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Associations of night-time road traffic noise with carotid intima-media thickness and blood pressure: The Whitehall II and SABRE study cohorts

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ABSTRACT

Background: Road traffic noise has been linked to increased risk of stroke, for which hypertension and carotid intima-media thickness (cIMT) are risk factors. A link between traffic noise and hypertension has been established, but there are few studies on blood pressure and no studies on cIMT.
Objectives: To examine cross-sectional associations for long-term exposure to night-time noise with cIMT, systolic blood pressure (SBP), diastolic blood pressure (DBP) and hypertension.
Methods: The study population consisted of 2592 adults from the Whitehall II and SABRE cohort studies living within Greater London who had cIMT, SBP and DBP measured. Exposure to night-time road traffic noise (A-weighted dB, referred to as dBA) was estimated at each participant's residential postcode centroid.
Results: Mean night-time road noise levels were 52 dBA (SD = 4). In the pooled analysis adjusted for cohort, sex, age, ethnicity, marital status, smoking, area-level deprivation and NOx there was a 9.1 μm (95% CI: −7.1, 25.2) increase in cIMT in association with 10 dBA increase in night-time noise. Analyses by noise categories of 55–60 dBA (16.2 μm, 95% CI: −8.7, 41.2), and >60 dBA (21.2 μm, 95% CI: −2.5, 44.9) vs. <55 dBA were also positive but non-significant, expect among those not using antihypertensive medication and exposed to >60 dBA vs. <55 dBA (32.6 μm, 95% CI: 6.2, 59.0). Associations for SBP, DPB and hypertension were close to null.
Conclusions: After adjustments, including for air pollution, the association between night-time road traffic noise and cIMT was only observed among non-medication users but associations with blood pressure and hypertension were largely null.

1. Introduction

There is growing interest in the potential link between exposure to traffic noise and various cardiovascular health outcomes (Babisch, 2014; Babisch et al., 2014; Barcelo et al., 2016; Bodin et al., 2016; Munzel et al., 2014, 2016; Stansfeld, 2015). We recently reported an area-level association between road traffic noise and increased risk of strokes in London, UK (Halonen et al., 2015b). The observed association is biologically plausible based on an established link between noise exposure and hypertension (van Kempen et al., 2012), a major risk factor for stroke (Elliott et al., 2005). Increasing carotid intima-media thickness (cIMT) reflects changes in the vascular walls due to plaque formation as part of the atherosclerotic process. These changes, when severe, increase the risk of occlusion that may result in acute atherothrombotic events such as myocardial infarction and stroke (Eikendal et al., 2015; O'Leary et al., 1999). Although associations between air pollution and cIMT have been investigated (Perez et al., 2015; Tonne et al., 2012; Wilker et al., 2013), we are not aware of studies examining associations between exposure to road traffic noise and cIMT. This association could be on the stress-related pathway between traffic noise exposure and

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cardiovascular events (Basner et al., 2014; Munzel et al., 2014) as systolic blood pressure stress reactions, for example, have been linked to progression of cIMT (Jennings et al., 2004).

In this cross-sectional study, we examined whether long-term exposure to night-time road traffic noise is associated with higher cIMT and blood pressure or higher odds of hypertension among participants of the Whitehall II (WHII) cohort study of British civil servants and the participants of tri-ethnic population-based Southall and Brent REvisited (SABRE) cohort study who lived within Greater London in 2002–2012. We hypothesized that higher road noise exposure at the participants' residential postcodes is associated with higher cIMT, higher blood pressure and higher odds of hypertension.

2. Methods

2.1. Study population

The study population consisted of participants of two UK cohorts: participants included in the phase 7 clinic visit (2002–2004) of the WHII study of civil servants in England, (Marmot et al., 2005) and participants of the phase 2 (2008–2012) clinic visit of the SABRE tri-ethnic population-based cohort (Tillin et al., 2012). We included participants from both cohorts who had cIMT and blood pressure measured, lived within Greater London and whose residential postcode was available for noise exposure linkage, a total of 3270 adults. Residential addresses were not available due to confidentiality. After excluding those with missing data on any of the covariates the analytical sample size was 2592. The University College London Medical School Committee on the Ethics of Human Research and NHS Health Research Authority NRES London-Harrow Committee (ref. 85/0938) provided ethical approval for the Whitehall II study, and written informed consent was obtained from all participants. Approval for the SABRE study at baseline was obtained from Ealing, Hounslow and Spelthorne, and University College London research ethics committees, and at follow-up from St Mary's Hospital Research Ethics Committee (ref. 07/H0712/109).

