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ORIGINAL ARTICLE

# The impact of neighborhood socioeconomic disparities on injury

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## Abstract

**Objectives** To examine the relationship between neighborhood socioeconomic level (NSEL) and injury-related hospitalization.

**Methods** The National Trauma Registry (INTR) and the National Population Census (NPC), including NSEL, were linked by individual identity number. Age-adjusted logistic regression predicted injury hospitalization. Mantel–Haenszel $X^2$ was used for linear trends. NSEL was divided into 20 clusters.

**Results** The population comprised 7,412,592 residents, of which 125,829 (1.7%) were hospitalized due to injury. The injury hospitalization rate was at least 42 per 10,000 per year. Except for the very low SEL, an inverse relationship between NSEL and all-cause injury was found: 46.1/10,000 in cluster 3 compared to 22.9/10,000 in cluster 20. Hip fracture-related hospitalizations among ages 65 + decreased as SEL increased (2.19% o in cluster 2 compared to 0.95% in cluster 19). In comparison with Jews, non-Jews were 1.5 times more likely to have an injury-related hospitalization [OR 1.5 (95% CI 1.50–1.55)].

**Conclusions** The INTR and the NPC were successfully linked providing individual and injury hospitalization data. The outcomes confirm the strong relationship between injury mechanism and NSEL.

**Keywords** Socioeconomic position · Injury · Trauma registry · Neighborhood statistical area · National population census

## Introduction

Injury, especially severe and critical injuries, hinders quality of life and places a burden on the individual, the family, the community and the national health system. Thus, injury prevention should be an important goal for public health policy makers. In Israel, while the relationship between health and socioeconomic level has been studied, research exploring the relationship between socioeconomic position (SEP) and injury is scarce.

The organization for economic co-operation and development (OECD) reported that in almost all OECD countries a socioeconomic gradient in health status exists (de Looper and Lafortune 2009). The circumstances in which people live and work are more detrimental in socioeconomic disadvantaged areas, contributing to poorer health outcomes and an accompanying increase in morbidity and mortality. Persons of lower SEP tend to have a higher prevalence of disease and have higher mortality rates. Socioeconomic inequalities in health have been reported among different groups both within and between countries (de Looper and Lafortune 2009). Bell claims that poverty is

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one of the strongest measures of health inequalities (Bell et al. 2015). Fighting health inequalities is a global issue, declared by the WHO member states' at the 2011 Rio Declaration (WHO 2011).

Similar to overall health measures, an inverse relationship between injury rates and SEP is often observed, that is, as SEP increases the risk of all-cause injury decreases (WHO 2012). On the global level, injury deaths rates in low-income countries are approximately 1.5 times greater than in high-income countries (WHO 2014). Lawson and colleagues studied all-cause severe injury and social material deprivation, on the neighborhood level, in Canada. They found an inverse relationship between neighborhood socioeconomic status (NSES) and injury risk. The rate of severe injury among adults (ages 20 +) was almost four times greater in the most deprived neighborhoods compared with least deprived neighborhoods (Lawson et al. 2015). Sociocultural milieu of a neighborhood, material deprivation and income, play important roles in the risk of injury.

In addition to all-cause injury rates, the relationship between socioeconomic disparities and specific mechanisms of injury has been studied. An area-based study in Montreal reported that children living in the poorest neighborhoods had a four times higher risk for road traffic injuries compared to children in the least poor neighborhoods (Dougherty et al. 1990). In contrast, another Canadian study showed that adolescents from high-income families were at greatest risk for recreation-related injuries in comparison with middle- and low-income families (Potter et al. 2005). Other studies have also shown varying relationships between specific injury cause and SEP (Hasselberg and Laflamme 2008; Roberts et al. 1995; Marcin et al. 2003). The risk of pedestrian injuries has been reported to be greater among children living in the lower-SEP communities (Roberts et al. 1995; Marcin 2003). Cubin examined both individual and neighborhood correlates of injury mortality and concluded that both individual and neighborhood characteristics contribute independently to the risk of injury death (Cubbin et al. 2000).

In Israel, studies have found a relationship between SEP and health, with regard to availability of health services, disease and mortality. Shmueli reported significant income-related inequalities in health and in the use of health services (Shmueli 2014). According to a self-assessment reported by Averbach and colleagues, 27% of persons with low income reported poor health, compared to 22% among those with middle income and 11% among high-income individuals. Morbidity and mortality were found to be associated with not only the socioeconomic gradient, but also with area cultural and religious components. (Averbach et al. 2010).

