



Traffic pollutant exposures experienced by pedestrians waiting to enter the U.S. at a major U.S.–Mexico border crossing



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HIGHLIGHTS

- Study measured pedestrian exposure to traffic pollutants at the San Ysidro, CA Port of Entry (POE).
- Participants wore personal air monitors for 24-h in addition to fixed site monitoring.
- Participants who crossed the border had increased exposure to 1-nitropyrene, CO, and PM_{2.5}.
- Fixed site measurements at the POE found elevated levels of ultrafine particles.
- Findings warrant concern for pedestrian commuters waiting in long lines at US–Mexico border POEs.

GRAPHICAL ABSTRACT



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ABSTRACT

Pedestrians waiting to cross into the US from Mexico at Ports of Entry experience long wait times near idling vehicles. The near-road environment is associated with elevated pollutant levels and adverse health outcomes. This is the first exposure assessment conducted to quantify northbound pedestrian commuter exposure to traffic-related air pollutants at the U.S.–Mexico border San Ysidro Port of Entry (SYPOE). Seventy-three persons who regularly crossed the SYPOE in the pedestrian line and 18 persons who did not cross were recruited to wear personal air monitors for 24-h to measure traffic pollutants particulate matter less than 2.5 μm (PM_{2.5}), 1-nitropyrene (1-NP) - a marker for diesel exhaust - and carbon monoxide (CO). Fixed site concentrations were collected at SYPOE and occurred during the time subjects were crossing northbound to approximate their exposure to 1-NP, ultrafine particles (UFP), PM_{2.5}, CO, and black carbon (BC) while standing in line during their border wait. Subjects who crossed the border in pedestrian lanes had a 6-fold increase in exposure to 1-NP, a 3-fold increase in exposure to CO, and a 2-fold increase in exposure to gravimetric PM_{2.5}, vs. non-border commuters. Univariate regression analysis for UFP (median 40,000 # cm⁻³) found that border wait time for vehicles explained 21% of variability and relative humidity 13%, but when modeled together neither predictor remained significant. Concentrations at the SYPOE of UFP, PM_{2.5}, CO, and BC are similar to those in other near-roadway studies that show associations with acute and chronic adverse health effects. Although results are limited by small sample numbers, these findings warrant concern for adverse health effects

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experienced by pedestrian commuters waiting in a long northbound queue at SYPOE and demonstrates a potential health benefit of reduced wait times at the border.

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1. Introduction

The U.S.–Mexico border is over 2000 miles in length and has 43 land Ports of Entry. The San Ysidro Port of Entry (SYPOE) is the westernmost port (Fig. 1A) and bounded by the community of San Ysidro, California, U.S.A. to the north and the city of Tijuana, Baja California, Mexico to the south. In 2011, the SYPOE had the highest number of northbound crossings along the US–Mexico border with 12.4 million personal vehicles and 8.5 million pedestrians (Quintana et al., 2012) and has been referred to as the busiest land border crossing in the world (GSA, 2013). Delays crossing the border northbound into the U.S. are much longer than those southbound into Mexico, and average north-bound wait times are often more than an hour for vehicles using the regular inspection lanes and for walk-in-line pedestrians, with peak times averaging 2–4 h (GAO, 2013; CBP, 2013). The pedestrian pathway (Fig. 1B and C) is located within 3 m (10 feet) of idling vehicles, and during long border wait-times pedestrians may have high exposures to traffic-related air pollutants. Acute exposure to traffic related air pollution has been shown to trigger cardiovascular events (Peters et al., 2004). Chronic exposure in close proximity to traffic exhaust is associated with a wide range adverse health effects including cardiovascular, respiratory, cancer, and reproductive effects (Brugge et al., 2007; Gauderman et al., 2007; McConnell et al., 2010; Wilhelm et al., 2011; Rosenbloom et al., 2012; Raaschou-Nielsen et al., 2011).

