, 5.9) | 2.3 (1.2, 4.2) | 2.6 (1.3, 5.0) |
| | SEP Index (quintile) | 1.2 | 1.3 | 1.3 | 0.4 | 0.5 | 0.5 | 2.8 (0.5, 15.9) | 2.7 (0.5, 13.1) | 2.6 (0.5, 13.0) | 2.6 (1.4, 4.7) | 2.7 (1.6, 4.8) | 3.4 (1.9, 6.1) |
| | Median value | 1.1 | 1.2 | 1.2 | 0.6 | 0.6 | 0.5 | 1.9 | 1.8 | 2.0 | 2.3 | 2.3 | 2.6 |

[a]Cut-points for each variable are presented in the Appendix 2.

[b]Age-standardized to the Year 2000 standard million.[57]

[c]In RI, analyses at the ZIP Code level pertain only to categories C1–C3, as no ZIP Codes belonged to C4 (20%–100% crowding).

higher among individuals in areas with the most economic resources, but more than 70 times higher (≈ 73 vs. ≈ 1.1 per 100,000) among individuals in areas with the least economic resources.

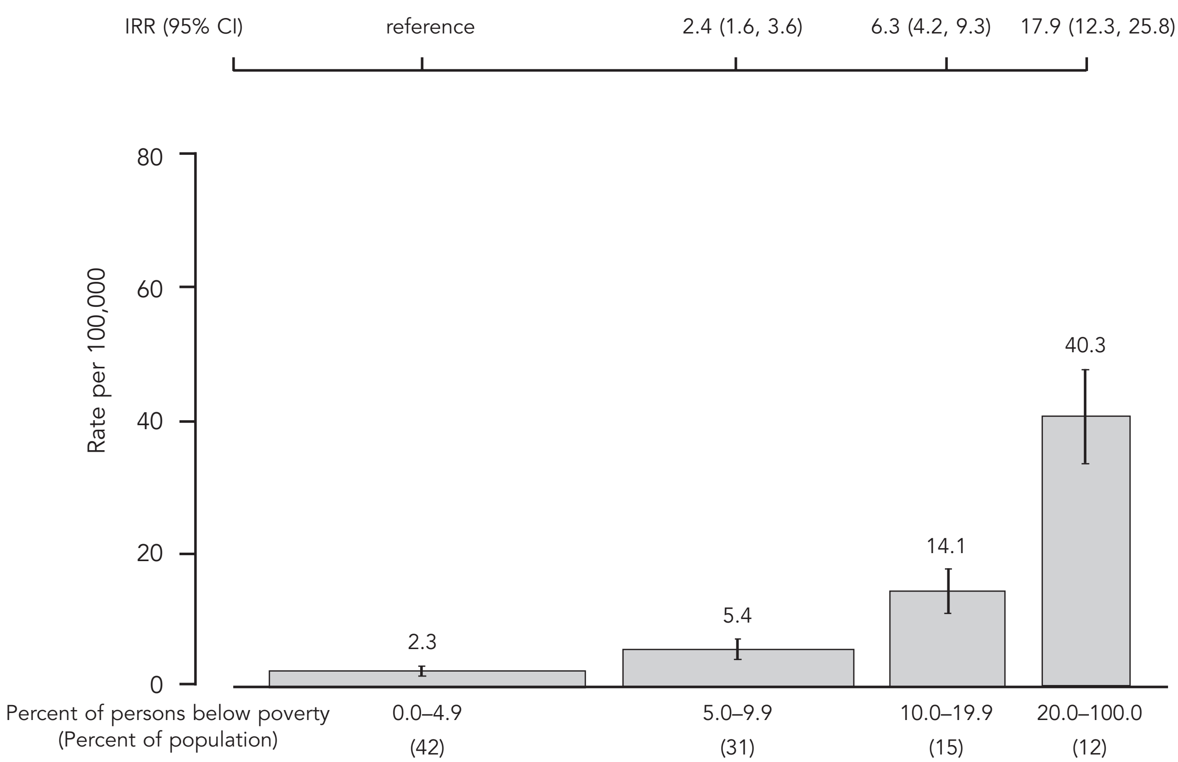
Among intentional injuries, the range of rates and effect estimates detected by different ABSMs varied considerably, with similar patterns observed at each level of geography. Measures of economic deprivation, such as the poverty rate, median household income, Townsend index, and the Index of Local Economic Resources, and also low education, detected the strongest socioeconomic gradients (IRR ≥10; RII ≥25). The lowest effect estimates, in turn, were observed for measures of wealth and income inequality, especially at the block group level (IRR ≈ 3–4; RII ≈ 7–13). By contrast, among the unintentional injuries, the socioeconomic gradient was much less steep, and the strongest socioeconomic gradients were detected by economic measures pertaining to occupational class and educational level, rather than economic deprivation. Thus, IRRs and RIIs >3 were observed only for measures of occupational class, less than high school, the Index of Local Economic Resources, SEP1, and the SEP index; only the Gini detected no socioeconomic gradient.

