AIR POLLUTION AND GASTROINTESTINAL DISEASES IN UTAH

by

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STATEMENT OF DISSERTATION APPROVAL

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ABSTRACT

The valleys of northern Utah, where most of Utah's population resides, experience episodic air pollution events well in excess of the National Ambient Air Quality Standards. Most of the events are due to an accumulation of particulate matter during persistent cold air pools in winter from both direct emissions and secondary chemical reactions in the atmosphere. High wintertime ozone concentrations are occasionally observed in the Uintah Basin, in addition to particulate matter. At other times of the year, blowing dust, wildland fires, fireworks, and summertime ozone formation contribute to local air pollution. The objective of this dissertation is to investigate one facet of the health effects of Utah's air pollution on its residents: the acute impacts of air pollution on gastrointestinal (GI) disease.

To study the health effects of these episodic pollution events, some measure of air pollution exposure must be matched to the health data. Time and place are used to link the health data for a person with the pollution data. This dissertation describes the method of kriging data from the sparse pollution monitoring network to estimate personal air pollution history based on the zip code of residence. This dissertation then describes the application of these exposure estimates to a health study on GI disease.

The purpose of the GI study is to retrospectively look at two groups of patients during 2000-2014: those with autoimmune disease of the GI tract (inflammatory bowel disease, IBD) and those with allergic disease of the GI tract (eosinophilic esophagitis, EoE) to determine whether disease exacerbations occur more commonly during and following periods of poor air quality compared to periods of good air quality. The primary analysis method is case crossover design. In addition to using the kriged air pollution estimates, the analysis was repeated using simpler empirical estimation methods to assess whether the odds ratios are sensitive to the air pollution estimation method.

The data suggests an association between particulate matter smaller than 2.5 microns and prednisone prescriptions, gastrointestinal infections in general, clostridium difficile

infections specifically, and hospitalizations among people who have at least five entries of IBD diagnosis codes in their medical records. EoE exacerbations appear to be associated with high concentrations of particulate matter as well as ozone.

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This dissertation is interdisciplinary, as it combines the fields of atmospheric science, medicine, epidemiology, and geography. This type of research cannot be done in isolation, and I want to acknowledge the multitude of people who had a hand in making this project a reality. I would like to thank my committee, Kevin Perry, Kathryn Peterson, Ken Smith, John Lin, and Court Strong for their valuable insight and guidance as this project unfolded. Rafael Firszt also provided valuable critique of the analysis. The support and resources from the Center for High Performance Computing at the University of Utah are gratefully acknowledged. Many people helped with acquisition of the medical data for this project, both with guidance through the approval process and providing the records. At the Utah Population Database (UPDB), I would like to thank Heidi Hansen, Yuan Wan, Diana Lane, Alison Fraser, Jahn Barlow, Marybeth Janerich, and Heather Anderson. Micky Daurelle, Vikrant Deshmukh, and Mingyuan Zhang gathered the data for the University of Utah Electronic Data Warehouse (EDW), and Josi Wood provided guidance for the University of Utah's internal review board (IRB) process. Intermountain Healthcare graciously provided data, and I would specifically like to thank Liz Joy, Kerry Rowe, Kent Korgenski, Jacob Wilkes, Amanda Borba, and Kyle John Morgan. Phoebe Mcneally at the DigitLab gave guidance in the use of ArcGIS. This work was partially supported by a University of Utah Seed Grant from the Vice President of Research. Last, but not least, I would like to thank my friends and family, especially my husband Clint Schmidt, both for distracting me from the dissertation and for supporting me as I worked on it.

CHAPTER 1

INTERPOLATION OF CRITERIA AIR POLLUTANT OBSERVATIONS IN UTAH TO FACILITATE HEALTH EFFECTS STUDIES

M.M. Maestas, K.D. Perry, and C. Strong

The primary motivation for studying, monitoring, and regulating air pollution is to protect human health. Many health studies use simple empirical methods, eg, closest monitor or county average to assess exposure, ie, to assign pollution data to health data. Due to its complex topography, episodic pollution patterns, and the sparse criteria pollutant monitoring network of Utah, these simple empirical methods may provide an insufficient measure of personal pollutant exposures for subsequent health effects studies. The objective herein is to compare these simple empirical methods against kriging, a more sophisticated geostatistical technique which objectively determines the relative weights of adjacent monitors during interpolation via the variogram. Areas of Utah with air pollution monitors were divided into nine airsheds. Variograms were fit to the data in each airshed on a seasonal basis for each of six criteria air pollutants. Leave-one-out cross validation was performed for four empirical methods: kriging, county average, closest monitor within airshed, and closest monitor limited to the footprint from the kriging fit. Kriging generally performed better than the simpler empirical methods for O_3, $PM_{2.5}$, and SO_2, was mixed for PM_{10}, and performed worse than the simpler empirical methods for NO_2 and CO.

1.1 Introduction

Air pollution concentrations in Utah are typically well below the National Ambient Air Quality Standards (NAAQS), see Table 1.1 , for all criteria pollutants. As a result, Utah is either in attainment or waiting to be redesignated as attainment for all criteria pollutants except $PM_{2.5}$, for which Utah is well within attainment for the annual mean NAAQS [1–7]. Elevated $PM_{2.5}$ concentrations occasionally arise due to wind-blown dust events, wild land fires, and holiday-related fireworks. However, elevated $PM_{2.5}$ concentrations are primarily observed during episodes of cold air pools (CAPs) during winter, and portions of Utah have been declared as nonattainment areas for the daily $PM_{2.5}$ NAAQS [5]. While Utah is currently in attainment for ozone (O_3), 8-hour average concentrations above 0.07 ppm are observed nearly annually at several locations throughout the state [3, 8]. For most locations in the United States and beyond, high O_3 concentrations are generally considered a warm season problem. However, the Uintah Basin in eastern Utah also experiences high wintertime O_3 when the ground is snow covered [9]. O_3 is formed when volatile organic compounds (VOCs) react with nitrogen oxides (NO_x) in the presence of sunlight [9]. Research into the causes of wintertime O_3 in the Uintah Basin is ongoing, but it is thought to be related to the combination of the concentrations of VOCs and NO_x present in the Uintah Basin (primarily from the oil and gas industry) and the sunlight from above as well as reflecting off the snow [10].

Significant concentrations of $PM_{2.5}$ can accumulate during the stagnant atmospheric conditions that can occur in mountain valley CAPs during winter [5,12]. The stable conditions during CAPs trap emissions within a shallow, near-surface layer [13]. Local sources

Table 1.1. The National Ambient Air Quality Standards (NAAQS) and corresponding averaging time [11] for each criteria pollutant included in this study.

Criteria Pollutant	NAAQS	Averaging Time
$PM_{2.5}$	35 μg m^{-3}	24 hours
PM_{10}	150 μg m^{-3}	24 hours
O_3	0.07 ppm	8 hours
NO_2	100 ppb	1 hour
CO	9 ppm	8 hours
SO_2	75 ppb	1 hour

of $PM_{2.5}$ and its precursors can be apportioned into four categories: (1) area sources, eg, home heating, water heating, restaurants, bakeries, etc.; (2) point sources, eg, manufacturing facilities, power plants, steel mills, etc.; (3) on-road mobile sources, eg, commercial and private vehicles on public roadways; and (4) off-road mobile sources, eg, airplanes, trains, generators, and construction equipment [5, 9, 14]. The majority of $PM_{2.5}$ observed during CAPs is secondary (ie, formed in the atmosphere from precursors), and much of the secondary $PM_{2.5}$ is ammonium nitrate (NH_4NO_3) [5]. The State of Utah has identified sulfur dioxide (SO_2), oxides of nitrogen (NO_x), VOCs, and ammonia (NH_4) as the most important precursors for Utah's winter $PM_{2.5}$ problem [5]. The majority of the primary $PM_{2.5}$ is organic carbon [5]. Elevated concentrations of carbon monoxide (CO), carbon dioxide (CO_2), and O_3 have also been observed during persistent CAPs [15, 16]. In addition, traffic can induce turbulence, which can cause particulate material to become resuspended in the atmosphere [17].

The Persistent Cold-Air Pool Study (PCAPS), which took place in the Salt Lake Valley of Utah, observed that $PM_{2.5}$ concentrations are strongly correlated with the strength and duration of CAPs [12]. The lake breeze from the Great Salt Lake into the Salt Lake Valley acts to strengthen CAPs [12]. However, CAPs can set up more quickly, more intensely, and last longer in Cache Valley compared to the Wasatch Front because Cache Valley is a closed basin with steeper surrounding mountains [5]. Valleys along the Wasatch Front are not closed basins, which allows for greater advection of pollutants and potentially weaker CAPs, compared to Cache Valley [5].

The highest pollution concentrations in Utah tend to occur in the more populated areas of the state. Utah is home to approximately three million people [18]. In order to study the impacts of our air pollution on the residents of Utah, data about the air pollution need to be combined with data about the people. The Utah Population Database (UPDB), which is unique within the United States, is a database of detailed medical, demographic, and genealogical information for the sole purpose of supporting biomedical and health-related research [19]. The combination of the episodic nature of Utah's air pollution and the existence of the UPDB make it possible to conduct large and detailed retrospective studies of the acute health effects of air pollution in Utah. To conduct such a study, air pollution data must be merged with the medical data in a way that accounts for the spatial and temporal variations in air pollution concentrations to the extent possible, given the sparseness of the air quality monitoring network.

Time and place are used to link the person with the pollution data. Pollution data are often matched to medical data by using simple empirical methods, such as by taking the county or city average on a given day or by taking data from the monitor closest to the residence of the person, or something similar [20–25]. There is a wide variety of footprints that have been used in various studies, from 1 mile (1.6 km) [25], 2 miles [25], 4 miles (6.4 km) [25], 5 miles (8 km) [26], 10 km, 16 km, 30 miles [24], or the nearest monitor up to 54 km. In addition, the footprint chosen seems to vary from one study to the next without a justification for the distance chosen, and there is no consensus regarding the maximum distance. Spatio-temporal variations in pollution measurements are strongly influenced by chemistry, topography, monitoring network density, and emissions patterns. Thus, the chosen footprint should depend on the region of interest and season, as well as which pollutant is being considered.

The main objective of this study is to evaluate whether kriging for all criteria air pollutants (except lead)—ie, O_3, $PM_{2.5}$, PM_{10}, SO_2, NO_2, and CO—improves estimations of concentrations over simpler empirical methods in the setting of Utah's complex topography and pollution episodes as well as its sparse monitoring network. To pursue this objective, we empirically fit variograms for each pollutant by airshed and season in nine airsheds in Utah where data were available. Leave-one-out cross validation was then performed to calculate root-mean-squared error (RMSE) and r^2 for each fit. These results were then compared to similar leave-one-out cross validations for simpler empirical methods: county average, closest monitor within airshed, and closest monitor limited to the footprint determined by the kriging fit.

1.2 Methods

The following subsections describe the airsheds and criteria pollutant data, variogram fitting, and cross validation.

1.2.1 Airsheds and Criteria Pollutant Data

Utah is located in the Western United States, and has 29 counties (Figure 1.1). According to the 2010 Census, Utah was home to 2.8 million residents, 79% of whom lived in five of the 29 Counties: Cache, Weber, Davis, Salt Lake, and Utah [27]. Juab, Millard, Beaver, Sanpete, Sevier, Morgan, Rich, Summit, Wasatch, and Piute Counties have no air pollution monitoring stations and are separated by mountains from counties that do have pollution monitoring. Daggett County has very little air pollution monitoring data. These counties are excluded from this analysis and will not be discussed further. Other areas of the state, which do have monitoring, were divided into nine airsheds based on topography, land-use characteristics, and the Environmental Protection Agency's airshed designations. Daily criteria air pollutant concentration data were downloaded from the EPA [28] for the study period (1988–2014). The study period for SO_2 was 2000–2014 because of a drastic reduction in emissions during the 1990s.

The Logan airshed encompasses the valley portion of Cache County (where most of the population resides), and was based on the Utah portion of the EPA's Logan/Franklin nonattainment area for $PM_{2.5}$ [5]. In 2010, Cache County was home to approximately 113,000 people [27]. As shown in Tables 1.2–1.3, there were 0–3 monitors for each of the criteria air pollutants included.

The Wasatch Front airshed consists of the portions (where most of the population resides) of Weber, Davis, and Salt Lake Counties that are west of the Wasatch Mountains. This is part of the EPA's Salt Lake nonattainment area for $PM_{2.5}$ [5]. In 2010, approximately 1.6 million people lived in Weber, Davis, and Salt Lake Counties [27]. The Box Elder and Tooele County portions of the EPA's Salt Lake nonattainment area were separated as their own airsheds for the purposes of this study because they are much more rural than Weber, Davis, and Salt Lake Counties. The western portions of Box Elder and Tooele Counties were not assigned to an airshed because there are no monitors there. Box Elder County was home to approximately 50,000 people in 2010, and Tooele County was home to approximately 58,000 [27]. See Tables 1.2–1.3 for information about pollutant data in these airsheds.

The Provo airshed is the valley portion of Utah County (where most of the population resides), and is based on the EPA's Provo nonattainment area for $PM_{2.5}$ [5]. Utah County

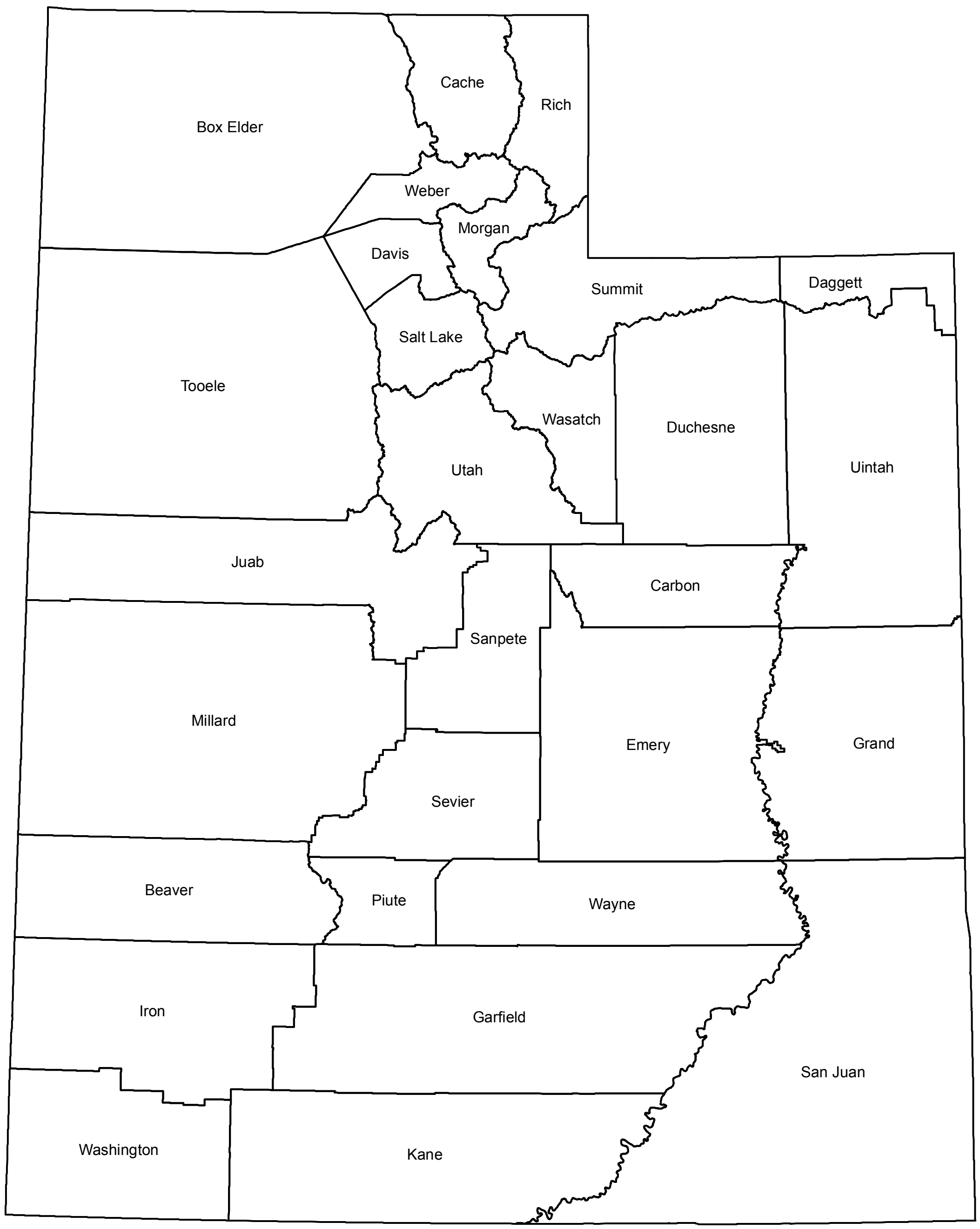

Figure 1.1. Counties of Utah [29].

Table 1.2. Summary of airsheds and air pollutant data. Median refers to the median concentration in the units listed in Table 1.1. The % $>$ NAAQS is based on the current NAAQS (Table 1.1), which is not necessarily the value of the NAAQS when any particular measurement was made. The abbreviations for the airshed names are as follows: L is Logan, WF is Wasatch Front, P is Provo, BE is Box Elder, T is Tooele, UB is Uintah Basin, I is Iron, WSH is Washington, SEUT is South-Eastern Utah. * means that not every year in the time frame indicated had data. + indicates that this airshed-pollutant had a variogram fit done. Criteria pollutant data were downloaded from the EPA [28].

Pollutant	Airshed	Years	# Monitors	# Data Points	Median	% $>$ NAAQS
+ $PM_{2.5}$	L	2000–2014	3	5120	6.50	4.75
+ $PM_{2.5}$	WF	1999–2014	14	23768	7.10	4.13
+ $PM_{2.5}$	P	1999–2014	5	12580	6.60	2.72
$PM_{2.5}$	BE	2000–2014	2	3227	5.50	2.26
$PM_{2.5}$	T	1999–2014*	2	3372	5.00	1.07
+ $PM_{2.5}$	UB	2009–2014	6	4674	5.30	0.30
$PM_{2.5}$	I	NA	0	0	NA	NA
$PM_{2.5}$	WSH	2000–2014	3	3195	3.60	0
+ $PM_{2.5}$	SEUT	1999–2013*	4	4065	2.40	0
PM_{10}	L	1995–2014	2	2352	21.00	0.04
+ PM_{10}	WF	1988–2014	15	38032	26.00	0.35
PM_{10}	P	1988–2014	4	17951	26.00	0.75
PM_{10}	BE	NA	0	0	NA	NA
PM_{10}	T	1993–1997	1	703	23.00	0.14
PM_{10}	UB	1988–2013*	5	1179	8.00	0.08
PM_{10}	I	1988–1997	1	530	19.00	0
PM_{10}	WSH	1995–1998	1	417	23.00	0
PM_{10}	SEUT	1988–2003	3	793	23.00	0.13
O_3	L	1995–2014	2	4755	0.05	1.11
+ O_3	WF	1988–2014	14	30907	0.05	7.19
+ O_3	P	1988–2014	4	10595	0.05	5.22
O_3	BE	2001–2014	2	4661	0.05	3.71
O_3	T	2005–2014	1	1435	0.05	4.04
+ O_3	UB	2007–2014	9	9184	0.05	5.12
O_3	I	NA	0	0	NA	NA
O_3	WSH	1995–2014*	4	5420	0.05	2.05
O_3	SEUT	1988–2014	4	10761	0.05	0.87

Table 1.3. Summary of airsheds and air pollutant data (continued). Median refers to the median concentration in the units listed in Table 1.1. The % > NAAQS is based on the current NAAQS (Table 1.1), which is not necessarily the value of the NAAQS when any particular measurement was made. The abbreviations for the airshed names are as follows: L is Logan, WF is Wasatch Front, P is Provo, BE is Box Elder, T is Tooele, UB is Uintah Basin, I is Iron, WSH is Washington, SEUT is South-Eastern Utah. * means that not every year in the time frame indicated had data. + indicates that this airshed-pollutant had a variogram fit done. Criteria pollutant data were downloaded from the EPA [28].

Pollutant	Airshed	Years	# Monitors	# Data Points	Median	% > NAAQS
NO_2	L	2002–2014	1	4157	28.00	0
+ NO_2	WF	1988–2014*	7	29545	41.00	0.39
NO_2	P	1988–2014*	1	8693	41.00	0.28
NO_2	BE	NA	0	0	NA	NA
NO_2	T	NA	0	0	NA	NA
+ NO_2	UB	2009–2014	8	7715	8.00	0.01
NO_2	I	NA	0	0	NA	NA
NO_2	WSH	2008–2014	2	1186	8.00	0
NO_2	SEUT	2011–2014	1	1253	10.00	0.08
CO	L	1995–2004	2	1316	1.30	0
+ CO	WF	1988–2014	12	36538	1.20	0.03
+ CO	P	1988–2014	10	18020	1.60	0.40
CO	BE	NA	0	0	NA	NA
CO	T	NA	0	0	NA	NA
CO	UB	2012–2013	1	503	0.30	0
CO	I	NA	0	0	NA	NA
CO	WSH	1995–1997	1	275	1.50	0
CO	SEUT	NA	0	0	NA	NA
SO_2	L	2002–2006	1	1230	2.00	0
+ SO_2	WF	2000–2014	9	21020	4.00	0.06
SO_2	P	NA	0	0	NA	NA
SO_2	BE	NA	0	0	NA	NA
SO_2	T	NA	0	0	NA	NA
SO_2	UB	2012–2013	2	433		0
SO_2	I	NA	0	0	NA	NA
SO_2	WSH	NA	0	0	NA	NA
SO_2	SEUT	NA	0	0	NA	NA

was home to approximately 517,000 people in 2010 [27].

The Uintah Basin airshed includes the valley portions of Duchesne and Uintah Counties as well as the northeast corner of Carbon County. (There are no municipalities in the northeast corner of Carbon County.) The combined population of Uintah and Duchesne Counties for 2010 was approximately 51,000 [27].

Southeastern Utah has low $PM_{2.5}$ concentrations nearly all of the time (Table 1.2). It is such a large area with so few monitors that the choices are to either have each monitor be its own airshed, or combine them into one very large airshed. We chose to combine them into one geographically extensive airshed that includes all or portions of Carbon, San Juan, Grand, Wayne, Garfield, Emery, and Kane Counties. These counties had a combined population of approximately 71,000 in 2010 [27].

Iron County had one PM_{10} monitor during the study period, which operated until 1997 (See Tables 1.2–1.3). Iron County is its own airshed due to being separated from neighboring counties by mountains and the elevation differences from the closest monitors to the one in Iron County. According to the 2010 Census, Iron County was home to 46,000 residents [27]. Washington County was also separated as its own airshed due to variations in elevation. The population of Washington County in 2010 was 138,000 [27].

1.2.2 Variogram Fitting

The purpose of kriging pollution data is to use observations to estimate the concentration at a location that does not have an observation [30]. This is essentially done by taking a weighted average of the observations. The weights are determined by the distance between the location for which the concentration is being estimated and the locations of the observations as well as the variogram model and parameters. Thus, an appropriate variogram model needs to be selected, and the parameters for the model need to be fit. The model and parameters also provide information about the length scales over which measurements are correlated [30]. This information can then be used to determine appropriate footprints for each pollutant in each airshed on a seasonal basis.

A variogram model was fit for each pollutant and each airshed independently. Fitting a variogram is an iterative process [30,31]. This process begins with an initial guess followed by refinements of the results in subsequent iterations. Since meteorological conditions and pollution concentrations often vary by season, we fit the variogram models to the data on annual and seasonal bases (ie, December-January-February, DJF; March-April-May, MAM; June-July-August, JJA; and September-October-November, SON). Additionally, since persistent CAPs are most common in Utah's valleys from mid-November to mid-March [5], we fit that part of the year as a cool season and also fit a warm season (mid-March to mid-November).

This study tested the Gaussian (Equation 1.1), Exponential (Equation 1.2), and Spherical (Equation 1.3) variogram models [30]. Although other models exist [30], these three were chosen because they allowed for more than one dimension with the assumption of isotropy and provided a means of calculating a characteristic footprint for monitors in an airshed. These models each have two parameters that constrain the model. One of these parameters is a length scale and the other is the variance (σ) [30]. For these models, the footprint (α) represents the distance at which the correlation between air quality measurements at separate monitors is ~ 0.05 [30]. For the Gaussian model (Equation 1.1), the length parameter is L, and α is $\sim 7 * L/4$. For the Exponential model (Equation 1.2), the length parameter is l, and α is $\sim 3 * l$. For the Spherical model (Equation 1.3), the length parameter is simply α. To get initial fits of the data, several values of α were chosen and used to calculate the length parameter. The values of α initially chosen were: 5, 10, 15, 30, 45, 60, and 80 km as well as the minimum, the maximum, and the median distances between monitors in a given airshed. The experimental variogram data, the length parameter, and the distances between monitors were then used to estimate the other model parameter, σ in Equations 1.1–1.3.

$$\gamma(h) = \sigma^2 \left(1 - \exp\left(-\frac{h^2}{L^2}\right)\right) \tag{1.1}$$

$$\gamma(h) = \sigma^2 \left(1 - \exp\left(-\frac{h}{l}\right)\right) \tag{1.2}$$

$$\gamma(h) = \begin{cases} \left(\frac{3}{2}\frac{h}{\alpha} - \frac{1}{2}\frac{h^3}{\alpha^3}\right)\sigma^2, & \text{for } 0 \le h \le \alpha \\ \sigma^2, & \text{for } h > \alpha \end{cases} \tag{1.3}$$

Each variogram model (Gaussian, Exponential, and Spherical) was fit for each season (year-round, DJF, MAM, JJA, SON, cool, and warm) for each of the chosen footprints (5, 10, 15, 30, 45, 60, and 80 km and minimum, maximum, and median distances between monitors) independently for every pollutant in every airshed. A leave-one-out method was used for calculating residuals [31, 32]. Following Section 4.5 of [30], several criteria were used to determine how well the various parameter estimates fit the data. First, the average of the residuals ($Q1$) was calculated, and the test failed if $|Q1| > 2/\sqrt(n-1)$. Second, the average of the square of the residuals ($Q2$) was calculated, and the test failed if $|Q2-1| > 2.8/\sqrt(n-1)$. Third, the distribution of the residuals was tested for normality. The tests for normality included the Shapiro-Wilk test, the Lilliefors test, the One-sample Kolmogorov-Smirnov test, and the chi-squared goodness-of-fit test [33–36]. Fourth, the residuals should be a random, uncorrelated variable [30], so the Pearson, Spearman, and Kendall correlations were tested between the residuals and each of the following variables: calendar date, number of monitors operational on the calendar date, the number of observations used in residual calculation, and the residuals themselves, but numerically sorted. Fifth, the RMSE was calculated, which should be minimized.

For the first round of variogram fitting, the tests described above were used to select the best variogram model and fit for each season (year-round, DJF, MAM, JJA, SON, cool, and warm), airshed, and pollutant. Next, the average of the RMSE of all seasons in a set (year-round, 4-seasons, 2-seasons) were calculated, and the season set with the lowest average RMSE was selected.

