PUBLIC HEALTH XXX (2015) 1–8

Available online at www.sciencedirect.com

Public Health

journal homepage: www.elsevier.com/puhe

Original Research

Close proximity to busy roads increases the prevalence and onset of cardiac disease – Results from RHINE Tartu

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ARTICLE INFO

Article history:
Received 3 October 2014
Received in revised form
2 April 2015
Accepted 12 July 2015
Available online xxx

Keywords:
Traffic proximity
Cardiac disease
Odds ratio
Prevalence
Onset

ABSTRACT

Objectives: To analyze whether living close to a busy road would increase the risk of having cardiac disease and hypertension.
Study design: Longitudinal cross-sectional study.
Methods: We used cross-sectional longitudinal questionnaire data from the RHINE study for Tartu in 2000/2001 and 2011/2012. Home addresses of the respondents were geocoded and traffic data obtained from annually conducted traffic counts in Tartu. Relationships between proximity to a busy road and self-reported cardiac disease and hypertension were analyzed with multiple logistic regression.
Results: In terms of total traffic (≥10,000 vehicles per day) within a 150-m zone of a busy road, the odds ratio (OR) for prevalence of cardiac disease was significant in 2000/2001 (1.91, 95% CI 1.15–3.16) and 2011/2012 (1.58, 95% CI 1.01–2.47). Prevalence of hypertension was significant only in 2011/2012 (1.61, 95% CI 1.08–2.39). In terms of heavy duty vehicle traffic (≥500 vehicles per day) within a 150-m zone in 2000/2001, the OR was 1.52 (95% CI 1.04–2.24) and 1.49 (95% CI 1.02–2.17) respectively for the prevalence of cardiac disease and hypertension. In 2011/2012 no significant relationship between heavy duty vehicle traffic and cardiac disease or hypertension was found. We also saw a significant relationship between total traffic and the onset of cardiac disease (OR = 2.04, 95% CI 1.07–3.87).
Conclusions: This study showed that living closer than 150 m to a busy road can increase the odds of having cardiac disease and hypertension, which should be taken into account in city planning.
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http://dx.doi.org/10.1016/j.puhe.2015.07.029
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Please cite this article in press as: Pindus M, et al., Close proximity to busy roads increases the prevalence and onset of cardiac disease – Results from RHINE Tartu, Public Health (2015), http://dx.doi.org/10.1016/j.puhe.2015.07.029

Introduction

Vehicles emit different pollutants into the air and increase noise levels, and the extent of both is connected to traffic density.[1] Long-term exposure to traffic related pollutants such as nitrogen oxide and black smoke are linked to causing cardiovascular diseases and other health problems.[1,2] Particulate matter (PM), which includes different chemical components of exhaust fumes, has also been linked to cardiovascular and respiratory diseases.[3] Some protein markers, for example high-sensitive C-reactive proteins, which are considered an independent predictor of cardiovascular disease, have been associated with source-type PM such as from traffic.[4] Numerous cohort studies have associated low PM concentrations with different coronary events.[5] Several studies suggest that PM cause lung cancer.[6,7] High levels of nitrogen oxide is also known to cause symptoms such as eye irritation.[8] Traffic noise is an important environmental pollutant and has been linked for e.g. to myocardial infarction, hypertension and diabetes.[9–12]

Complementary to the actual measured exposure data, geographical exposure metrics are common in studies of environmental exposures and health.[6] Several studies have used Geographical Information System (GIS) approaches to study potential connections between environmental exposure (air pollution and noise)[13,14] and disease symptoms at a spatial level.[15] Using a procedure called geocoding, the addresses of participants in a survey can be linked to their corresponding geographical coordinates and plotted on a digital map. It is then possible to perform different calculations with geographical exposure metrics, for example the distance from a person's home to the nearest major road[16] or to study the dispersions of different traffic-related pollutants.[17] Several studies have shown that large numbers of people in different European cites live within 150 m of a road with traffic of more than 10,000 vehicles per day.[18,19] Living in close proximity to a major road has been shown to cause several health problems, such as asthma, allergic sensitisation, wheezing, rhinitis and diabetes.[16,20,21] Living within 50–100 m of dense traffic has also been linked to high odds 1.77 (95% CI 1.01–3.11) of having coronary heart disease.[20] However, there are few studies which show how living near a major road in a mid-sized city (100–500,000 inhabitants) could affect the population's health, especially in relation to the cardio-vascular system.

