Census-based socioeconomic indicators for monitoring injury causes in the USA: a review

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ABSTRACT

Background Unlike the UK or New Zealand, there is no standard set of census variables in the USA for characterising socioeconomic (SES, socioeconomic status) inequalities in health outcomes, including injury. We systematically reviewed existing US studies to identify conceptual and methodological strengths and limitations of current approaches to determine those most suitable for research and surveillance.

Methods We searched seven electronic databases to identify census variables proposed in the peer-reviewed literature to monitor injury risk. Inclusion criteria were that numerator data were derived from hospital, trauma or vital statistics registries and that exposure variables included census SES constructs.

Results From 33 eligible studies, we identified 70 different census constructs for monitoring injury risk. Of these, fewer than half were replicated by other studies or against other causes, making the majority of studies non-comparable. When evaluated for a statistically significant relationship with a cause of injury, 74% of all constructs were predictive of injury risk when assessed in pairwise comparisons, whereas 98% of all constructs were significant when aggregated into composite indices. Fewer than 30% of studies selected SES constructs based on known associations with injury risk.

Conclusions There is heterogeneity in the conceptual and methodological approaches for using census data for monitoring injury risk as well as in the recommendations as to how these constructs can be used for injury prevention. We recommend four priority areas for research to facilitate a more unified approach towards use of the census for monitoring socioeconomic inequalities in injury risk.

INTRODUCTION

In the USA, the burden of injury is neither equally nor equitably distributed.1–7 In particular, it follows a social gradient, whereby risk increases with each decrease in socioeconomic position or status (SES).8 Those in the lowest SES classes are particularly at risk.9 Both Canadian and US studies have shown that 40–48% of the population-attributable risk of injury can be accounted for by socioeconomic inequalities.10 11

Apart from national surveys,12 13 demonstrating either a relationship with or a gradient across SES classes using hospitalisation data is primarily accomplished using US census data. Through geocoding, patient address information from billing records can be linked to census-based geographical and socioeconomic records for their neighbourhood, zip code, and county of residence. This requirement is a compromise to account for the lack of individual or household SES data in the registries. Hospital registries, for example, contain little socioeconomic information other than categorical data on patient race/ethnicity and insurance status, both of which are tenuous if not substantiated with additional SES measures.14

There are four inherent advantages to using the census to ascertain disparities in injury risk. First, its data categories and geographies are commonly used in health policy and health promotion.15–17 Another is that the decennial questionnaire remains fairly consistent between cycles, which allows for consistency in measurement over time.18 Another is that census geographies capture information about place-based influences on health, something that individual-level data do not.19 Lastly, unlike national population health surveys, census-derived data can be readily produced and corroborated with hospitalisation records through geocoding.

Notwithstanding these advantages, a primary and methodological limitation is that unlike in the UK and New Zealand,20 21 there is no standard set of census variables in the USA for monitoring health outcomes. Instead, associations are drawn from several independent studies across the country. Although higher SES tends to predict lower injury risk, however measured, the pattern is not always consistent.19 23 Conceptual differences in how SES is defined may contribute to this problem. For example, that not all SES constructs are equally associated with health inequalities is a topic rarely broached in the injury literature.24

Just as monitoring the quality of trauma care requires evidence-based tools, monitoring socioeconomic inequalities in injury risk requires constructs that are theoretically justified and supported by evidence. However, it is unclear if the SES constructs currently in use meet either criterion. Exacerbating this issue is the lack of national reporting on SES and injury. As of yet, neither the National Center for Injury Prevention and Control nor the National Trauma Data Bank produce annual reports of injury statistics by SES, despite evidence that that social inequalities in health are increasing.25 26 The purpose of this review is to add to the knowledge base concerning the use of census SES data to quantify injury risk, particularly by identifying opportunities for greater consistency in how registry and census data are used for healthcare policy and injury prevention.

METHODS

Search strategy

Relevant articles were identified from seven electronic databases, including: BioMed Central, CINAHL, the Cochrane database, MEDLINE, PsychINFO, Sociological Abstracts and Web of