While extensive data describing the relationship between socioeconomic position and mortality have been published, few researchers have focused on the relationship between NSES and injury. Jaffe and colleagues compared injury hospitalization rates among children in three cities characterized by low, medium and high socioeconomic levels. They concluded that strong social capital of a specific community is associated with reduced pediatric injury risks regardless of the socioeconomic status of the community (Jaffe et al. 2011).

Magid compared traffic-related injuries and mortality between the Arab minority and the Jewish majority. Arabs were found to be at increased risk of traffic-related injury and mortality (Magid et al. 2015). In general, the SES of Arab communities is lower than that of the majority of Jewish communities (Central Bureau of Statistics 2013b).

Methods for measuring SEP vary, including income, occupation, education, accommodation type, housing density or combination of all mentioned above (Adler and Newman, 2002). Others may use census data, self-reporting questionnaires, regional data or various data which may be inadequately defined (Cubbin and Smith 2002) After reviewing studies based on census SES data to quantify injury risk, Bell concluded that using census data is advantageous to ascertain disparities in injury risk and is often used for determining health care policies (Bell 2015).

The purpose of this study was to examine the relationship between NSES and injury hospitalization rates in Israel including injury severity, mechanism of injury and demographic characteristics. The current study used data from the National Population Census 2008 to categorize the Israeli population into socioeconomic clusters and to determine the relationship between the socioeconomic level of the neighborhood and injury risk. The strobe statement has been followed in reporting the design and results of this study (Vandenbrouke et al. 2014).

## Methods

This observational study is based on linking two national databases: The Israel National Trauma Registry (INTR) 2008–2011 and The Israel National Population Census (NPC) 2008, including the socio-economic Index (SEI).

### Data sources

The INTR provides comprehensive data on hospitalized trauma patients from all Level I trauma centers and the majority of Level II trauma centers. The INTR includes data from all six Level I trauma centers and 13 Level II trauma centers. All hospitalized trauma patients classified with an ICD-9-CM diagnosis code 800–989.9 who were admitted to the Department of Emergency Medicine (ER) and hospitalized, died in the ER or were transferred to or from another hospital are included in the database. The registry does not include poisoning, drowning and choking; casualties who died at the scene of the event or on the way to hospital; and admissions 72 or more hours following the event. It should be noted that the data are recorded by trained trauma registrars at each trauma center under the supervision of a trauma director and trauma coordinator. Electronic files are transferred to the INTR where quality assurance is carried out prior to data analysis. Unclear or erroneous data are referred back to the trauma centers for clarification or completion. The data in the INTR are anonymous. Injury data for the years 2008–2011 were used for this study. The INTR database is not publically available; however, published reports can be accessed from the website (www.gertnerinst.org.il/e/) and specific requests can be prepared. The Central Bureau of Statistics conducted Israel's NPC in December 2008. The census was based on a systematic sample of households living in Israel. The census database includes data on 1,067,174 citizens and residents (living at least 1 year in Israel) which is 20% of the population. The census provides demographic, social and economic information, updated to the census day. Each entry of a person has a weighting coefficient (weight) assigned to it, which indicates the number of persons the entry represents in the general population (Central Bureau of Statistics 2013b).

The socioeconomic level was acquired from the SEI. The socioeconomic level of the population is measured by a combination of the following characteristics: demography, education, employment and benefits, standard of living (financial income, motorization level, housing characteristics). The calculation of the socio-economic index value for each geographical unit was based on 16 variables selected from these fields by a number of criteria. After the index values were calculated, the geographical units were allocated to 20 clusters (homogeneous groups with respect to the index values), in which cluster 1 signifies the lowest socioeconomic level and 20 the highest socioeconomic level.