Despite relatively low air pollution levels in Estonia, fine particles have been estimated to cause up to 462 preterm deaths annually in major cities.[21] The amount of traffic pollutants varies geographically, but with the crustal component (e.g. silicates) it has been estimated that fine particles make up at least 13% of the pollutant mass in urban areas.[22] Despite the average age of cars having decreased since the early 1990s and as a consequence lower emissions due to more effective engines and catalytic converters, increased traffic volumes have resulted in pollution levels remaining almost the same.[23] Moreover, during winter studded tires are used, which increases particulate air pollution emissions (especially coarse particles, $PM_{2.5-10}$)[24] and depending on vehicle speed noise emissions by up to several tens of dBA.[25] This current study aims to determine if living close to busy roads increases the risk of having cardiac disease and hypertension for the Respiratory Health in Northern Europe (RHINE) Tartu cohort.

Methods

Study site and traffic data

Tartu is the second largest city in Estonia with a population of almost 100,000 people, while the population of the Republic of Estonia is 1.3 million people. 72% of the population are Estonian and 14% Russian. The most populated city regions are the Annelinna and Karlova districts. One-third of the people live in large (up to nine storey) block-houses located in the Annelinna district. The second most populated is the Karlova district, which has many two to three storey apartment houses (Figs. 1 and 2).

Traffic has been counted annually by the Estonian Road Administration and Stratum Inc located in Tallinn. We used rush hour traffic data for 2000 and 2011, which included the total number of vehicles and the number of heavy duty vehicles. The count sites were located at important traffic junctions. Traffic modelling using CUBE software (Citilabs Inc.) was performed for the remaining roads. In total, our analyzis included 487 road segments for the year 2000 (Fig. 1) and 910 road segments for 2011 (Fig. 2). After consulting Stratum Inc., we multiplied rush hour data with different suggested expansion factors. Roads were divided into three categories: arterial roads ($n = 11$); main roads (10); small roads (9). ArcGIS 10.1 (ESRI, Inc.) was used for dealing with spatial data.

RHINE study

From the early 1990s, seven Northern European centres, including Tartu in Estonia, have participated in the longitudinal cohort study ECHRS I (European Community Respiratory Health Survey). In parallel with ECHRS, the RHINE II (Respiratory Health in Northern Europe) study – which targeted the respondents of ECHRS I – started in 1999–2001 (2000/2001 in Tartu). The latest cross-sectional survey (RHINE III) of the Tartu cohort was conducted in 2011–2012.

In 1993, 2459 of 3000 randomly selected participants for Tartu answered the ERCHS I questionnaire. In 2000/2001, 69% (1708 people aged between 25 and 50 years old) of the 2459 respondents of ERCHS I completed RHINE II questionnaires. For RHINE III in 2011/2012, 2130 questionnaires were sent out (to the people who answered in 1993 and answered/not answered in 2000/2001 and, excluding those who had died or left Estonia). The response rate was 64%, with 1370 completed questionnaires from respondents aged between 39 and 63 years old.

Even though the RHINE study focused on respiratory health, it included two questions about cardiac health that used in this current study. Using questionnaire data could generate a problem called selection bias, which occurred for cardiac disease and hypertension cases with both RHINE surveys. The questions were asked in the order 'Have you ever been diagnosed for hypertension?' and then 'Do you have any cardiac disease?' to avoid answering hypertension under

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