

UNIVERSITY OF CALIFORNIA

Los Angeles

Motor Vehicle-Related Air Pollution and Adverse Birth Outcomes
in Los Angeles County, California, 1994-2000

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Epidemiology

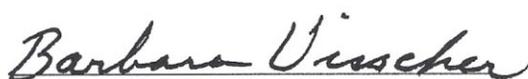
by

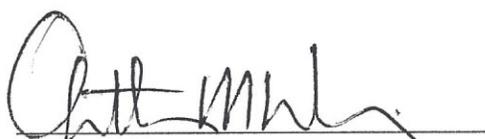
Michelle Holly Wilhelm

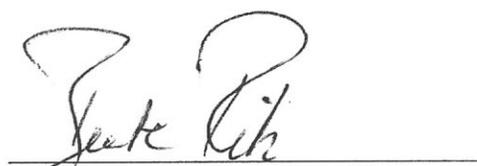
2004

The dissertation of Michelle Holly Wilhelm is approved.


Sander Greenland


Barbara Visscher


Arthur Winer


Beate R. Ritz, Committee Chair

University of California, Los Angeles

2004

This dissertation is dedicated to my husband, Carl Stuart Turner,
and my son, Samuel Raymond Turner.

Table of Contents

<u>Chapter</u>	<u>Page</u>
1.0 Motor Vehicle-Related Air Pollution and Adverse Birth Outcomes in Los Angeles County, California, 1994-1996.....	1
1.1 Introduction.....	1
1.2 Methods.....	2
1.3 Results.....	7
1.4 Discussion.....	10
1.5 Conclusions.....	19
1.6 References.....	35
2.0 Motor Vehicle-Related Air Pollution and Adverse Birth Outcomes in Los Angeles County, California, 1994-1996.....	40
2.1 Introduction.....	40
2.2 Methods.....	41
2.3 Results.....	46
2.4 Discussion.....	50
2.5 Conclusions.....	58
2.6 References.....	69
3.0 Estimating Exposure to Motor Vehicle-Related Air Pollution Using GIS Methods – An Application in Los Angeles County, California.....	73
3.1 Introduction.....	73
3.2 Methods.....	74
3.3 Results.....	76
3.4 Discussion.....	82
3.5 Conclusions.....	90
3.6 References.....	107

List of Tables

	<u>Page</u>
Table 1-1. Percent of subjects in each outcome group by individual-level demographic characteristics.....	21
Table 1-2. Percent of subjects in each outcome group by census block group-level demographic characteristics.....	24
Table 1-3. ORs and 95% CIs for three outcome groups for each covariate included in the adjusted model	26
Table 1-4. Association (RR point estimate, 95% CI) between residential DWTD and risk of preterm birth for infants born between 1994 and 1996 to mothers living in 112 zip codes located in Los Angeles County, California	28
Table 1-5. Association (OR point estimate, 95% CI) between residential DWTD and risk of LBW and preterm birth for infants born between 1994 and 1996 to mothers living in 112 zip codes located in Los Angeles County, California	30
Table 1-6. Association (OR point estimate, 95% CI) between residential DWTD and risk of term LBW for infants born between 1994 and 1996 to mothers living in 112 zip codes located in Los Angeles County, California.....	32
Table 2-1. Percent of subjects in each outcome group by individual-level characteristics – 1997-2000	60
Table 2-2. Percent of subjects in each outcome group by census block group-level demographic characteristics – 1997-2000	63
Table 2-3. Percent of subjects in each outcome group by freeway truck exposure categories – 1994-2000	65
Table 2-4. Association between residential distance-weighted traffic density (DWTD) and risk of preterm birth for infants born between 1997-2000 to mothers living in 111 zip codes located in Los Angeles County, CA.....	66
Table 2-5. Association between residential proximity to freeway trucks and risk of LBW and preterm birth for infants born between 1994-2000 to mothers living in 111 zip codes located in Los Angeles County, CA - ORs and 95% confidence intervals for 90 th and 95 th percentiles of truck variable distributions	67
Table 2-6. Changes in motor vehicle emission standards between 1994-2000	68
Table 3-1. List of traffic radii and 96% decay distances used to construct DWTD measures.....	92
Table 3-2. Summary of linear regression models relating monitoring station pollutant concentrations to traffic density (DWTD) and average inversion layer..	93
Table 3-3. Characteristics of roadways within 5,500ft of SCAQMD air monitoring stations in Los Angeles County, California	94
Table 3-4. Distribution of pollutant and meteorological variables at SCAQMD monitoring stations in LA County, California – mean (range).....	95