Urban localities with 10,000 residents or more are divided into statistical areas, which generally number 2000–5000 residents. In order to derive the socio-economic index, statistical areas numbering less than 2000 residents were combined with adjacent statistical areas, which were as similar as possible in their socioeconomic profile. The analysis was performed for 1616 statistical areas (some of them single, some of them combined), including localities which are not divided into statistical areas (i.e., consisting of a single statistical area). The statistical areas were allocated to 20 homogeneous clusters according to their socio-economic index values. The statistical areas in cluster 20 (the highest socioeconomic level) are characterized by a high level of average income per standard person (the mean value is more than 12 times greater than the mean value in cluster 1), by a high median age (a mean value of 43 compared to a mean value of 12.5 in cluster 1), by a low dependency ratio (a mean value of 72 compared to a mean value of 230 in cluster 1), and by a high average number of vehicles at household disposal (the mean value is more than 7 times greater than the mean value in cluster 1). In order to build the 20 categories, factor analysis was performed followed by cluster analysis, which was based on the outcomes from the factor analysis. (For further details, see Central Bureau of Statistics publication 1530).

Estimates of the dispersion of the index values within the locality were calculated for 117 municipalities and local councils, divided into statistical areas. The index value ranges from − 2.952 for the lowest NSA in clusters 1 to 3.145 for the highest NSA in cluster 2 (Table 1).

It should be noted the SEI of statistical area differs from the SEI of local authorities. The SEI of local authorities is categorized into 10 clusters, in which an entire city or community receives the same SEL. For example, the city of Tel Aviv is comprised of both disadvantaged and wealthy neighborhoods and is made up of 117 statistical areas ranging from cluster 4 to cluster 20. However, the SEI for local authorities categorizes Tel Aviv in cluster 8 (Central Bureau of Statistics 2013a, b).

## Data linkage

Israel has a national population register in which every resident is provided with a unique identity number. The INTR was matched with the NPC, by identity number, in which every trauma patient reported in the INTR between January 1, 2008, and December 31, 2011, was cross-checked with the NPC database. Fourteen percent of the INTR was matched with the NPC, which perfectly matched the final sample size of the census. The matched data underwent a variety of quality assurance checks to ensure quality and completeness of the data. Only 11 cases were removed due to unsuitability, in which there were age and gender differences for the matched data. The linkage of the two databases was performed by the Israel Central Bureau of Statistics. The final data for analysis were anonymous. The data presented in this study are weighted according to the NPC and represent the population of Israel and hospitalized trauma patients during the four-year period.

## Variables

E-codes were used to categorize mechanism of injuries which divided into five groupings: falls, transportation, intentional (violence), burns and other unintentional injuries (struck from object/people, cutting/piercing and others). Transportation injuries were further categorized as

**Table 1** Variability of socio-economic index values of statistical areas within cluster, population size and hospitalization rate by cluster, Israel 2008

| Socioeconomic cluster | Number of statistical areas | Maximum index value | Minimum index value | Range | Mean | SD | Total population n | Children (0–14) % | Elderly (65 +) % | Injury hospitalization rate/10,000* |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1616 | | | | | | 6,537,695 | 1,816,204 | 671,808 | 42.4 |
| 1 | 4 | − 2.399 | − 2.952 | 0.553 | − 2.611 | 0.248 | 20,306 | 59.8 | 1.1 | 31.6 |
| 2 | 30 | − 1.828 | − 2.240 | 0.413 | − 1.960 | 0.107 | 219,164 | 47.7 | 2.5 | 34.0 |
| 3 | 47 | − 1.578 | − 1.795 | 0.217 | − 1.669 | 0.067 | 254,289 | 46.3 | 2.9 | 46.1 |
| 4 | 126 | − 1.225 | − 1.572 | 0.347 | − 1.388 | 0.104 | 649,798 | 40.2 | 4.1 | 53.4 |
| 5 | 87 | − 1.002 | − 1.216 | 0.214 | − 1.112 | 0.060 | 366,570 | 36.9 | 5.2 | 54.4 |
| 6 | 94 | − 0.777 | − 0.993 | 0.216 | − 0.871 | 0.062 | 374,568 | 29.4 | 10.0 | 52.6 |
| 7 | 114 | − 0.543 | − 0.770 | 0.227 | − 0.649 | 0.068 | 432,705 | 25.2 | 11.6 | 52.6 |
| 8 | 67 | − 0.403 | − 0.533 | 0.130 | − 0.457 | 0.038 | 249,580 | 21.9 | 13.1 | 50.4 |
| 9 | 118 | − 0.216 | − 0.396 | 0.180 | − 0.296 | 0.052 | 426,856 | 22.2 | 13.2 | 46.8 |
| **10** | 155 | 0.021 | − 0.211 | 0.232 | − 0.091 | 0.070 | 605,047 | 22.7 | 12.3 | 44.2 |
| **11** | 168 | 0.284 | 0.026 | 0.258 | 0.147 | 0.075 | 644,502 | 22.1 | 12.3 | 40.8 |
| **12** | 149 | 0.585 | 0.293 | 0.291 | 0.433 | 0.080 | 578,101 | 21.8 | 11.8 | 41.5 |
| **13** | 123 | 0.847 | 0.593 | 0.254 | 0.716 | 0.074 | 465,985 | 23.3 | 11.3 | 38.2 |
| **14** | 97 | 1.116 | 0.855 | 0.261 | 0.978 | 0.078 | 386,969 | 23.4 | 10.7 | 29.7 |
| **15** | 70 | 1.336 | 1.125 | 0.211 | 1.234 | 0.058 | 258,016 | 22.7 | 11.1 | 30.5 |
| **16** | 53 | 1.555 | 1.360 | 0.195 | 1.440 | 0.056 | 194,463 | 24.1 | 11.5 | 31.1 |
| **17** | 60 | 1.860 | 1.570 | 0.290 | 1.704 | 0.081 | 226,309 | 21.3 | 12.9 | 27.9 |
| **18** | 25 | 2.045 | 1.878 | 0.167 | 1.968 | 0.053 | 82,710 | 21.4 | 13.2 | 27.4 |
| **19** | 24 | 2.512 | 2.083 | 0.429 | 2.266 | 0.134 | 84,929 | 21.2 | 18.0 | 26.7 |
| **20** | 5 | 3.145 | 2.594 | 0.551 | 2.800 | 0.229 | 16,828 | 19.8 | 14.2 | 22.9 |