For the second round of variogram fitting, each parameter from the chosen fits of the first round of fitting was perturbed by a factor of 0.33, 0.67, 1.0, 1.5, and 3.0 to allow coarse adjustments to the best fits found from the first round of fitting. The same procedure for finding the best fit was repeated for the Q1, Q2, etc. results from the coarsely perturbed fits.

For the third round of variogram fitting, the parameters from the best fits determined in the second round of fitting were each perturbed by a factor of 0.70, 0.80, 0.85, 0.90, 0.95, 1.0, 1.05, 1.10, 1.15, 1.2, and 1.3 to allow fine adjustments to find the best fit. The same procedure for finding the best fit was repeated for the Q1, Q2, etc. results from the finely perturbed fits.

1.2.3 Cross Validation

Leave-one-out cross validation was performed for four empirical methods: kriging, county average, closest monitor within airshed, and closest monitor limited to those within the footprint determined from the kriging fit. For the kriging cross validation, for each day, each monitor in an airshed was left out one at a time and the remaining monitors were used to krig the concentration at the location of the left-out monitor. The residual was calculated as the difference between the estimated and observed concentrations. The collection of all residuals for all monitors for all days (in the season corresponding to the fit) in an airshed were used to calculate the RMSE and r^2, similar to [31, 32]. For the county average cross validation, for each county, leave-one-out cross validation was performed by calculating a pseudo-county average using the not-left-out monitors and then proceeding as described above. For the closest monitor within airshed cross validation, cross validation was calculated using only the closest monitor to the left-out monitor within the same airshed. The cross validation for the closest monitor limited to those within the footprint determined by the kriging fit was the same as that for the closest monitor, except that no calculation was done if the closest monitor to the left-out monitor was further away than the footprint listed in Table 1.4.

1.3 Results

Table 1.4 shows the variogram model fits. The quality of the fit was judged by the RMSE and r^2, which are shown in Tables 1.5–1.6. Due to an insufficient number of monitors, not all pollutants could be fit for all airsheds shown in Tables 1.2–1.3. $PM_{2.5}$ was fit for the Logan, Wasatch Front, Provo, Uintah Basins, and South-Eastern Utah airsheds. The Box Elder and Tooele airsheds each only had two monitors (Table 1.2), which is not enough to fit a variogram. While Washington county had three monitors, only two were ever run simultaneously.

PM_{10} was only fit for the Wasatch Front airshed. Provo was not fit because all monitors are within 11 km of each other, which did not allow an assessment of much spatial variation, and for the majority of the study period, only two PM_{10} monitors were operating in the Provo airshed. The remaining airsheds (Logan, Box Elder, Tooele, Uintah Basin, Iron, and Washington, SEUT) had at most 0–2 PM_{10} monitors operating at any one time during

Table 1.4. Variogram fits. L is Logan, WF is Wasatch Front, P is Provo, UB is Uintah Basin, and SEUT is South-Eastern Utah. Dist P is Distance Parameter and Fp is Footprint.

Pollutant	Airshed	Season	Model	σ	Dist P	Fp (km)
$PM_{2.5}$	L	cool	Spherical	4.48	10.94	10.94
$PM_{2.5}$	L	warm	Spherical	1.72	10.94	10.94
$PM_{2.5}$	WF	DJF	Gaussian	5.95	9.43	16.50
$PM_{2.5}$	WF	MAM	Exponential	1.31	8.04	24.12
$PM_{2.5}$	WF	JJA	Gaussian	3.33	2.57	4.50
$PM_{2.5}$	WF	SON	Exponential	3.02	8.00	24.00
$PM_{2.5}$	P	DJF	Spherical	4.35	18.00	18.00
$PM_{2.5}$	P	MAM	Exponential	1.90	13.00	39.00
$PM_{2.5}$	P	JJA	Gaussian	2.05	8.57	15.00
$PM_{2.5}$	P	SON	Spherical	2.35	25.50	25.50
$PM_{2.5}$	UB	DJF	Gaussian	11.44	101.30	177.28
$PM_{2.5}$	UB	MAM	Spherical	3.00	118.19	118.19
$PM_{2.5}$	UB	JJA	Spherical	3.50	52.26	52.26
$PM_{2.5}$	UB	SON	Gaussian	1.75	27.43	48.00
$PM_{2.5}$	SEUT	cool	Gaussian	0.98	168.07	294.12
$PM_{2.5}$	SEUT	warm	Spherical	1.21	197.06	197.06
PM_{10}	WF	cool	Exponential	12.70	3.25	9.75
PM_{10}	WF	warm	Gaussian	44.55	7.29	12.75
O_3	WF	year-round	Exponential	0.00493	11.58	34.74
O_3	P	MAM	Spherical	0.00295	24.00	24.00
O_3	P	JJA	Gaussian	0.00414	13.71	24.00
O_3	P	SON	Gaussian	0.00457	5.71	10.00
O_3	UB	DJF	Spherical	0.00889	66.00	66.00
O_3	UB	MAM	Exponential	0.00493	31.50	94.50
O_3	UB	JJA	Exponential	0.00297	10.50	31.50
O_3	UB	SON	Spherical	0.00418	21.00	21.00
NO_2	WF	DJF	Exponential	9.20	13.50	40.50
NO_2	WF	MAM	Spherical	1.75	10.16	10.16
NO_2	WF	JJA	Spherical	2.05	15.00	15.00
NO_2	WF	SON	Gaussian	1.56	8.14	14.25
NO_2	UB	DJF	Spherical	12.29	7.00	7.00
NO_2	UB	MAM	Gaussian	13.63	43.43	76.00
NO_2	UB	JJA	Exponential	5.22	0.39	1.16
NO_2	UB	SON	Spherical	10.91	60.45	60.45
CO	WF	DJF	Gaussian	2.16	30.86	54.00
CO	WF	MAM	Exponential	0.13	0.81	2.42
CO	WF	JJA	Exponential	0.59	7.50	22.50
CO	WF	SON	Gaussian	0.85	2.71	4.75
CO	P	year-round	Exponential	0.51	3.33	10.00
SO_2	WF	cool	Gaussian	5.06	8.14	14.25
SO_2	WF	warm	Gaussian	7.40	5.09	8.91

Table 1.5. Comparison of RMSE and r^2 for four pollution assignment methods. The units for RMSE are the units shown in Table 1.1 for a given pollutant. The lowest RMSE and highest r^2 on each row are bolded. K = kriged, CFP = closest limited to footprint, C = closest, and CA = county average.

Pollutant	Airshed	Season	K RMSE	K r^2	CFP RMSE	CFP r^2	C RMSE	C r^2	CA RMSE	CA r^2
$PM_{2.5}$	L	cool	**5.71**	**0.88**			6.71	0.85	**5.71**	**0.88**
$PM_{2.5}$	L	warm	**2.28**	**0.48**			2.71	0.39	**2.28**	**0.48**
$PM_{2.5}$	WF	DJF	5.39	0.88	**4.96**	**0.91**	5.96	0.87	5.39	0.89
$PM_{2.5}$	WF	MAM	2.48	0.68	2.69	0.66	2.92	0.61	**2.34**	**0.72**
$PM_{2.5}$	WF	JJA	**3.89**	**0.47**	5.56	0.37	4.84	0.33	4.16	0.39
$PM_{2.5}$	WF	SON	**3.01**	**0.75**	3.61	0.70	3.62	0.70	3.13	**0.75**
$PM_{2.5}$	P	DJF	**4.93**	**0.90**	5.31	0.89	5.31	0.89	5.00	**0.90**
$PM_{2.5}$	P	MAM	**1.93**	0.79	2.00	0.78	2.00	0.78	1.96	0.78
$PM_{2.5}$	P	JJA	**2.46**	**0.68**	2.66	0.65	2.66	0.65	2.48	0.67
$PM_{2.5}$	P	SON	**2.31**	**0.76**	2.47	0.75	2.47	0.75	2.41	0.73
$PM_{2.5}$	UB	DJF	**4.59**	**0.63**	5.05	0.55	5.05	0.55	5.31	0.37
$PM_{2.5}$	UB	MAM	**2.72**	**0.40**	2.80	**0.40**	2.80	**0.40**	2.99	0.32
$PM_{2.5}$	UB	JJA	4.33	**0.52**	**4.29**	0.43	4.56	0.49	4.79	0.41
$PM_{2.5}$	UB	SON	2.17	0.56	**2.14**	**0.60**	2.21	0.57	2.20	0.52
$PM_{2.5}$	SEUT	cool	**0.87**	**0.32**	0.94	0.26	0.94	0.26		
$PM_{2.5}$	SEUT	warm	1.45	0.57	**1.39**	**0.62**	1.52	0.55		
PM_{10}	WF	cool	14.51	0.74	**13.77**	**0.81**	16.60	0.73	16.13	0.71
PM_{10}	WF	warm	**15.54**	**0.43**	19.83	0.27	20.23	0.28	18.40	0.33
O_3	WF	year-round	**0.00519**	**0.88**	0.00590	0.84	0.00589	0.85	0.00531	0.84
O_3	P	MAM	0.00371	**0.75**	0.00400	0.72	0.00398	0.72	**0.00369**	**0.75**
O_3	P	JJA	**0.00480**	**0.77**	0.00503	0.75	0.00506	0.75	0.00484	0.76
O_3	P	SON	0.00580	0.60	**0.00455**	**0.79**	0.00670	0.53	0.00580	0.60
O_3	UB	DJF	**0.00864**	**0.85**	0.00933	0.83	0.00933	0.83	0.00985	0.80
O_3	UB	MAM	**0.00452**	**0.71**	0.00479	0.68	0.00479	0.68	0.00478	0.69
O_3	UB	JJA	**0.00315**	**0.75**	0.00463	0.56	0.00415	0.62	0.00330	0.73
O_3	UB	SON	**0.00479**	**0.69**	0.00706	0.48	0.00643	0.53	0.00545	0.62

Table 1.6. Comparison of RMSE and r^2 for four pollution assignment methods (continued). The units for RMSE are the units shown in Table 1.1 for a given pollutant. The lowest RMSE and highest r^2 on each row are bolded. K = kriged, CFP = closest limited to footprint, C = closest, and CA = county average.

Pollutant	Airshed	Season	K RMSE	K r^2	CFP RMSE	CFP r^2	C RMSE	C r^2	CA RMSE	CA r^2
NO_2	WF	DJF	10.56	0.58	10.36	0.55	11.14	0.56	**6.77**	**0.72**
NO_2	WF	MAM	9.73	0.45			11.23	0.35	**8.63**	**0.48**
NO_2	WF	JJA	11.51	0.35	12.29	0.25	13.33	0.26	**9.22**	**0.44**
NO_2	WF	SON	8.93	0.49	**7.24**	**0.57**	10.37	0.40	**7.24**	**0.57**
NO_2	UB	DJF	13.85	**0.14**	**12.78**	0.01	16.10	0.11	16.97	0.03
NO_2	UB	MAM	**8.55**	0.05	8.60	**0.08**	8.60	**0.08**	8.49	0.01
NO_2	UB	JJA	**6.27**	0.01			7.21	**0.04**	7.01	0.00
NO_2	UB	SON	**9.48**	0.02	9.51	**0.06**	9.95	0.05	10.17	0.00
CO	WF	DJF	2.56	0.12	1.39	0.29	**1.37**	0.30	1.38	**0.31**
CO	WF	MAM	0.69	0.30	**0.30**	**0.76**	0.84	0.15	0.84	0.16
CO	WF	JJA	0.71	0.29	**0.37**	**0.57**	0.65	0.40	**0.37**	**0.57**
CO	WF	SON	**0.95**	**0.41**	1.38	0.23	1.18	0.25	1.18	0.28
CO	P	year-round	1.39	**0.37**	1.55	0.31	1.55	0.31	**1.38**	**0.37**
SO_2	WF	cool	**5.55**	**0.10**	6.35	**0.10**	6.41	0.09	6.44	0.02
SO_2	WF	warm	**8.45**	**0.03**			10.37	0.01	9.69	0.02

the study period.

O_3 was fit for the Wasatch Front (Figure 1.2), Provo, and Uintah Basin airsheds. However, Provo was not fit for O_3 during DJF because there were not enough data during that season. The remaining airsheds had at most 0–2 O_3 monitors operating at any one time during the study period. The σ values are numerically much smaller than the other pollutants because unlike the other criteria pollutants, concentrations are less than an integer value when measured in ppm (See Table 1.1).

NO_2 was fit for the Wasatch Front and Uintah Basin airsheds. The remaining airsheds had at most one NO_2 monitor operating at any one time (except for two days in Washington County). CO was fit for the Wasatch Front and Provo airsheds. All other airsheds had 0–2 CO monitors operating during the study period. SO_2 was only fit for the Wasatch Front. All other airsheds had 0–2 SO_2 monitors during the study period.

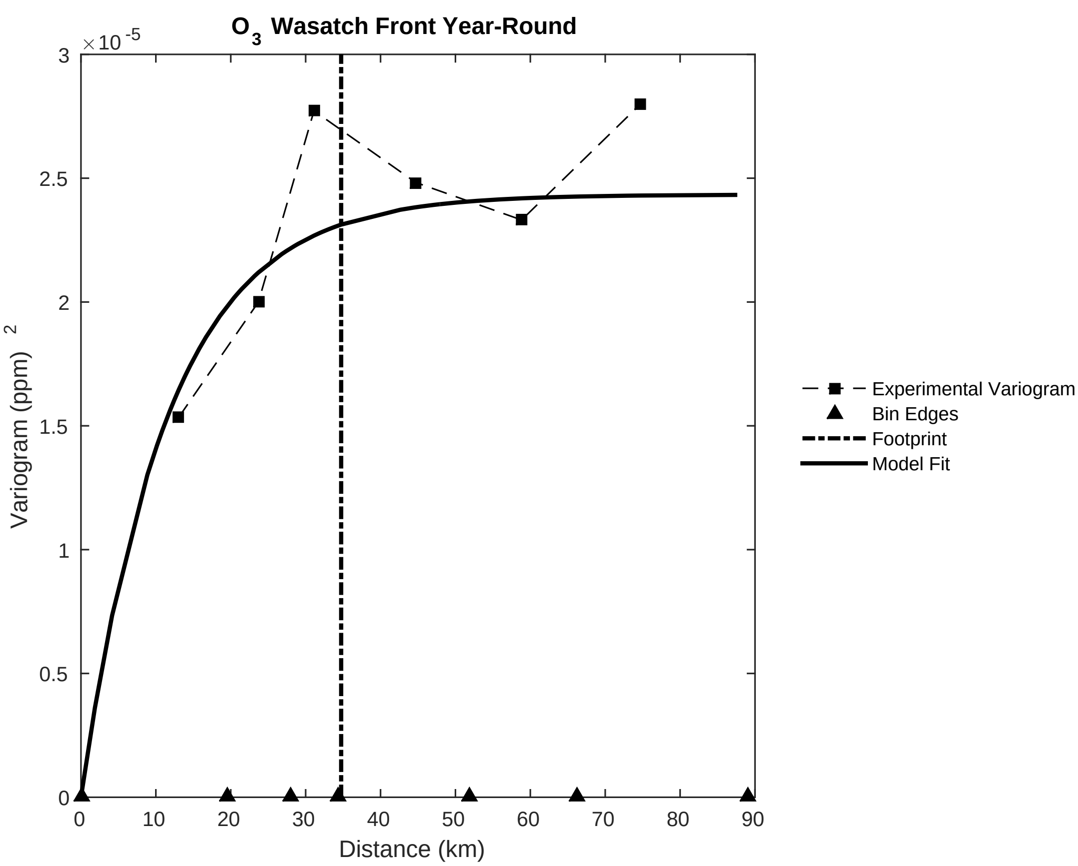

Figure 1.2. Wasatch Front O_3 variogram.

1.4 Discussion

The consistency of variogram fits and quality of the pollution concentration estimation methods will be discussed in the following subsections.

1.4.1 Consistency of Fits

Of the airsheds that could be fit for variograms (Table 1.4), the Wasatch Front and Provo airsheds are more similar to each other in terms of land use, population, emissions, and number of observations than any other pair of airsheds, so the fits for these airsheds are most directly comparable to each other. The Uintah Basin is unique with its winter ozone problem [9] and numerous oil and gas wells. SEUT covers a very large land area, and in the presence of more monitors, would be broken up into smaller airsheds. SEUT was only fit for $PM_{2.5}$, for which it has lower concentrations than all of the other airsheds that were fit (Table 1.2). The Logan airshed is geographically much smaller than the other airsheds that were fit, more of an enclosed basin, and its emissions are more agriculturally based than the other airsheds that were fit.

In studies examining the health effects of air pollution that use the closest monitor, we suggest only assigning pollution data to persons residing within the distance of the footprint to the closest monitor. The footprint is an indication of the homogeneity of pollutant concentrations within an airshed, ie, the longer the footprint, the more homogenous the pollutant concentrations.

The $PM_{2.5}$ footprint calculated for DJF for Wasatch Front and Provo are similar (16.5 km and 18.0 km, respectively). The footprint calculated for SON for these airsheds is also consistent (24.0 km for Wasatch Front and 25.5 km for Provo). The footprint for the $PM_{2.5}$ variogram fit had the shortest distance in summer (JJA) compared to the other seasons for both the Wasatch Front and Provo airsheds (Table 1.4). It is possible that wildfire smoke and smoke from fireworks (both of which can create isolated plumes) are responsible for the summertime heterogeneity of $PM_{2.5}$ concentrations. Additionally, the Wasatch Front is a longer airshed, spanning from Weber to Salt Lake Counties, so the plume from a wildfire in the mountains adjacent to Weber County, for example, may not impact Salt Lake County monitors, depending on wind direction. The Provo airshed is smaller and it is more likely that a smoke plume from a wildfire in the mountains adjacent to the Provo airshed would impact all monitors in the airshed. This could explain why the footprint for $PM_{2.5}$ in JJA is so much smaller in the Wasatch Front (4.5 km) than in Provo (15.0 km).

With the exception of JJA, the footprints for PM_{10} for the Wasatch Front were shorter than those for PM_{10}. This makes sense because PM_{10} includes larger particles in addition to the $PM_{2.5}$, and larger particles are expected to fall out of the atmosphere more quickly than smaller particles.

1.4.2 Quality of Estimation Methods

The quality of the estimation method for a given pollutant/airshed/season combination was judged by the RMSE and r^2, which are shown in Tables 1.5–1.6. A high-quality estimation method has a low RMSE value and a high r^2. The best estimation method is the one with both the lowest RMSE value and the highest r^2. In the circumstance that one method did not have both the lowest RMSE and highest r^2, it is less clear which method performed best. This only occurred in circumstances where no method did well (ie, all had $r^2 \leq 0.31$). It would not be a fair comparison to compare RMSE values directly between different pollutants because they are based on various units (Table 1.1) and have different typical concentrations (Tables 1.2–1.3).

For most of the time series for $PM_{2.5}$ in Logan, there was only one monitor operating. For approximately a year, three monitors were running simultaneously. The cross validation could only be based on the one year where there were multiple monitors, and leaving one out to do the cross validation means that only data for two monitors were used for both the kriging and county average. This is why RMSE and r^2 are so similar for the kriging and county average methods, which performed better than closest monitor.

For $PM_{2.5}$ during DJF in the Wasatch Front, the closest monitor limited to those within the footprint (16.5 km as shown in Table 1.4) performed better than the other methods. County average performed better during MAM, and kriging performed the best during JJA and SON. Kriging performed better for $PM_{2.5}$ in the Provo airshed than all other methods for all seasons. Given the size of the population in the Wasatch Front and Provo airsheds (1.6 million and 517,000 residents, respectively [27]), and the nonattainment status of these two airsheds for $PM_{2.5}$ due primarily to winter pollution events [5], it is worth noting that all estimation methods for these airsheds had $r^2 \geq 0.87$ during DJF, and the best-performing methods (CFP for Wasatch Front and kriging for Provo) had $r^2 \geq 0.90$ for DJF. For $PM_{2.5}$ in the Uintah Basin, kriging performed best for DJF and MAM, while closest monitor limited to footprint performed best during JJA and SON.

Tables 1.5–1.6 show that kriging or closest monitor limited to the footprint that was determined by the kriging fit improved the $PM_{2.5}$ concentration estimation for 13 out of 16 pollutant/airshed/season combinations for $PM_{2.5}$, while it tied for two (Logan). The kriging fit only failed to tie or improve the $PM_{2.5}$ estimation for springtime (MAM) in the Wasatch Front.

For PM_{10}, kriging improved estimation for both of the fits (Wasatch Front cool and warm seasons) over closest monitor in airshed and county average. Closest monitor limited to the footprint determined by the kriging performed better than kriging directly for the cool season.

Kriging performed better than all other estimation methods for 6 of the 8 O_3 fits. County average performed best for MAM in Provo, though the r^2 tied with that for kriging. Closest monitor limited to the footprint determined by the kriging fit performed best on the 8th fit.

County average did as well or tied for all NO_2 fits in the Wasatch Front compared to other estimation methods. All estimation methods performed quite poorly for NO_2 fits in the Uintah Basin, as all r^2 are ≤ 0.14. Unlike most of the cross validations, there is inconsistency between which method performed better based on RMSE versus r^2.

County average did as well or tied for three of the five CO cross validations. Kriging did not improve estimation for any of the fits for CO. All estimation methods performed quite poorly for both SO_2 fits, as all r^2 are ≤ 0.10. Kriging did perform better than the other estimation methods.

A monitoring network with different numbers and locations of monitors would likely impact on quality of fit and what the parameters are. Additional monitors would likely improve the fits. The methods discussed herein are best suited when considering temporal variations in pollutant concentration, such as in case crossover studies. This method is not as well suited when considering chronic exposures to highly localized sources such as freeways, but in the setting of a much denser monitoring network, kriging could be applied.

While topography and population density were considered when determining the spatial extent of each airshed, those decisions are still somewhat arbitrary, especially in SEUT, which is a vast geographic portion of Utah with very few monitors. The choices were to either consider every monitor as its own airshed, which would not allow for any variogram fitting, or combine large areas into an airshed. Even with combining such a large area, SEUT could only be fit for $PM_{2.5}$, for which that area of the state typically has very low concentrations.

Closest monitor within airshed did not have both the lowest RMSE and the highest r^2 for any pollutant in any season in any of the airsheds considered in this study. Therefore, we do not recommend this method for assigning pollution data to medical data in health studies. However, closest monitor limited to a calculated footprint (eg, Table 1.4) performs as well or better than either kriging or county average in some circumstances (Tables 1.5–1.6).

The performance of each method varied by pollutant, season, and airshed. Kriging generally performed better than the simpler empirical methods for O_3, $PM_{2.5}$, and SO_2, while it was mixed for PM_{10}. Kriging did not perform better than the simpler empirical methods for NO_2 and CO. The performance of the kriging method for each criteria pollutant is thought to be influenced by the chemistry, emissions patterns, and the number and spatial distribution of monitoring stations for each criteria pollutant. We urge careful consideration of the method of assigning air pollution data to individuals in air pollution - health effects studies. Some health outcomes are likely to have such a strong signal when analyzing the effects of air pollution that the marginal improvement of using one air pollution assignment method over another will have minimal impact on the findings of the study. However, if the magnitude of the effect of air pollution on the health outcome of interest is smaller, the method used to assign pollution data to the medical records could alter the conclusions of the study. This work could be extended by using the various air quality modeling approaches to estimate pollutant concentrations and comparing the predicted and observed values to calculate the RMSE, which could be directly compared to the RMSE values calculated in this paper. This work can also be extended by analyzing whether odds ratios in health studies are sensitive to which method of air pollution assignment is used. This will likely depend on how sensitive the disease outcomes are to air pollution.

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CHAPTER 2

INFLAMMATORY BOWEL DISEASE AND ACUTE EXPOSURES TO AMBIENT AIR POLLUTION

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Studies have suggested a possible link between ambient air pollution and inflammatory bowel disease (IBD). Herein, IBD exacerbations are compared to acute exposures to ambient air pollution. Individual-level patient data from the Utah Population Database, Intermountain Healthcare, and University of Utah Health Sciences Center for patients with IBD were used to identify zip code of residence and timing of IBD exacerbations during January 2000 through May 2014. Daily concentrations of particulate matter, ozone, and nitrogen dioxide were obtained from the Environmental Protection Agency and then interpolated (kriged) from monitor locations in the airshed of residence to the zip codes of residence, creating individual daily pollution histories for the study period. Case crossover design analysis was performed at the individual level. The analysis was repeated using the county average, closest monitor within airshed, and closest monitor limited to a specified footprint to evaluate the sensitivity of the results to the personal exposure estimation methodology. The odds ratio (OR) of prednisone prescription for a person with IBD with a 4-day mean $PM_{2.5}$ exposure above 125% of the National Ambient Air Quality Standard (NAAQS) was 4.2, with a 95% confidence interval (CI) of 2.0-8.7 and a p-value of 0.0001. The OR of a gastrointestinal infection for a person with Crohn's Disease with $PM_{2.5}$ analyzed as a continuous variable (where 1% of NAAQS is the 1-unit increment) was 1.0123, with a CI of 1.0031-1.0216 and a p-value of 0.009. When restricting the infection analysis to only include Clostridium difficile (C. diff), the OR became 1.0135, with a CI of 1.0005-1.0267

and a p-value of 0.042. None of the analyses for infection in ulcerative colitis had a p-value < 0.1. In this individual-level case-crossover analysis, acute $PM_{2.5}$ exposures appear to be associated with increased use of prednisone prescriptions and gastrointestinal infections among individuals with at least five entries of IBD diagnosis ICD-9 codes (555.x, 556.x) in their medical records.

2.1 Introduction

Pathogenesis of inflammatory bowel disease (IBD) relates specifically to an over-reactive, dysregulated immune response in the intestine [1,2]. IBD collectively refers to both Crohn's disease (CD) and ulcerative colitis (UC) [3]. Gastrointestinal infection, particularly Clostridium difficile (C. diff) infection, is a common co-morbidity of IBD. Heritability is $\sim$20% with increasing incidence [3, 4], a pattern that is not consistent with a strictly genetic explanation. This has led to an increased search for environmental influences, and several environmental factors are thought to exacerbate IBD, including nonsteriodal anti-inflammatory drugs (NSAIDs), infection, and stress [5, 6]. A small but growing body of literature suggests that air pollution could exacerbate IBD as well [1, 2, 6–8].

The few studies that have directly looked at the impacts of air pollution on IBD encourage further research on the topic [1, 2, 9]. Ananthakrishnan et al. [1] found that the 2002 emissions inventories in Wisconsin for CO, NO_2, SO_2, and $PM_{2.5}$ were positively correlated with the annual rate of IBD hospitalizations at the county level. Kaplan et al. [7] found that the diagnosis of CD occurred more often in young patients with exposure to increased NO_2. Some studies suggest an association between another GI disease (appendicitis) and air pollution [10–12].

It is plausible that pollution may play a role in IBD because air pollution can enter the gastrointestinal (GI) tract by 1) being inhaled, absorbed systemically, and carried to the GI tract by the bloodstream; 2) being inhaled, adhering to the airways, being cleared by cilia and ingested; 3) contaminating food or water that is ingested; or 4) swallowing air [2, 8, 13]. Once in the intestinal tract, air pollution can cause direct toxic effects on the epithelial cells (DNA damage and permeability disruption) [2, 8, 14]. Air pollution can also cause systemic inflammation, oxidative stress, immune activation, bone marrow stimulation, increased cytokine levels, as well as increased white blood cells [1, 2, 14].