2.2. Carotid intima-media thickness

For the participants of the WHII cohort in Phase 7 clinical examination, ultrasound vascular measures were performed at the Vascular Physiology Unit, Institute of Child Health, London UK. Measurements were taken in a temperature controlled (22–26 degrees centigrade), quiet room using a non-invasive, high- resolution ultrasound system, the Aloka 5500 with a 7.5 MHz transducer. Participants were examined in a supine position, with the head turned to a 45 degree angle away from the side to be scanned. Intima-media thickness was measured in the right and left common carotid arteries. Longitudinal images of the common carotid artery, triggered on the R-wave of the ECG, were magnified and recorded in DICOM format as a cine loop, on the hard drive of the ultrasound machine for later analysis. The common cIMT was measured at its thickest part 1 cm proximal to the bifurcation. A measurement was taken between the leading edge of the intima and the media adventitia on three separate images on each side using electronic calipers and the mean of the six measures was used for analysis.

For all participants of the SABRE cohort who attended for a clinic visit, cIMT was measured by an experienced sonographer at St Mary's hospital in London, UK, using an iE33 ultrasound machine with a 7.5 MHz transducer (Philips UK Ltd., Guildford, UK) and concurrent recording of 3-lead ECG. Participants were in supine position on the scan bed. The distal 1 cm of the (left and right) common carotid artery was imaged after identifying the plane containing the bifurcation of the carotid bulb into the internal and external carotid arteries. Two additional angles, approximately 45 degrees anteriorly and posteriorly, were also used. Three to five cardiac cycles were stored as cine loops for analysis.

2.3. Blood pressure

In the WHII study, blood pressure was measured at the same clinic visit as cIMT. SBP and DBP were measured twice in the sitting position after five minutes of rest with an Omron HEM 907 digital blood pressure monitor (Omron Healthcare, Inc., Bannockburn, Illinois). The average of the two readings was taken to be the measured SBP and DBP (Kivimaki et al., 2009).

Blood pressure of the SABRE cohort participants was measured at St Mary's hospital in London, UK. Resting SBP and DBP were measured three times using an Omron 705IT (Omron Healthcare, Inc., Bannockburn, Illinois). For both SBP and DBP, the average of the second and third measurements was retained as the measured SBP and DBP.

Because 34% of the study sample had medication for hypertension (Table 1), we adjusted their measurement for SBP with an additional 10 mmHg, and DBP with an additional 5 mmHg (Cui et al., 2003).

2.4. Hypertension

Use of hypertension medication was requested in the study questionnaires in both cohorts. For the analyses hypertension was defined as taking hypertension medication and/or having SBP > 140 and DBP > 90.

2.5. Road traffic noise

Annual, A-weighted road traffic noise levels (all dB are A-weighted and hereafter referred to as dBA) for the years 2003–2009 were modelled at geometric centroids of the 2592 participants' residential

Table 1
Characteristics of the study participants included in the analysis.

	All participants*	Included participants*		
	Pooled	Pooled	WHII	SABRE
Variable	$n = 3270$	$n = 2592$	$n = 1965$	n = 627
Outcomes				
SBP (mean (sd)) [mmHg]	135.3 (20.4)	133.1 (19.8)	128.4 (17.6)	147.5 (19.4)
DBP (mean (sd)) [mmHg]	76.4 (10.9)	75.7 (11.0)	74.2 (10.8)	80.7 (10.0)
cIMT (mean (sd)) [μm]	840 (192.9)	823.2 (180.8)	791.6 (155.9)	922.3 (214.6)
Covariates				
Age (mean (sd)) [years]	64.1 (7.4)	62.8 (7.0)	60.8 (5.9)	69.4 (6.2)
Sex = male (%)	2235 (68.3)	1800 (69.4)	1315 (66.9)	485 (77.4)
Hypertension treatment = yes (%)	1311 (40.1)	890 (34.3)	460 (23.4)	430 (68.6)
Marital status = non-married (%)	804 (25.8)	682 (26.3)	471 (24.0)	211 (33.7)
Smoking = current smoker (%)	251 (7.7)	199 (7.7)	154 (7.8)	45 (7.2)
Ethnicity = non-Caucasian (%)	975 (29.8)	593 (22.9)	269 (13.7)	324 (51.7)

* All participants are those participants from both cohorts who had cIMT and blood pressure measured, lived within Greater London and whose residential postcode was available for noise exposure linkage. Included participants are those among all participants without missing data on any of the covariates.

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