*Annual injury-related hospitalization rates for 2008–2011 were calculated by population size in each cluster and divided by 4 years

pedestrian, bicycle, motorcycle, vehicle drivers, vehicle passengers and other. Demographic characteristics included gender, age and race (Jew and non-Jew) and religion (Jew, Muslim, Christian, Druze, other). Children were defined as ages 0–14 and elderly from age 65 and above. The injury severity score (ISS) was used to assess severity and classified as: ISS 1–8, minor; ISS 9–14, moderate; ISS 16–24 severe; and ISS 25–75, critical (Champion et al. 1995; Rozenfeld et al. 2014).

## Bias

Although all six Level I trauma centers are included in the INTR, only 13 of the 20 of regional Level II trauma centers are included, thus allowing for a potential bias. Any potential bias has been controlled for since: (1) most severe and critical casualties are admitted to Level I trauma centers and (2) the centers not included in the registry are dispersed throughout the country and serve all population groups and all socioeconomic clusters. Thus, the trauma registry represents all populations.

## Study size

The study was based on a representative sample (20%) of the Israeli population, including 1,067,174 citizens and residents (living at least 1 year in Israel). Among the study sample, a total of 18, 275 casualties were hospitalized.

## Statistical analysis

Quantitative data analyses were performed using SAS-PC software version 9.1 A value of $P < 0.05$ was considered to be statistically significant. Mantel–Haenszel Chi-square test was used for linearity trends. Age-adjusted logistic regression was performed to predict hospitalization due to trauma by SEL. Annual injury-related hospitalization rates were calculated by population size in each cluster (Table 1) and divided by four years. Logistic regression models, controlling for age and socioeconomic level, were used to calculate odds ratio (OR) and 95% confidence intervals (CI).

Weighted statistical analyses were performed.

## Results

The weighted census population included 7,412,592 residents living in Israel in 2008, of which 51% are females, 28.3% are children under age 15 and 9.6% are elderly ages 65 + . The non-Jewish minority comprises 24.6% of the population. Following data linkage, 125,829 (1.7%) of the population were hospitalized due to an injury between 2008 and 2011 Among the hospitalized trauma casualties, 39% were female, 26.7% children under age 15, 23.5% over age 64 and 31.8% were non-Jews. During the study period, the injury hospitalization rate in Israel was at least 42 per 10,000 residents per year.