Pollution can change intestinal disease via effects upon microbiota and/or the effects of swallowed pollutants on epithelial cells within the GI tract [2, 14]. Additionally, pollution elevates levels of tumor necrosis factor (TNF)-α and interleukin (IL)-6 [2, 14]. Air pollution is detrimental to the immune system, increasing susceptibility to respiratory infection [15]. Thus, it is conceivable that through direct ingestion or indirect exposure, patients with IBD may develop worsening symptoms or susceptibility to GI infection with exposure to air pollution.

Case-crossover design (CCOD) analysis was utilized to investigate the potential association between ambient air pollution and IBD, with prednisone prescriptions and gastrointestinal infections as the endpoints of interest.

2.2 Materials and Methods

The following subsections will describe the study population, environmental variables, and health endpoints considered in this research as well as case-crossover design, which was used to perform the analysis.

2.2.1 Study Population

The setting for the present study was the state of Utah. Located in the western U.S., Utah was home to an estimated 2.8 million residents in 2010, of which 2.2 million lived in the Cache, Weber, Davis, Salt Lake, and Utah Counties in Northern Utah [16]. The geography of Utah is characterized by complex topography with a mix of mountains, valleys, and canyon-rich deserts. Both the complex topography and the uneven distribution of the population strongly influence the spatial distribution of criteria pollutants across the state, which can be divided into distinct airsheds [17, 18]. Several areas of the state have been designated as nonattainment areas for particulate matter with an aerodynamic diameter less than 2.5 μm ($PM_{2.5}$), and exceedances of the daily National Ambient Air Quality Standards (NAAQS) are observed for both $PM_{2.5}$ and ozone (O_3) nearly annually [17, 19–22]. The Uintah Basin in Eastern Utah is unusual in that elevated O_3 concentrations are observed in both summer and winter [23].

The population of interest for this study was all persons who were coded for IBD via ICD-9 codes 556.x for Crohns Disease (CD) or 555.x for ulcerative colitis (UC), and who resided in counties within Utah that had air pollution monitoring during January 2000 through May 2014. The analysis was limited to persons who were at least one year old and not older than 90 years of age. To control for the lack of sensitivity of ICD-9 codes for CD and UC, we required at least five separate entries of the inclusion codes (555.x, 556.x) for a person to be included in the analysis [24, 25]. Medical data were obtained from the Utah Population Database (UPDB) [26], Intermountain Healthcare (IH), and University of Utah Health Sciences Center (UUHSC). The UPDB is a shared research resource of the University of Utah. The UPDB contains linked data from the Utah Cancer Registry, driver licenses, voter registration, genealogy data, and vital records. This resource has also been linked to inpatient and outpatient electronic medical records from 1995 to the present drawn from the UUHSC and IH, which together account for approximately 85% of all medical encounters in Utah. Through the UPDB, all inpatient and outpatient electronic medical records from IH, UUHSC, and other available statewide medical data collected by the Utah Department of Health (ie, all statewide outpatient surgeries and hospital discharge summaries) have been linked. Patient records included zip code of residence.

2.2.2 Environmental Variables

Ambient concentration data for nitrogen dioxide (NO_2), ozone (O_3), and $PM_{2.5}$ are publicly available and were downloaded from the Environmental Protection Agency (EPA) [27]. Daily personal histories of pollution data from January 2000 through May 2014 were created by interpolating (via kriging) available pollution data from monitors to the centroids (geometric centers) of zip codes of residence, as described in Maestas et al. [18]. Some airsheds have monitoring data, but not enough to fit a variogram [18], so variogram fits for some airsheds were borrowed from neighboring airsheds. Not all pollutants are measured in all airsheds and not all are observed on a daily basis, so there are gaps in the personal histories. The National Ambient Air Quality Standards (NAAQS) for NO_2, O_3, and $PM_{2.5}$ are 100 ppb, 0.07 ppm, and 35 μg m^{-3}, respectively. The current NAAQS were applied to the entire time series of pollution data, regardless of when any given NAAQS value was set by the EPA. For ease of interpretation, the units of all pollutants were converted to what will be referred to as Common Units (CU), which is the percentage of the NAAQS. For example, if the daily average concentration of $PM_{2.5}$ is 35 μg m^{-3}, that concentration is 100 CU since the NAAQS for this pollutant is also 35 μg m^{-3}. Temperature data from the National Weather Service [28, 29] were also included in the daily personal histories.

To evaluate the sensitivity of the results to the personal exposure estimation methodology, the analysis was repeated using four versions of air pollution data: 1) interpolated to zip code of residence using kriging, 2) county average, 3) closest monitor to centroid within zip code of residence, and 4) closest monitor to centroid within airshed code of residence, limited to those centroids within a certain distance (footprint) of a monitor (footprint determined by kriging analysis) [18].

2.2.3 Endpoints

The primary clinical endpoint considered was prednisone prescription. All prednisone prescriptions that could be tracked and confirmed from clinics, emergency visits, hospitalizations, and telephone encounters were considered to be positive for analysis. Other endpoints considered included emergency visits and hospitalizations coded for the underlying disease. It was recognized, however, that emergency visits coded for underlying inflammatory disease could be confounded by infections causing such a flare. Additionally, we recognized that many emergency visits and hospitalizations are avoided by the use of prednisone. Thus, prednisone was used as the primary outcome for analysis. Hospitalizations were considered in a secondary analysis (see Table 2.1).

Endpoints for infection were stratified by the use of ICD-9 codes 8.x for intestinal infection. Any subjects coded for one of these after any visit type or encounter were considered to have intestinal infection. Further validation of infection risk included analysis on C. diff alone, as this is commonly seen in inflammatory bowel disease.

2.2.4 Statistical Analysis

We used CCOD, which is a variant of the case control design in which only cases are studied and each subject serves as their own control [30]. CCOD is a good choice for health effects-pollution research because characteristics that are invariant on the timescale of several weeks (eg, age, gender, and smoker status) are controlled for. In this context, prednisone prescriptions, gastrointesinal infections, and hospitalizations are referred to as

Table 2.1. ICD-9 and CPT codes required for IBD exacerbation events. (It as an event if at least one of the codes in a given column occurred.) Code refers to the ICD-9 or CPT code.

Description	Code	Hosp	Pred	Inf.	c diff
admissions with discharge diagnoses pertaining to IBD	560.x	X			
colectomy	44144	X			
colectomy	44150	X			
colectomy	44155	X			
resection of intestinal obstruction	44615	X			
non-infectious enteritis	558.9	X			
drainage of abscess	569.5	X			
CMV ent.	078.5	X		X	
infectious colitis or enteritis	008.x	X		X	
Intestinal infection due to clostridium difficile (c diff)	008.45	X		X	X
infectious colitis enteritis and gastroenteritis	009.0	X			
colitis enteritis and gastroenteritis of presumed infectious origin	009.1	X		X	

"events". We considered 4-day (4D) and 1-week (1W) symmetric bidirectional time frames, and Figure 2.1 shows example hazard and control periods for each time frame. For the 4D time frame, the four days leading up to and including the day of the event was the hazard period, and the exposure during this time was compared to six control periods: four-day windows ending 1, 2, and 3 weeks before and after date of event. For the 1W time frame, a one-week time window ending on the date of the event was the hazard period, and the exposure during this time window was compared to the exposure during two control periods: the 1-week windows before and after the 1-week hazard period. If a person had a repeated event within 56 days, only the first was counted. Separately, the mean and maximum pollutant concentration for each time frame were analyzed.

Analyses were performed using exposure variables as categorical and (separately) continuous variables. Several categorical analyses were performed where various thresholds for "exposed" were set: 75 CU, 100 CU, and 125 CU. Analyses were run one pollutant at a time (data not shown), as well as in multipollutant mode. When multiple pollutants were included, the exposed threshold for all pollutants was held at 50 CU, except for one pollutant (at a time), for which the threshold was set to 75, 100, and 125 CU.

For any given categorical analysis, if there were not at least 10 hazard periods in the

a) 4D

Su	M	Tu	W	Th	F	Sa
	June 1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18 (1)	19	20
21	22	23	24	25 (2)	26	27
28	29	30	July 1	2 (3)	3	4
5	6	7	8	9 (Event)	10	11
12	13	14	15	16 (4)	17	18
19	20	21	22	23 (5)	24	25
26	27	28	29	30 (6)	31	

b) 1W

Su	M	Tu	W	Th	F	Sa
	June 1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	July 1	2 (1)	3	4
5	6	7	8	9 (Event)	10	11
12	13	14	15	16 (2)	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Figure 2.1. This figure shows the pattern for time frames used for case-crossover design, using an example event occuring on July 9. Black denotes the hazard period and grey denotes the control periods. The number in parentheses denotes the end of the control period. a) 4D, length of each hazard and control period is four days. b) 1W, length of each hazard and control period is one week.

exposed category as well as 10 hazard periods in the unexposed category, than that analysis was skipped. Likewise, if there were not at least 10 control periods in the exposed category and 10 control periods in the unexposed category, then the analysis was skipped. Continuous analyses were skipped if there were not at least 10 hazard and 10 control periods of at least 50 CU. For the continuous analysis, one unit was 1 CU, ie, 1% of NAAQS. Analyses were carried out using MatLab (mathworks.com) and SAS software (Release 9.4; SAS Institute, Cary, North Carolina, USA).

The study was approved by the Institutional Review Boards (IRB) for the University of Utah (IRB # 55618) and Intermountain Healthcare (IRB # 1040202), as well as the Utah Resource for Genetic and Epidemiological Research, which is the regulatory body that oversees access to the UPDB.

2.3 Results

There are 3,343 persons in this cohort who had at least five entries of IBD diagnosis ICD-9 codes (556.x and/or 555.x) in their record, 47.3% of whom were male. This cohort is 84.3% non-Hispanic and white. Table 2.2 shows the number of IBD events, not all of which could be assigned pollution data. If someone had multiple zip codes in their record in a given year, then no pollution data were assigned to that person for that year. No polllution data were assigned if someone was living outside the airsheds with pollution data at the time of the event. Also, ozone was not measured in the Tooele and Uintah Basin airsheds during 2000-2005 and 2000-2007, respectively. Table 2.2 also shows the age distribution.

Figure 2.2 is a summary plot of the odds ratios (OR) for prednisone prescriptions and $PM_{2.5}$ controlling for O_3, NO_2, and temperature for each of the four air pollution estimation methods used. None of the analyses for the 1W mean above 125 CU could be performed due to low numbers of exposed cases at that threshold, as denoted by hatching. A few other analyses are absent for the same reason. Figure 2.3 shows the OR and confidence intervals for categorical analyses of prednisone prescriptions and $PM_{2.5}$ using kriged data. This corresponds to the first column of Figure 2.2 without the middle sections (which are the continuous analyses). The OR and confidence intervals for the continuous analyses and other pollution estimation methods are given in the Supplemental Material.

Table 2.2. Age distribution of IBD exacerbation events. (See Table 2.1 for list of codes for each event type.) Descriptions are based on the events, so some people will be counted multiple times. The project spans January 2000 through May 2014, so people who have multiple events could be different ages at each of those events. Not all of the events could be assigned air pollution data. Demographic data were not known for all events, so the numbers in each age group may not add up to the total number of events. Some people were coded for both CD and UC, so their events will show up in the analyses for both phenotypes. This is also why the number of CD events plus the number of UC events adds up to a larger number than the number of IBD events. SD = standard deviation.

	Pred			Inf			C. diff			Hosp		
Description	IBD	UC	CD	IBD	UC	CD	IBD	UC	CD	IBD	UC	CD
# events	475	259	256	490	262	279	330	185	180	1581	519	1181
# people	292	146	171	384	195	218	254	132	141	1040	362	733
% male	52	60	44	47	53	43	47	55	42	51	53	50
mean age (years)	42	41	43	41	41	39	41	42	39	43	42	43
age SD (years)	16	16	16	20	19	19	20	20	19	18	18	18

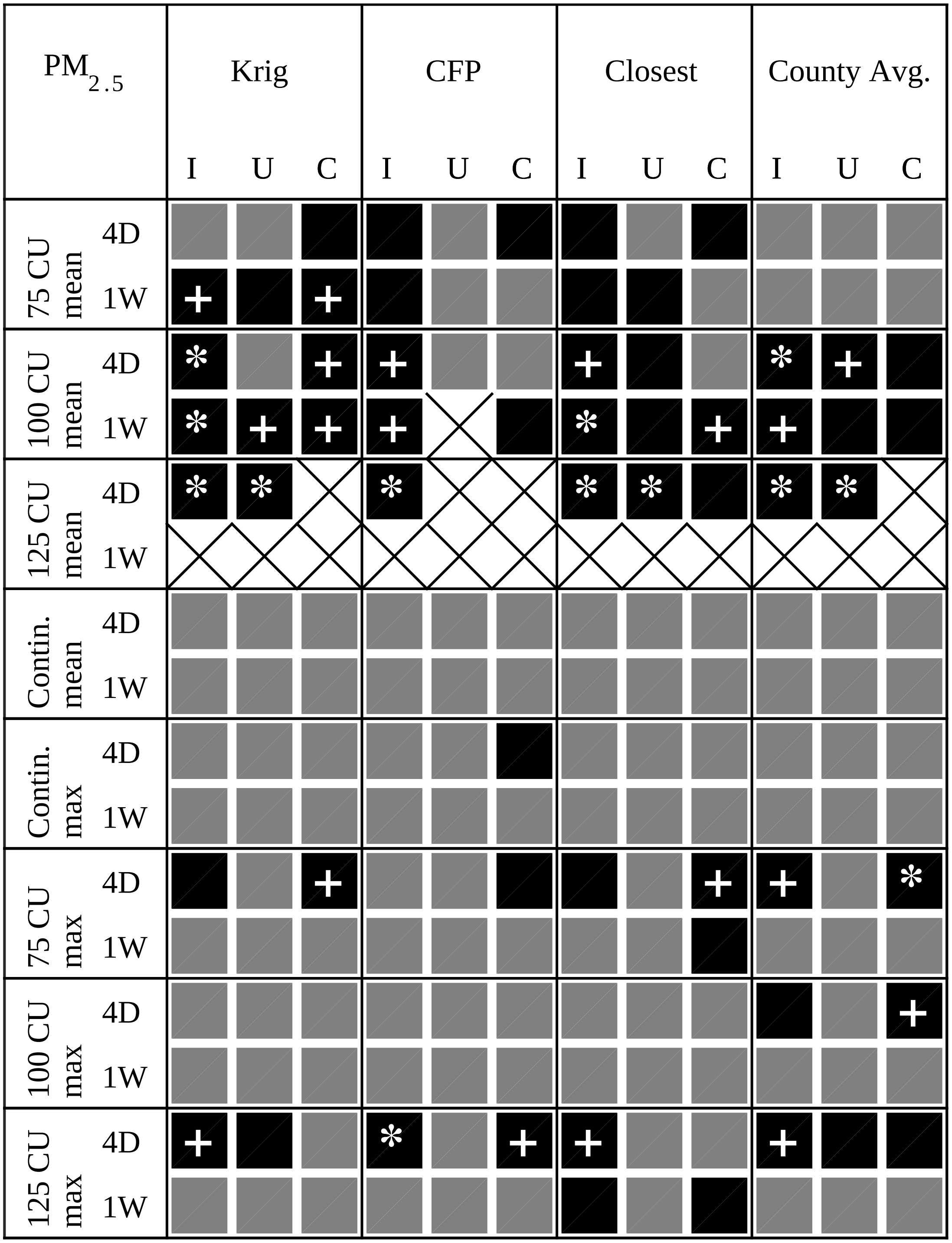

Figure 2.2. Summary plot of odds ratios (OR) for IBD prednisone prescriptions and $PM_{2.5}$ for both continuous as well as categorical analyses at 75 CU, 100 CU, and 125 CU using the mean or maximum concentration during the 4-day (4D) and 1-week (1W) time frames for four methods of assigning pollution data, controlling for O_3, NO_2, and temperature. Grey squares indicate p-value$\geq$0.10. Black squares indicate OR$>$1 with p-value$<$0.10. The plus sign indicates p-value $<$0.05. The asterisk indicates p-value $<$0.01. CFP is closest within footprint. I is all IBD. U is ulcerative colitis. C is Crohn's Disease.

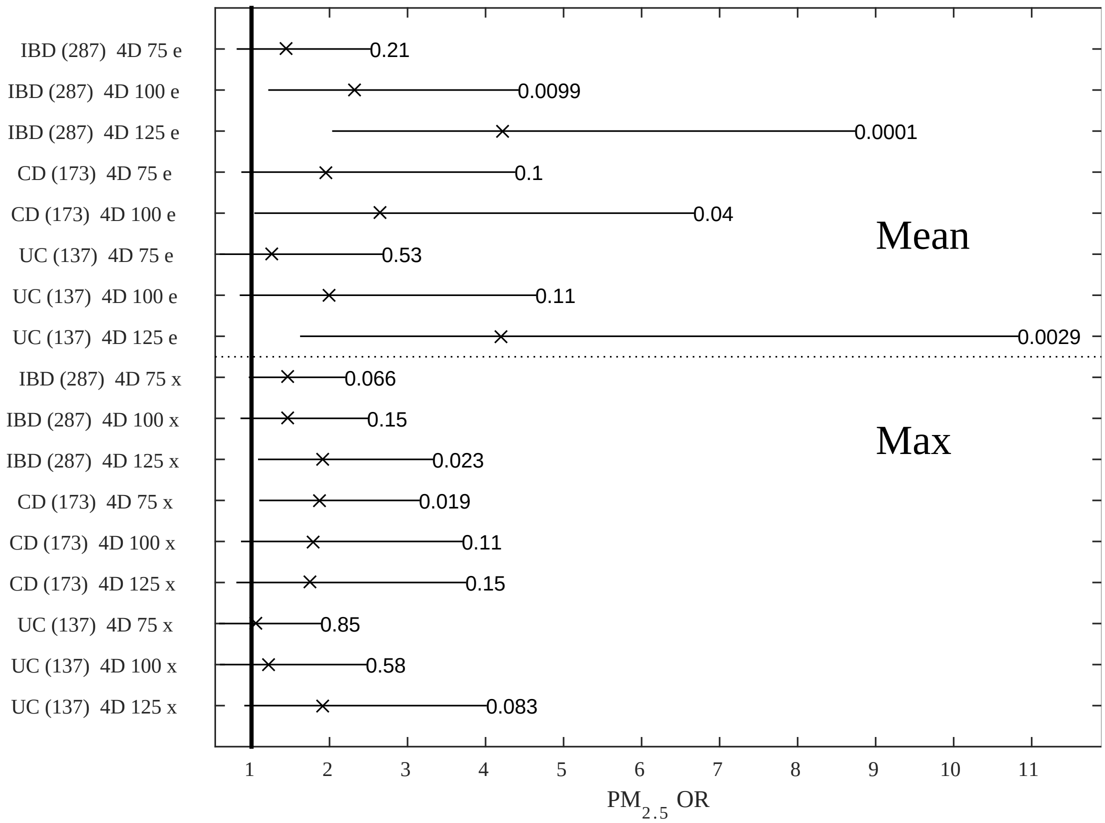

Figure 2.3. Odds Ratio (OR) for prednisone prescriptions and $PM_{2.5}$, controlling for O_3, NO_2, and temperature. The number in parentheses indicates how many events had exposure data for all pollutants. 4D denotes 4-day hazard and control periods, while 1W denotes 1-week hazard and control periods. The letter “e” indicates that the mean pollutant concentrations were used, while “x” indicates maximum pollutant concentrations. The number to the right of the error bar indicates the p-value. Pollution values were estimated using the kriging estimation method.

Figure 2.4 is a summary plot of the OR for infections and $PM_{2.5}$ controlling for O_3, NO_2, and temperature for each of the four air pollution estimation methods used. See Table 2.1 for the list of ICD-9 codes. Several analyses were not performed due to low numbers of exposed cases. Tables of OR and confidence intervals are given in the Supplemental Material. The C. diff analyses (Figure 2.5) are subsets of the infection analyses, and the majority of the analyses could not be performed due to low numbers of exposed cases. Figure 2.6 is a summary plot of the OR for hospitalizations and $PM_{2.5}$ controlling for O_3, NO_2, and temperature for each of the four air pollution estimation methods used.

2.4 Discussion

In our case-crossover analysis examining IBD exacerbations and acute exposure to ambient air pollution, we demonstrate that prednisone usage was higher during times of high $PM_{2.5}$ concentrations. We also found that gastrointestinal infections were associated with $PM_{2.5}$ concentrations. Analysis of hospitalizations and $PM_{2.5}$ were significant for ulcerative colitis.

As shown in Figure 2.2, several analyses were significant for $PM_{2.5}$ and prednisone prescriptions, particularly for the categorical analyses using the mean $PM_{2.5}$ concentration (ie, the top three sections of Figure 2.2). There is general agreement among the four air pollution estimation methods. Figure 2.3 shows that there is a dose-response pattern for the categorical mean $PM_{2.5}$ analyses for IBD as a whole as well as CD and UC separately. The same pattern is present, though not significant, in the categorical maximum $PM_{2.5}$ analyses for ulcerative colitis. The predominance of the categorical mean $PM_{2.5}$ analyses over both the continuous and maximum $PM_{2.5}$ analyses in the setting of Utah's episodic pollution pattern suggests that it is the prolonged periods of very high pollution concentrations that are having the most impact on the use of prednisone among IBD patients.

We tried to control for prednisone prescriptions that may have been given for comorbidities (such as asthma) by requiring a prednisone prescription in conjunction with at least one of the ICD-9 codes used for the hospitalization analyses, but there were too few events that had a prednisone prescription, a code, and air pollution data. In a previous study, 7% of IBD cases also had asthma [31].

Among the infection analyses, more of the continuous analyses were significant than

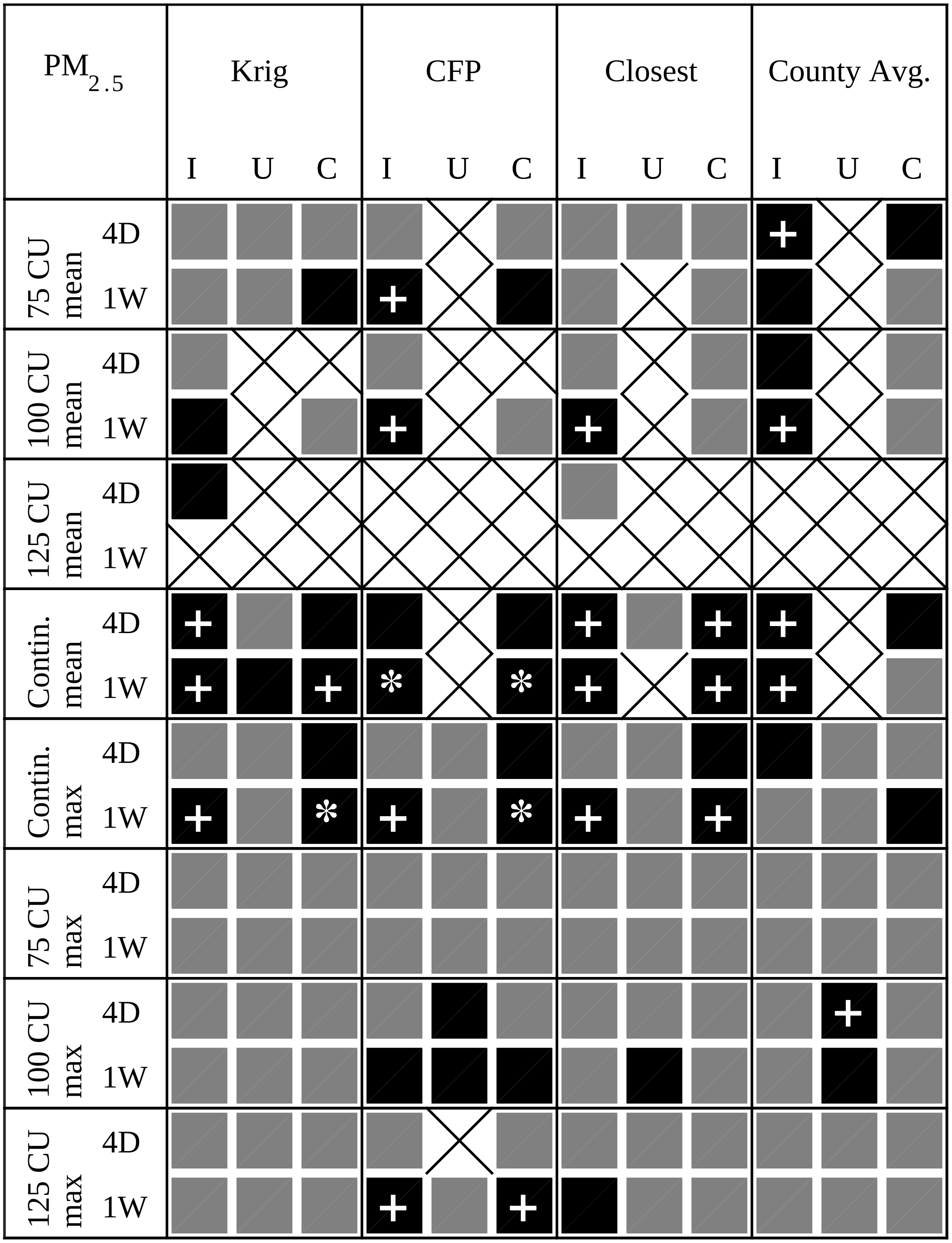

Figure 2.4. Summary plot of odds ratios (OR) for IBD infections and $PM_{2.5}$ for both continuous as well as categorical analyses at 75 CU, 100 CU, and 125 CU using the mean or maximum concentration during the 4-day (4D) and 1-week (1W) time frames for four methods of assigning pollution data, controlling for O_3, NO_2, and temperature. Grey squares indicate p-value$\geq$0.10. Black squares indicate OR$>$1 with p-value$<$0.10. The plus sign indicates p-value $<$0.05. The asterisk indicates p-value $<$0.01. CFP is closest within footprint. I is all IBD. U is ulcerative colitis. C is Crohn's Disease. See Table 2.1 for list of ICD-9 codes used for infections.