List of Figures

	<u>Page</u>
Figure 1-1. Location of Zip Codes Included in DWTD Analysis, Los Angeles County, CA.....	34
Figure 3-1a. Correlations between CO and DWTD1 – Excl. Outliers - 1994	96
Figure 3-1b. Correlations between CO and DWTD1 – Excl. Outliers - 2000	96
Figure 3-1c. Correlations between CO and DWTD1 – Incl. Outliers - 1994.....	97
Figure 3-1d. Correlations between CO and DWTD2 – Incl. Outliers - 1994.....	97
Figure 3-1e. Correlations between CO and DWTD1 – Incl. Outliers - 2000.....	98
Figure 3-1f. Correlations between CO and DWTD2 – Incl. Outliers - 2000.....	98
Figure 3-2a. Correlations between NO ₂ and DWTD1 – Excl. Outliers - 1994.....	99
Figure 3-2b. Correlations between NO ₂ and DWTD1 – Excl. Outliers - 2000.....	99
Figure 3-2c. Correlations between NO ₂ and DWTD1 – Excl. Outliers - 1994.....	100
Figure 3-2d. Correlations between NO ₂ and DWTD2 – Excl. Outliers - 1994.....	100
Figure 3-2e. Correlations between NO ₂ and DWTD1 – Excl. Outliers - 2000.....	101
Figure 3-2f. Correlations between NO ₂ and DWTD2 – Excl. Outliers - 2000.....	101
Figure 3-3a. Correlations between PM _{2.5} and DWTD1 - 2000	102
Figure 3-3b. Correlations between PM _{2.5} and DWTD2 - 2000	102
Figure 3-3c. Correlations between PM _{2.5} and DWTD3 - 2000	103
Figure 3-4a. Correlations between PM ₁₀ and DWTD1 - 1994.....	103
Figure 3-4b. Correlations between PM ₁₀ and DWTD1 - 2000.....	104
Figure 3-4c. Correlations between PM ₁₀ and DWTD2 - 1994.....	104
Figure 3-4d. Correlations between PM ₁₀ and DWTD2 - 2000.....	105
Figure 3-5a. Correlations between CO and Number of Freeway Trucks - Excl. Outliers - 1994	105
Figure 3-5b. Correlations between CO and Number of Freeway Trucks - Excl. Outliers - 2000	106
Figure 3-5c. Correlations between PM _{2.5} and Number of Heavy-Duty Diesel Freeway Trucks - 2000	106

Acknowledgments

This work was supported by the UCLA Southern California Particle Center and Supersite: U.S. Environmental Protection Agency grant number R82735201 and the National Institute of Environmental Health Sciences: grant number R01 ES010960-01. Chapter One was also supported by the UCLA Center for Occupational and Environmental Health.

I thank Curt Miller of the South Coast Air Quality Management District for providing air monitoring data and Keith Farnsworth of the California Department of Transportation for providing traffic count data.

Chapter One is a version of Wilhelm M, Ritz B. Residential proximity to traffic and adverse birth outcomes in Los Angeles County, California, 1994-1996. *Environmental Health Perspectives*, Volume 11, Number 2, February 2003, pages 207-216. I thank Zarina Iqbal for help with the traffic data mapping in support of the analyses presented in Chapter One. I also thank Fei Yu, Dan Stram and Janice Kim for their helpful comments on draft versions of the manuscript on which Chapter One is based.