### Population group

The Jewish majority comprises 75.6% of the population, followed by 16.9% Muslims, 2.0% Christians and 1.7% Druze (data for 2008, Central Bureau of Statistics 2014). It was found that the overall injury hospitalization rate for the Jewish population was lower than for non-Jews. A logistic regression model, controlling for age and SEL, showed that non-Jews had at least a 1.5 greater chance of being hospitalized due to an injury compared to Jews (OR 1.5 (95% CI 1.50–1.55), concordant index c = 0.64). In other words, for Jews and non-Jews living in the same socioeconomic cluster, there was a greater chance for non-Jews to be hospitalized due to injury. It should be noted that while Jews reside in all 20 socioeconomic clusters, the majority of non-Jews reside in clusters 1–12. In addition, the Jewish population living in clusters one and two are primarily ultra-religious Jews.

### Socioeconomic level

Except for the very low SEL, (clusters one and two), an inverse relationship was observed between SEL and all-cause injury, that is, as SEL increased injury-related hospitalization rates decreased (Table 1). Similarly, Fig. 1 illustrates the age-adjusted OR for the risk of injury-related hospitalization for each cluster. Persons residing in clusters three to eight had a 2.3 to 2.7 greater odds of injury hospitalization than persons residing in clusters 19 and 20 (OR 2.7 95% CI 2.3–3.2). Figure 1 clearly depicts the contrasting trend; as SEL decreases, the odds of hospitalization increases. It is important to note that the rate of injury hospitalization for persons living in the very low SEL (clusters one and two) was lower than for persons living in clusters three through 12. The discussion will provide possible explanations for this phenomenon. While the trend for all injury-related hospitalizations was well illustrated, unique differences were found for specific injury characteristics and population groups.

### Injury severity

Over a twofold risk of injury-related hospitalizations was found for patients hospitalized with minor injuries (ISS 1–8) living in clusters 3–5 (1.38–1.57%) compared to persons living in clusters 14–20 (0.6–0.78%). Expectantly, injury hospitalization rates for casualties with minor injuries living in very low-SEL neighborhoods (clusters 1–3) were relatively low (0.87, 0.83, 1.38%, respectively, for clusters 1, 2 and 3).

For casualties with severe and critical injuries (ISS 16 +), an inverse trend was also present, with the peak hospitalization rate among severe and critical casualties living in clusters 4–8 (0.17–0.19%) (Figure 2).

### Injury mechanism

Hospitalization rates for injury mechanism (falls, traffic and intentional injuries) by SEL are illustrated in Fig. 3.

Fall-related hospitalization rates were highest for persons living in neighborhoods comprised of clusters 3–13 (0.79–1.12%). It should be noted that for clusters greater than ten, hospitalization rates decreased as SEL increased.

Similarly, the trend for all traffic injuries indicated an inverse effect, as SEL increased traffic-related hospitalization rates decreased (from 0.56% in cluster 4–0.25% in cluster 20). However, the trend varied for specific types of road users (Fig. 4).

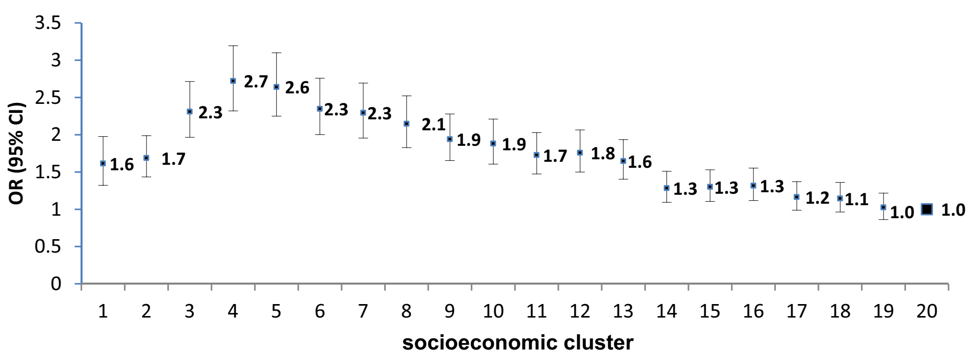


**Fig. 1** Age-adjusted risk of injury-related hospitalization, by socioeconomic cluster, Israel 2008–2011. (1) Cluster 20 is the reference group