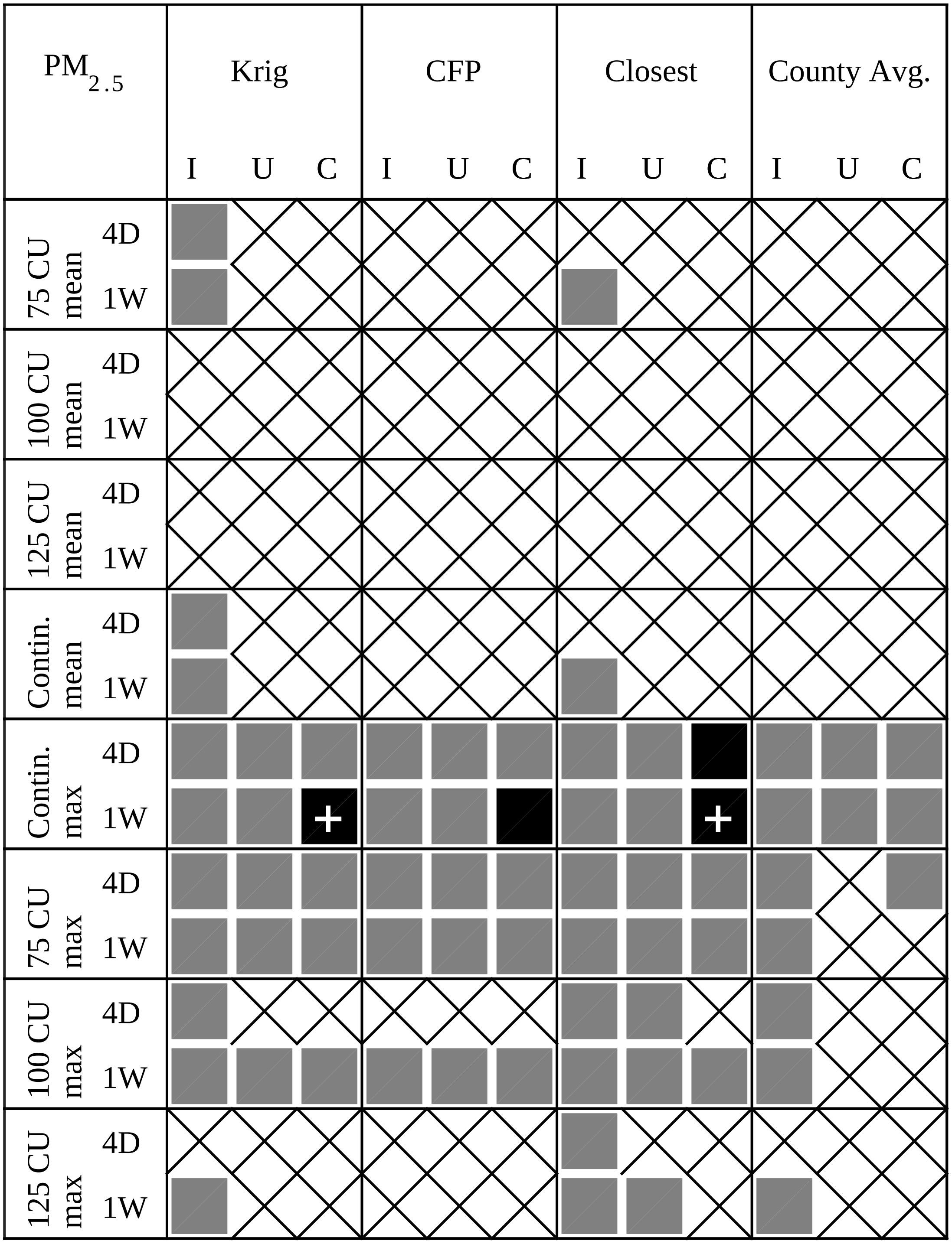

Figure 2.5. Summary plot of odds ratios (OR) for IBD clostridium difficile (C. diff) infections and $PM_{2.5}$ for both continuous as well as categorical analyses at 75 CU, 100 CU, and 125 CU using the mean or maximum concentration during the 4-day (4D) and 1-week (1W) time frames for four methods of assigning pollution data, controlling for O_3, NO_2, and temperature. Grey squares indicate p-value$\geq$0.10. Black squares indicate OR$>$1 with p-value$<$0.10. The plus sign indicates p-value $<$0.05. CFP is closest within footprint. I is all IBD. U is ulcerative colitis. C is Crohn's Disease. See Table 2.1 for list of ICD-9 codes used for infections.

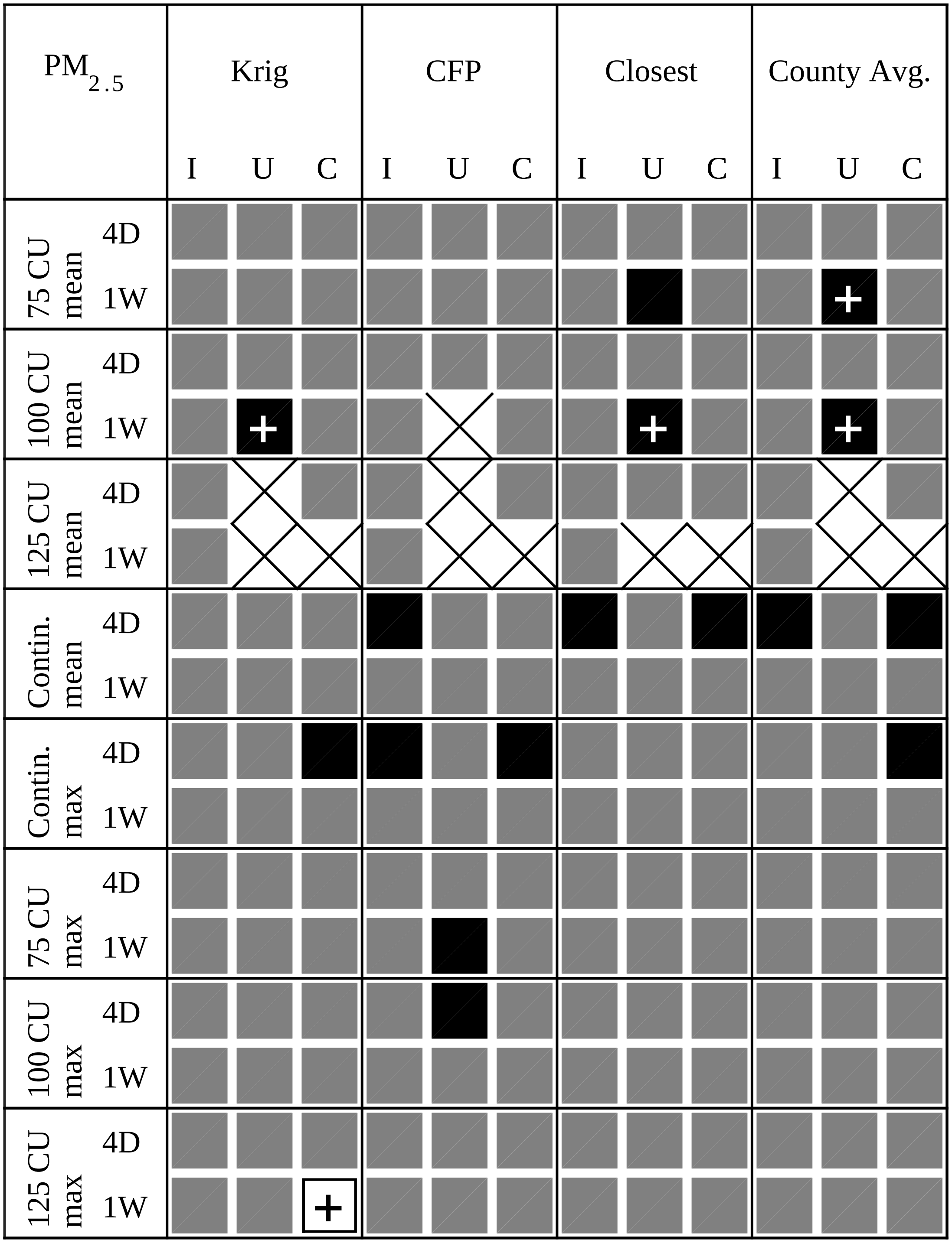

Figure 2.6. Summary plot of odds ratios (OR) for IBD hospitalizations and $PM_{2.5}$ for both continuous as well as categorical analyses at 75 CU, 100 CU, and 125 CU using the mean or maximum concentration during the 4-day (4D) and 1-week (1W) time frames for four methods of assigning pollution data, controlling for O_3, NO_2, and temperature. Grey squares indicate p-value$\geq$0.10. Black squares indicate OR$>$1 with p-value$<$0.10. The plus sign indicates p-value $<$0.05. CFP is closest within footprint. I is all IBD. U is ulcerative colitis. C is Crohn's Disease.

the categorical. The 1W continuous maximum infection analysis was significant for Crohn's Disease using both kriged and closest monitor estimation methods (Figure 2.4). This association was still significant when the analysis was restricted to C. diff infections (Figure 2.5).

The hospitalization analyses were significant for ulcerative colitis for the 1W mean $PM_{2.5}$ concentrations above 100 CU using the kriged, closest, and county average methods. This test could not be analyzed for CFP due to the smaller number of events that could be assigned pollution data. CFP typically has the smallest number of events that can be assigned pollution data because no data are assigned if the centroid of the zip code of residence is further from the pollution monitor than the footprint [18]. All of the analyses for IBD or Crohns alone are null for all pollution assignment methods, with the exception of the 1W maximum concentration above 125 CU for Crohn's Disease using kriged data, which gives a counterintuitive result. This could be a spurious result as this study is subject to the issue of multiple comparisons. The lack of a significant results for Crohn's Disease hospitalizations in the analyses using mean concentration, other thresholds, the 4D time frame, or continuous analyses gives little confidence that this result is meaningful.

Our findings for ulcerative colitis are consistent with Ananthakrishnan et al. [1], who found an association between hospitalizations and criteria pollutant emissions. That study considered pollution emissions of different geographic areas with 1 year as the unit of time. This study considered the temporal variations in daily personal histories of ambient air pollution concentrations, and each person was their own control.

Several environmental exposures have been shown to influence IBD, particularly smoking and intestinal commensal flora [6]. Smoking has been shown to make CD worse, while it has a protective effect for UC [6], which is thought to be related to the nicotine.

IBD has been found to occur most commonly among non-Hispanic whites [4], which was also found in our data. This cohort is 84.3% non-Hispanic and white, while the general population of Utah was 80.6% and 79.0% non-Hispanic and white in 2010 and 2015, respectively [32].

2.4.1 Potential Biological Mechanisms

Ingested pollutant particles altered gut microbiome (which influences whether colitis forms) and function in interleukin (IL)-10 knockout mice [13]. Ingested pollutants can alter metabolic processes and decrease butyrate, an essential fatty acid for colonocytes [13]. Pollution can also affect epithelial cells, alter the immune response, and increase intestinal permeability. Pollution causes a rearrangement of tight junction proteins and is linked to inflammatory free radical oxygen species (ROS). Increased permeability can result in increased microbial exposure to deeper levels of mucosa and systemic circulation, leading to a proinflammatory response. Mice exposed to particulate matter have had mitochondrial generation of ROS, cell death, increased permeability and cytokine, and decreased zonolin [8, 13, 14]. Particulate matter can decrease the effectiveness in macrophages in fighting off infection [14, 15]. Air pollution induces inflammatory response and oxidative damage in colonic mucosa [12]. It is possible that one or more of these mechanisms contributed to the response observed the the present study. Further research is necessary to elucidate the specific mechanisms involved.

2.4.2 Limitations

Assignment of air pollution data to patient data was based on interpolation from community-based ambient air pollution monitors and zip code of residence instead of basing exposure on personal monitors and indoor monitors. Additionally, the pollution data were interpolated to the centroid of the zip code of residence, not the actual residential location. We cannot rule out the possibility that some of the prednisone prescriptions among IBD patients (who had at least five IBD diagnosis ICD-9 codes) were given for comorbidities such as asthma. The issue of multiple comparison is common among case-crossover air pollution health effects studies due to the number of pollutants and the number of different time frames that are considered [12]. Kaplan et al. [12] suggest addressing the issue by looking for consistency among different studies with different populations.

2.4.3 Conclusion

Our findings in this pilot study show an association between $PM_{2.5}$ and prednisone prescriptions, gastrointestinal infections generally and clostridium difficile infections specifically among people who have at least five entries of IBD diagnosis in their medical records.

2.5 Acknowledgments

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CHAPTER 3

EMERGENCY DEPARTMENT VISITS AND HOSPITALIZATIONS AMONG PATIENTS WITH EOSINOPHILIC ESOPHAGITIS AND ACUTE EXPOSURES TO AMBIENT AIR POLLUTION

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Aeroallergens are known to exacerbate eosinophilic esophagitis (EoE), and some papers have hypothesized that air pollution could also exacerbate EoE. This study examines EoE exacerbations and acute exposures to ambient air pollution. Retrospective case crossover analyses of EoE exacerbations (January 2000 - May 2014) were performed at the individual level using data from the Utah Population Database, University of Utah Health Sciences Center, and Intermountain Healthcare and ambient air pollution data. Multiple methods of assigning pollution data to patient data were used to test for methodological sensitivity. The odds ratio (OR) of an Emergency Department (ED) visit for an esophageal impaction with a 1-week maximum particulate matter with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) exposure above the National Ambient Air Quality Standard (NAAQS) was 3.50, with a 95% confidence interval (CI) of 1.03-11.90 using kriged data. This analysis was not significant when using the closest monitor to assign pollution data. For O_3, the 4-day analysis using O_3 as a continuous variable, with 1% of NAAQS as one unit, was significant for ED visits for dysphagia and/or impaction [OR: 1.0257, CI: 1.0005-1.0516 using kriged data]. All analyses for hospitalizations had p-values less than 0.10 for $PM_{2.5}$ as well as O_3. In this individual-level case-crossover analysis, acute exposures to $PM_{2.5}$ and O_3 appear to be associated with exacerbations of EoE. Further research into the effects of

air pollution on EoE is warranted, with careful consideration of the method used to assign pollution data to patient data.

3.1 Introduction

Eosinophilic esophagitis (EoE) is an allergic disease affecting the esophagus. EoE is characterized by eosinophilic infiltration of the esophageal mucosa [1, 2], resulting in inflammation and esophageal symptoms. EoE is more common among males than females, with a ratio of 3:1, and most common among non-Hispanic whites [1, 3, 4]. Incidence of EoE is increasing, which may be due in part to increasing awareness of EoE [5].

While EoE is primarily driven by food allergy, environmental exposures are also thought to play a role in its development and presentation [2,4,6–9]. Several studies have reported increased diagnosis and exacerbations of EoE during pollen seasons [4, 10]. Additionally, a study on elemental diet noted a recurrence of eosinophilia in a few patients after seasonal and occupational exposures to grass and pollens [6]. To our knowledge, there have been no prior studies analyzing EoE exacerbations and acute exposures to criteria air pollutants, but the literature suggests the possibility that air pollution could influence EoE [11–13]. Furthermore, aeroallergens such as dust mites and pollen are known to affect EoE [1, 4, 9, 10, 14, 15], so it is plausible that other inhaled matter, ie, criteria pollutants, could also affect EoE. Elitsur [12] suggests that aeroallergens (as well as food allergens) may be absorbed through the epithelial cells of the esophagus in EoE patients due to a dysfunctional, leaking esophageal mucosa [7, 8, 12].

We used case-crossover design, using cases as their own controls, to investigate the possible relationship between EoE exacerbations and select criteria pollutant concentrations on the time scale of days and weeks.

3.2 Materials and Methods

The following subsections will describe the study population, the environmental variables, and the health outcomes considered in this study. Finally, the analytical method employed (case-crossover design) will also be described.

3.2.1 Study Population

This study was conducted in the state of Utah, in the western United States, which was home to ∼2.8 million residents in 2010. Approximately 79% of the residents live in just 5 of Utah's 29 counties [16]. Complex topography consisting of mountains, valleys, and canyon-rich deserts characterizes Utah's landscape, thus Utah can be divided into several airsheds. The combination of the uneven population distribution and complex topography drives the uneven distribution of criteria pollutant concentrations in Utah. Exceedances of daily National Ambient Air Quality Standards (NAAQS) are observed nearly annually for particulate matter with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) and ozone (O_3). Some parts of the state have been designated as nonattainment areas for $PM_{2.5}$ [17–21].

The population of interest for this study was all persons who were coded for EoE via International Classifcation of Disease, 9th revision (ICD-9) code 530.13, and lived in Utah counties that had air pollution monitoring during at least part of the study period, January 2000 through May 2014. Children under age 1 were excluded, as were adults over age 90. The ICD-9 code for EoE has been demonstrated to have a specificity of 93% or greater [22, 23], so only one occurrence of the code was required for a person's record to be included in the analysis. Medical data were obtained from the Utah Population Database (UPDB) [24], Intermountain Healthcare (IH), and University of Utah Health Sciences Center (UUHSC), and include zip code of residence. The UPDB is a shared research resource of the University of Utah and contains linked inpatient and outpatient electronic medical records from 1995 to the present drawn from the UUHSC and IH. These two institutions account for 85% of all medical encounters in Utah. The UPDB also links to data for all statewide outpatient surgeries and hospital discharge summaries via the Utah Department of Health as well as vital records, Utah Cancer Registry, genealogy, driver's license, and voter registration data [24]. The study was approved by the Institutional Review Boards (IRB) for Intermountain Healthcare (IRB # 1040202), the University of Utah (IRB # 55618), as well as the Utah Resource for Genetic and Epidemiological Research, which is the governing body for the UPDB.

3.2.2 Environmental Variables

Data for ambient ozone (O_3), $PM_{2.5}$, and nitrogen dioxide (NO_2) concentrations were downloaded from the Environmental Protection Agency (EPA) [25] and were used to create daily personal histories of air pollution (based on the centroid, ie, the geometric center, of zip code of residence) from January 2000 through May 2014 via four separate methods: 1) interpolation (kriging) [26], 2) county average, 3) closest monitor within airshed, and 4) closest monitor limited to those centroids within a specified footprint of the monitor (CFP) [26]. Kriging takes a weighted average of all monitors in an airshed to estimate the concentration at the centroid of the zip code of residence. Kriging makes use of all of the monitor data in an airshed and the distances from the centroid of the zip code of residence to each of those monitors, giving a higher weight to nearby monitors [26]. Zip code centroids more than 500 m [27] above the lowest centroid in an airshed were not assigned kriged data due to vertical variations in pollution concentrations, because the monitoring network is insufficient to capture the vertical variations which are known to exist. Gaps in the personal histories created from these data sometimes exist because not all pollutants are measured in all airsheds and some monitors do not operate on a daily basis. Gaps can also occur if the zip code of residence information is missing or is from an area that did not have air monitors. Finally, gaps occur if multiple zip codes appeared in the record for a person within a single year, in which case, that year was not assigned pollution data (zip code information only had the year associated with it, not month or day). For ease of interpretation, the criteria pollutant concentrations were all converted to a percentage of the current NAAQS, and the units will be referred to as Common Units (CU). The NAAQS for O_3, $PM_{2.5}$, and NO_2 are 0.07 ppm, 35 μg m^{-3}, and 100 ppb, respectively. The NAAQS is represented as 100 CU. For example, a $PM_{2.5}$ concentration of 21 μg m^{-3} is 60 CU since the NAAQS for $PM_{2.5}$ is 35 μg m^{-3}. Additionally, temperature data from a representative weather station in each airshed (downloaded from the National Weather Service [28, 29]) were included in the daily personal histories.

3.2.3 Primary Outcomes

Four types of EoE exacerbations were analyzed: 1) Emergency Department (ED) visits which include chest pain, dysphagia, and/or impaction, referred to as “A” for “Any ED”;

2) ED visits which include dysphagia and/or impaction, referred to as "D"; 3) ED visits for impaction, referred to as "I."; and 4) hospitalizations which include chest pain, dysphagia, and/or impaction, referred to as "H". See Table 3.1 for the lists of ICD-9 and CPT codes used to define each type of exacerbation. The inclusion ICD-9 code for EoE (530.13) was in the record for all persons in the study, but not necessarily at the time of the event. The event was defined by the presence of at least one of the ICD-9 or CPT codes listed in Table 3.1 for each type of EoE exacerbation. Note that the various ED events are not mutually exclusive.

3.2.4 Statistical Analysis

EoE exacerbations were analyzed using case-crossover design, a variant of the case-control design, in which only cases are studied and each subject serves as their own control [30]. The time frames considered were symmetric bidirectional (See Figure 3.1): 1) The 4-day (4D) window leading up to and including the date of the EoE exacerbation (hazard period) compared with 4-day windows ending 1, 2, and 3 weeks before and after date of event (6 control periods per event); and 2) the 1-week (1W) leading up to and including the date of the EoE exacerbation (hazard period) compared to the 1-week periods preceding and following the hazard period (2 control periods per event). At least one-quarter of the days during the time window were required to have air pollution data, eg, at least 1 of the

Table 3.1. ICD-9 and CPT codes required for EoE exacerbation events. (It is an event if at least one of the codes in a given column occurred.) "A" is any ED visit. "D" is emergency department visits involving impaction and/or dysphagia. "I" is emergency department visits for impaction. "H" is any hospitalization involving any of the listed codes.

Description	ICD-9/CPT code	A	D	I	H
chest pain	ICD-9 786.50	X			X
chest pain (other)	ICD-9 786.59	X			X
heartburn	ICD-9 787.1	X			X
dysphagia, unspecified	ICD-9 787.20	X	X		X
other dysphagia	ICD-9 787.29	X	X		X
esophageal bolus impaction	ICD-9 935.1	X	X	X	X
Upper GI endoscopy	CPT 43215	X	X	X	X
	CPT 43247	X	X	X	X
	CPT 43235	X	X	X	X
	CPT 43239	X	X	X	X

a) 4D

Su	M	Tu	W	Th	F	Sa
Feb. 1	2	3	4	5	6	7
8	9	10	11	12	13	14 (1)
15	16	17	18	19	20	21 (2)
22	23	24	25	26	27	28 (3)
March 1	2	3	4	5	6	7 (Event)
8	9	10	11	12	13	14 (4)
15	16	17	18	19	20	21 (5)
22	23	24	25	26	27	28 (6)
29	30	31	April 1	2	3	4

b) 1W

Su	M	Tu	W	Th	F	Sa
Feb. 1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28 (1)
March 1	2	3	4	5	6	7 (Event)
8	9	10	11	12	13	14 (2)
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	April 1	2	3	4

Figure 3.1. Time frames used in case-crossover analysis with an example event on March 7. The control periods are shown in grey while the hazard periods are shown in black. The end of each control period is denoted by a number in parentheses. a) 4D, Four-day hazard and control periods. b) 1W, One-week hazard and control periods.

four days in the 4D window needed pollution, or no data were assigned. Separate analyses were performed using the mean and maximum concentration observed during the hazard and control periods. Repeated events occurring within 56 days were discarded to ensure there was no overlap between separate exacerbations for the same person. Separate analyses were performed with the pollution data as categorical and continuous variables. For various categorical analyses, the exposed threshold was set to 75 CU, 100 CU, and 125 CU. For continuous analyses, the 1-unit increment was 1 CU. To ensure that there was at least some variability in the data in the categorical analyses, each analysis was skipped unless there were at least 10 hazard periods in each of the exposed and unexposed categories. Likewise, the analysis was skipped unless there were at least 10 control periods in each of the exposed and unexposed categories. Similarly, continuous analyses were skipped if there were not at least 10 hazard and control periods of at least 50 CU.

3.3 Results

There were 4,381 persons in this cohort of EoE patients, 64.9% of whom were male. This cohort is 81.4% non-Hispanic and white. Table 3.2 shows the number of events for each type of EoE exacerbation as well as the age distribution. Not all of the events could be assigned air pollution data, and the number of events that could be assigned pollution data varied by pollutant and time frame considered. This can be due to someone having more than one zip code of residence in the same year, in which case no pollution data were assigned to that person for that year. Also, people were included in the study if they lived in an airshed with pollution monitoring during at least part of the study period. If their event occurred while they were living outside of one of those airsheds, no pollution data were assigned. Additionally, not all pollutants were observed in all airsheds during the entire study period. For example, ozone was not measured in the Tooele and Uintah Basin airsheds during the study period prior to 2005 and 2007, respectively.

Figure 3.2 is a summary plot of the odds ratio (OR) for EoE exacerbations and O_3 for each of the four air pollution exposure estimation methods used. The majority of these analyses could not be performed because of the low number of exposed cases (eg 4D and 1W mean O_3 above 100 CU do not occur in the record). Figure 3.3 shows the OR and confidence intervals for continuous analyses EoE exacerbations and O_3 for the kriging

Table 3.2. Age distribution of EoE exacerbation events. A is any ED visit for chest pain, dysphagia, and/or impaction. D is an ED visit for dysphagia and/or impaction. I is an ED visit for impaction. H is a hospitalization for chest pain, dysphagia, and/or chest pain. Please see Table 3.1 for list of ICD-9 codes used for exacerbations. Descriptions are based on the events, so some people will be counted multiple times. The project spans January 2000 through May 2014, so people who have multiple events could be different ages at each of those events.

Description	A	D	I	H
# events	298	184	161	100
# people	242	170	149	85
% male	59	65	66	65
mean age (years)	41	39	39	43
standard deviation (years)	15	15	14	21

method. This corresponds to the first column and the middle two sections of Figure 3.2. The OR and confidence intervals for the other pollutant estimation methods are given in the Supplemental Material (Appendix B).

Figure 3.4 is a summary plot of OR for EoE exacerbations and $PM_{2.5}$ for each of the four air pollution exposure estimation methods used. Similar to O_3, the majority of these analyses could not be performed because of the low number of exposed cases (eg 4D and 1W mean $PM_{2.5}$ above 100 CU do not occur in the record). Figure 3.5 shows the OR and confidence intervals for continuous analyses EoE exacerbations and $PM_{2.5}$ for the kriging method. This corresponds to the first column and the middle two sections of Figure 3.4. Again, the OR and confidence intervals for the other pollutant estimation methods are given in the Supplemental Material (Appendix B).