I thank the members of my doctoral committee, Sander Greenland, Hal Morgenstern, Arthur Winer and Barbara Visscher, for their time and input. Finally, I thank my doctoral advisor, Beate Ritz, for her invaluable input on all chapters of this dissertation and her tireless support of this research over the past four years.

VITA

December 25, 1968	Born, Milwaukee, Wisconsin
1991	B.A., Geography/Ecosystems University of California, Los Angeles Magna Cum Laude, Phi Beta Kappa
1991-1993	Associate Scientist, Radian Corporation El Segundo, California
1993-1994	Graduate Student Researcher Department of Environmental Health Sciences University of California, Los Angeles
1994	M.S., Environmental Health Sciences University of California, Los Angeles
1994-1998	Staff Scientist, Radian International LLC El Segundo, California
1998	Special Reader Department of Environmental Health Sciences University of California, Los Angeles
1998-1999	Teaching Assistant Institute of the Environment University of California, Los Angeles
1999-2003	Staff Research Assistant Department of Epidemiology University of California, Los Angeles

PUBLICATIONS AND PRESENTATIONS

Ritz, B., and Wilhelm, M (September 2001). Traffic Exhaust and Adverse Birth Outcomes in Los Angeles County, California, 1994-1996. Paper presented at the 13th Conference of the International Society for Environmental Epidemiology, Garmisch-Partenkirchen, Germany.

Ritz, B., and Wilhelm, M (August 2002). Air pollution and adverse birth outcomes in the South Coast Air Basin, 1994-2000. Paper presented at the 14th Conference of the International Society for Environmental Epidemiology, Vancouver, Canada.

Wilhelm M, and Ritz, B. (2003). Residential proximity to traffic and adverse birth outcomes in Los Angeles County, California, 1994-1996. *Environmental Health Perspectives*, 111(2):207-216.

ABSTRACT OF THE DISSERTATION

Motor-Vehicle Related Air Pollution and Adverse Birth Outcomes
in Los Angeles County, California, 1994-2000

by

Michelle Holly Wilhelm

Doctor of Philosophy in Epidemiology

University of California, Los Angeles, 2004

Professor Beate R. Ritz, Chair

A number of studies reported positive relationships between maternal exposure to outdoor air pollution and adverse birth outcomes. However, outdoor concentrations measured at monitoring stations may not take into account differential exposure to pollutants found in elevated concentrations near heavy traffic roadways. Therefore, we used an epidemiologic case-control study design to examine whether residential proximity to heavy traffic influenced the occurrence of low birth weight (LBW) and/or preterm birth in Los Angeles County between 1994 and 2000. We mapped subject home

locations at birth and estimated exposure to traffic-related air pollution using a distance-weighted traffic density (DWTD) measure. We calculated odds ratios (ORs) and risk ratios (RRs) for being LBW and/or preterm per quintile of DWTD. For the time period 1994-1996, we observed an approximately 10-20% increase in risk of preterm birth (both normal and low weight) and term LBW in infants born to women potentially exposed to high levels of motor vehicle exhaust, as represented by DWTD. These risks appeared to be strongest for women whose third trimesters fell during November-May, consistent with elevated pollution in proximity to sources during more stagnant air conditions present in cooler months.

Although residential proximity to traffic did not appear to be associated with higher risks of term LBW or preterm and LBW birth during 1997-2000, residential proximity to trucks on freeways did appear to be associated with greater risks of these outcomes. This suggests more heavily polluting vehicles within the overall cleaner motor vehicle fleet, such as trucks, may now be more important. Positive associations between background CO concentrations and LBW and preterm birth in 1997-2000 suggest, overall, air pollution may still be harmful.

Annual average, winter and spring concentrations of CO, NO₂, PM_{2.5} measured at monitoring stations in LA County were well correlated with DWTD, but fall and summer averages were only weakly or negatively correlated with traffic density. Such differences may be of importance to studies focused on assessing health impacts of short-term air pollution exposures. Additional measurements at locations in closer proximity to traffic are needed to further evaluate the validity of the DWTD measure.