Lastly, visually summarizing key results, Figure 1 depicts socioeconomic gradients in syphilis, TB, and non-fatal intentional injuries for MA, using the tract level measure of percent of persons below poverty. This figure employs a new format for graphically displaying data for monitoring socioeconomic inequalities in health, whereby the width of the bars is proproportional to the size of the population in each socioeconomic stratum.[46,47]

## DISCUSSION

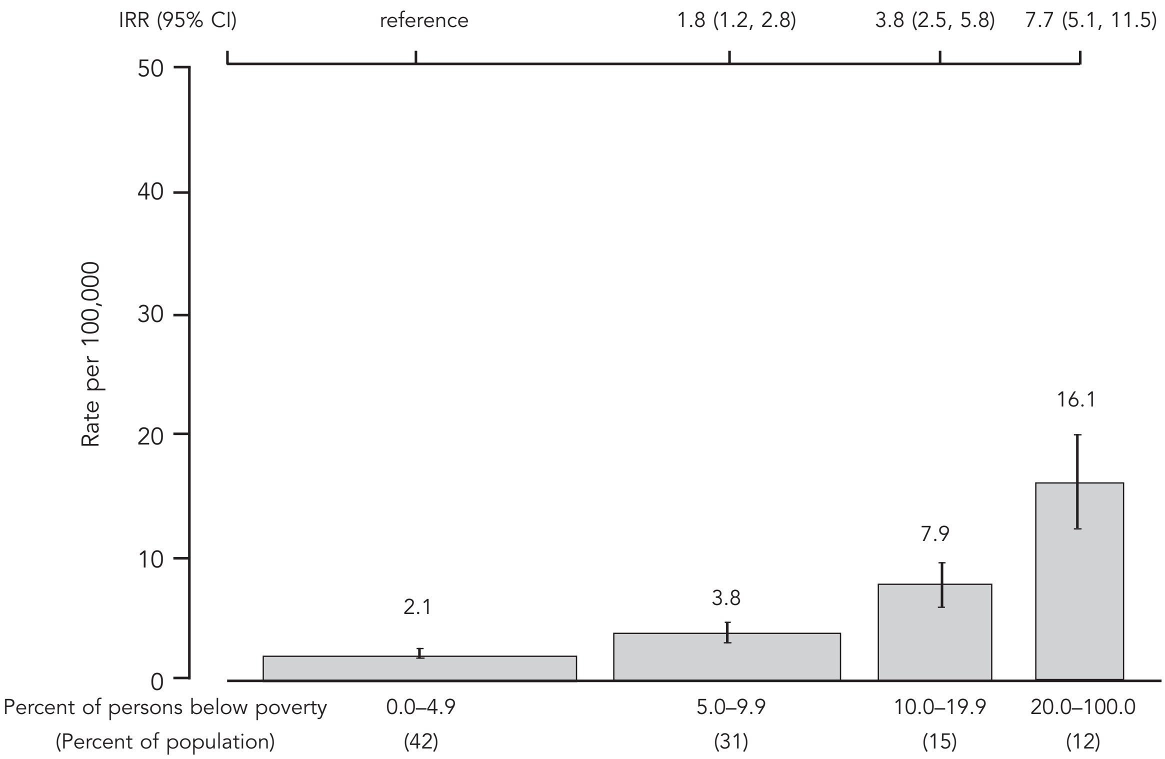
This study, part of the first systematic U.S. investigation of ABSMs suitable for monitoring population health across a range of health outcomes and also the first simultaneously comparing diverse ABSMs within and across levels of geography,[46,47] provides empirical