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Science. To increase the sensitivity of our review, we also hand-
searched the Journal of the American College of Surgeons, Injury
Prevention, and the Journal of Trauma and Acute Care Surgery
using the keywords ‘census’ and ‘socioeconomic’ to identify addi-
tional US studies measuring injury risk using socioeconomic vari-
ables derived from the census. Each database and journal was
searched between 1 October 2013 and 30 November 2013. Search
terms were developed to reflect the three research domains relevant to the study objectives: (1) injury, (2) socio-
economic conditions and (3) census-based measurement. From
the literature, we identified medical subject headings (MeSH) and
keywords associated with each domain of knowledge. The
following MeSH were used to identify articles within the injury
domain: wounds and injuries, accidents and trauma centers. MeSH terms and key words used to identify articles within the
socioeconomic conditions domain included: demography, educa-
tional status, population dynamics, urban population, occupa-
tions, social class, socioeconomic factors, socioeconomic,
privation, health status disparities, poverty, poverty areas, deprivation index, and health status indicators. The census-based
measurement domain was constructed using the keyword census. Search terms from each domain were then intersected.
The first search strategy was developed for the MEDLINE refer-
ence database, with subsequent searches of the remaining data-
bases derived using this taxonomy.

Article selection
We selected for full-text review all articles that were derived
using numerator data from US hospital discharge summaries,
trauma registries or vital statistics records. As per our criteria,
socioeconomic variables were to be derived using census vari-
ables. This resulted in the exclusion of studies that derived their
measure of SES from national or prospective surveys, or occupa-
tional health and safety databases. A second exclusion criterion
was that patient race/ethnicity or insurance status was not the
primary construct of SES. Lastly, we included only articles that
either reported a statistical association between injury and SES
(eg, β-coefficient) or reported rates across SES classes (eg, histo-
grams, ORs). Our rationale for first criteria was to identify
studies that most likely classified injury using standard inclusion
rules. Our rationale for the second criteria was based on the
predominant evidence that socioeconomic differences between
racial groups are largely responsible for observed patterns of
racial disparities in health status.27 Our rationale for the last
exclusion criteria was to enable a comparison of constructs that
have been applied in practice. We did not specify criteria in
which injury cases were excluded by severity, hospital length of
stay, age or injury type.

Article review
Eligible articles were identified through three screening phases.
First, all authors reviewed manuscript abstracts of retrieved pub-
llications, selecting for further review those articles that were
most likely derived through linking registry and census records.
Next, two authors (NB and AA) independently evaluated manu-
scripts selected for further review. One author (SAA) intervened
when consensus was not reached. Second, each manuscript selected for full-text review was evaluated for content. This
included documenting the census variables used, how it was
they were constructed, and whether statistical associations were
derived from composite (eg, principal component analysis) or
pairwise (eg, regression coefficient) comparisons. We also doc-
umented whether a social gradient was assessed, the theoretical
methods that were discussed, the rationale for the variable
classification, and recommendations for prevention. Lastly, articles
were classified and collated by cause of injury and SES. For all
studies, we counted each variable association in the event that a
study reported multiple comparisons with different injury
causes, age or race/ethnic groups.

RESULTS
The literature search resulted in 1392 articles that had the
potential to meet our search criteria. After removing duplicates,
1247 titles remained for screening. A review of titles and
abstracts led to the retrieval of 76 articles for further review. We
identified by consensus 33 articles for full evaluation. Of these,
29 articles were identified from our search criteria, 2 from
article references, and 2 from hand searching journal websites.
A flow chart of the manuscript review process is provided in
figure 1.

Table 1 lists the manuscript IDs and reference information for
all original studies that were reviewed. Table 2 summarises the
conceptual and methodological approaches and principal find-
ings comparing the SES constructs to injury risk.

In total, we identified 70 different SES constructs from the lit-

erature. As a method of organisation, we classified each con-
struct into one of eight domains. The Cultural domain contains
variables that were defined by a measure of language. The
Demographics domain contains variables that described the
household in terms of composition, mobility, age or abilities. The
Education domain contains variables that were used to
define primary, secondary or postgraduate education. The
Ethnicity domain contains variables that described an area’s
racial or ethnicity composition. The domain Housing contains

![Figure 1 Schematic representation of the manuscripts identified at different phases of the review.](http://injuryprevention.bmj.com/)

variables that described the dwelling category, as well as housing types and structures and household size. The Income domain contains variables that defined permanent wealth (eg, home value) as well as distributed or central tendency measures of annual income. The Occupation domain contains employment-related variables and rates. The Population domain contains constructs that defined an area’s population size or its administrative designation, such as urban or rural.

Overall, 82% of the constructs either produced a statistically significant relationship with an injury cause or demonstrated a social gradient across SES classes. Ranking the domains based on the number of instances where its constructs produced either of these effects places the Demographics domain first at 100% of attempts, followed by the Occupation (98%), Ethnicity (86%), Income (80%), Cultural (80%), Education (78%), Population (78%) and Housing (50%) domains. When stratified by a methodological approach, 74% of all pairwise comparisons demonstrated either a statistically significant association with an injury cause or produced a social gradient across SES classes. In contrast, 98% of all studies that aggregated census constructs into a composite index produced this effect.