3.4 Discussion

Figures 3.2 and 3.3 show that the continuous analysis of ED visits including chest pain, dysphagia, and/or impactions ("A") for O_3 had an OR > 1 and p-value < 0.05 when considering the mean concentration for both the 4D and 1W analyses using the kriged method. When looking at the maximum concentrations on 4D and 1W time frames, the OR was still > 1 with p-values of 0.029 and 0.095, respectively. This suggests an association between ED visits and O_3 among people with EoE. The codes for this type of exacerbation did include chest pain, and it is well known that O_3 can cause chest pain, even among healthy individuals [31]. Therefore, it is possible that this signal is not directly related

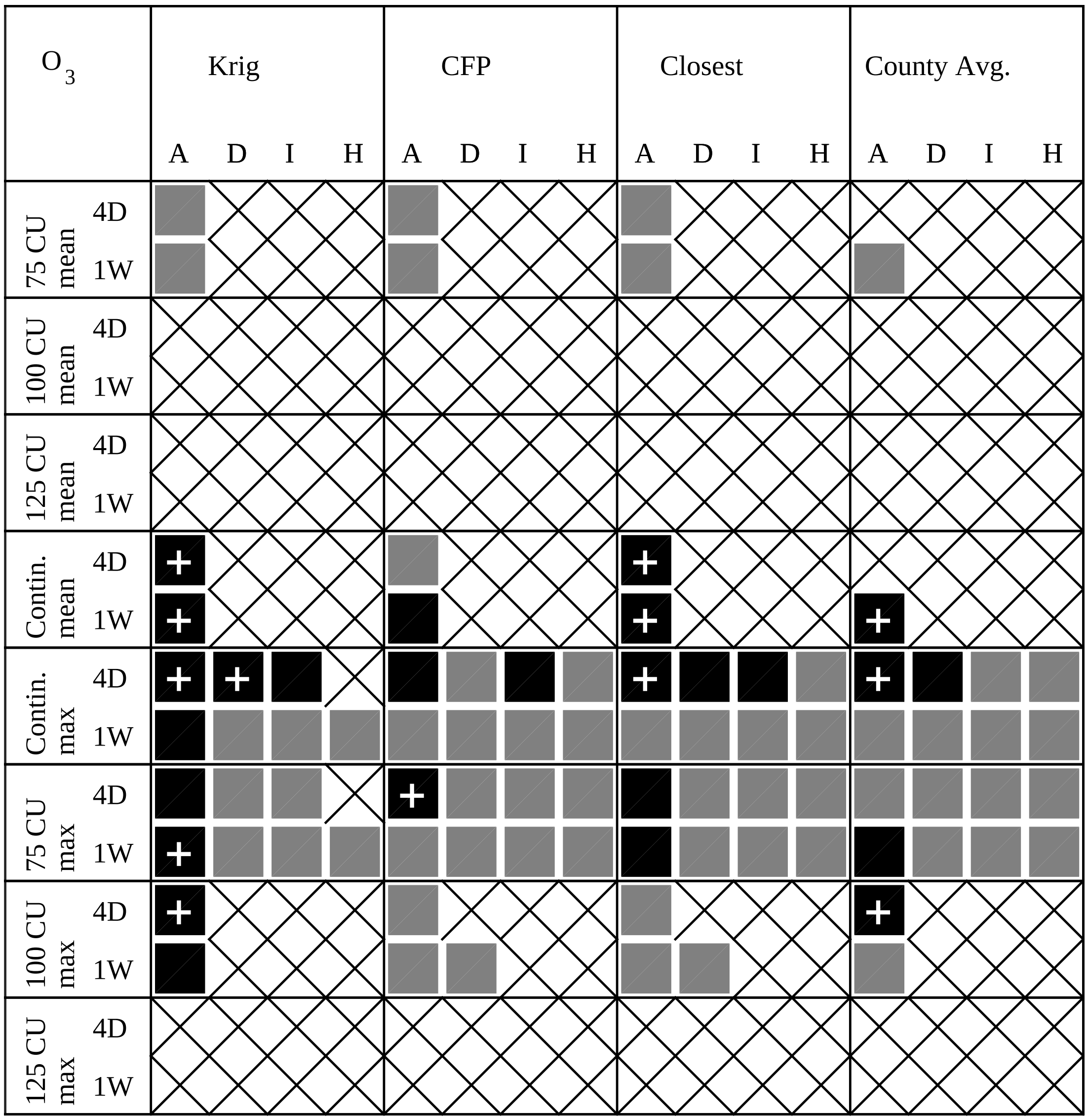

Figure 3.2. Summary plot of odds ratios (OR) for EoE exacerbations and O_3 for both continuous as well as categorical analyses at 75 CU, 100 CU, and 125 CU using the maximum or mean concentration during the 4-day (4D) and 1-week (1W) time frames for four methods of assigning pollution data, controlling for $PM_{2.5}$, NO_2, and temperature. Grey squares indicate p-value$\geq$0.10. Black squares indicate OR$>$1 with p-value$<$0.10. The plus sign indicates p-value $<$0.05. CFP is closest within footprint. A is any ED visit for chest pain, dysphagia, and/or impaction. D is an ED visit for dysphagia and/or impaction. I is an ED visit for impaction. H is a hospitalization for chest pain, dysphagia, and/or chest pain. See Table 3.1 for list of ICD-9 codes used for exacerbations.

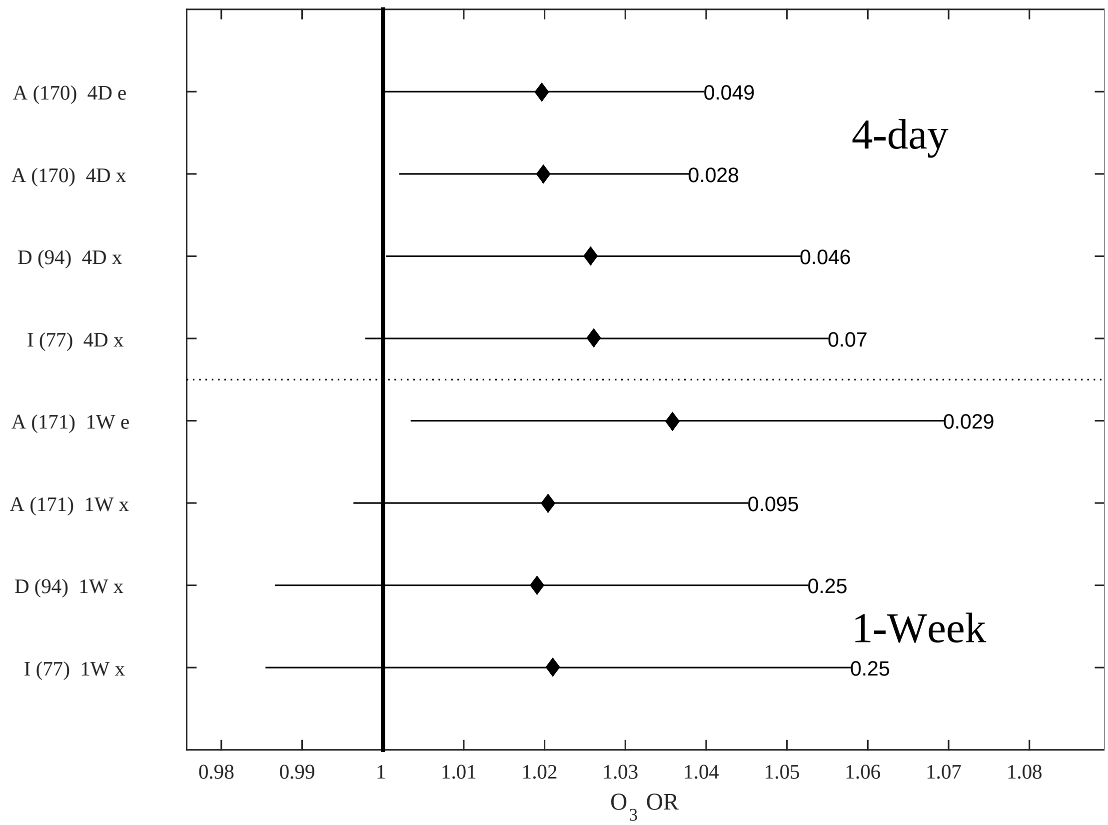

Figure 3.3. Odds Ratio (OR) for EoE exacerbations and O_3, controlling for $PM_{2.5}$, NO_2, and temperature. A = Any ED visit (chest pain, dysphagia, and/or impaction). D = dysphagia and/or impaction. I = impaction. See Table 3.1 for list of ICD-9 codes used for exacerbations. The number in parentheses indicates how many events had exposure data for all pollutants. 4D denotes 4-day hazard and control periods, while 1W denotes 1-week hazard and control periods. The letter "e" indicates that the mean pollutant concentrations were used, while "x" indicates maximum pollutant concentrations. The number to the right of the error bar indicates the p-value. Pollution values were estimated using the kriging estimation method.

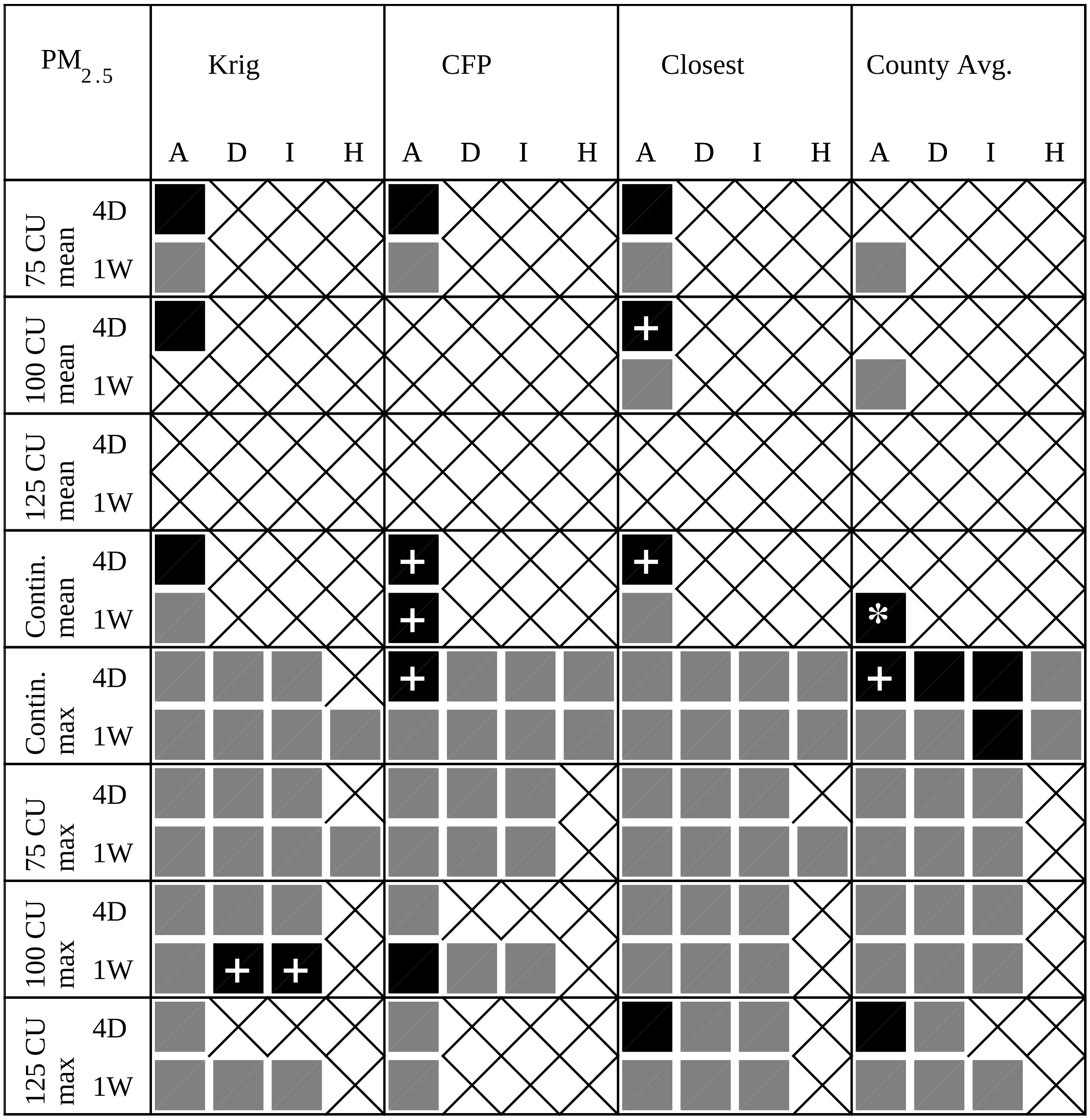

Figure 3.4. Summary plot of odds ratios (OR) for EoE exacerbations and $PM_{2.5}$ for both continuous as well as categorical analyses at 75 CU, 100 CU, and 125 CU using the maximum or mean concentration during the 4-day (4D) and 1-week (1W) time frames for four methods of assigning pollution data, controlling for O_3, NO_2, and temperature. Grey squares indicate p-value$\geq$0.10. Black squares indicate OR$>$1 with p-value$<$0.10. The plus sign indicates p-value $<$0.05. CFP is closest within footprint. A is any ED visit for chest pain, dysphagia, and/or impaction. D is an ED visit for dysphagia and/or impaction. I is an ED visit for impaction. H is a hospitalization for chest pain, dysphagia, and/or chest pain. See Table 3.1 for list of ICD-9 codes used for exacerbations.

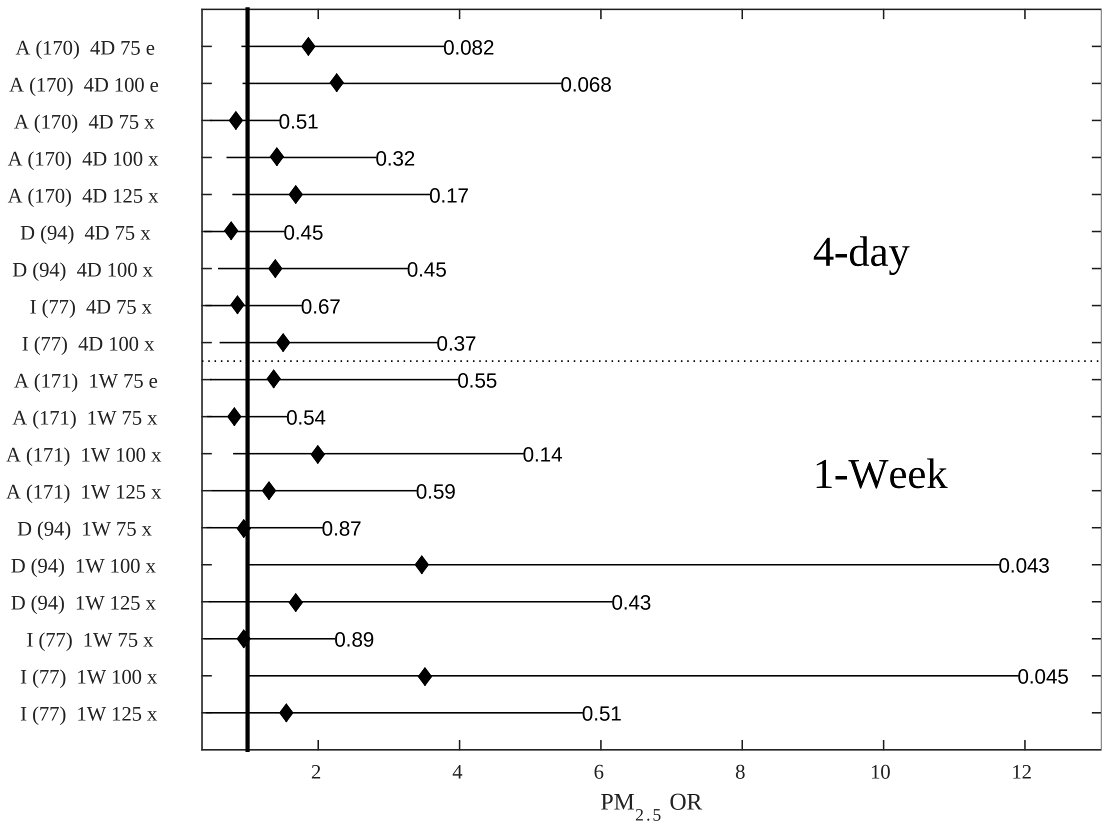

Figure 3.5. Odds Ratio (OR) for EoE exacerbations and $PM_{2.5}$, controlling for O_3, NO_2, and temperature. A = Any ED visit (chest pain, dysphagia, and/or impaction). D = dysphagia and/or impaction. I = impaction. See Table 3.1 for list of ICD-9 codes used for exacerbations. The number in parentheses indicates how many events had exposure data for all pollutants. 4D denotes 4-day hazard and control periods, while 1W denotes 1-week hazard and control periods. The letter “e” indicates that the mean pollutant concentrations were used, while “x” indicates maximum pollutant concentrations. The number to the right of the error bar indicates the p-value. Pollution values were estimated using the kriging estimation method.

to eosinophilic esophagitis. However, when chest pain codes were ignored, and only dysphagia and/or impaction ED visits (exacerbation “D”) were considered for the 4D maximum O_3 concentration, the p-value was 0.046 and the OR point estimate increased to 1.026 relative to that for exacerbation “A”, which had OR = 1.020. When further restricting the analysis to impaction only (exacerbation “I”), the point estimate increased very slightly to 1.026. The error bars widened slightly due to the decrease in sample size (94 to 77) to give a p-value of 0.07. Both dysphagia and impaction are symptoms that are very particular to eosinophilic esophagitis, so events considered in the “D” and “I” analyses are unlikely to be confounded by a comorbidity already known to be affected by O_3, such as asthma or cardiovascular disease. Therefore, we suggest that there may be an association between EoE exacerbation and O_3 exposure.

Figures 3.4 and 3.5 show that the categorical analyses of exacerbation “D” and “I” for 1W maximum $PM_{2.5}$ concentration above 100 CU (ie, the NAAQS), have OR of 3.476 and 3.500 with p-values of 0.043 and 0.045, respectively. While all of the p-values for the 4D analysis in Figure 3.5 are greater than 0.10, it is worth noting that all of the point estimates for the OR do follow the expected dose-response pattern when the exposed threshold is increased from 75 CU to 100 CU to 125 CU. On the 1W time frame, the dose-response pattern fails when the exposed threshold is increased from 100 CU to 125 CU. We think this is happening for two reasons. First, most of the high-$PM_{2.5}$ episodes in Utah occur during winter cold air pool events (commonly referred to as “inversions”) [17]. During a cold air pool event, $PM_{2.5}$ concentrations typically build up at a rate of about 28.6 CU (10 μg m^{-3}) per day [21]. We suspect that many of the people who were going to have an ED visit due to the high pollution had already done so before concentrations built up past 125 CU. Second, those who were exposed over 125 CU are a subset of those who were exposed over 100 CU. In the 125 CU analysis, those who were exposed at, say, 115 CU are considered unexposed even though that is still a high $PM_{2.5}$ concentration. This is a limitation of the way we constructed the analysis. Additionally, it may be an issue of small sample size: both $PM_{2.5}$ concentrations above 125 CU and ED visits are rare.

We hypothesize that O_3 was most significant in the continuous analyses while $PM_{2.5}$ was most significant in the categorical analyses because O_3 is known to cause health effects at all concentrations, even relatively low concentrations [31], while there may be more of a threshold effect for $PM_{2.5}$, which sets off a cascade of inflammation. This difference between the pollutants may also be reflective of the concentration patterns observed in Utah: $PM_{2.5}$ concentrations are low most of the time, except during high-pollution events due to pollution build-up during cold air pools in winter and warm-season wildfires, dust storms, and fireworks. Ozone, in contrast, is less starkly episodic.

There is some variation in the number of events that could be assigned pollution data. CFP restricts the number of events that can be assigned pollution data because the zip code of residence must be within the specified footprint. By definition, the number of events assigned pollution data will be equal to or fewer than the closest within the airshed. Some airsheds have multiple counties, and not every county has a monitor for a given pollutant, so events from those counties without monitors are not assigned pollution data when the county average is used.

Among the four methods used to assign pollution data, there are some variations as to which analyses reach the level of significance. For example, the continuous analysis using the 4D maximum O_3 concentration for the dysphagia and impaction ED visits (exacerbation "D") had a p-value of 0.046, significant at the 95% confidence level. Meanwhile, the p-values for the closest limited to a specified footprint, closest within airshed, and county average were 0.016, 0.059, and 0.062, respectively, none of which reach the 95% confidence level.

The same mechanism that Elitsur [12] suggests (that aeroallergens may be absorbed through the epithelial cells of the esophagus in EoE patients due to a dysfunctional, leaking esophageal mucosa [7, 8, 12]) could apply to criteria air pollutants as well. Yeatts et al. [32] found that circulating eosinophils in asthmatics increased with increasing particulate matter.

EoE has been found to occur most commonly among non-Hispanic whites [4]. This cohort is 81.4% non-Hispanic and white. This is slightly higher than the general population of Utah, which was 80.6% and 79.0% non-Hispanic and white in 2010 and 2015, respectively [33]. This cohort of EoE patients was 64.9% male, which is lower than the 3:1 ratio noted elsewhere [4].

3.4.1 Limitations

Our study was based on residence location at the zip code level and used ambient air pollution monitors, not indoor observations. Zip code of residence does not account for commuting to place of employment or school, which could have higher or lower pollutant concentrations and may be in a different airshed.

The ICD-9 code for EoE has been demonstrated to have a specificity of 93% or greater [22, 23]. Including chest pain may cause confounding as pollution is known to affect cardiac and airway function [31]. However, asthma exacerbations are coded as such, and our population is younger than that considered to be at risk for cardiac events. We confirmed our findings by isolating our analysis to purely esophageal symptoms of dysphagia and impaction with significant results. Children with foreign ingestions is a possible, but unlikely, confounder, since we only included those with the ICD-9 code for EoE.

The study is limited by possible associations between O_3 and pollen. While case crossover controls for season, both daily O_3 and pollen concentrations are influenced by daily weather patterns. High ozone has been associated with increased allergenicity of pollen and exposure to O_3 and NO_2 may exacerbate the health effects of pollen exposure [34–38]. Future studies should simultaneously consider the direct effects of O_3, the direct effects of pollen, and the secondary effects of O_3 via increases in the allergencity of pollen on acute exacerbations of EoE. Episodes of elevated $PM_{2.5}$ are predominantly observed during winter in Utah, when pollen levels are much lower, so confounding of pollen for $PM_{2.5}$ is less of an issue than for O_3.

Separate analyses were performed using the maximum and mean pollutant concentrations to represent the 4-day and 1-week concentrations for the personal daily exposure histories. It is unclear which is the better metric to use in health studies. An analysis using one-week or 4-day maximum pollutant concentrations at high thresholds will have a larger number of exposed cases than a similar analysis that uses the one-week or 4-day mean pollutant concentrations. For example, it is more common to have one day in a seven-day period be above 125 CU than it is to have concentrations sufficiently high to bring the seven-day mean above 125 CU. Data-limited studies may need to use maximum to be able to analyze high exposure thresholds. The choice of which metric to use may depend on the hypothesized physiological response. If one day at high concentrations is thought to be sufficient to induce a physiological response, then maximum is an adequate choice. If the physiological response to pollution exposure is hypothesized to result from several days of exposure at high concentration, then mean pollutant concentration would be the preferred metric. It is important to note that maximum and mean pollutant concentrations are not independent of each other, especially in Utah, where build-up of pollution during a persistent cold air pool occurs over several days [21].

As noted by Kaplan et. al [39], case-crossover air pollution health effects studies have the issue of multiple comparison due to the number of pollutants and the number of different time frames that are considered. Kaplan et al. [39] suggest looking for consistency among multiple studies to address the issue.

3.4.2 Future Work

This study focused on eosinophilic esophagitis. One may hypothesize that air pollution may also affect other eosinophilic gastrointestinal diseases, such as eosinophilic gastroenteritis and eosinophilic colitis. Ideas for future research include focusing on children, who tend to spend more of their time near home than adults, and improving assignment of pollution data via personal monitors in a prospective study. A prospective study could also consider subclinical disease exacerbations. In a prospective study, more detailed information regarding patient residential and occupational locations could be available, and pollution data could be kriged to those locations instead of just the centroid of the zip code of residence.

3.4.3 Conclusions

We found in this pilot study that $PM_{2.5}$ and O_3 appear to be associated with exacerbations of EoE. The findings of this study should be tested in further studies in other geographic areas, especially other EPA nonattainment areas. Current patients with EoE should be aware of pollution warnings and plan to stay inside during these times until more data are obtained demonstrating the exact risk O_3 and $PM_{2.5}$ pose to health.

3.4.4 Acknowledgments

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APPENDIX A

SUPPLEMENTAL MATERIAL FOR CHAPTER 2

A.1 Odds Ratios for IBD Prednisone Prescriptions and Particulate Matter

Table A.1. Supplementary table for IBD Prednisone for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	1.4358	(0.8198	2.5145)	0.206
1W e 75 CU	475	2.2023	(1.1344	4.2754)	0.020
4D e 100 CU	475	2.3245	(1.2248	4.4118)	0.010
1W e 100 CU	475	3.4422	(1.5440	7.6739)	0.003
4D e 125 CU	475	4.2237	(2.0438	8.7285)	0.000
1W 125 CU			(	)	
4D e Contin.	287	1.0034	(0.9954	1.0115)	0.407
1W e Contin.	288	1.0043	(0.9921	1.0166)	0.492
4D x Contin.	287	1.0025	(0.9967	1.0083)	0.396
1W x Contin.	288	1.0010	(0.9939	1.0082)	0.775
4D x 75 CU	475	1.4620	(0.9749	2.1925)	0.066
1W x 75 CU	475	1.2044	(0.7221	2.0090)	0.476
4D x 100 CU	475	1.4688	(0.8691	2.4822)	0.151
1W x 100 CU	475	1.0798	(0.5860	1.9897)	0.806
4D x 125 CU	475	1.9045	(1.0935	3.3170)	0.023
1W x 125 CU	475	1.4133	(0.7626	2.6192)	0.272

Table A.2. Supplementary table for Ulcerative Colitis Prednisone for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.2684	(0.6026	2.6698)	0.531
1W e 75 CU	259	2.2964	(0.9745	5.4115)	0.057
4D e 100 CU	259	1.9965	(0.8591	4.6398)	0.108
1W e 100 CU	259	2.9924	(1.0569	8.4729)	0.039
4D e 125 CU	259	4.2028	(1.6326	10.8191)	0.003
1W 125 CU			(	)	
4D e Contin.	137	1.0059	(0.9943	1.0176)	0.318
1W e Contin.	137	1.0036	(0.9861	1.0214)	0.692
4D x Contin.	137	1.0027	(0.9940	1.0114)	0.550
1W x Contin.	137	1.0002	(0.9893	1.0113)	0.965
4D x 75 CU	259	1.0570	(0.5942	1.8805)	0.850
1W x 75 CU	259	0.8987	(0.4383	1.8426)	0.771
4D x 100 CU	259	1.2211	(0.6053	2.4634)	0.577
1W x 100 CU	259	1.0172	(0.4322	2.3943)	0.969
4D x 125 CU	259	1.9174	(0.9177	4.0061)	0.083
1W x 125 CU	259	1.5217	(0.6712	3.4499)	0.315

Table A.3. Supplementary table for Crohns Disease Prednisone for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	1.9608	(0.8795	4.3713)	0.100
1W e 75 CU	256	3.0342	(1.1148	8.2586)	0.030
4D e 100 CU	256	2.6403	(1.0464	6.6621)	0.040
1W e 100 CU	256	3.3143	(1.0903	10.0750)	0.035
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	173	1.0008	(0.9902	1.0115)	0.879
1W e Contin.	174	1.0024	(0.9861	1.0190)	0.773
4D x Contin.	173	1.0016	(0.9941	1.0092)	0.675
1W x Contin.	174	1.0008	(0.9915	1.0102)	0.861
4D x 75 CU	256	1.8681	(1.1092	3.1462)	0.019
1W x 75 CU	256	1.4800	(0.7546	2.9028)	0.254
4D x 100 CU	256	1.7982	(0.8752	3.6945)	0.110
1W x 100 CU	256	1.3553	(0.6015	3.0540)	0.463
4D x 125 CU	256	1.7469	(0.8157	3.7411)	0.151
1W x 125 CU	256	1.6578	(0.7028	3.9108)	0.248