**Figure 1a. Socioeconomic gradients in average annual age-standardized incidence rates (per 100,000 person years, using the year 2000 standard million) for syphilis (1994–1998): Massachusetts, using census tract measure "percent of persons below poverty."**




NOTE: The width of each bar is proportional to the size of the population in the specific socioeconomic stratum, as indicated by the lower x-axis. The upper x-axis provides the incidence rate ratio (IRR), with the referent category set as population residing in the least poor census tract (<5% below poverty).

**Figure 1b. Socioeconomic gradients in average annual age-standardized incidence rates (per 100,000 person years, using the year 2000 standard million) for tuberculosis (1993–1998): Massachusetts, using census tract measure "percent of persons below poverty."**



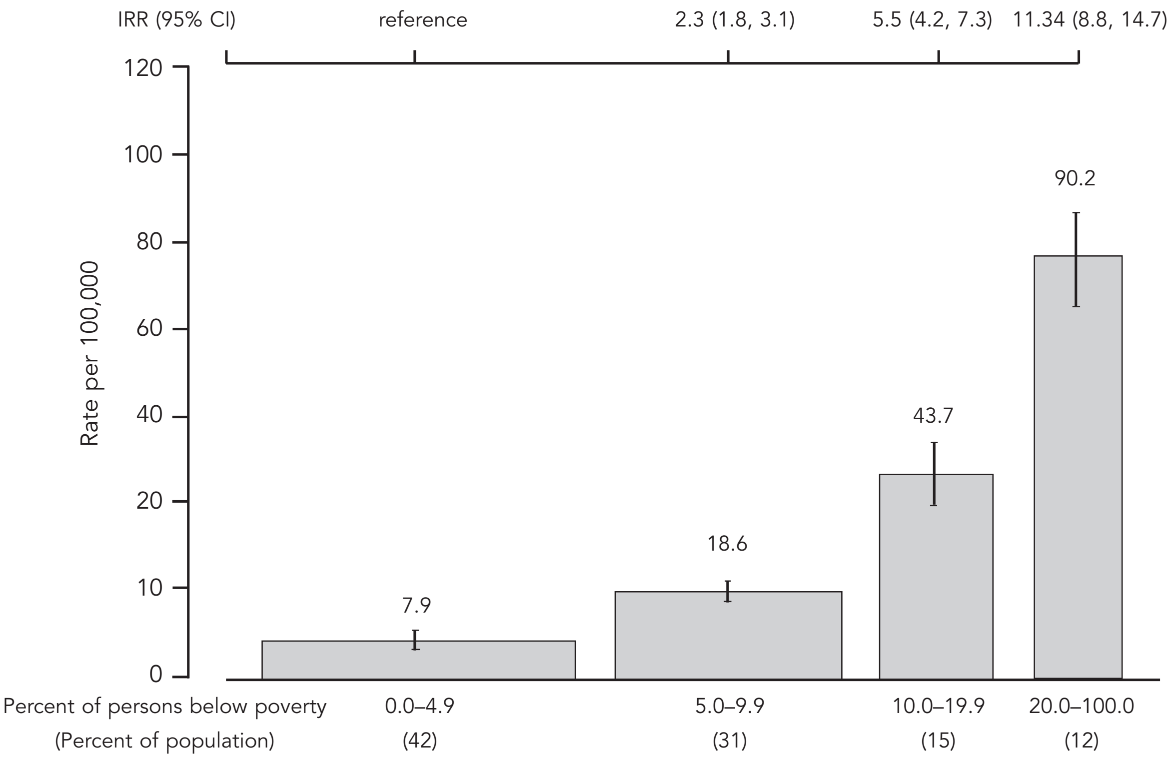

NOTE: The width of each bar is proportional to the size of the population in the specific socioeconomic stratum, as indicated by the lower x-axis. The upper x-axis provides the incidence rate ratio (IRR), with the referent category set as population residing in the least poor census tract (<5% below poverty).