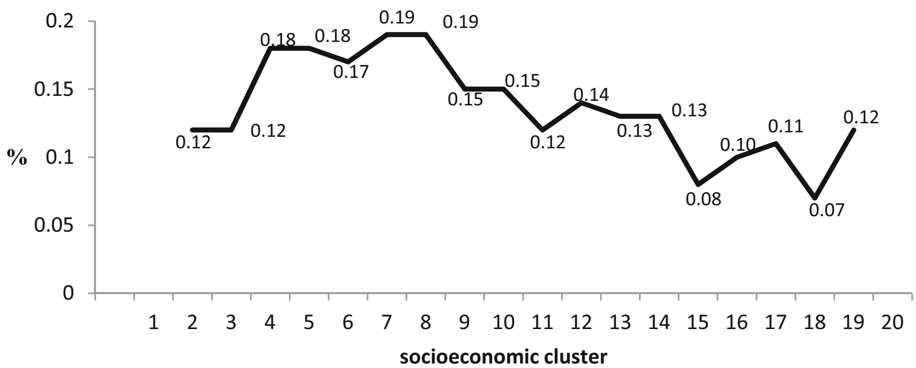


**Fig. 2** Severe and critical casualties (ISS 16 +) by socioeconomic cluster, Israel 2008–2011. (1) There are fewer than five hospitalizations in cluster 1 (0.17%) and cluster 20 (0.10%), (2) Cluster 1 is based on 4 statistical areas and cluster 20 is based on 5 statistical areas, (3) Mantel-Haenszel Chi-Square < 0.0001, (4) *ISS* injury severity score

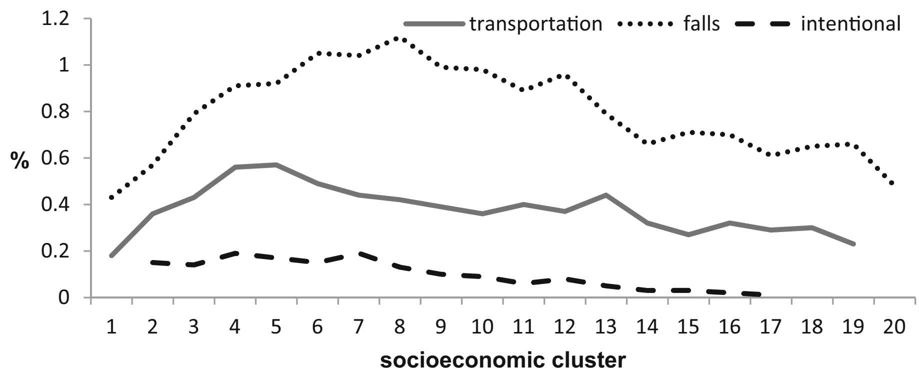


**Fig. 3** Injury mechanism by socioeconomic cluster, Israel 2008–2011. (1) For transportation injuries: there are fewer than five hospitalizations in cluster 20 (0.25%); For intentional injuries: there are fewer than five hospitalizations in cluster 1 (0.17%), 18 (0.02%), 19 (0.02%), 20(0), (2) Cluster 1 is based on 4 statistical areas and cluster 20 is based on 5 statistical areas, (3) For each mechanism of injury Mantel-Haenszel Chi-Square < 0.0001

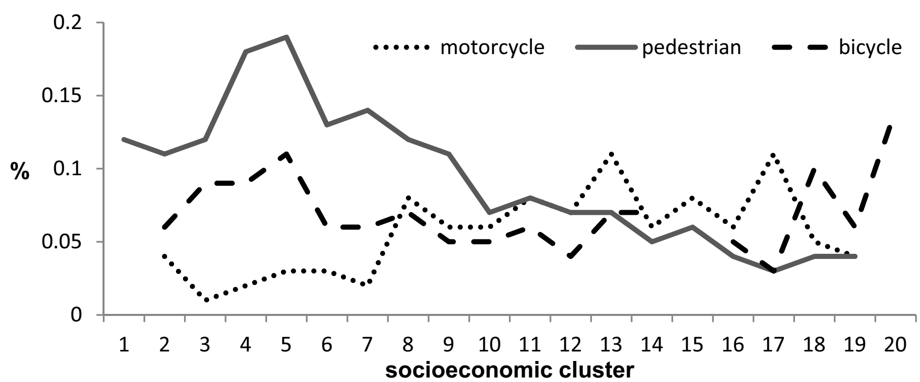


**Fig. 4** Road user type by socioeconomic cluster, Israel 2008–2011. (1) For motorcycle injuries: there were no hospitalizations in clusters 1 and 20; For pedestrian injuries: there were no hospitalizations in cluster 20, and for bicycle injuries: there are fewer than 5 hospitalizations in clusters 1 (0.01%), 15 (0), 20 (0.14%), (2) Cluster 1 is based on 4 statistical areas and cluster 20 is based on 5 statistical areas, (3) For each mechanism of injury Mantel-Haenszel Chi-Square < 0.0001