Table A.4. Supplementary table for IBD Prednisone for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	1.7204	(0.9654	3.0661)	0.066
1W e 75 CU	475	1.8647	(0.9042	3.8456)	0.092
4D e 100 CU	475	1.9473	(1.0194	3.7197)	0.044
1W e 100 CU	475	2.5772	(1.1032	6.0203)	0.029
4D e 125 CU	475	3.3182	(1.5695	7.0154)	0.002
1W 125 CU			(	)	
4D e Contin.	147	1.0045	(0.9955	1.0135)	0.329
1W e Contin.	151	1.0119	(0.9974	1.0265)	0.108
4D x Contin.	147	1.0052	(0.9984	1.0120)	0.137
1W x Contin.	151	1.0042	(0.9955	1.0130)	0.349
4D x 75 CU	475	1.4625	(0.9296	2.3008)	0.100
1W x 75 CU	475	1.2487	(0.7078	2.2029)	0.443
4D x 100 CU	475	1.5200	(0.8545	2.7037)	0.154
1W x 100 CU	475	1.2625	(0.6513	2.4472)	0.490
4D x 125 CU	475	2.2567	(1.2228	4.1648)	0.009
1W x 125 CU	475	1.8405	(0.8811	3.8443)	0.105

Table A.5. Supplementary table for Ulcerative Colitis Prednisone for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.3424	(0.6156	2.9274)	0.459
1W e 75 CU	259	2.0184	(0.7589	5.3682)	0.159
4D e 100 CU	259	1.6060	(0.6826	3.7789)	0.278
1W e 100 CU			(	)	
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	78	1.0025	(0.9898	1.0153)	0.702
1W e Contin.	80	1.0047	(0.9855	1.0243)	0.635
4D x Contin.	78	1.0021	(0.9921	1.0123)	0.679
1W x Contin.	80	0.9996	(0.9880	1.0113)	0.946
4D x 75 CU	259	1.1196	(0.5999	2.0898)	0.723
1W x 75 CU	259	1.0284	(0.4872	2.1710)	0.941
4D x 100 CU	259	1.3096	(0.6061	2.8297)	0.493
1W x 100 CU	259	1.6440	(0.6670	4.0523)	0.280
4D x 125 CU	259	1.7921	(0.7859	4.0865)	0.165
1W x 125 CU	259	1.8828	(0.6920	5.1231)	0.215

Table A.6. Supplementary table for Crohns Disease Prednisone for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	2.2804	(0.9965	5.2185)	0.051
1W e 75 CU	256	1.7364	(0.6141	4.9100)	0.298
4D e 100 CU	256	2.1189	(0.8423	5.3300)	0.111
1W e 100 CU	256	3.1441	(0.9469	10.4404)	0.061
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	74	1.0086	(0.9962	1.0210)	0.174
1W e Contin.	75	1.0168	(0.9956	1.0384)	0.120
4D x Contin.	74	1.0083	(0.9987	1.0181)	0.090
1W x Contin.	75	1.0053	(0.9915	1.0192)	0.453
4D x 75 CU	256	1.7666	(0.9668	3.2279)	0.064
1W x 75 CU	256	1.4505	(0.6578	3.1983)	0.357
4D x 100 CU	256	1.5578	(0.6955	3.4895)	0.281
1W x 100 CU	256	1.0954	(0.4383	2.7374)	0.845
4D x 125 CU	256	2.5872	(1.1095	6.0329)	0.028
1W x 125 CU	256	1.9171	(0.6885	5.3377)	0.213

Table A.7. Supplementary table for IBD Prednisone for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	1.6457	(0.9730	2.7836)	0.063
1W e 75 CU	475	1.9283	(0.9680	3.8411)	0.062
4D e 100 CU	475	2.0097	(1.1062	3.6510)	0.022
1W e 100 CU	475	3.0918	(1.4514	6.5861)	0.003
4D e 125 CU	475	3.6509	(1.8542	7.1889)	0.000
1W 125 CU			(	)	
4D e Contin.	287	1.0017	(0.9944	1.0091)	0.644
1W e Contin.	288	1.0036	(0.9927	1.0147)	0.515
4D x Contin.	287	1.0017	(0.9965	1.0070)	0.525
1W x Contin.	288	1.0030	(0.9963	1.0097)	0.380
4D x 75 CU	475	1.4715	(0.9755	2.2196)	0.066
1W x 75 CU	475	1.4225	(0.8493	2.3828)	0.181
4D x 100 CU	475	1.5239	(0.9165	2.5340)	0.104
1W x 100 CU	475	1.3924	(0.7731	2.5077)	0.270
4D x 125 CU	475	1.8349	(1.0696	3.1480)	0.028
1W x 125 CU	475	1.7060	(0.9377	3.1036)	0.080

Table A.8. Supplementary table for Ulcerative Colitis Prednisone for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.4785	(0.7290	2.9990)	0.278
1W e 75 CU	259	2.2577	(0.9152	5.5690)	0.077
4D e 100 CU	259	2.0610	(0.9295	4.5700)	0.075
1W e 100 CU	259	2.5867	(0.9605	6.9659)	0.060
4D e 125 CU	259	3.8871	(1.5970	9.4612)	0.003
1W 125 CU			(	)	
4D e Contin.	137	1.0032	(0.9926	1.0140)	0.554
1W e Contin.	137	1.0007	(0.9850	1.0167)	0.929
4D x Contin.	137	1.0010	(0.9930	1.0091)	0.811
1W x Contin.	137	0.9987	(0.9878	1.0098)	0.822
4D x 75 CU	259	1.1065	(0.6195	1.9761)	0.732
1W x 75 CU	259	1.0196	(0.4932	2.1078)	0.958
4D x 100 CU	259	1.3983	(0.7035	2.7794)	0.339
1W x 100 CU	259	1.6032	(0.7001	3.6713)	0.264
4D x 125 CU	259	1.7322	(0.8384	3.5790)	0.138
1W x 125 CU	259	1.7007	(0.7122	4.0611)	0.232

Table A.9. Supplementary table for Crohns Disease Prednisone for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	2.0658	(0.9986	4.2735)	0.050
1W e 75 CU	256	1.9936	(0.7541	5.2701)	0.164
4D e 100 CU	256	1.8289	(0.8081	4.1393)	0.147
1W e 100 CU	256	3.1229	(1.1025	8.8458)	0.032
4D e 125 CU	256	2.5333	(0.9991	6.4231)	0.050
1W 125 CU			(	)	
4D e Contin.	173	1.0000	(0.9904	1.0097)	0.996
1W e Contin.	174	1.0028	(0.9882	1.0177)	0.708
4D x Contin.	173	1.0013	(0.9945	1.0082)	0.701
1W x Contin.	174	1.0048	(0.9964	1.0133)	0.262
4D x 75 CU	256	1.9155	(1.1231	3.2669)	0.017
1W x 75 CU	256	1.8740	(0.9455	3.7144)	0.072
4D x 100 CU	256	1.6818	(0.8408	3.3641)	0.142
1W x 100 CU	256	1.5035	(0.6839	3.3054)	0.310
4D x 125 CU	256	1.8279	(0.8826	3.7857)	0.104
1W x 125 CU	256	2.1602	(0.9848	4.7388)	0.055

Table A.10. Supplementary table for IBD Prednisone for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	1.3943	(0.8148	2.3861)	0.225
1W e 75 CU	475	1.7031	(0.9018	3.2164)	0.101
4D e 100 CU	475	2.3585	(1.2831	4.3352)	0.006
1W e 100 CU	475	2.6248	(1.2469	5.5251)	0.011
4D e 125 CU	475	2.7647	(1.3910	5.4950)	0.004
1W 125 CU			(	)	
4D e Contin.	247	1.0004	(0.9917	1.0091)	0.933
1W e Contin.	256	1.0014	(0.9890	1.0140)	0.827
4D x Contin.	247	1.0014	(0.9951	1.0077)	0.662
1W x Contin.	256	1.0001	(0.9928	1.0075)	0.976
4D x 75 CU	475	1.5170	(1.0118	2.2743)	0.044
1W x 75 CU	475	1.1265	(0.6991	1.8153)	0.625
4D x 100 CU	475	1.5992	(0.9450	2.7061)	0.080
1W x 100 CU	475	1.1293	(0.6248	2.0411)	0.687
4D x 125 CU	475	2.0206	(1.1470	3.5593)	0.015
1W x 125 CU	475	1.6994	(0.9015	3.2037)	0.101

Table A.11. Supplementary table for Ulcerative Colitis Prednisone for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.6159	(0.7855	3.3242)	0.192
1W e 75 CU	259	2.0359	(0.8663	4.7843)	0.103
4D e 100 CU	259	2.7615	(1.2419	6.1405)	0.013
1W e 100 CU	259	2.2389	(0.8690	5.7683)	0.095
4D e 125 CU	259	4.4224	(1.7490	11.1824)	0.002
1W 125 CU			(	)	
4D e Contin.	120	0.9993	(0.9873	1.0114)	0.910
1W e Contin.	124	0.9934	(0.9763	1.0107)	0.452
4D x Contin.	120	0.9989	(0.9898	1.0082)	0.821
1W x Contin.	124	0.9974	(0.9870	1.0078)	0.623
4D x 75 CU	259	1.0209	(0.5682	1.8342)	0.945
1W x 75 CU	259	0.7679	(0.3898	1.5126)	0.445
4D x 100 CU	259	1.3183	(0.6502	2.6728)	0.444
1W x 100 CU	259	1.2588	(0.5496	2.8832)	0.586
4D x 125 CU	259	2.0064	(0.9556	4.2129)	0.066
1W x 125 CU	259	1.8346	(0.8075	4.1681)	0.147

Table A.12. Supplementary table for Crohns Disease Prednisone for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	1.5926	(0.7631	3.3237)	0.215
1W e 75 CU	256	1.7077	(0.7055	4.1335)	0.235
4D e 100 CU	256	2.1504	(0.8979	5.1500)	0.086
1W e 100 CU	256	2.8479	(0.9567	8.4779)	0.060
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	147	1.0003	(0.9882	1.0126)	0.962
1W e Contin.	152	1.0062	(0.9883	1.0244)	0.501
4D x Contin.	147	1.0024	(0.9936	1.0112)	0.596
1W x Contin.	152	1.0025	(0.9918	1.0132)	0.651
4D x 75 CU	256	2.1527	(1.2819	3.6149)	0.004
1W x 75 CU	256	1.6424	(0.8721	3.0931)	0.124
4D x 100 CU	256	2.2527	(1.0779	4.7076)	0.031
1W x 100 CU	256	1.2612	(0.5613	2.8338)	0.574
4D x 125 CU	256	2.1959	(0.9828	4.9063)	0.055
1W x 125 CU	256	2.1545	(0.8499	5.4616)	0.106

A.2 Odds Ratios for IBD Prednisone Prescriptions and Ozone

Table A.13. Supplementary table for IBD Prednisone for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	0.9487	(0.6369	1.4130)	0.795
1W e 75 CU	475	0.7019	(0.4218	1.1682)	0.173
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	287	1.0045	(0.9882	1.0211)	0.589
1W e Contin.	288	0.9925	(0.9675	1.0181)	0.563
4D x Contin.	287	1.0072	(0.9925	1.0221)	0.341
1W x Contin.	288	1.0057	(0.9850	1.0269)	0.592
4D x 75 CU	475	1.3686	(0.9133	2.0510)	0.128
1W x 75 CU	475	1.7336	(0.9435	3.1856)	0.076
4D x 100 CU	475	0.9357	(0.5338	1.6405)	0.817
1W x 100 CU	475	0.8137	(0.4347	1.5232)	0.519
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.14. Supplementary table for Ulcerative Colitis Prednisone for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.0172	(0.5779	1.7904)	0.953
1W e 75 CU	259	0.6615	(0.3297	1.3270)	0.245
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	1.0152	(0.9904	1.0406)	0.231
1W e Contin.	137	1.0027	(0.9661	1.0407)	0.886
4D x Contin.	137	1.0071	(0.9853	1.0294)	0.525
1W x Contin.	137	1.0064	(0.9768	1.0368)	0.678
4D x 75 CU	259	1.6008	(0.9034	2.8369)	0.107
1W x 75 CU	259	1.4565	(0.6242	3.3986)	0.384
4D x 100 CU	259	1.2308	(0.5715	2.6507)	0.596
1W x 100 CU	259	0.9463	(0.4284	2.0906)	0.892
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.15. Supplementary table for Crohns Disease Prednisone for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	0.7365	(0.4354	1.2458)	0.254
1W e 75 CU	256	0.6937	(0.3571	1.3477)	0.280
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	173	0.9937	(0.9734	1.0145)	0.551
1W e Contin.	174	0.9817	(0.9501	1.0144)	0.270
4D x Contin.	173	1.0012	(0.9826	1.0201)	0.901
1W x Contin.	174	0.9976	(0.9712	1.0247)	0.858
4D x 75 CU	256	1.1090	(0.6466	1.9019)	0.707
1W x 75 CU	256	1.8100	(0.8102	4.0436)	0.148
4D x 100 CU			(	)	
1W x 100 CU	256	0.5836	(0.2337	1.4577)	0.249
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.16. Supplementary table for IBD Prednisone for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	1.0332	(0.6862	1.5557)	0.876
1W e 75 CU	475	0.7333	(0.4395	1.2236)	0.235
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	147	1.0009	(0.9795	1.0228)	0.934
1W e Contin.	151	0.9894	(0.9568	1.0230)	0.531
4D x Contin.	147	1.0085	(0.9889	1.0285)	0.399
1W x Contin.	151	1.0028	(0.9750	1.0314)	0.845
4D x 75 CU	475	1.3228	(0.8744	2.0011)	0.185
1W x 75 CU	475	2.0897	(1.1080	3.9413)	0.023
4D x 100 CU	475	1.0378	(0.6190	1.7399)	0.888
1W x 100 CU	475	0.9450	(0.5087	1.7554)	0.858
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.17. Supplementary table for Ulcerative Colitis Prednisone for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.0600	(0.5898	1.9053)	0.845
1W e 75 CU	259	0.5557	(0.2593	1.1910)	0.131
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	78	1.0221	(0.9903	1.0549)	0.175
1W e Contin.	80	0.9970	(0.9540	1.0419)	0.892
4D x Contin.	78	1.0163	(0.9880	1.0455)	0.261
1W x Contin.	80	1.0075	(0.9713	1.0450)	0.690
4D x 75 CU	259	1.7127	(0.9373	3.1296)	0.080
1W x 75 CU	259	1.9051	(0.7734	4.6927)	0.161
4D x 100 CU	259	1.1978	(0.5754	2.4934)	0.629
1W x 100 CU	259	0.8028	(0.3492	1.8451)	0.605
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.18. Supplementary table for Crohns Disease Prednisone for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	0.9557	(0.5611	1.6277)	0.868
1W e 75 CU	256	0.7816	(0.4104	1.4884)	0.453
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	74	0.9843	(0.9561	1.0134)	0.289
1W e Contin.	75	0.9878	(0.9413	1.0366)	0.619
4D x Contin.	74	0.9956	(0.9692	1.0227)	0.747
1W x Contin.	75	0.9891	(0.9476	1.0324)	0.617
4D x 75 CU	256	1.0370	(0.6056	1.7758)	0.895
1W x 75 CU	256	2.1437	(0.9295	4.9443)	0.074
4D x 100 CU	256	0.8601	(0.4279	1.7291)	0.672
1W x 100 CU	256	0.9603	(0.4094	2.2524)	0.926
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.19. Supplementary table for IBD Prednisone for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	0.9999	(0.6675	1.4979)	1.000
1W e 75 CU	475	0.7121	(0.4312	1.1759)	0.185
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	287	1.0034	(0.9883	1.0188)	0.658
1W e Contin.	288	0.9931	(0.9708	1.0158)	0.548
4D x Contin.	287	1.0030	(0.9896	1.0166)	0.658
1W x Contin.	288	1.0030	(0.9837	1.0227)	0.763
4D x 75 CU	475	1.2568	(0.8407	1.8788)	0.265
1W x 75 CU	475	1.8681	(1.0202	3.4206)	0.043
4D x 100 CU	475	0.9971	(0.5983	1.6614)	0.991
1W x 100 CU	475	0.9122	(0.4962	1.6769)	0.767
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.20. Supplementary table for Ulcerative Colitis Prednisone for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.0179	(0.5718	1.8121)	0.952
1W e 75 CU	259	0.5635	(0.2697	1.1777)	0.127
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	1.0147	(0.9913	1.0387)	0.221
1W e Contin.	137	1.0030	(0.9708	1.0362)	0.858
4D x Contin.	137	1.0039	(0.9837	1.0245)	0.707
1W x Contin.	137	0.9999	(0.9719	1.0287)	0.994
4D x 75 CU	259	1.4541	(0.8178	2.5855)	0.202
1W x 75 CU	259	1.7517	(0.7390	4.1520)	0.203
4D x 100 CU	259	1.1824	(0.5687	2.4584)	0.654
1W x 100 CU	259	0.8758	(0.3866	1.9842)	0.751
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.21. Supplementary table for Crohns Disease Prednisone for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	0.9355	(0.5510	1.5883)	0.805
1W e 75 CU	256	0.7772	(0.4144	1.4576)	0.432
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	173	0.9936	(0.9749	1.0127)	0.509
1W e Contin.	174	0.9843	(0.9560	1.0135)	0.289
4D x Contin.	173	0.9975	(0.9808	1.0145)	0.774
1W x Contin.	174	0.9975	(0.9729	1.0227)	0.842
4D x 75 CU	256	1.0946	(0.6460	1.8548)	0.737
1W x 75 CU	256	1.9684	(0.8875	4.3660)	0.096
4D x 100 CU	256	0.7917	(0.3954	1.5855)	0.510
1W x 100 CU	256	0.8446	(0.3686	1.9356)	0.690
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.22. Supplementary table for IBD Prednisone for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	475	0.9893	(0.6652	1.4711)	0.957
1W e 75 CU	475	0.7455	(0.4361	1.2743)	0.283
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	247	1.0136	(0.9956	1.0319)	0.139
1W e Contin.	256	0.9999	(0.9718	1.0289)	0.997
4D x Contin.	247	1.0092	(0.9936	1.0250)	0.248
1W x Contin.	256	1.0022	(0.9800	1.0249)	0.847
4D x 75 CU	475	1.4572	(0.9760	2.1757)	0.066
1W x 75 CU	475	1.8136	(0.9608	3.4232)	0.066
4D x 100 CU	475	0.6381	(0.3563	1.1428)	0.131
1W x 100 CU	475	0.5390	(0.2791	1.0409)	0.066
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.23. Supplementary table for Ulcerative Colitis Prednisone for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	259	1.0027	(0.5633	1.7846)	0.993
1W e 75 CU	259	0.7251	(0.3490	1.5064)	0.389
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	120	1.0224	(0.9948	1.0508)	0.112
1W e Contin.	124	1.0012	(0.9607	1.0435)	0.953
4D x Contin.	120	1.0082	(0.9845	1.0325)	0.501
1W x Contin.	124	1.0017	(0.9702	1.0341)	0.918
4D x 75 CU	259	1.4232	(0.8128	2.4918)	0.217
1W x 75 CU	259	1.5713	(0.6408	3.8527)	0.323
4D x 100 CU	259	0.9920	(0.4583	2.1473)	0.984
1W x 100 CU	259	0.6983	(0.2978	1.6372)	0.409
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.24. Supplementary table for Crohns Disease Prednisone for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	256	0.9263	(0.5532	1.5510)	0.771
1W e 75 CU	256	0.6751	(0.3405	1.3383)	0.260
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	147	1.0048	(0.9823	1.0277)	0.680
1W e Contin.	152	0.9961	(0.9600	1.0336)	0.836
4D x Contin.	147	1.0031	(0.9835	1.0231)	0.757
1W x Contin.	152	0.9942	(0.9658	1.0234)	0.692
4D x 75 CU	256	1.4316	(0.8382	2.4453)	0.189
1W x 75 CU	256	2.4252	(1.0385	5.6639)	0.041
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

A.3 Odds Ratios for IBD Prednisone Prescriptions and Nitrogen Dioxide

Table A.25. Supplementary table for IBD Prednisone for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	287	1.0046	(0.9769	1.0332)	0.747
1W e Contin.	288	0.9910	(0.9502	1.0335)	0.673
4D x Contin.	287	1.0061	(0.9830	1.0296)	0.609
1W x Contin.	288	0.9933	(0.9660	1.0213)	0.635
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.26. Supplementary table for Ulcerative Colitis Prednisone for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	1.0174	(0.9771	1.0594)	0.403
1W e Contin.	137	1.0145	(0.9567	1.0757)	0.631
4D x Contin.	137	1.0139	(0.9789	1.0502)	0.441
1W x Contin.	137	1.0008	(0.9609	1.0424)	0.968
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.27. Supplementary table for Crohns Disease Prednisone for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	173	1.0001	(0.9639	1.0377)	0.995
1W e Contin.	174	0.9806	(0.9257	1.0387)	0.505
4D x Contin.	173	1.0096	(0.9780	1.0422)	0.555
1W x Contin.	174	0.9971	(0.9576	1.0383)	0.889
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.28. Supplementary table for IBD Prednisone for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	147	0.9945	(0.9604	1.0298)	0.757
1W e Contin.	151	0.9623	(0.9137	1.0134)	0.145
4D x Contin.	147	0.9979	(0.9729	1.0235)	0.868
1W x Contin.	151	0.9921	(0.9645	1.0204)	0.579
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.29. Supplementary table for Ulcerative Colitis Prednisone for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	78	1.0118	(0.9633	1.0628)	0.639
1W e Contin.	80	0.9755	(0.9102	1.0454)	0.482
4D x Contin.	78	1.0080	(0.9672	1.0505)	0.706
1W x Contin.	80	0.9955	(0.9517	1.0412)	0.843
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.30. Supplementary table for Crohns Disease Prednisone for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	74	0.9876	(0.9384	1.0393)	0.631
1W e Contin.	75	0.9615	(0.8886	1.0404)	0.329
4D x Contin.	74	1.0064	(0.9657	1.0488)	0.763
1W x Contin.	75	1.0044	(0.9566	1.0547)	0.859
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.31. Supplementary table for IBD Prednisone for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	287	1.0137	(0.9893	1.0388)	0.273
1W e Contin.	288	1.0000	(0.9658	1.0354)	0.998
4D x Contin.	287	1.0119	(0.9936	1.0305)	0.205
1W x Contin.	288	0.9974	(0.9770	1.0181)	0.803
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.32. Supplementary table for Ulcerative Colitis Prednisone for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	1.0319	(0.9960	1.0691)	0.083
1W e Contin.	137	1.0274	(0.9780	1.0794)	0.282
4D x Contin.	137	1.0249	(0.9956	1.0550)	0.096
1W x Contin.	137	1.0156	(0.9843	1.0478)	0.333
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.33. Supplementary table for Crohns Disease Prednisone for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	173	1.0084	(0.9764	1.0414)	0.612
1W e Contin.	174	0.9929	(0.9465	1.0416)	0.771
4D x Contin.	173	1.0127	(0.9860	1.0401)	0.354
1W x Contin.	174	0.9915	(0.9601	1.0240)	0.603
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.34. Supplementary table for IBD Prednisone for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	247	1.0176	(0.9904	1.0456)	0.207
1W e Contin.	256	1.0017	(0.9644	1.0405)	0.929
4D x Contin.	247	1.0111	(0.9913	1.0312)	0.275
1W x Contin.	256	0.9978	(0.9768	1.0193)	0.839
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.35. Supplementary table for Ulcerative Colitis Prednisone for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	120	1.0442	(1.0042	1.0858)	0.030
1W e Contin.	124	1.0366	(0.9847	1.0912)	0.170
4D x Contin.	120	1.0330	(1.0020	1.0649)	0.037
1W x Contin.	124	1.0116	(0.9810	1.0433)	0.462
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.36. Supplementary table for Crohns Disease Prednisone for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	147	1.0054	(0.9697	1.0425)	0.769
1W e Contin.	152	0.9830	(0.9320	1.0368)	0.528
4D x Contin.	147	1.0036	(0.9740	1.0340)	0.816
1W x Contin.	152	0.9916	(0.9587	1.0257)	0.626
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

A.4 Odds Ratios for Infections and Particulate Matter

Table A.37. Supplementary table for IBD Infection for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.5765	(0.8814	2.8199)	0.125
1W e 75 CU	490	1.6929	(0.7918	3.6195)	0.175
4D e 100 CU	490	1.3495	(0.6464	2.8173)	0.425
1W e 100 CU	490	2.3241	(0.9231	5.8514)	0.073
4D e 125 CU	490	2.1542	(0.9378	4.9484)	0.070
1W 125 CU			(	)	
4D e Contin.	253	1.0096	(1.0005	1.0188)	0.040
1W e Contin.	256	1.0158	(1.0027	1.0290)	0.018
4D x Contin.	253	1.0043	(0.9981	1.0106)	0.173
1W x Contin.	256	1.0083	(1.0012	1.0155)	0.022
4D x 75 CU	490	0.9807	(0.6236	1.5424)	0.933
1W x 75 CU	490	1.0609	(0.6375	1.7653)	0.820
4D x 100 CU	490	1.2319	(0.7243	2.0953)	0.441
1W x 100 CU	490	1.4102	(0.7753	2.5651)	0.260
4D x 125 CU	490	1.4503	(0.7961	2.6420)	0.224
1W x 125 CU	490	1.5959	(0.8268	3.0805)	0.164

Table A.38. Supplementary table for Ulcerative Colitis Infection for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	262	1.5282	(0.7251	3.2206)	0.265
1W e 75 CU	262	1.6702	(0.6722	4.1498)	0.269
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	127	1.0058	(0.9930	1.0188)	0.375
1W e Contin.	128	1.0166	(0.9974	1.0362)	0.091
4D x Contin.	127	0.9996	(0.9909	1.0085)	0.936
1W x Contin.	128	1.0064	(0.9956	1.0174)	0.243
4D x 75 CU	262	0.9113	(0.5012	1.6570)	0.761
1W x 75 CU	262	1.4737	(0.7247	2.9969)	0.284
4D x 100 CU	262	1.2150	(0.6218	2.3739)	0.569
1W x 100 CU	262	1.5274	(0.6999	3.3333)	0.287
4D x 125 CU	262	1.2616	(0.5612	2.8358)	0.574
1W x 125 CU	262	1.7670	(0.7294	4.2807)	0.207

Table A.39. Supplementary table for Crohns Disease Infection for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.7661	(0.8574	3.6380)	0.123
1W e 75 CU	279	2.5496	(0.8828	7.3631)	0.084
4D e 100 CU			(	)	
1W e 100 CU	279	1.8646	(0.5759	6.0376)	0.299
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	154	1.0113	(1.0000	1.0228)	0.050
1W e Contin.	156	1.0179	(1.0015	1.0345)	0.032
4D x Contin.	154	1.0073	(0.9994	1.0153)	0.070
1W x Contin.	156	1.0123	(1.0031	1.0216)	0.009
4D x 75 CU	279	1.3057	(0.7376	2.3115)	0.360
1W x 75 CU	279	1.0813	(0.5603	2.0869)	0.816
4D x 100 CU	279	1.5501	(0.7958	3.0194)	0.198
1W x 100 CU	279	1.5871	(0.7464	3.3748)	0.230
4D x 125 CU	279	1.5429	(0.7411	3.2123)	0.246
1W x 125 CU	279	1.6155	(0.7233	3.6082)	0.242