evidence that both choice of measure and level of geography matter. Specifically, examining STI, TB, and non-fatal weapons-related injury rates for two New England states during the period around 1990 in conjunction with 1990 census data, we found that measures designed to detect economic deprivation, including the percent below poverty, were most robust, consistently detecting expected gradients across all outcomes, whereas measures pertaining to educational level, wealth, and income inequality often detected smaller gradients or missed them entirely. Second, census block group and census tract measures performed similarly for virtually all outcomes (with a higher proportion of records geocoded to the census tract compared to the block group level), whereas ZIP Code measures were more variable and in some cases failed to detect gradients observed with the block group and tract measures. Lastly, categories based on quintiles and a priori cut-points detected similar socioeconomic gradients; only the latter, however, could be meaningfully compared across states, an important attribute for public health monitoring.

**Study limitations**

Several sources of error and bias could have affected our findings. If, for example, economic deprivation were associated with increased likelihood of being included in the STI and TB registries,[3,5,8,30] the net effect would be to truncate the upper end of socioeconomic distribution of reported cases and thereby lead to underestimating socioeconomic gradients in the specified outcomes (since rates of the most impoverished would be compared to rates among the less impoverished, but not the most affluent). A conservative bias would also have occurred if individuals subject to socioeconomic deprivation were less likely to have a geocodable address, but our analyses indicated this problem was unlikely to have affected our data. Were such biases operative, however, they would have equally affected analyses at each geographic level and thus

**Figure 1c. Socioeconomic gradients in average annual age-standardized incidence rates (per 100,000 person years, using the year 2000 standard million) for non-fatal intentional weapons-related injury (1995–1997): Massachusetts, using census tract level measure "percent of persons below poverty."**




NOTE: The width of each bar is proportional to the size of the population in the specific socioeconomic stratum, as indicated by the lower x-axis. The upper x-axis provides the incidence rate ratio (IRR), with the referent category set as population residing in the least poor census tract (<5% below poverty).

would not invalidate comparison of socioeconomic gradients across socioeconomic measures and across levels of geography. Adding further credence to our findings, the proportion of areas without data on the ABSMs was so low as to render negligible the impact of these missing data, and we minimized geocoding error by using a firm whose accuracy we validated with records from the study's death and birth databases.[61]

Other concerns involve our selection and use of ABSMs. Two debates in the literature pertain to: (1) benefits and drawbacks of using single-variable indicators versus composite indicators—a topic as relevant to individual-level socioeconomic data as ABSMs;[17,25,67–70] and (2) use of continuous vs categorical socioeconomic data.[17,25,67–70] To address these issues empirically, our study accordingly employed a variety of single-variable and composite socioeconomic measures, using cut-points based on both percentile distribution and a priori considerations. Notably, the single-variable measure of poverty, along with several other single-variable measures, detected the same magnitude of socioeconomic inequalities in health as the composite measures. Additionally, categorical variables based on a priori cut-points, unlike the data-driven quintiles, could be uniformly applied to—and compared across—each level of geography in each state.

Analyses conducted for this first phase of our project did not take into account either spatial correlation of geographic areas (e.g., nesting of block groups within tracts) or issues of adjacency (e.g., effects of living in a poor block group adjacent to chiefly poor vs. more affluent block groups). Existing literature, however, suggests that use of multilevel models to take into account geographic nesting would have improved the precision of our effect estimates, albeit without substantially changing the estimates themselves or patterns of associations we observed.[85–87] Had analyses taken into account issues of adjacency, however, different and additional effect estimates might have been obtained.[85–87] Of note, the type of aggregation bias typically referred to in epidemiologic literature as "ecologic fallacy" is not germane,[88–92] since in our analyses individuals constituted the unit of observation for both the dependent variables (health outcomes) and the independent variables (living in an area with certain sociodemographic characteristics). At issue is whether the specified area is a meaningful unit of geography, as is more likely to be the case for block groups and census tracts, compared to ZIP Codes.