Pedestrian injuries were up to six times greater for persons living in clusters 1–8 (0.12–0.19%) compared to clusters 14–19 (0.03–0.06%). The hospitalization rate for pedestrians was even more pronounced for children (ages 0–14) living in clusters 1–8 (0.15–0.31%) compared to children living in clusters 10–17 (0.02–0.1%). In comparison with elderly living in high-SEL neighborhoods, elderly living in clusters two through nine (0.15–0.48%) had up to a sixfold chance of a pedestrian-related hospitalization compared to elderly in clusters 10–18 (0.08–0.16%). Clusters 7, 12 and 13 did not follow the trend (data not presented).

Hospitalization rates for motorcycle casualties were most prevalent for persons living in clusters 8–17

(0.6–0.11%). While no specific trend for bicycle injuries was found, both in low- and high-SEL neighborhoods bicycle-related hospitalization rates were high.

High rates of hospitalization due to intentional injuries (violence) were found among persons living in clusters one through eight (0.13–0.19%), and as SEL increased, the hospitalization rate decreased. For clusters 13–19, the violence-related injury rate ranged from 0.02 to 0.05%.

### Age

A high incidence of home injuries among children aged 0–14 was found, especially among those living in low-SEL areas. It should be noted that cluster one is comprised of a young population; 60% of the population is under age 15 (Table 1). A fourfold greater risk of hospitalizations due to injuries in and around the home was found for children living in clusters one through six (0.8–0.89% excluding cluster two), in comparison with children living in wealthier areas, clusters 14–19 (0.16–0.29%).

### Elderly ages 65 +, hip fractures

Elderly in every SEL were hospitalized with a diagnosis of hip fracture, yet those living in very low to middle SEL had an increased risk. The hospitalization rate due to a hip fracture for elderly living in cluster two was 2.19%, which decreased to 0.55% for elderly living in cluster 20. (Only 1% of the population living in cluster one is older than 64 (Table 1 and Fig. 5.)

## Discussion

Reducing inequality is the basis of public health for both policy and action. Thus, it is of utmost importance that the health system in Israel invests in identifying the gaps and accordingly, and reduces health inequalities, in general, and specifically those that play a role in injury.

The outcomes from this study provide an in-depth analysis of neighborhood socioeconomic position and injury, specific to age group, population group, injury severity and mechanism of injury. This study is unique given that it focuses on the socioeconomic differences of hospitalized casualties based on the statistical area of the neighborhood, rather than targeting a city or community, as a whole. As opposed to the SEI for local authorities, the SEI for statistical areas used in this study allows for differentiating between neighborhoods within a city. Thus, the methods and outcomes of the current study enable a much more precise and detailed relationship between individual socioeconomic position and injury.

The findings of this study present a strong socioeconomic gradient associated with all-cause injury hospitalization. However, in contrast to many publications, (WHO 2012; MacKay et al. 1999; Kim et al. 2007), the outcomes of this study indicate low overall injury hospitalization rates among the very poor (clusters one and two). One possible explanation for low overall injury rates in clusters one and two may be fear of paying for hospital expenses, in which case the very poor go to the hospital only for severe injuries. In Israel, the health funds are obligated to cover the cost of emergency room (ER) admissions under specific circumstances, for example, if the patient is hospitalized or if the patient was referred by a physician to the ER. Supporting this theory is the fact that low hospitalization rates for minor and moderate injuries were reported, while rates for critical injuries were high.

After controlling for age and SEL, non-Jews were found to be at greater risk for injury-related hospitalizations. While it was often believed that non-Jews are at greater risk due to living in disadvantaged neighborhoods, the findings indicate that the hospitalization rate was lower among Jews who resided in the same socioeconomic cluster as non-Jews. This finding needs to be addressed and researched to understand the factors contributing to this disparity.