Table A.40. Supplementary table for IBD Infection for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.6428	(0.8959	3.0125)	0.109
1W e 75 CU	490	2.5182	(1.0739	5.9049)	0.034
4D e 100 CU	490	1.5368	(0.7220	3.2713)	0.265
1W e 100 CU	490	3.2707	(1.2509	8.5519)	0.016
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	120	1.0087	(0.9993	1.0182)	0.069
1W e Contin.	123	1.0232	(1.0072	1.0394)	0.004
4D x Contin.	120	1.0041	(0.9974	1.0108)	0.229
1W x Contin.	123	1.0121	(1.0027	1.0215)	0.012
4D x 75 CU	490	1.1695	(0.7125	1.9195)	0.536
1W x 75 CU	490	0.9719	(0.5544	1.7037)	0.921
4D x 100 CU	490	1.5722	(0.9081	2.7221)	0.106
1W x 100 CU	490	1.7668	(0.9353	3.3374)	0.079
4D x 125 CU	490	1.4022	(0.7081	2.7766)	0.332
1W x 125 CU	490	2.5582	(1.1429	5.7259)	0.022

Table A.41. Supplementary table for Ulcerative Colitis Infection for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	60	0.9993	(0.9901	1.0085)	0.880
1W x Contin.	61	1.0039	(0.9917	1.0163)	0.530
4D x 75 CU	262	1.2389	(0.6435	2.3853)	0.522
1W x 75 CU	262	0.8860	(0.4214	1.8627)	0.749
4D x 100 CU	262	1.9140	(0.9488	3.8613)	0.070
1W x 100 CU	262	2.2094	(0.9510	5.1331)	0.065
4D x 125 CU			(	)	
1W x 125 CU	262	2.4073	(0.8167	7.0955)	0.111

Table A.42. Supplementary table for Crohns Disease Infection for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.5506	(0.7164	3.3565)	0.266
1W e 75 CU	279	2.9848	(0.9965	8.9408)	0.051
4D e 100 CU			(	)	
1W e 100 CU	279	2.2899	(0.7038	7.4502)	0.169
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	72	1.0110	(0.9988	1.0233)	0.077
1W e Contin.	75	1.0334	(1.0103	1.0571)	0.004
4D x Contin.	72	1.0085	(0.9991	1.0181)	0.078
1W x Contin.	75	1.0244	(1.0088	1.0402)	0.002
4D x 75 CU	279	1.3995	(0.7474	2.6205)	0.294
1W x 75 CU	279	1.2699	(0.6176	2.6113)	0.516
4D x 100 CU	279	1.6405	(0.8181	3.2897)	0.163
1W x 100 CU	279	2.0691	(0.8807	4.8609)	0.095
4D x 125 CU	279	1.5882	(0.6891	3.6608)	0.278
1W x 125 CU	279	2.9245	(1.0565	8.0953)	0.039

Table A.43. Supplementary table for IBD Infection for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.5093	(0.8447	2.6970)	0.165
1W e 75 CU	490	1.6752	(0.7899	3.5526)	0.179
4D e 100 CU	490	1.5106	(0.7471	3.0545)	0.251
1W e 100 CU	490	3.3516	(1.3295	8.4492)	0.010
4D e 125 CU	490	1.8786	(0.8413	4.1946)	0.124
1W 125 CU			(	)	
4D e Contin.	253	1.0089	(1.0007	1.0171)	0.034
1W e Contin.	256	1.0148	(1.0029	1.0268)	0.015
4D x Contin.	253	1.0043	(0.9991	1.0095)	0.102
1W x Contin.	256	1.0065	(1.0005	1.0126)	0.034
4D x 75 CU	490	1.0627	(0.6923	1.6312)	0.781
1W x 75 CU	490	1.0418	(0.6353	1.7083)	0.871
4D x 100 CU	490	1.3865	(0.8538	2.2515)	0.186
1W x 100 CU	490	1.3814	(0.7969	2.3947)	0.250
4D x 125 CU	490	1.4687	(0.8321	2.5921)	0.185
1W x 125 CU	490	1.8043	(0.9426	3.4539)	0.075

Table A.44. Supplementary table for Ulcerative Colitis Infection for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	262	1.6954	(0.8137	3.5324)	0.159
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	127	1.0050	(0.9934	1.0168)	0.400
1W e Contin.			(	)	
4D x Contin.	127	1.0006	(0.9933	1.0081)	0.865
1W x Contin.	128	1.0050	(0.9960	1.0141)	0.280
4D x 75 CU	262	0.8959	(0.5042	1.5917)	0.708
1W x 75 CU	262	1.1569	(0.5935	2.2554)	0.669
4D x 100 CU	262	1.5233	(0.8271	2.8057)	0.177
1W x 100 CU	262	1.9137	(0.9275	3.9482)	0.079
4D x 125 CU	262	1.3839	(0.6448	2.9701)	0.404
1W x 125 CU	262	2.0942	(0.8423	5.2068)	0.112

Table A.45. Supplementary table for Crohns Disease Infection for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.7274	(0.8310	3.5908)	0.143
1W e 75 CU	279	2.0505	(0.7930	5.3025)	0.138
4D e 100 CU	279	1.1637	(0.4759	2.8456)	0.740
1W e 100 CU	279	2.2931	(0.7482	7.0277)	0.146
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	154	1.0109	(1.0006	1.0214)	0.038
1W e Contin.	156	1.0165	(1.0014	1.0318)	0.032
4D x Contin.	154	1.0068	(1.0000	1.0136)	0.050
1W x Contin.	156	1.0109	(1.0024	1.0195)	0.011
4D x 75 CU	279	1.4292	(0.8236	2.4800)	0.204
1W x 75 CU	279	1.1582	(0.6032	2.2236)	0.659
4D x 100 CU	279	1.4159	(0.7504	2.6719)	0.283
1W x 100 CU	279	1.3066	(0.6170	2.7670)	0.485
4D x 125 CU	279	1.5317	(0.7500	3.1279)	0.242
1W x 125 CU	279	1.9913	(0.8567	4.6287)	0.109

Table A.46. Supplementary table for IBD Infection for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.8867	(1.0730	3.3174)	0.027
1W e 75 CU	490	1.9519	(0.9379	4.0625)	0.074
4D e 100 CU	490	1.8809	(0.9183	3.8527)	0.084
1W e 100 CU	490	3.5179	(1.3417	9.2238)	0.011
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	229	1.0098	(1.0009	1.0187)	0.031
1W e Contin.	233	1.0148	(1.0023	1.0275)	0.020
4D x Contin.	229	1.0052	(0.9991	1.0113)	0.092
1W x Contin.	233	1.0053	(0.9984	1.0122)	0.130
4D x 75 CU	490	1.2215	(0.7864	1.8974)	0.373
1W x 75 CU	490	1.0785	(0.6417	1.8127)	0.775
4D x 100 CU	490	1.5158	(0.9024	2.5462)	0.116
1W x 100 CU	490	1.3496	(0.7347	2.4791)	0.334
4D x 125 CU	490	1.3375	(0.7365	2.4287)	0.339
1W x 125 CU	490	1.5998	(0.8301	3.0831)	0.160

Table A.47. Supplementary table for Ulcerative Colitis Infection for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	113	1.0038	(0.9956	1.0121)	0.365
1W x Contin.	114	1.0059	(0.9955	1.0165)	0.267
4D x 75 CU	262	1.2830	(0.7249	2.2708)	0.392
1W x 75 CU	262	1.4725	(0.7151	3.0322)	0.294
4D x 100 CU	262	2.0675	(1.0664	4.0087)	0.032
1W x 100 CU	262	2.0988	(0.9057	4.8639)	0.084
4D x 125 CU	262	1.2316	(0.5520	2.7476)	0.611
1W x 125 CU	262	1.7977	(0.7296	4.4292)	0.202

Table A.48. Supplementary table for Crohns Disease Infection for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.9389	(0.9515	3.9512)	0.068
1W e 75 CU	279	2.1594	(0.8500	5.4859)	0.106
4D e 100 CU	279	1.4550	(0.5990	3.5344)	0.408
1W e 100 CU	279	2.1605	(0.7191	6.4912)	0.170
4D e 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	1.0101	(0.9986	1.0218)	0.086
1W e Contin.	140	1.0126	(0.9968	1.0285)	0.118
4D x Contin.	137	1.0055	(0.9972	1.0139)	0.197
1W x Contin.	140	1.0087	(0.9993	1.0183)	0.070
4D x 75 CU	279	1.4156	(0.8023	2.4977)	0.230
1W x 75 CU	279	1.1204	(0.5753	2.1823)	0.738
4D x 100 CU	279	1.5356	(0.7925	2.9753)	0.204
1W x 100 CU	279	1.1345	(0.5151	2.4986)	0.754
4D x 125 CU	279	1.2366	(0.5824	2.6256)	0.580
1W x 125 CU	279	1.4258	(0.6190	3.2842)	0.405

A.5 Odds Ratios for Infections and Ozone

Table A.49. Supplementary table for IBD Infection for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.1340	(0.7859	1.6365)	0.501
1W e 75 CU	490	0.8490	(0.5063	1.4236)	0.535
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	253	1.0068	(0.9904	1.0235)	0.418
1W e Contin.	256	1.0065	(0.9791	1.0347)	0.644
4D x Contin.	253	1.0015	(0.9868	1.0163)	0.846
1W x Contin.	256	1.0063	(0.9845	1.0287)	0.573
4D x 75 CU	490	0.9847	(0.6673	1.4529)	0.938
1W x 75 CU	490	1.1199	(0.6517	1.9244)	0.682
4D x 100 CU	490	0.9012	(0.5523	1.4704)	0.677
1W x 100 CU	490	0.9995	(0.6054	1.6499)	0.998
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.50. Supplementary table for Ulcerative Colitis Infection for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	262	1.0483	(0.6253	1.7573)	0.858
1W e 75 CU	262	0.7708	(0.3829	1.5518)	0.466
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	127	1.0012	(0.9782	1.0248)	0.918
1W e Contin.	128	1.0128	(0.9753	1.0518)	0.508
4D x Contin.	127	1.0003	(0.9798	1.0213)	0.975
1W x Contin.	128	1.0115	(0.9819	1.0420)	0.449
4D x 75 CU	262	1.0017	(0.5737	1.7488)	0.995
1W x 75 CU	262	1.2771	(0.5884	2.7719)	0.536
4D x 100 CU	262	1.1213	(0.5651	2.2253)	0.743
1W x 100 CU	262	1.6264	(0.7607	3.4771)	0.210
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.51. Supplementary table for Crohns Disease Infection for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.1972	(0.7260	1.9742)	0.481
1W e 75 CU	279	0.8676	(0.4233	1.7782)	0.698
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	154	1.0150	(0.9934	1.0372)	0.175
1W e Contin.	156	1.0184	(0.9815	1.0567)	0.333
4D x Contin.	154	1.0037	(0.9844	1.0234)	0.709
1W x Contin.	156	1.0133	(0.9826	1.0450)	0.399
4D x 75 CU	279	0.9254	(0.5416	1.5810)	0.777
1W x 75 CU	279	1.1334	(0.5196	2.4724)	0.753
4D x 100 CU	279	0.7941	(0.4030	1.5648)	0.505
1W x 100 CU	279	0.9586	(0.4951	1.8560)	0.900
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.52. Supplementary table for IBD Infection for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	0.9524	(0.6509	1.3934)	0.802
1W e 75 CU	490	1.0468	(0.6329	1.7314)	0.859
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	120	1.0047	(0.9819	1.0280)	0.689
1W e Contin.	123	1.0196	(0.9799	1.0609)	0.338
4D x Contin.	120	0.9992	(0.9787	1.0202)	0.943
1W x Contin.	123	0.9994	(0.9674	1.0324)	0.969
4D x 75 CU	490	1.0468	(0.6960	1.5744)	0.826
1W x 75 CU	490	1.4281	(0.8102	2.5170)	0.218
4D x 100 CU	490	0.8587	(0.5334	1.3823)	0.530
1W x 100 CU	490	1.0389	(0.6200	1.7409)	0.885
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.53. Supplementary table for Ulcerative Colitis Infection for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	60	0.9932	(0.9648	1.0224)	0.643
1W x Contin.	61	0.9903	(0.9463	1.0364)	0.675
4D x 75 CU	262	1.0126	(0.5729	1.7896)	0.966
1W x 75 CU	262	1.6598	(0.7363	3.7414)	0.222
4D x 100 CU	262	0.8415	(0.4165	1.7003)	0.631
1W x 100 CU	262	1.2771	(0.6108	2.6705)	0.516
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.54. Supplementary table for Crohns Disease Infection for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.1198	(0.6678	1.8777)	0.668
1W e 75 CU	279	1.1355	(0.5674	2.2725)	0.720
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	72	1.0097	(0.9799	1.0405)	0.527
1W e Contin.	75	1.0504	(0.9942	1.1097)	0.080
4D x Contin.	72	1.0010	(0.9737	1.0290)	0.945
1W x Contin.	75	1.0144	(0.9703	1.0605)	0.529
4D x 75 CU	279	1.0387	(0.5844	1.8464)	0.897
1W x 75 CU	279	1.6514	(0.7056	3.8647)	0.248
4D x 100 CU	279	0.9027	(0.4830	1.6869)	0.748
1W x 100 CU	279	1.0056	(0.5069	1.9947)	0.987
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.55. Supplementary table for IBD Infection for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.0191	(0.7053	1.4725)	0.920
1W e 75 CU	490	0.9595	(0.5816	1.5828)	0.871
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	253	1.0064	(0.9907	1.0222)	0.427
1W e Contin.	256	1.0044	(0.9791	1.0304)	0.735
4D x Contin.	253	1.0007	(0.9870	1.0145)	0.926
1W x Contin.	256	1.0038	(0.9844	1.0236)	0.700
4D x 75 CU	490	1.0756	(0.7259	1.5938)	0.716
1W x 75 CU	490	1.3957	(0.8004	2.4336)	0.240
4D x 100 CU	490	0.8715	(0.5464	1.3901)	0.564
1W x 100 CU	490	0.9437	(0.5701	1.5620)	0.822
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.56. Supplementary table for Ulcerative Colitis Infection for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	262	0.9230	(0.5444	1.5648)	0.766
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	127	0.9997	(0.9776	1.0223)	0.980
1W e Contin.			(	)	
4D x Contin.	127	0.9974	(0.9780	1.0172)	0.792
1W x Contin.	128	1.0041	(0.9781	1.0308)	0.761
4D x 75 CU	262	1.0671	(0.6119	1.8610)	0.819
1W x 75 CU	262	1.5692	(0.7063	3.4861)	0.269
4D x 100 CU	262	0.9085	(0.4589	1.7987)	0.783
1W x 100 CU	262	1.3000	(0.6271	2.6951)	0.481
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.57. Supplementary table for Crohns Disease Infection for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.2040	(0.7313	1.9823)	0.465
1W e 75 CU	279	0.9595	(0.4845	1.9002)	0.906
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	154	1.0146	(0.9939	1.0356)	0.167
1W e Contin.	156	1.0158	(0.9824	1.0503)	0.359
4D x Contin.	154	1.0035	(0.9857	1.0217)	0.702
1W x Contin.	156	1.0112	(0.9841	1.0391)	0.422
4D x 75 CU	279	1.0194	(0.5912	1.7579)	0.945
1W x 75 CU	279	1.4672	(0.6520	3.3018)	0.354
4D x 100 CU	279	0.8637	(0.4637	1.6089)	0.644
1W x 100 CU	279	0.8589	(0.4364	1.6903)	0.660
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.58. Supplementary table for IBD Infection for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	490	1.0759	(0.7400	1.5643)	0.701
1W e 75 CU	490	0.9716	(0.5834	1.6181)	0.912
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	229	1.0010	(0.9841	1.0181)	0.912
1W e Contin.	233	1.0032	(0.9751	1.0320)	0.827
4D x Contin.	229	0.9990	(0.9840	1.0141)	0.892
1W x Contin.	233	1.0004	(0.9791	1.0222)	0.972
4D x 75 CU	490	1.0982	(0.7343	1.6427)	0.648
1W x 75 CU	490	1.1797	(0.6674	2.0850)	0.570
4D x 100 CU	490	0.9375	(0.5804	1.5144)	0.792
1W x 100 CU	490	1.1222	(0.6715	1.8754)	0.660
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.59. Supplementary table for Ulcerative Colitis Infection for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	113	1.0038	(0.9830	1.0251)	0.724
1W x Contin.	114	1.0063	(0.9782	1.0352)	0.664
4D x 75 CU	262	1.3244	(0.7490	2.3417)	0.334
1W x 75 CU	262	1.4945	(0.6541	3.4144)	0.341
4D x 100 CU	262	1.2193	(0.6218	2.3910)	0.564
1W x 100 CU	262	1.6002	(0.7505	3.4118)	0.224
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.60. Supplementary table for Crohns Disease Infection for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	279	1.3024	(0.7810	2.1719)	0.311
1W e 75 CU	279	0.8981	(0.4474	1.8028)	0.762
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	1.0043	(0.9813	1.0278)	0.716
1W e Contin.	140	1.0039	(0.9661	1.0432)	0.844
4D x Contin.	137	0.9947	(0.9747	1.0151)	0.606
1W x Contin.	140	1.0032	(0.9725	1.0349)	0.839
4D x 75 CU	279	0.9299	(0.5351	1.6158)	0.796
1W x 75 CU	279	1.0624	(0.4647	2.4289)	0.886
4D x 100 CU	279	0.7381	(0.3800	1.4335)	0.370
1W x 100 CU	279	1.0950	(0.5521	2.1719)	0.795
4D 125 CU			(	)	
1W 125 CU			(	)	

A.6 Odds Ratios for Infections and Nitrogen Dioxide

Table A.61. Supplementary table for IBD Infection for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	253	0.9689	(0.9400	0.9987)	0.041
1W e Contin.	256	0.9627	(0.9196	1.0078)	0.104
4D x Contin.	253	0.9880	(0.9630	1.0138)	0.359
1W x Contin.	256	0.9883	(0.9573	1.0204)	0.471
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.62. Supplementary table for Ulcerative Colitis Infection for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	127	0.9669	(0.9281	1.0072)	0.106
1W e Contin.	128	0.9425	(0.8819	1.0072)	0.080
4D x Contin.	127	0.9877	(0.9546	1.0219)	0.476
1W x Contin.	128	0.9826	(0.9413	1.0257)	0.423
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.63. Supplementary table for Crohns Disease Infection for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	154	0.9673	(0.9305	1.0055)	0.092
1W e Contin.	156	0.9617	(0.9077	1.0190)	0.186
4D x Contin.	154	0.9824	(0.9492	1.0168)	0.313
1W x Contin.	156	0.9748	(0.9307	1.0211)	0.281
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.64. Supplementary table for IBD Infection for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	120	0.9721	(0.9387	1.0067)	0.113
1W e Contin.	123	0.9594	(0.9109	1.0105)	0.118
4D x Contin.	120	0.9986	(0.9738	1.0240)	0.911
1W x Contin.	123	0.9982	(0.9702	1.0269)	0.899
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.65. Supplementary table for Ulcerative Colitis Infection for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	60	0.9989	(0.9700	1.0286)	0.941
1W x Contin.	61	0.9990	(0.9668	1.0322)	0.951
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.66. Supplementary table for Crohns Disease Infection for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	72	0.9703	(0.9258	1.0170)	0.209
1W e Contin.	75	0.9494	(0.8845	1.0191)	0.151
4D x Contin.	72	0.9804	(0.9402	1.0224)	0.355
1W x Contin.	75	0.9643	(0.9122	1.0193)	0.199
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.67. Supplementary table for IBD Infection for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	253	0.9725	(0.9475	0.9982)	0.036
1W e Contin.	256	0.9712	(0.9342	1.0096)	0.139
4D x Contin.	253	0.9897	(0.9693	1.0105)	0.329
1W x Contin.	256	0.9971	(0.9740	1.0208)	0.811
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.68. Supplementary table for Ulcerative Colitis Infection for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	127	0.9744	(0.9407	1.0092)	0.147
1W e Contin.			(	)	
4D x Contin.	127	0.9923	(0.9667	1.0187)	0.564
1W x Contin.	128	0.9936	(0.9636	1.0246)	0.683
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.69. Supplementary table for Crohns Disease Infection for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	154	0.9676	(0.9352	1.0012)	0.058
1W e Contin.	156	0.9701	(0.9229	1.0197)	0.232
4D x Contin.	154	0.9831	(0.9549	1.0121)	0.250
1W x Contin.	156	0.9818	(0.9457	1.0192)	0.335
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.70. Supplementary table for IBD Infection for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	229	0.9577	(0.9298	0.9865)	0.004
1W e Contin.	233	0.9521	(0.9114	0.9947)	0.028
4D x Contin.	229	0.9722	(0.9480	0.9970)	0.028
1W x Contin.	233	0.9931	(0.9665	1.0205)	0.618
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.71. Supplementary table for Ulcerative Colitis Infection for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	113	0.9619	(0.9288	0.9961)	0.029
1W x Contin.	114	0.9866	(0.9505	1.0242)	0.479
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.72. Supplementary table for Crohns Disease Infection for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	137	0.9676	(0.9307	1.0060)	0.097
1W e Contin.	140	0.9650	(0.9134	1.0195)	0.203
4D x Contin.	137	0.9873	(0.9558	1.0199)	0.441
1W x Contin.	140	0.9842	(0.9465	1.0235)	0.426
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

A.7 Odds Ratios for Clostridium Difficile (C. diff) and Particulate Matter

Table A.73. Supplementary table for IBD clostridium difficile infection for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	330	1.0937	(0.5096	2.3475)	0.818
1W e 75 CU	330	0.9316	(0.3551	2.4442)	0.885
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	159	1.0067	(0.9940	1.0196)	0.300
1W e Contin.	161	1.0159	(0.9968	1.0354)	0.102
4D x Contin.	159	1.0013	(0.9925	1.0102)	0.773
1W x Contin.	161	1.0073	(0.9976	1.0172)	0.140
4D x 75 CU	330	0.7194	(0.3883	1.3326)	0.295
1W x 75 CU	330	1.1153	(0.5733	2.1697)	0.748
4D x 100 CU	330	0.7452	(0.3469	1.6007)	0.451
1W x 100 CU	330	1.0967	(0.4785	2.5135)	0.827
4D x 125 CU			(	)	
1W x 125 CU	330	1.2398	(0.4980	3.0867)	0.644

Table A.74. Supplementary table for Ulcerative Colitis clostridium difficile infection for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	87	0.9929	(0.9809	1.0051)	0.254
1W x Contin.	88	1.0020	(0.9880	1.0163)	0.781
4D x 75 CU	185	0.6255	(0.2848	1.3735)	0.242
1W x 75 CU	185	1.7533	(0.7064	4.3515)	0.226
4D x 100 CU			(	)	
1W x 100 CU	185	1.3405	(0.4585	3.9188)	0.592
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.75. Supplementary table for Crohns Disease clostridium difficile infection for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	91	1.0080	(0.9971	1.0190)	0.150
1W x Contin.	92	1.0135	(1.0005	1.0267)	0.042
4D x 75 CU	180	0.9968	(0.4690	2.1187)	0.993
1W x 75 CU	180	0.9971	(0.4072	2.4413)	0.995
4D x 100 CU			(	)	
1W x 100 CU	180	1.0703	(0.3878	2.9543)	0.896
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.76. Supplementary table for IBD clostridium difficile infection for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	75	0.9963	(0.9859	1.0069)	0.494
1W x Contin.	76	1.0047	(0.9899	1.0198)	0.536
4D x 75 CU	330	0.8326	(0.4227	1.6399)	0.596
1W x 75 CU	330	0.8546	(0.3865	1.8898)	0.698
4D x 100 CU			(	)	
1W x 100 CU	330	1.4938	(0.5882	3.7938)	0.399
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.77. Supplementary table for Ulcerative Colitis clostridium difficile infection for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	40	0.9909	(0.9774	1.0047)	0.195
1W x Contin.	40	0.9923	(0.9750	1.0098)	0.387
4D x 75 CU	185	0.8302	(0.3563	1.9345)	0.666
1W x 75 CU	185	0.7940	(0.2767	2.2782)	0.668
4D x 100 CU			(	)	
1W x 100 CU	185	2.6996	(0.6982	10.4375)	0.150
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.78. Supplementary table for Crohns Disease clostridium difficile infection for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	43	1.0035	(0.9896	1.0177)	0.621
1W x Contin.	44	1.0278	(0.9988	1.0576)	0.060
4D x 75 CU	180	0.9643	(0.4152	2.2394)	0.933
1W x 75 CU	180	0.9437	(0.3439	2.5896)	0.910
4D x 100 CU			(	)	
1W x 100 CU	180	1.1720	(0.3447	3.9848)	0.799
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.79. Supplementary table for IBD clostridium difficile infection for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU	330	1.2233	(0.4566	3.2774)	0.689
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.	161	1.0143	(0.9965	1.0325)	0.116
4D x Contin.	159	1.0028	(0.9958	1.0100)	0.431
1W x Contin.	161	1.0058	(0.9981	1.0136)	0.142
4D x 75 CU	330	0.8822	(0.5011	1.5533)	0.664
1W x 75 CU	330	1.0052	(0.5282	1.9128)	0.987
4D x 100 CU	330	0.7732	(0.3838	1.5576)	0.472
1W x 100 CU	330	1.2275	(0.5915	2.5475)	0.582
4D x 125 CU	330	1.2460	(0.5736	2.7068)	0.578
1W x 125 CU	330	2.0486	(0.8427	4.9806)	0.114

Table A.80. Supplementary table for Ulcerative Colitis clostridium difficile infection for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	87	0.9965	(0.9866	1.0065)	0.497
1W x Contin.	88	1.0026	(0.9916	1.0138)	0.642
4D x 75 CU	185	0.6481	(0.3080	1.3635)	0.253
1W x 75 CU	185	1.1514	(0.4915	2.6973)	0.745
4D x 100 CU	185	0.8811	(0.3862	2.0099)	0.763
1W x 100 CU	185	1.8206	(0.7083	4.6797)	0.214
4D x 125 CU			(	)	
1W x 125 CU	185	2.2577	(0.6959	7.3250)	0.175

Table A.81. Supplementary table for Crohns Disease clostridium difficile infection for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	91	1.0077	(0.9986	1.0168)	0.099
1W x Contin.	92	1.0123	(1.0003	1.0246)	0.045
4D x 75 CU	180	1.2067	(0.5916	2.4612)	0.605
1W x 75 CU	180	0.9510	(0.4028	2.2453)	0.909
4D x 100 CU			(	)	
1W x 100 CU	180	0.8441	(0.3022	2.3576)	0.746
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.82. Supplementary table for IBD clostridium difficile infection for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	143	1.0011	(0.9920	1.0102)	0.816
1W x Contin.	145	1.0037	(0.9942	1.0133)	0.445
4D x 75 CU	330	0.7571	(0.4159	1.3785)	0.363
1W x 75 CU	330	0.8245	(0.4103	1.6566)	0.588
4D x 100 CU	330	0.7349	(0.3438	1.5710)	0.427
1W x 100 CU	330	0.8143	(0.3509	1.8898)	0.632
4D x 125 CU			(	)	
1W x 125 CU	330	1.1766	(0.4671	2.9641)	0.730