**Interpretation and implications**

The notably high yet differing magnitudes of socioeconomic inequalities observed across the three STI outcomes, and also for TB and non-fatal weapons related injury, typically matched and often exceeded rates reported in the limited extant population-based data on U.S. socioeconomic gradients in these outcomes,[7,10,12,28–30,33–39,41,42] with the variation in observed rates by economic measure likely reflecting different pathways by which diverse aspects of socioeconomic position influence health. That such large and presumably preventable socioeconomic disparities are not routinely monitored is cause for concern, given their implications for public health initiatives to reduce social disparities in health. The finding that the single-variable and composite measures explicitly capturing aspects of economic impoverishment consistently detected the sharpest socioeconomic gradients in STIs, TB, and non-fatal weapons-related injuries additionally highlights the profound impact of material deprivation on health, and underscores their value for public health monitoring. From an etiologic perspective, however, it might be apt to use a variety of ABSMs, and likewise might be germane to conduct analyses based on individuals as well as on cases.

Given that block groups and tracts would, by design, be expected to contain more homogenous populations than ZIP Codes,[17,56] the similarity of patterns at the block group and census tract level, and greater variability at the ZIP Codes level that we observed in this study and for our project's other outcomes,[46,47] is perhaps not surprising. The handful of prior epidemiologic studies investigating use of individual vs. ABSMs have likewise reported similar performance by the block group and tract measures (or their equivalents), as well as inconsistent results for ZIP Code data.[16,93–102] Together, these results suggest that the added effort to geocode to the tract and block group level is likely to offset the greater ease of obtaining potentially misleading ZIP Code data.

Further rendering use of census data at the ZIP Code level problematic is that these data will no longer be available, as of the Year 2000 census.[60,103–105] Instead, the U.S. Bureau of Census has created a new statistical entity built from census blocks: the 5-digit ZIP Code Tabulation Area (ZCTA).[103] This new entity was specifically designed to "overcome the difficulties in precisely defining the land area covered by each ZIP Code,"[103] at a given point in time and over time (since a ZIP Code's boundaries can change over time, plus ZIP Codes are also added and deleted in non-decennial years).[104] Of note, ZCTAs and ZIP Codes sharing the same 5-digit code may not necessarily cover the same area,[105] such that ZIP Codes obtained by self-report or from addresses in medical records cannot be assumed to correspond to census-defined ZCTAs.[60]

In conclusion, drawing on our a priori criteria pertaining to external validity, robustness, completeness, and user-friendliness, along with Rossi and Gilmartin's criteria for valid and useful social indicators—that they be: (*a*) conceptually-based; (*b*) constructed from valid, reliable, and accessible data using appropriate statistical techniques; (*c*) comparable over time and across population groups; and (*d*) readily understandable, with normative value relevant to timely policymaking,[106] we offer a tentative recommendation, reflecting not only our findings for this study but also our related analyses pertaining to mortality, cancer incidence, low birthweight, and childhood lead poisoning.[46,47] Specifically, drawing on additional analyses stratifying results by race/ethnicity and gender, our data suggest that efforts to monitor U.S. socioeconomic inequalities in health using ABSMs will be best served by those tract or block group measures that are (*a*) most attuned to capturing economic deprivation; (*b*) meaningful across regions and over time; and (*c*) easily understood, hence based on readily interpretable variables with a priori categorical cut-points.[107] One likely candidate meeting all of these criteria is the census tract measure "percent of persons below poverty."

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**Appendix 1. Relative index of inequality (RII) technical documentation**

The relative index of inequality (RII)[81–83] is a measure developed to address the concern that classifications producing smaller groups at the margins might produce larger incidence rate ratios, e.g., comparing the most deprived with the most affluent, than measures designed to yield more equal distributions (e.g., quintiles), solely because of finer discrimination of the extremes. The RII accordingly was designed to provide a single metric that can be meaningfully compared across diverse socioeconomic measures, regardless of the proportion of population included in any given socioeconomic stratum, assuming ordinality of the categories employed. For this study, we calculated an age-standardized RII by regressing the age-standardized incidence rate in each ABSM category on the total population that is more deprived in the socioeconomic hierarchy, using the following steps:

1) We calculated the age-standardized rate $IR_{st}$ in each stratum $j$ defined by ABSM;
2) We determined the approximate cumulative distribution function (cdf) of the categorical ABSM over the entire population;
3) We multiplied the age-standardized rate $IR_{st}$ by the crude denominator ($pop_j$) in each stratum of the ABSM to obtain an expected number of cases; and
4) We fit the Poisson model:

$$cases_j \sim Poisson(\lambda_j)$$
$$\log(\lambda_j) = \log(pop_j) + \beta_0 + \beta_1 * cdf(ABSM_j)$$

Exponentiation of the $\beta_1$ yields the RII, which is interpretable as an incidence rate ratio comparing the rates in the bottom to the top of the hierarchy encompassed by the ABSM.

**Appendix 2. Cut-points for each variable in Tables 2a–2b were as follows**

| *Single variable* | | *L U* | *Area* | *Q1* *L U* | *Q2* *L U* | *Q3* *L U* | *Q4* *L U* | *Q5* *L U* |
|---|---|---|---|---|---|---|---|---|
| Working class (categorical; percent) | C1: | (0.0, 49.9) | | | | | | |
| | C2: | (50.0, 65.9) | | | | | | |
| | C3: | (66.0, 74.9) | | | | | | |
| | C4: | (75.0, 100.0) | | | | | | |
| Median household income (quintile; dollars) | | | MA BG | (4,999, 26,110) | (26,111, 33,749) | (33,750, 40,798) | (40,799, 49,903) | (49,904, 150,001) |
| | | | MA CT | (4,999, 26,471) | (26,472, 33,162) | (33,163, 39,286) | (39,287, 47,124) | (47,125, 102,797) |
| | | | MA ZC | (9,726, 30,624) | (30,625, 36,246) | (36,247, 41,396) | (41,397, 48,841) | (48,842, 94,898) |
| | | | RI BG | (4,999, 22,088) | (22,089, 30,293) | (30,294, 35,567) | (35,568, 41,204) | (41,205, 150,001) |
| | | | RI CT | (6,462, 23,667) | (23,668, 31,032) | (31,033, 35,300) | (35,301, 40,606) | (40,607, 78,666) |
| | | | RI ZC | (8,787, 29,548) | (29,549, 33,614) | (33,615, 36,921) | (36,922, 41,356) | (41,357, 60,705) |
| Poverty (categorical; percent) | C1: | (0.0, 4.9) | | | | | | |
| | C2: | (5.0, 9.9) | | | | | | |
| | C3: | (10.0, 19.9) | | | | | | |
| | C4: | (20.0, 100.0) | | | | | | |
| Gini (quintile) | | | MA BG | (0.009, 0.314) | (0.315, 0.350) | (0.351, 0.379) | (0.380, 0.421) | (0.422, 0.688) |
| | | | MA CT | (0.009, 0.348) | (0.349, 0.371) | (0.372, 0.395) | (0.396, 0.428) | (0.429, 0.650) |
| | | | MA ZC | (0.208, 0.344) | (0.345, 0.369) | (0.370, 0.387) | (0.388, 0.414) | (0.415, 0.614) |
| | | | RI BG | (0.014, 0.318) | (0.319, 0.351) | (0.352, 0.381) | (0.382, 0.422) | (0.423, 0.650) |
| | | | RI CT | (0.050, 0.349) | (0.350, 0.373) | (0.374, 0.395) | (0.396, 0.426) | (0.427, 0.595) |
| | | | RI ZC | (0.186, 0.352) | (0.353, 0.364) | (0.365, 0.394) | (0.395, 0.417) | (0.418, 0.551) |
| Wealth (categorical; percent) | C1: | (0.0, 4.9) | | | | | | |
| | C2: | (5.0, 9.9) | | | | | | |
| | C3: | (10.0, 19.9) | | | | | | |
| | C4: | (20.0, 100.0) | | | | | | |
| Crowding (categorical; percent) | C1: | (0.0, 4.9) | | | | | | |
| | C2: | (5.0, 9.9) | | | | | | |
| | C3: | (10.0, 19.9) | | | | | | |
| | C4: | (20.0, 100.0) | | | | | | |
| Low education (categorical; percent) | C1: | (0.0, 14.9) | | | | | | |
| | C2: | (15.0, 24.9) | | | | | | |
| | C3: | (25.0, 39.9) | | | | | | |
| | C4: | (40.0, 100.0) | | | | | | |

