ORIGINAL RESEARCH

Population Density and Occurrence of Accidents in Finland

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Abstract

Introduction: About one million accidents occur yearly in Finland (population 5.2 million), resulting in over 3,000 deaths, annually. The governmental and municipal authorities are responsible for the healthcare services that respond to these accidents. So far, resources for these services have been allocated according to regional equality, or in some cases, on the basis of population numbers. However, economical and effective resource allocation should be based on detailed risk analysis of the accidents.

Hypothesis: In areas with more dense populations, the level of social activity is greater, which leads to an increased risk for accidents (traffic, civil disturbance, etc.).

Methods: The number of accidents was estimated on the basis of registered emergency trauma patients using the Finnish healthcare statistics for the year 1999. The emergency visits were compared to the populations and populations' densities of the regional sub-units. The rate of emergency injuries was analysed by regression analysis according to varying population density in Finland.

Results: The number of accidents per inhabitants was related directly to population density. There was a correlation between emergency visits per inhabitant and population density (p <0.0001). According to estimates, each 1% increase in population density is associated with a 0.4% increase in the risk of accidents.

Conclusion: The relationship between population density and rate of emergency visits is decisive for the planning of emergency services. Services should be placed in areas of high population densities where there are more people with greater risk of accidents.

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Introduction

In Finland, with a population of 5.2 million, about one million accidents occurevery year. The costs associated with these accidents have been estimated to be between 3.3 and 5.0 billion Euros,[1] and result in 3,000 fatalities, annually. Moreover, 100,000 injuries and 1,500 deaths per year are due to violence. Some 9% of the patient injuries treated in hospitals are caused by accidents or violence.[2,3]

To date, the allocation of emergency healthcare services in Finland has been based mainly on regional equity. However, in Finland, the population density ranges from the rural, deserted areas in the north to the crowded cities in the south. Despite natural disasters and international crises, the most common causes of accidents have been public transport, riots during mass events, and industrial accidents. [4] Usually, risk analysis of accidents has been based on the

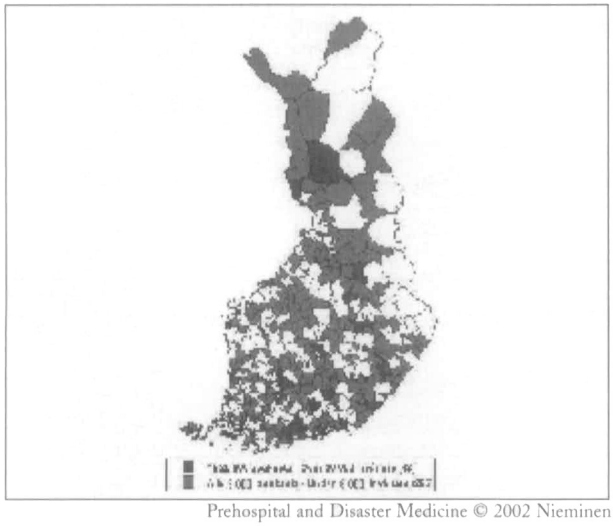

Figure 1—The population in the municipalities in Finland 1999. Dark areas: more than 20,000 inhabitants. Gray areas: less than 6,000 inhabitants

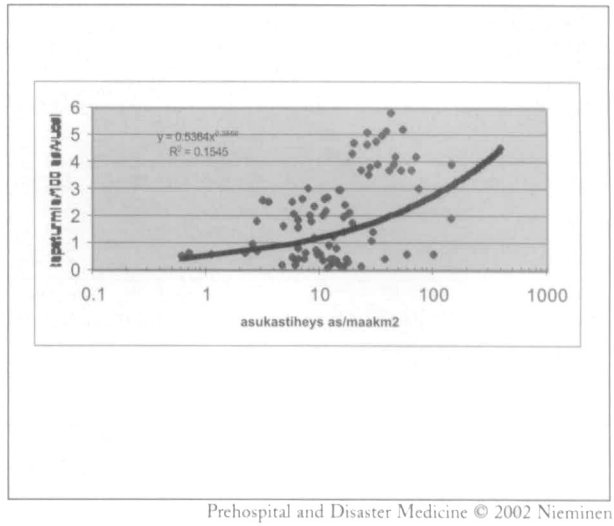

Figure 3—The relation between emergency visits per 100 inhabitants per year and population density (inhabitants/km^2) in the regional sub-units in Finland in 1999.

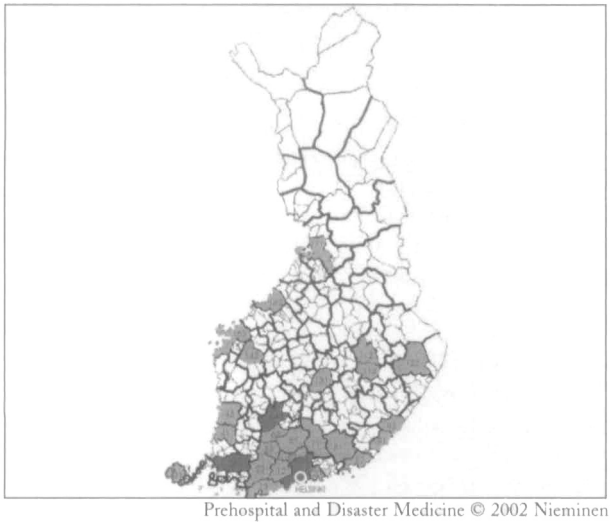

Figure 2—The population density and the risk of accidents in the regions, on the average, in Finland 1999

probabilities of different kinds of threats.[5,6] However, since the most commonly occurring accidents seemingly are related closely to population density, the relationship between the rate of emergency injuries and population density in Finland was studied. The aim of this study was to assist in appropriate resource allocation for emergency and rescue services.