Of particular concern is the proximity of the bus lane to the pedestrian pathway (Fig. 1C). Diesel exhaust (DE) was recently designated a human carcinogen by IARC (IARC, 2012) and previous

studies have linked DE exposure to 80% of the total carcinogenic risk from air pollution in the South Coast Air Basin in California (AQMD, 2012). Air pollutants of concern at SYPOE include both gases, such as carbon monoxide (CO), and particulates, including fine particulate matter (PM_{2.5}) ultrafine particles (UFP), and DE. Surveys have been conducted on pedestrians who cross the border to evaluate the frequency and purpose of their crossings (SANDAG, 2004). However, quantitative assessment of air pollutant exposures that pedestrian commuters experience during the border crossing have not been previously investigated. Walk-in-line pedestrians likely experience much greater levels of air pollution that would be predicted from regional air quality monitoring stations, which are typically located in areas relatively unaffected by local sources such as traffic. Roadside monitoring studies have found that pollutants are highly elevated near busy roads (Kinney et al., 2000; Karner et al., 2010).

The objective of this study was to characterize traffic-related air pollutant exposures experienced by pedestrians who frequently cross SYPOE and stand in long lines during the northbound commute, as compared to exposures experienced by people who live in San Ysidro or nearby but do not cross SYPOE.

2. Materials and methods

2.1. Personal sampling

Participants were recruited with the help of Casa Familiar, a community agency. “Border Commuter” eligibility criteria included: 1) ≥ 18 years, 2) non-smokers in a non-smoking home, 3)

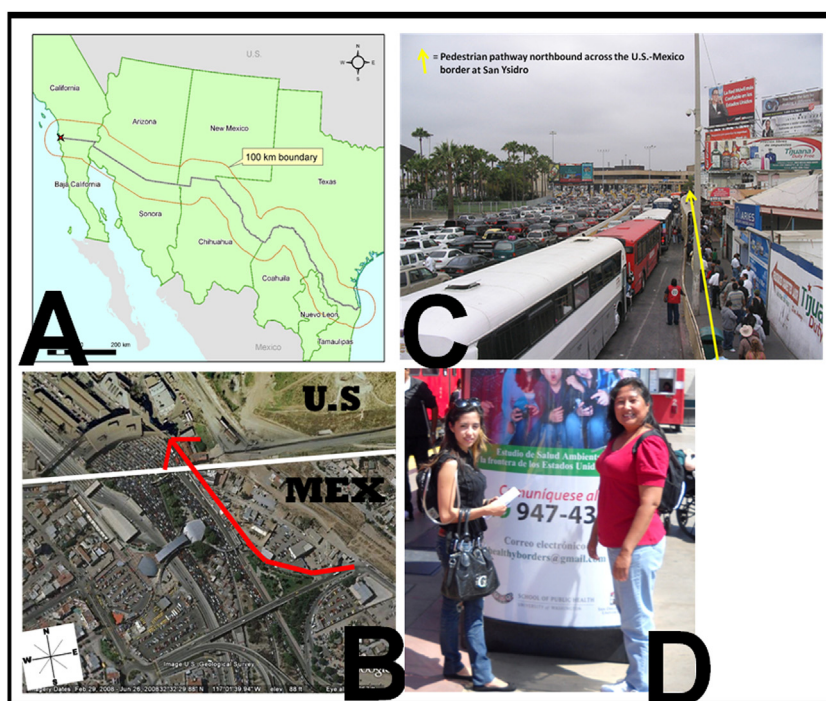


Fig. 1. (1A) U.S.–Mexico Border with San Ysidro Port of Entry marked by a red “X” Source: EPA page at <http://water.epa.gov/infrastructure/wastewater/mexican/> (1B) Pedestrian pathway northbound marked by arrow (1C) Proximity of pedestrian pathway to vehicles (1D) Study participants wearing personal monitoring equipment (photo used with permission).

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