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Association between mobile phone traffic volume and road crash fatalities: A population-based case-crossover study

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ABSTRACT

Use of mobile phones while driving is known to cause crashes with possible fatalities. Different habits of mobile phone use might be distracting forces and display differential impacts on accident risk; the assessment of the relative importance is relevant to implement prevention, mitigation, and control measures. This study aimed to assess the relationship between the use of mobile phones at population level and road crash fatalities in large urban areas. Data on road crashes with fatalities were collected from seven Italian metropolitan areas and matched in time and space with high resolution mobile phone traffic volume data about calls, texts, Internet connections and upload/download data. A case-crossover study design was applied to estimate the relative risks of road accident for increases in each type of mobile phone traffic volumes in underlying population present in the small areas where accidents occurred. Effect modification was evaluated by weekday/weekend, hour of the day, meteorological conditions, and street densities.

Positive associations between road crashes rates and the number of calls, texts, and Internet connections were found, with incremental risks of 17.2% (95% Confidence Interval [CI] 7.7, 27.6), 8.4% (CI 0.7, 16.8), and 54.6% (CI 34.0, 78.5) per increases (at 15 min intervals) of 5 calls/100 people, 3 text/100 people, and 40 connections/100 people, respectively. Small differences across cities were detected. Working days, nighttime and morning hours were associated with greater phone use and more road accidents.

The relationship between mobile phone use and road fatalities at population level is strong. Strict controls on cellular phone in the vehicle may results in a large health benefit.

1. Introduction

Fatalities caused by road crashes are considered a major problem for both lives lost and social costs. Crashes triggered by distracted driving are a major cause of mortality, with financial and social costs (National Highway Traffic Safety Administration (NHTSA, 2015; World Health Organization (WHO, 2015). Mobile phone use is one of the main contributors to these distracting factors (World Health Organization (WHO, 2011; Oviedo-Trespalacios et al., 2016). In the United States, observational studies revealed that 31.4% of drivers talk on the phone and 16.6% text or dial (Huisingh et al., 2015). Similar studies in Spain and Italy quantified the prevalence of mobile phone usage while driving to 3.8% and 4.5%, respectively (Martínez-Sánchez et al., 2014; Lorini et al., 2012). Assessment of crash risks related to mobile phone use has been carried out by applying different methods and study designs (Oviedo-Trespalacios et al., 2016; Simmons et al., 2016; McCartt et al., 2006; Svenson and Patten, 2005).

"Naturalistic" study (Simmons et al., 2016), based on the involvement of volunteer drivers to capture their behaviours, is one of the most common methods used in the literature. Simulation of specific in-vehicle tasks in a laboratory or simulated driving under controlled conditions (Caird et al., 2014; Garrison and Williams, 2013) and the use of surveys (Yannis et al., 2015) are other methods used by investigators to assess crash risks. Epidemiologic studies based on road crash data (Redelmeier and Tibshirani, 1997; McEvoy et al., 2005) or collected video data from volunteers (Klauer et al., 2006; Fitch et al., 2013) are another approach to estimate risks. Data are examined to determine whether a distracting activity was involved in the crash or might be the cause of it.

Using a different approach, Muehlegger and Shoag (2014) examined the relationship between car accidents and directly observed hourly data on cell phone call volumes at the local level, investigating whether

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there was a nearby vehicle accident that led to a serious injury or fatality. This methodology enables the measurement of real-world crash outcomes based on information on all traffic accidents reported by police departments, and relate them with real-time detailed information on cell phone use provided by mobile phone operators. This novel approach, based on mobile traffic volumes at the exact time of the crash episode, offers the opportunity to investigate the impact on crash risk of alternative ways to use smartphones, such as Internet connections for interacting with social networks (such as Facebook, Twitter and WhatsApp) as well as other activities that need cognitive resources and a substantial amount of attention deflected from driving. Such a large amount of data can be analysed using a case-crossover study design, an epidemiological method perfectly suited when the risk factor/exposure of interest is transient, as in the case of cell phone use. This methodology has been largely used in several epidemiological studies addressing various risk factors (Navidi and Weinhandl, 2002; Bateson and Schwartz, 1999; Stafoggia et al., 2006, 2010).

The present paper aims to investigate the impact of different types of mobile phone use traffic volumes at population level on road crash fatalities in seven Italian urban areas using the case-crossover design. Specifically, the study hypothesis is that increased use of mobile phones (in various forms, calls, texts, internet) in the underlying population (of both drivers and non-drivers) in a given time period can act as a distracting force for that population, increasing the probability of crash fatalities. The distracting forces can be the individual driver using the phone, other individuals using the phone in the same car, use of the phone in another vehicle involved in the same crash, or even distracted pedestrian crossing urban road while using the phone. In addition, the study aims to evaluate specific temporal or meteorological covariates as potential effect modifiers.