We identified nine different constructs used to capture the extent of deprivation in terms of secondary or post-secondary education and training in a local area. Of these, six constructs were specific to high school educational attainment. Overall, each education construct was attributed to an increased risk of injury with the exception of when an area’s proportion of lone parent families was identified under the Demographics domain. Each construct addresses a component of deprivation, such as the proportion of households with more than one person per room. All constructs were statistically significantly associated with rates of injury in at least one study. The least representative measure of SES was the proportion of an area’s Hispanic population.

Five different ethnicity-focused SES constructs were identified in the articles. The predominant construct was the percentage of black population per census area and the percentage of non-white population. All constructs were statistically significantly associated with rates of injury in at least one study. The least representative measure of SES was the proportion of an area’s Hispanic population.

We classified 12 different constructs into the Housing domain. Each construct addresses a component of deprivation pertaining to the living environment. Of these, four different measures were identified that addressed household overcrowding, such as the proportion of households with more than one person per room. The remaining constructs were either specific to housing structure or zoning/rental status. When evaluated, only 3 of the 14 pairwise (21%) evaluations of household overcrowding were associated with either injury risk or a social gradient in injury risk.

A total of 20 different constructs were used to measure the relationship between income and injury. The majority of
constructs reflected either measures of central tendency (eg, median income) or distributed income (eg, below poverty). In total, median/mean income was constructed in eight different ways.11 28 30–32 34 35 37 38 40 42 45–53 Distinctive measures of income were represented in seven different ways, such as concentrated poverty,36 ratios of income distribution,32 44 or using various percentages of populations or population groups below the poverty line.11 28 32 34 37 40–42 52 54 55 Other frequently used constructs were measures of permanent income or wealth, such as car ownership or housing value.11 42 When compared with rates of injury, distinctive measures of income were significant in 22 of 26 comparisons, whereas measures of central tendency were significant indicators of injury risk in 23 of all 37 tests. We classified six different SES constructs into the Occupation domain. Of these, four were various measures of an area’s unemployment rate, such as the percentage of unemployed males, the overall unemployment rate, or the proportion of mothers not employed.11 29 32 35 42 47 56 Other constructs included the proportion of white collar occupations, the proportion of working class occupations, and the Duncan SES index.11 42 57 With the exception of the Duncan SES index, which is a measure of occupational prestige, all constructs were significant indicators of injury risk. Both the Cultural and Population domains contained constructs that were evaluated less frequently than constructs included in the other six domains, though each domain contained indicators that were statistically significantly associated with injury risk overall. Online supplementary appendix 1 tables A1–A8 summarise the frequency of statistically significant associations observed when each SES construct was assessed singularly or as a composite indicator for each cause of injury. Overall, the proportion of publications producing a reference or justification for the SES variables included in their approach was low. For example, a reference or supporting claim as to why the SES variable was chosen was missing in nearly half (42%) of all studies. Less than half of the studies (45%) we reviewed provided a complete description on how the variables were constructed, such as listing the census category where the variable originated, or how its numerator and denominator proportions were calculated.

DISCUSSION
In our review of literature, we identified 70 different census constructs that have previously been used to characterise socio-economic determinants of injury risk. Of these, fewer than half were replicated by other studies or against other causes, making the majority of studies non-comparable. Variation in measurement occurs as a result of defining similar constructs differently. It is also attributed to inconsistency in how researchers conceptualise the purpose of SES for injury prevention. For example, should emphasis be placed on changing behaviour by targeting the most vulnerable,29 31 32 38–40 45 50 51 54 55 58–60 mitigating the effects of social inequalities,10 36 46 47 53 56 or both?42 37 43 44 48 Over the past two decades, there has been significant discussion over the use of the census for monitoring social determinants in health.61–63 Previous reviews from the injury literature have similarly discussed some of the inherent weaknesses in how SES is conceptualised.64 Building on these discussions, we recommend four priority areas in efforts to facilitate a more unified approach towards the use of registry and census data for injury prevention and control. First, there is a need for greater conceptual and methodological agreement for selecting census constructs to characterise injury risk. Not all SES constructs are equally attributable to injury risk. We found that the likelihood of injury was more strongly associated with measures of relative poverty when measured in conjunction with the level of education,11 32 40 but not when measured using median income.32 40 Employment-related variables were more indicative of unintentional rather than intentional injury.42 Permanent income or wealth-related constructs produce narrower IRRs than measures of average or relative income,42 which run in contrast to previous evidence.65

Nor are all indicators of SES specifically relevant to injury risk. For example, household overcrowding and mean household income were inconsistent measures of injury risk compared to other constructs within their domains. In contrast, factors including the unemployment rate, the proportion of female lone parent families, and the percentage of the population below the poverty line were consistently more indicative of injury risk for all injury causes. It is worth emphasising that the income constructs were less consistent indicators of injury risk, on average, than demographic and occupational constructs.