Transportation-related hospitalization rates were very low for persons living in cluster one. This may be due to

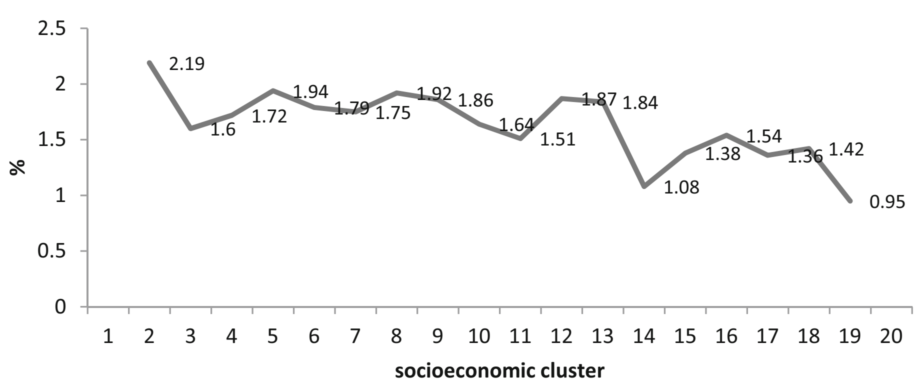


**Fig. 5** Hip fractures by socioeconomic cluster, ages 65+, Israel 2008–2011. (1) There are fewer than five hospitalizations in clusters 1 (0) and 20 (0.55%), (2) Cluster 1 is based on 4 statistical areas and cluster 20 is based on 5 statistical areas, (3) Mantel-Haenszel Chi-Square < 0.0001

the unique social, cultural and religious attributes of this predominately ultra-religious Jewish population. Living in a religiously affiliated community has been associated with lower mortality and injury hospitalization rates among children (Jaffe et al. 2005, 2011). This population has a strong social capital network as well as religious attributes which influence the exposure risk. For example, the religious observance of the Sabbath laws prohibits "work" (which includes transportation via motorized vehicles) during a 25-hour period from approximately sunset on Friday to sunset on Saturday. This "Sabbath" theory has been suggested elsewhere for both disease and injury trends (Kark et al. 1996; Jaffe et al. 2011). Pedestrian injuries are the leading cause of traffic-related hospitalizations for low–middle NSES. Policy makers should use these data to develop focused injury prevention programs since pedestrian injuries have been reported to be the leading cause of mortality among children and adolescents (Grajda et al. 2017).

Childhood injuries occurring in and around the home are more prevalent in low-SEL neighborhoods. In these disadvantaged families, children may be left unsupervised or may be acting as caregiver to their younger siblings (Khambalia 2006).

Although hip fractures and home injuries among the elderly were prevalent in all socioeconomic clusters, a clear increase was observed in the poorer NSES areas. Since falls among the elderly, and specifically hip fractures, are known to cause long-term complications as well as a burden on the individual, the family and the health system, fall prevention programs are vital for all elderly with a focus on elderly living in disadvantaged areas.

Due to the unique and varied societal values and sociocultural characteristics of the population in Israel, interventions to reduce health disparities must be specific to the neighborhood in focus. It has been suggested that the Israel national health authority develops and implements a national strategy to mitigate health disparities, while using the experience from other countries (Horev and Averbach 2012). However, the results from this study suggest that interventions should be designed to focus on strategies specific to the social, material and educational levels of the neighborhood in order to effectively tackle socioeconomic disparities and reduce injury.

### Limitations

During the study period, the National Trauma Registry included 17–19 trauma centers, out of a total of 26. The medical centers not represented in the trauma registry are small regional centers with relatively few injury-related hospitalizations. These hospitals are located throughout the country and serve all population groups and all socioeconomic levels. Since data from all six Level I trauma centers are included in the INTR, severe and critical casualties are fully represented. (Even if they arrive at a regional center, they will be transferred to a Level I trauma center for further treatment.) While casualties with minor or moderate injuries may be underrepresented, all population groups and SEL should be fairly represented.

## Conclusion

This study successfully matched national census data with a national trauma registry to determine the risk of injury-related hospitalization at the neighborhood level. An inverse relationship between injury-related hospitalization and SEP was identified, reconfirming that inequality has an impact on injury. However, an in-depth look at the data showed that while an inverse trend exists between all-cause injury hospitalization rates and socioeconomic cluster, the trend changes for cause-specific injury. Policy makers should take into account neighborhood SEP and injury mechanism when designing and implementing injury prevention interventions.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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