Methods

The healthcare statistics for Finland for 1999 developed by the National Research and Development Centre for Welfare and Health, estimated the rate of accidents on the basis of the number of emergency patients treated in public healthcare facilities. Emergency patients treated in hospitals or hospital polyclinics because of the ICD-10 main diagnosis groups S00-Y89 were registered according to their area of residence.

The regional distribution of the patient admissions was categorizeed according to regional sub-units. The 452 municipalities in Finland were grouped into 85 regional sub-units according to work places, cooperation between the municipalities, and economical structures.

The population of each of the regional sub-units was obtained from The Association of Finnish Local and Regional Authorities. The population in the municipalities is diagrammed in Figure 1, and the population densities of the regional sub-units are depicted in Figure 2.

Results

The numbers of emergency visits were compared with the populations and population densities of the regional sub-units. According to population density, the regional sub-units can be classified into three groups (Table 1), each harbouring approximately one-third of the inhabitants in Finland. In three regional sub-units, the population density is at least 100 inhabitants per km^2; 24 regional sub-units the population density is 20–100 inhabitants per km^2; and in the remaining 58 regional sub-units, the population density is 19 inhabitants, or less, per km^2. As an extreme, in the two northernmost regional sub-units, there is <1 inhabitant per km^2.

The rate of emergency visits per inhabitant is not standard. In the three most densely inhabited regional sub-units, there were, on an average, 0.0403 emergency visits per inhabitant/year. In the second most densely populated group (20–100 inhabitants per km^2), the rate of emergency visits was 0.0339/inhabitant; and in the regional sub-units with the lowest population density, the emergency visit rate was 0.0138/inhabitant (Table 1; Figure 2).

The relationship between the number of emergency visits and population density was analysed by regression analysis. There was a statistically significant correlation between the number of emergency visits per inhabitant and population density (p <0.0001). An increase in population

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Population Density (Inhabitants/km^2)	Total Population	Average Population per Regional Sub-unit *	Population Density (average #/km^2)*	Emergency injuries/year*
>100	1.75 million			
3 regional sub-units*		582,255	224.8	23,438
20-100	1.86 million			
24 regional sub-units*		77,531 ±40,037	42.8 ±19.1	2,632 ±1,705
<20	1.56 million			
58 regional sub-units*		26,962 ±15,204	9.9 ±5.3	371 ±390

Table 1—The rate of emergency visits, population and population density according to regional sub-units in Finland in 1999 (* = average ±sd; # = number)

density of 1% corresponded to an increase of 0.4% in the rate of emergency visits. (Figure 3).

Discussion

The planning of emergency and rescue services demands reliable information related to the rate of accidents. So far, in Finland, the services have been planned largely on the basis of population. However, this study demonstrates that the population density affects the rate of accidents. In areas with more dense populations, the rate of accidents per inhabitants is greater than in the areas with lower density populations.

Usually, for international comparisons, the rates of accidental deaths have been analysed; the quality of the statistics varied.[7,8] As regards to registration of accidents, the habits of the population and compensation systems affect the registration of the accidents. There are uncertainties even in this kind of registration.[3,7] For example, in the United States, two-thirds of accidents require medical intervention,[9] whereas the corresponding ratio in Finland is about one-half.

The diagnosis register for hospital and hospital polyclinic care in Finland has a good coverage because the healthcare system, largely, is public. By far, this is more reliable than the police road-injury data that cover about 15% of the hospital admissions caused by traffic accidents.[10]

A limitation of the present study is that emergency visits to facilities other than hospitals (private doctors, and primary health care) were not included.[11] This may explain the large variation in the rates of emergency visits between different regional sub-units, since in some sub-units the primary healthcare system may have a greater responsibility for emergency patients than do other sub-units. However, all the severe cases, as well those requiring diagnostic procedures, have been included in the current study.

To our knowledge, there are no previous reports on the relationship between emergency visits and population density. However, one Danish study demonstrated that emergency transports per inhabitant clearly were more frequent (101/1,000 inhabitants) in Copenhagen (metropolitan) than in Odense (rural, 44/1,000 inhabitants) or in Ringkobing (mixed rural urban, 19/1,000 inhabitants).[12]

Conclusion

Resource allocation for the health care services responding to accidents has been planned according to regional equality, or, in some cases, on the basis of population numbers. However, economical and effective resource allocation should be based on detailed risk analysis of the accidents.

A possible explanation may be that in more dense populations the social activity is greater and leads to an increased risk of accidents. In this study, the number of accidents was estimated on the basis of registered emergency trauma patients. The emergency visits were compared to the populations and populations densities. There was a significant correlation between emergency visits per inhabitant and population density in Finland. According to our estimates, an increase in the population density by 1 per cent increases the risk of accidents by 0.4%. The result of the present study supports the view that services should be placed in areas of high population densities where there are not only more people, but a greater increase in the risk of accidents.

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