*continued on p. 260*

**Appendix 2 (continued). Cut-points for each variable in Tables 2a–2b were as follows**

| | | Q1 | Q2 | Q3 | Q4 | Q5 |
|---|---|---|---|---|---|---|
| *Composite variable* | *Area* | *L U* | *L U* | *L U* | *L U* | *L U* |
| Townsend index (quintile) | MA BG | (–5.531, –2.468) | (–2.467, –1.331) | (–1.330, 0.094) | (0.095, 2.425) | (2.426, 11.804) |
| | MA CT | (–8.123, –2.797) | (–2.796, –1.596) | (–1.595, –0.051) | (–0.050, 2.860) | (2.861, 11.223) |
| | MA ZC | (–7.864, –2.388) | (–2.387, –1.411) | (–1.410, –0.165) | (–0.164, 1.645) | (1.646, 13.626) |
| | RI BG | (–5.811, –2.410) | (–2.409, –1.250) | (–1.249, 0.162) | (0.163, 2.293) | (2.294, 9.832) |
| | RI CT | (–5.572, –2.595) | (–2.594, –1.502) | (–1.501, –0.078) | (–0.077, 2.793) | (2.794, 9.103) |
| | RI ZC | (–8.003, –1.905) | (–1.904, –0.929) | (–0.928, –0.246) | (–0.245, 2.301) | (2.302, 10.060) |
| Index of local economic resources (quintile) | MA BG | (0, 6) | (7, 11) | (12, 15) | (16, 20) | (21, 27) |
| | MA CT | (0, 5) | (6, 10) | (11, 15) | (16, 19) | (20, 26) |
| | MA ZC | (0, 8) | (9, 12) | (13, 15) | (16, 19) | (20, 26) |
| | RI BG | (0, 4) | (5, 8) | (9, 12) | (13, 17) | (18, 27) |
| | RI CT | (0, 4) | (5, 8) | (9, 12) | (13, 16) | (17, 26) |
| | RI ZC | (0, 8) | (9, 10) | (11, 13) | (14, 15) | (16, 27) |
| SEP index (quintile) | MA BG | (–16.524, –2.975) | (–2.974, –1.099) | (–1.098, 0.479) | (0.480, 2.701) | (2.702, 22.208) |
| | MA CT | (–13.768, –3.265) | (–3.264, –1.153) | (–1.152, 0.396) | (0.397, 3.006) | (3.007, 20.605) |
| | MA ZC | (–14.165, –3.122) | (–3.121, –0.956) | (–0.955, 0.794) | (0.795, 2.744) | (2.745, 18.943) |
| | RI BG | (–16.457, –3.001) | (–3.000, –1.282) | (–1.281, 0.630) | (0.631, 2.966) | (2.967, 17.356) |
| | RI CT | (–15.883, –3.452) | (–3.451, –1.684) | (–1.683, 0.388) | (0.389, 3.767) | (3.768, 12.140) |
| | RI ZC | (–8.976, –3.221) | (–3.220, –1.079) | (–1.078, 0.411) | (0.412, 2.834) | (2.835, 13.497) |

| | | *Percent below poverty* | *Percent working class* | *Percent expensive homes* |
|---|---|---|---|---|
| SEP1 (categorical) | C1: | >20 | >75 | any value |
| | C2: | >20 | 50–74 | <10 |
| | C3: | <20 | >75 | any value |
| | C4: | <20 | 50–74 | <10 |
| | C5: | {any value} | <50 | <10 |
| | C6: | {any value} | 50–74 | >10 |
| | C7: | {any value} | <50 | >10 |

NOTE: for percent poverty, C5–C7 is effectively ,20%; for percent expensive homes, C1 and C3 are effectively ,10%

C = category
Q = quintile
L = lower bound
U = upper bound
MA = Massachusetts
RI = Rhode Island
BG = block group
CT = census tract
ZC = ZIP Code