2. Materials and methods

2.1. Road crash fatalities

In the present study, data on road crashes that led to an injury or fatality were collected for two months in 2015 (March and April) for seven Italian cities and the corresponding Provinces (Rome, Milan, Turin, Naples, Venice, Palermo and Bari). Data are collected by the National Institute of Statistics (ISTAT), on the basis on data recorded from different authorities, “Carabinieri”, Road Police, and Local Police, to document traffic accidents occurred on the national public roads network. The collected data include information about time and location of the accident, classification of type of road, paving and meteorological conditions, number and types of vehicles involved, general characteristics of the road accident, and data about possible injuries and fatalities. In addition, information was available on the geographic coordinates of the location of accidents. A GIS mapping procedure was then applied to assign each accident to a corresponding mobile phone traffic cell to further link with the mobile traffic volume data. Fig. 1 shows the road crashes (red circles) occurring in Rome during the study period.

These data are gathered by means of questionnaires filled in by the involved Authorities, based on accident reports. The procedure of data collection is standardized among the Authorities, as it follows a unique form delivered by ISTAT. The form contains variables and classifications harmonized at European level, allowing the CARE (Community Road accident database) to be used for data archiving, reporting and dissemination of results. In this way the consistency and integrity of data among Authorities are assured. The ISTAT archive represents the most complete and accurate information about road accidents available at the national level. However, some inaccuracies at territorial level

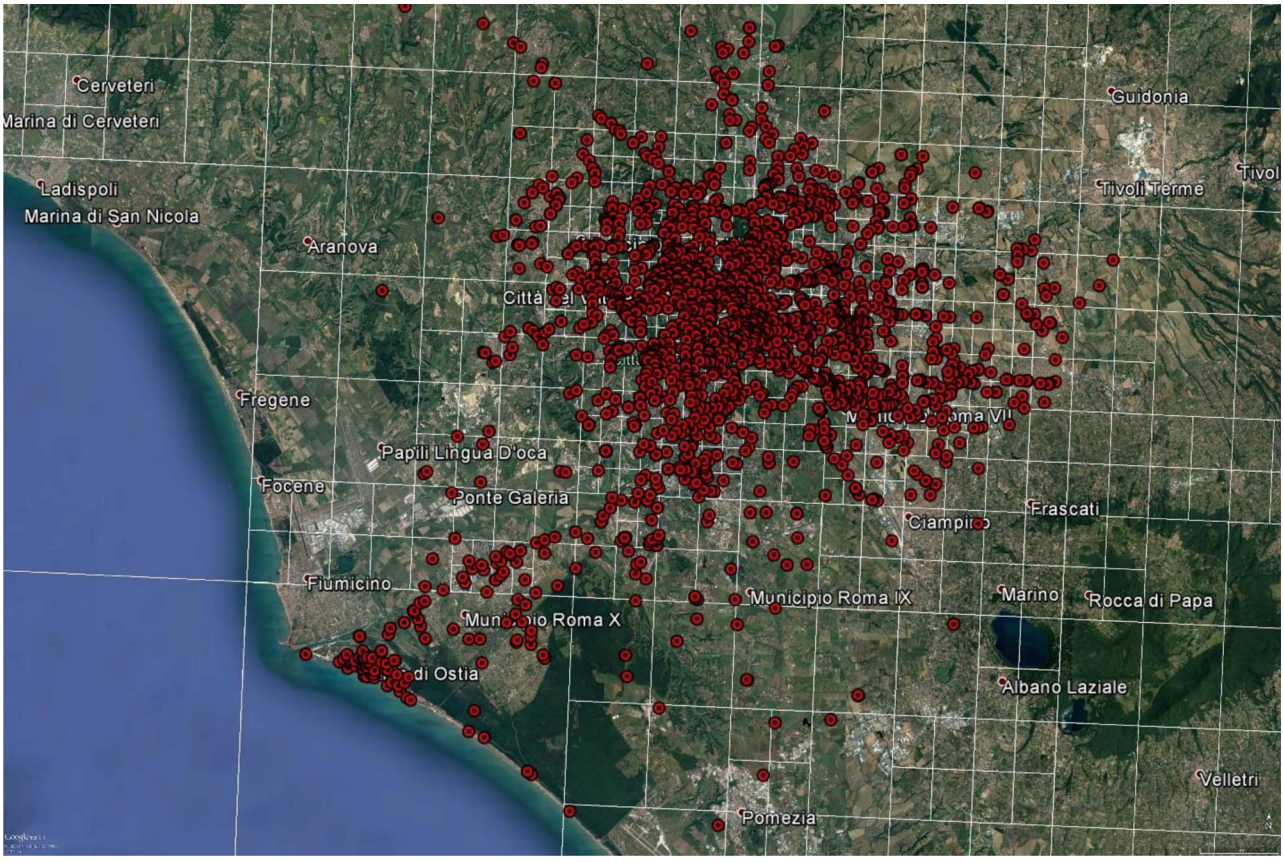

Fig. 1. Road crashes (red circles) occurring in Rome during the study period superimposed with mobile phone traffic volume data grid. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)