One recommendation proposed by Krieger et al66 and subsequently either directly55 or indirectly50 44 52 supported by trauma researchers is to monitor health inequalities using a single indicator: the percentage of persons below the federally defined poverty line. Poverty measures are one of the strongest measures of health inequities as they take into account the number of adults and children dependent on family income. Similarly, poverty is strongly correlated with a host of other factors, including lack of amenities, poor education, unsafe working conditions, unemployment, neighbourhood crime, and its consequential effect on family life. The studies we reviewed support this position as distinctive measures of income were more consistently related to injury risk than measures of central tendency.

An important distinction in Krieger et al’s66 recommendation is that area poverty rates should be expressed in percentages to emphasise the proportion of population within its bounds as opposed to being used as a dichotomous marker. The distinction is that the latter method emphasises those populations that fall into the ‘tailings’ of a distribution, while the former emphasises the incremental impact of inequities across all populations. If in fact there were a threshold in relationship between income and income (which no study found), it would still require looking further along the gradient to determine when its effect weakens.

However, our review suggests that no single census construct exists that reflects the complexities of social inequalities in injury risk. Rather, social advantages and disadvantages are attributable to multiple, interrelated causes, including income distribution, occupation type and working conditions, racial tensions, family demographics, and accessibility to educational opportunities, among others. The fact that composite indicators of SES were statistically significantly related to injury in 98% of all analyses supports the premise that the most consistent markers of injury risk appear when constructs are combined. While there is value in selecting a single indicator to represent social inequities in health, particularly for policy-related directives, there is also value in understanding the combined effect of its determinants. In this vein, we recommend testing the utility of the Health Disparities Calculator to facilitate comparisons of multiple determinants of injury, as well as support comparisons with other health outcomes using a common metric.66

Second, greater emphasis needs to be placed on measuring the interactions between race/ethnicity and insurance status with SES. A prevailing trend in the trauma literature is the use of patient race as an indicator of SES.67–70 This practice is multifaceted, as race is a mandated data field for federal statistical
The importance of social determinants of injury inequalities is well established.

There is increasing emphasis to use census socioeconomic data to direct injury prevention towards the most vulnerable as well as advocate for inequalities in access to resources known to be determinants of health.

However, there is no standard set of census variables to monitor inequalities in injury risk nor is there a common conceptual or methodological framework to structure evaluations.
What this study adds

- This study synthesises the census variables thus far used to measure socioeconomic determinants of injury risk through classifying each construct into specific domains, thus identifying where there is variability in measurement as a result of defining similar constructs differently.
- This study summarises which census constructs have thus far proven to be significant indicators of injury risk as well as those that remain inconsistent or non-significant indicators, thereby suggesting which measures may have the most impact on addressing injury inequalities.
- Evidence of a social gradient in injury risk is evident across all causes of injury, yet the majority of studies focus on the relationship between low social class and injury; nor is there a common conceptual or methodological approach in how these variables should be used for prevention, suggesting the need for a more organised approach for using the census for injury prevention.

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REFERENCES

Systematic review


Firearm-related hospitalisations

A retrospective study at the University of Washington compared the risk for subsequent violent injury, death, or crime among patients with a firearm hospitalisation, hospitalisations for non-injury reasons, and the general population. The results show that hospitalisation for a firearm-related injury is associated with a much greater risk for subsequent violent victimisation or crime. More research is needed at the intersection of clinical care, the criminal justice system and public health. Comment: Too often we overlook the role of the justice system - noted by IBP.

Action on fake motorcycle helmets

Previously we reported on the growing number of cheap novelty helmet imports linked to motorcycle crash deaths. The risk of serious head injury from the novelty helmets is almost triple. To reduce the number of such helmets and make it easier for state law enforcement officials to identify them, it is proposed that distributors must comply with existing standards and limit their ability to ‘insulate themselves from legal liability’. Comment: Too often the law seems to favour large companies - noted by IBP.