Table A.83. Supplementary table for Ulcerative Colitis clostridium difficile infection for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	0.9993	(0.9870	1.0117)	0.906
1W x Contin.	78	1.0032	(0.9896	1.0169)	0.648
4D x 75 CU			(	)	
1W x 75 CU			(	)	
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table A.84. Supplementary table for Crohns Disease clostridium difficile infection for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	79	1.0035	(0.9910	1.0162)	0.587
1W x Contin.	80	1.0124	(0.9974	1.0276)	0.106
4D x 75 CU	180	0.8673	(0.4084	1.8416)	0.711
1W x 75 CU			(	)	
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D x 125 CU			(	)	
1W x 125 CU			(	)	

A.8 Odds Ratios for Clostridium Difficile (C. diff) and Ozone

Table A.85. Supplementary table for IBD clostridium difficile infection for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	330	1.1017	(0.7075	1.7155)	0.668
1W e 75 CU	330	0.8358	(0.4535	1.5403)	0.565
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	159	1.0139	(0.9933	1.0350)	0.187
1W e Contin.	161	1.0232	(0.9893	1.0582)	0.181
4D x Contin.	159	1.0020	(0.9837	1.0207)	0.829
1W x Contin.	161	1.0114	(0.9835	1.0402)	0.426
4D x 75 CU	330	1.0192	(0.6387	1.6263)	0.937
1W x 75 CU	330	1.3672	(0.7046	2.6531)	0.355
4D x 100 CU	330	0.9006	(0.5091	1.5932)	0.719
1W x 100 CU	330	0.8143	(0.4455	1.4886)	0.504
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.86. Supplementary table for Ulcerative Colitis clostridium difficile infection for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	87	0.9996	(0.9746	1.0252)	0.974
1W x Contin.	88	1.0153	(0.9794	1.0525)	0.408
4D x 75 CU	185	1.0888	(0.5710	2.0763)	0.796
1W x 75 CU	185	1.5007	(0.6042	3.7274)	0.382
4D x 100 CU	185	0.9521	(0.4354	2.0816)	0.902
1W x 100 CU	185	1.3453	(0.5857	3.0903)	0.484
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.87. Supplementary table for Crohns Disease clostridium difficile infection for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	91	1.0082	(0.9835	1.0336)	0.518
1W x Contin.	92	1.0155	(0.9745	1.0583)	0.463
4D x 75 CU	180	0.9054	(0.4715	1.7386)	0.765
1W x 75 CU	180	1.2656	(0.5040	3.1778)	0.616
4D x 100 CU	180	0.9623	(0.4327	2.1402)	0.925
1W x 100 CU	180	0.6790	(0.2933	1.5720)	0.366
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.88. Supplementary table for IBD clostridium difficile infection for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	75	0.9950	(0.9680	1.0229)	0.724
1W x Contin.	76	1.0006	(0.9622	1.0405)	0.976
4D x 75 CU	330	1.2282	(0.7498	2.0118)	0.414
1W x 75 CU	330	1.5635	(0.7684	3.1812)	0.218
4D x 100 CU	330	0.9444	(0.5360	1.6640)	0.843
1W x 100 CU	330	0.9330	(0.4988	1.7451)	0.828
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.89. Supplementary table for Ulcerative Colitis clostridium difficile infection for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	40	0.9874	(0.9497	1.0265)	0.522
1W x Contin.	40	0.9923	(0.9409	1.0465)	0.775
4D x 75 CU	185	1.2135	(0.6238	2.3607)	0.569
1W x 75 CU	185	1.8557	(0.6942	4.9602)	0.218
4D x 100 CU			(	)	
1W x 100 CU	185	1.0577	(0.4747	2.3567)	0.891
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.90. Supplementary table for Crohns Disease clostridium difficile infection for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	43	1.0019	(0.9662	1.0388)	0.920
1W x Contin.	44	1.0138	(0.9577	1.0731)	0.638
4D x 75 CU	180	1.1737	(0.5752	2.3951)	0.660
1W x 75 CU	180	1.4494	(0.5153	4.0763)	0.482
4D x 100 CU	180	1.2931	(0.5989	2.7918)	0.513
1W x 100 CU	180	0.8766	(0.3634	2.1144)	0.769
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.91. Supplementary table for IBD clostridium difficile infection for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU	330	1.1375	(0.6371	2.0310)	0.663
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.	161	1.0158	(0.9847	1.0479)	0.323
4D x Contin.	159	1.0012	(0.9839	1.0188)	0.893
1W x Contin.	161	1.0060	(0.9815	1.0312)	0.634
4D x 75 CU	330	1.2110	(0.7526	1.9488)	0.430
1W x 75 CU	330	1.4003	(0.7160	2.7385)	0.325
4D x 100 CU	330	0.9251	(0.5330	1.6056)	0.782
1W x 100 CU	330	0.8271	(0.4512	1.5160)	0.539
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.92. Supplementary table for Ulcerative Colitis clostridium difficile infection for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	87	0.9956	(0.9718	1.0201)	0.725
1W x Contin.	88	1.0056	(0.9741	1.0382)	0.730
4D x 75 CU	185	1.3284	(0.6914	2.5522)	0.394
1W x 75 CU	185	1.5733	(0.6205	3.9894)	0.340
4D x 100 CU	185	0.8017	(0.3664	1.7541)	0.580
1W x 100 CU	185	1.1003	(0.4961	2.4402)	0.814
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.93. Supplementary table for Crohns Disease clostridium difficile infection for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	91	1.0092	(0.9860	1.0330)	0.440
1W x Contin.	92	1.0102	(0.9741	1.0476)	0.586
4D x 75 CU	180	1.0363	(0.5312	2.0218)	0.917
1W x 75 CU	180	1.2234	(0.4748	3.1523)	0.676
4D x 100 CU	180	1.1456	(0.5364	2.4468)	0.725
1W x 100 CU	180	0.6925	(0.2916	1.6445)	0.405
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.94. Supplementary table for IBD clostridium difficile infection for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	143	0.9976	(0.9788	1.0169)	0.808
1W x Contin.	145	1.0003	(0.9734	1.0279)	0.985
4D x 75 CU	330	1.1427	(0.7024	1.8591)	0.591
1W x 75 CU	330	1.3874	(0.6861	2.8054)	0.362
4D x 100 CU	330	0.8982	(0.5085	1.5865)	0.711
1W x 100 CU	330	0.8967	(0.4838	1.6621)	0.729
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.95. Supplementary table for Ulcerative Colitis clostridium difficile infection for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	1.0014	(0.9763	1.0271)	0.916
1W x Contin.	78	1.0083	(0.9743	1.0434)	0.637
4D x 75 CU	185	1.4748	(0.7462	2.9149)	0.264
1W x 75 CU	185	2.0003	(0.7349	5.4446)	0.175
4D x 100 CU	185	1.0564	(0.4918	2.2693)	0.888
1W x 100 CU	185	1.1793	(0.5143	2.7041)	0.697
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.96. Supplementary table for Crohns Disease clostridium difficile infection for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	79	0.9958	(0.9695	1.0228)	0.757
1W x Contin.	80	0.9927	(0.9522	1.0350)	0.731
4D x 75 CU	180	0.8875	(0.4539	1.7351)	0.727
1W x 75 CU	180	0.9584	(0.3577	2.5682)	0.933
4D x 100 CU			(	)	
1W x 100 CU	180	0.7962	(0.3349	1.8926)	0.606
4D 125 CU			(	)	
1W 125 CU			(	)	

A.9 Odds Ratios for Clostridium Difficile (C. diff) and Nitrogen Dioxide

Table A.97. Supplementary table for IBD clostridium difficile infection for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	159	0.9787	(0.9424	1.0165)	0.266
1W e Contin.	161	0.9677	(0.9130	1.0257)	0.268
4D x Contin.	159	0.9932	(0.9623	1.0250)	0.670
1W x Contin.	161	0.9855	(0.9480	1.0244)	0.459
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.98. Supplementary table for Ulcerative Colitis clostridium difficile infection for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	87	1.0032	(0.9644	1.0436)	0.873
1W x Contin.	88	0.9940	(0.9487	1.0415)	0.801
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.99. Supplementary table for Crohns Disease Disease clostridium difficile infection for NO_2 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	91	0.9757	(0.9348	1.0185)	0.262
1W x Contin.	92	0.9553	(0.8998	1.0142)	0.134
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.100. Supplementary table for IBD clostridium difficile infection for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	75	1.0031	(0.9757	1.0312)	0.827
1W x Contin.	76	1.0025	(0.9725	1.0334)	0.871
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.101. Supplementary table for Ulcerative Colitis clostridium difficile infection for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	40	1.0130	(0.9826	1.0443)	0.407
1W x Contin.	40	1.0112	(0.9779	1.0457)	0.515
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.102. Supplementary table for Crohns Disease Disease clostridium difficile infection for NO_2 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	43	0.9647	(0.9140	1.0182)	0.192
1W x Contin.	44	0.9411	(0.8774	1.0094)	0.089
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.103. Supplementary table for IBD clostridium difficile infection for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.	161	0.9891	(0.9419	1.0386)	0.659
4D x Contin.	159	0.9966	(0.9726	1.0211)	0.783
1W x Contin.	161	1.0004	(0.9742	1.0274)	0.975
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.104. Supplementary table for Ulcerative Colitis clostridium difficile infection for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	87	1.0060	(0.9797	1.0330)	0.660
1W x Contin.	88	1.0063	(0.9768	1.0366)	0.680
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.105. Supplementary table for Crohns Disease Disease clostridium difficile infection for NO_2 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	91	0.9744	(0.9381	1.0121)	0.181
1W x Contin.	92	0.9666	(0.9194	1.0162)	0.183
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.106. Supplementary table for IBD clostridium difficile infection for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	143	0.9777	(0.9460	1.0105)	0.181
1W x Contin.	145	0.9959	(0.9639	1.0291)	0.807
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.107. Supplementary table for Ulcerative Colitis clostridium difficile infection for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	0.9660	(0.9228	1.0112)	0.138
1W x Contin.	78	0.9954	(0.9570	1.0354)	0.819
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table A.108. Supplementary table for Crohns Disease Disease clostridium difficile infection for NO_2 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	79	0.9903	(0.9489	1.0336)	0.656
1W x Contin.	80	0.9723	(0.9224	1.0250)	0.298
4D 75 CU			(	)	
1W 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

APPENDIX B

SUPPLEMENTAL MATERIAL FOR CHAPTER 3

Table B.1. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	298	1.4247	(0.8347	2.4318)	0.194
1W e 75 CU	298	1.2204	(0.5744	2.5928)	0.604
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	170	1.0197	(1.0000	1.0397)	0.049
1W e Contin.	171	1.0359	(1.0035	1.0693)	0.029
4D x Contin.	170	1.0198	(1.0021	1.0378)	0.028
1W x Contin.	171	1.0205	(0.9965	1.0451)	0.095
4D x 75 CU	298	1.6085	(0.9166	2.8226)	0.098
1W x 75 CU	298	2.8506	(1.1201	7.2545)	0.028
4D x 100 CU	298	2.2554	(1.1783	4.3172)	0.014
1W x 100 CU	298	2.0254	(0.9451	4.3407)	0.070
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.2. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	94	1.0257	(1.0005	1.0516)	0.046
1W x Contin.	94	1.0191	(0.9867	1.0525)	0.251
4D x 75 CU	184	1.2990	(0.6254	2.6979)	0.483
1W x 75 CU	184	1.7432	(0.5320	5.7119)	0.359
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.3. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	1.0261	(0.9979	1.0550)	0.070
1W x Contin.	77	1.0211	(0.9856	1.0578)	0.248
4D x 75 CU	161	1.4993	(0.6998	3.2119)	0.298
1W x 75 CU	161	1.7730	(0.5434	5.7847)	0.343
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.4. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for O_3 using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.			(	)	
1W x Contin.	57	1.0274	(0.9834	1.0733)	0.226
4D x 75 CU			(	)	
1W x 75 CU	100	0.7092	(0.1962	2.5642)	0.600
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.5. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	298	1.1537	(0.6812	1.9538)	0.595
1W e 75 CU	298	1.3613	(0.6312	2.9356)	0.432
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	96	1.0208	(0.9958	1.0464)	0.103
1W e Contin.	98	1.0421	(0.9995	1.0865)	0.053
4D x Contin.	96	1.0207	(0.9986	1.0432)	0.067
1W x Contin.	98	1.0220	(0.9889	1.0561)	0.195
4D x 75 CU	298	1.8284	(1.0233	3.2668)	0.042
1W x 75 CU	298	1.8959	(0.8045	4.4679)	0.144
4D x 100 CU	298	1.4168	(0.7358	2.7279)	0.297
1W x 100 CU	298	1.0919	(0.4663	2.5569)	0.840
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.6. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	53	1.0230	(0.9912	1.0558)	0.158
1W x Contin.	54	1.0108	(0.9689	1.0544)	0.619
4D x 75 CU	184	1.3158	(0.6196	2.7941)	0.475
1W x 75 CU	184	1.1311	(0.3818	3.3508)	0.824
4D x 100 CU			(	)	
1W x 100 CU	184	0.9536	(0.2516	3.6152)	0.944
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.7. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	45	1.0329	(0.9965	1.0706)	0.077
1W x Contin.	45	1.0198	(0.9713	1.0708)	0.430
4D x 75 CU	161	1.3266	(0.5970	2.9480)	0.488
1W x 75 CU	161	1.3195	(0.4141	4.2047)	0.639
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.8. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for O_3 using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	27	1.0274	(0.9863	1.0701)	0.194
1W x Contin.	27	1.0413	(0.9754	1.1116)	0.225
4D x 75 CU	100	0.6365	(0.2707	1.4965)	0.300
1W x 75 CU	100	0.7174	(0.2237	2.3001)	0.576
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.9. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	298	1.1937	(0.7112	2.0038)	0.503
1W e 75 CU	298	1.3763	(0.6555	2.8900)	0.399
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	170	1.0186	(1.0002	1.0374)	0.048
1W e Contin.	171	1.0332	(1.0028	1.0645)	0.032
4D x Contin.	170	1.0211	(1.0047	1.0379)	0.012
1W x Contin.	171	1.0146	(0.9927	1.0370)	0.193
4D x 75 CU	298	1.7305	(0.9866	3.0355)	0.056
1W x 75 CU	298	2.0414	(0.8833	4.7180)	0.095
4D x 100 CU	298	1.4049	(0.7290	2.7074)	0.310
1W x 100 CU	298	1.1294	(0.4832	2.6395)	0.779
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.10. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	94	1.0225	(0.9992	1.0464)	0.059
1W x Contin.	94	1.0127	(0.9833	1.0430)	0.400
4D x 75 CU	184	1.2083	(0.5935	2.4600)	0.602
1W x 75 CU	184	1.2087	(0.4288	3.4072)	0.720
4D x 100 CU			(	)	
1W x 100 CU	184	1.0527	(0.2820	3.9295)	0.939
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.11. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	1.0231	(0.9970	1.0498)	0.083
1W x Contin.	77	1.0156	(0.9829	1.0493)	0.354
4D x 75 CU	161	1.2085	(0.5727	2.5500)	0.619
1W x 75 CU	161	1.3575	(0.4637	3.9735)	0.577
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.12. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for O_3 using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	57	1.0133	(0.9871	1.0401)	0.322
1W x Contin.	57	1.0239	(0.9842	1.0651)	0.242
4D x 75 CU	100	0.7111	(0.3178	1.5910)	0.407
1W x 75 CU	100	0.8700	(0.2888	2.6213)	0.805
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.13. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU	298	1.3615	(0.6160	3.0094)	0.446
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.	153	1.0449	(1.0088	1.0823)	0.014
4D x Contin.	152	1.0211	(1.0025	1.0400)	0.026
1W x Contin.	153	1.0141	(0.9888	1.0402)	0.278
4D x 75 CU	298	1.5112	(0.8647	2.6411)	0.147
1W x 75 CU	298	2.3162	(0.9322	5.7549)	0.070
4D x 100 CU	298	2.2390	(1.1393	4.4003)	0.019
1W x 100 CU	298	1.7005	(0.8094	3.5725)	0.161
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.14. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	83	1.0253	(0.9987	1.0526)	0.062
1W x Contin.	83	1.0167	(0.9816	1.0531)	0.355
4D x 75 CU	184	1.1804	(0.5720	2.4359)	0.654
1W x 75 CU	184	0.7239	(0.2197	2.3852)	0.595
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.15. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	68	1.0194	(0.9910	1.0486)	0.183
1W x Contin.	68	1.0177	(0.9804	1.0564)	0.358
4D x 75 CU	161	1.0898	(0.5066	2.3444)	0.826
1W x 75 CU	161	0.7206	(0.2191	2.3697)	0.590
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

Table B.16. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for O_3 using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D 100 CU			(	)	
1W 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	49	1.0147	(0.9829	1.0476)	0.368
1W x Contin.	51	1.0296	(0.9816	1.0799)	0.231
4D x 75 CU	100	0.6890	(0.3002	1.5817)	0.380
1W x 75 CU	100	0.9082	(0.2338	3.5277)	0.889
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	

B.1 Odds Ratios for EoE Exacerbations and Particulate Matter

Table B.17. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	298	1.8660	(0.9241	3.7679)	0.082
1W e 75 CU	298	1.3796	(0.4794	3.9698)	0.551
4D e 100 CU	298	2.2594	(0.9404	5.4284)	0.068
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	170	1.0099	(0.9991	1.0208)	0.072
1W e Contin.	171	1.0120	(0.9963	1.0280)	0.135
4D x Contin.	170	1.0037	(0.9962	1.0113)	0.337
1W x Contin.	171	1.0020	(0.9930	1.0111)	0.659
4D x 75 CU	298	0.8332	(0.4814	1.4420)	0.514
1W x 75 CU	298	0.8221	(0.4370	1.5465)	0.543
4D x 100 CU	298	1.4159	(0.7133	2.8104)	0.320
1W x 100 CU	298	1.9878	(0.8074	4.8936)	0.135
4D x 125 CU	298	1.6858	(0.7961	3.5699)	0.172
1W x 125 CU	298	1.3031	(0.5021	3.3823)	0.586

Table B.18. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	94	1.0052	(0.9951	1.0155)	0.314
1W x Contin.	94	1.0027	(0.9903	1.0152)	0.675
4D x 75 CU	184	0.7722	(0.3951	1.5090)	0.449
1W x 75 CU	184	0.9372	(0.4283	2.0507)	0.871
4D x 100 CU	184	1.3903	(0.5939	3.2546)	0.448
1W x 100 CU	184	3.4764	(1.0394	11.6270)	0.043
4D x 125 CU			(	)	
1W x 125 CU	184	1.6839	(0.4611	6.1500)	0.430

Table B.19. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	1.0061	(0.9949	1.0175)	0.289
1W x Contin.	77	1.0053	(0.9917	1.0191)	0.447
4D x 75 CU	161	0.8549	(0.4163	1.7559)	0.669
1W x 75 CU	161	0.9425	(0.3985	2.2291)	0.893
4D x 100 CU	161	1.5047	(0.6160	3.6756)	0.370
1W x 100 CU	161	3.5002	(1.0299	11.8952)	0.045
4D x 125 CU			(	)	
1W x 125 CU	161	1.5553	(0.4220	5.7321)	0.507

Table B.20. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for $PM_{2.5}$ using kriged data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.			(	)	
1W x Contin.	57	1.0054	(0.9875	1.0235)	0.558
4D x 75 CU			(	)	
1W x 75 CU	100	0.9088	(0.2520	3.2766)	0.884
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table B.21. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	298	1.9347	(0.9529	3.9282)	0.068
1W e 75 CU	298	1.8422	(0.5921	5.7315)	0.291
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	96	1.0144	(1.0026	1.0264)	0.016
1W e Contin.	98	1.0226	(1.0034	1.0422)	0.021
4D x Contin.	96	1.0095	(1.0004	1.0186)	0.040
1W x Contin.	98	1.0059	(0.9945	1.0174)	0.309
4D x 75 CU	298	1.1016	(0.6170	1.9669)	0.744
1W x 75 CU	298	1.3176	(0.6881	2.5231)	0.405
4D x 100 CU	298	1.0363	(0.4863	2.2085)	0.926
1W x 100 CU	298	2.4377	(0.9389	6.3289)	0.067
4D x 125 CU	298	1.7727	(0.7769	4.0447)	0.174
1W x 125 CU	298	1.7615	(0.4797	6.4688)	0.394

Table B.22. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	53	1.0070	(0.9952	1.0190)	0.245
1W x Contin.	54	1.0003	(0.9846	1.0162)	0.972
4D x 75 CU	184	0.8100	(0.3808	1.7232)	0.584
1W x 75 CU	184	1.0686	(0.4774	2.3919)	0.872
4D x 100 CU			(	)	
1W x 100 CU	184	2.2499	(0.7143	7.0869)	0.166
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table B.23. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	45	1.0088	(0.9960	1.0217)	0.180
1W x Contin.	45	1.0032	(0.9847	1.0221)	0.733
4D x 75 CU	161	0.9518	(0.4225	2.1440)	0.905
1W x 75 CU	161	1.3079	(0.5200	3.2899)	0.568
4D x 100 CU			(	)	
1W x 100 CU	161	2.3817	(0.6230	9.1053)	0.205
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table B.24. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for $PM_{2.5}$ using CFP data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	27	1.0046	(0.9879	1.0215)	0.595
1W x Contin.	27	1.0099	(0.9888	1.0316)	0.360
4D x 75 CU			(	)	
1W x 75 CU			(	)	
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table B.25. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU	298	1.8589	(0.9584	3.6056)	0.067
1W e 75 CU	298	1.5761	(0.5651	4.3958)	0.385
4D e 100 CU	298	2.5354	(1.1365	5.6564)	0.023
1W e 100 CU	298	1.4984	(0.4860	4.6195)	0.481
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.	170	1.0106	(1.0010	1.0203)	0.031
1W e Contin.	171	1.0115	(0.9978	1.0254)	0.102
4D x Contin.	170	1.0058	(0.9989	1.0128)	0.100
1W x Contin.	171	1.0017	(0.9931	1.0103)	0.701
4D x 75 CU	298	1.1831	(0.6941	2.0169)	0.537
1W x 75 CU	298	1.3694	(0.7440	2.5203)	0.312
4D x 100 CU	298	0.9469	(0.4902	1.8292)	0.871
1W x 100 CU	298	1.4681	(0.6690	3.2220)	0.338
4D x 125 CU	298	1.8187	(0.8990	3.6794)	0.096
1W x 125 CU	298	1.2748	(0.4731	3.4347)	0.631

Table B.26. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	94	1.0047	(0.9956	1.0140)	0.309
1W x Contin.	94	0.9989	(0.9871	1.0108)	0.857
4D x 75 CU	184	0.8152	(0.4107	1.6180)	0.559
1W x 75 CU	184	0.9643	(0.4464	2.0830)	0.926
4D x 100 CU	184	0.6871	(0.3031	1.5575)	0.369
1W x 100 CU	184	1.3200	(0.5242	3.3239)	0.556
4D x 125 CU	184	1.4902	(0.6403	3.4678)	0.355
1W x 125 CU	184	1.6348	(0.4484	5.9596)	0.456

Table B.27. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	77	1.0061	(0.9961	1.0162)	0.233
1W x Contin.	77	1.0016	(0.9885	1.0148)	0.814
4D x 75 CU	161	1.0467	(0.5052	2.1684)	0.902
1W x 75 CU	161	1.1532	(0.4833	2.7515)	0.748
4D x 100 CU	161	0.8843	(0.3713	2.1062)	0.781
1W x 100 CU	161	1.2789	(0.4516	3.6215)	0.643
4D x 125 CU	161	1.7421	(0.7110	4.2686)	0.225
1W x 125 CU	161	1.9476	(0.4981	7.6155)	0.338

Table B.28. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for $PM_{2.5}$ using closest data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	57	1.0074	(0.9946	1.0204)	0.257
1W x Contin.	57	1.0098	(0.9920	1.0279)	0.282
4D x 75 CU			(	)	
1W x 75 CU	100	1.9581	(0.4218	9.0895)	0.391
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D x 125 CU			(	)	
1W x 125 CU			(	)	

Table B.29. Supplementary table for Eosinophilic Esophagitis Any Event Emergency Department for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU	298	1.7741	(0.6510	4.8347)	0.262
4D e 100 CU			(	)	
1W e 100 CU	298	2.1659	(0.5861	8.0037)	0.247
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.	153	1.0225	(1.0056	1.0397)	0.009
4D x Contin.	152	1.0084	(1.0005	1.0163)	0.037
1W x Contin.	153	1.0056	(0.9958	1.0155)	0.263
4D x 75 CU	298	0.7953	(0.4512	1.4018)	0.428
1W x 75 CU	298	0.9832	(0.5023	1.9242)	0.960
4D x 100 CU	298	1.1170	(0.5595	2.2301)	0.754
1W x 100 CU	298	1.3326	(0.5397	3.2901)	0.534
4D x 125 CU	298	1.8312	(0.9020	3.7174)	0.094
1W x 125 CU	298	1.3118	(0.5018	3.4294)	0.580

Table B.30. Supplementary table for Eosinophilic Esophagitis Impaction and/or dysphagia Emergency Department for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	83	1.0093	(0.9983	1.0204)	0.097
1W x Contin.	83	1.0088	(0.9941	1.0238)	0.243
4D x 75 CU	184	0.7609	(0.3747	1.5453)	0.450
1W x 75 CU	184	1.0046	(0.4449	2.2685)	0.991
4D x 100 CU	184	1.0502	(0.4437	2.4858)	0.911
1W x 100 CU	184	2.0530	(0.6293	6.6972)	0.233
4D x 125 CU	184	1.5939	(0.6715	3.7837)	0.291
1W x 125 CU	184	1.7404	(0.4631	6.5405)	0.412

Table B.31. Supplementary table for Eosinophilic Esophagitis Impaction Emergency Department for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	68	1.0114	(0.9992	1.0237)	0.067
1W x Contin.	68	1.0159	(0.9986	1.0334)	0.071
4D x 75 CU	161	1.0075	(0.4770	2.1282)	0.984
1W x 75 CU	161	1.1579	(0.4619	2.9026)	0.755
4D x 100 CU	161	1.2036	(0.4801	3.0175)	0.693
1W x 100 CU	161	2.4800	(0.7254	8.4787)	0.148
4D x 125 CU			(	)	
1W x 125 CU	161	1.9536	(0.4870	7.8376)	0.345

Table B.32. Supplementary table for Eosinophilic Esophagitis Any Event Hospitalization for $PM_{2.5}$ using county ave data to assign pollution data.

	N	OR	CI LB	CI UB	p-value
4D e 75 CU			(	)	
1W e 75 CU			(	)	
4D e 100 CU			(	)	
1W e 100 CU			(	)	
4D 125 CU			(	)	
1W 125 CU			(	)	
4D e Contin.			(	)	
1W e Contin.			(	)	
4D x Contin.	49	1.0050	(0.9909	1.0193)	0.490
1W x Contin.	51	1.0162	(0.9948	1.0381)	0.139
4D x 75 CU			(	)	
1W x 75 CU			(	)	
4D x 100 CU			(	)	
1W x 100 CU			(	)	
4D x 125 CU			(	)	
1W x 125 CU			(	)	