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INCREASED PM2.5 LEVELS ASSOCIATED WITH INCREASED INCIDENCE OF COVID-19: THE WASHINGTON WILDFIRES OF 2020

Aumentos nos níveis de PM2.5 associados ao aumento de incidência de Covid-19: os incêndios de 2020 em Washington

Aumentos en los niveles de PM2.5 asociados con una mayor incidencia de Covid-19: los incendios de Washington de 2020

Augmentation des niveaux de PM2,5 associée à une incidence accrue de Covid-19 : les incendies de Washington de 2020

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Abstract

Yakima County, Washington was subject to the extrordinary Washington Wildfire Season of 2020 in which unhealty air (PM2.5) persisted for a 14-day period. This remarkable fire and smoke season began in tandem with the COVID-19 pandemic. SARS-CoV-2 virus, like inhaled particulate matter is known to cause respiratory illness or injury. This study sought to determine through publicly available data whether increased levels of PM2.5 were associated with increased cases of COVID-19. Using a 12-day lag analysis, Pearson product correlations were performed between PM2.5 24-hour averages in Yakima County Washington and daily confirmed cases of COVID-19 for data available on March 1, 2020-October 15, 2020. In addition, total running cases of confirmed COVID-19, daily mortality and total running mortality rates were compared in the lag analyses. All days (PM2.5) in the lag analysis were found to have a statistically significant positive correlation with COVID-19 case counts and total running counts of COVID-19 (p<.001) with correlation coefficients ranging from 0.24-0.28. The total running mortality rates were also significantly associated with daily PM2.5 (p<.001); however, the daily mortality rates were not found to be statistically significantly related to PM2.5. This simple analysis provides preliminary evidence that increased air pollution (PM2.5) is associated with higher rates of confirmed COVID-19 cases. However, further research is required to determine the potentially confounding factors in this relationship.

Keywords: PM2.5, Air Pollution, Climate Change, COVID-19, Respiratory Disease

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Resumo

O condado de Yakima, em Washington, passou por uma temporada severa de incêndios florestais no ano de 2020, na qual o ar poluído (PM2.5) persistiu por um período de 14 dias. Esta extensa temporada de fogo e fumaça começou em conjunto com a pandemia da COVID-19. O vírus SARS-CoV-2, quando tem suas partículas inaladas, é conhecido por causar doenças ou lesões respiratórias. Este estudo buscou determinar, por meio de dados disponíveis publicamente, se níveis elevados de PM2.5 estavam associados ao aumento de casos de COVID-19. Usando uma análise de dados de 12 dias, para análise estatística foi utilizado o coeficiente de correlação de Pearson entre médias de PM2.5 durante 24 horas em Yakima County em Washington e casos confirmados diariamente de COVID-19 para dados disponíveis em 1 de março de 2020 e 15 de outubro de 2020. Além disso, casos momentâneos confirmados de COVID-19, mortalidade diária e taxas de mortalidade total foram comparados nas análises de defasagem. Todos os dias (PM2,5) na análise de latência mostraram ter uma correlação positiva estatisticamente significativa com as contagens de casos COVID-19 e contagens totais em execução de COVID-19 (p <0,001) tendo coeficientes de correlação variando de 0,24-0,28. As taxas de mortalidade total também foram significativamente associadas com PM2,5 diário (p <0,001); no entanto, as taxas de mortalidade diárias não foram consideradas estatisticamente relacionadas ao PM2,5. Esta análise simples fornece evidências preliminares de que o aumento da poluição do ar (PM2.5) está associado a taxas mais altas de casos COVID-19 confirmados. No entanto, mais pesquisas são necessárias para determinar a potencialidade dos fatores nesta relação.

Palavras-chave: PM2.5. Poluição do Ar. Mudanças Climáticas. COVID-19. Doença Respiratória.

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Resumen

El condado de Yakima, Washington, experimentó una severa temporada de incendios forestales en el año 2020, en la que el ruido (PM2.5) persistió durante un período de 14 días. Esta extensa temporada de fuego y humo comenzó junto con la pandemia de COVID-19. Se sabe que el virus SARS-CoV-2, cuando se inhalan sus partículas, causa enfermedades o lesiones respiratorias. Este estudio buscó determinar, a través de datos disponibles públicamente, si los niveles elevados de PM2.5 se asociaron con un aumento en los casos de COVID-19. Utilizando un análisis de datos de 12 días, se utilizó el coeficiente de correlación de Pearson entre las medias de PM2.5 de 24 horas en el condado de Yakima en Washington y los casos de COVID-19 confirmados diariamente para los datos disponibles el 1 de marzo de 2020 y el 15 de octubre de 2020. Además, los casos momentáneos confirmados de COVID-19, la mortalidad y las tasas de mortalidad se compararon en los análisis de retardo. Todos los días (PM2.5) en el análisis de alta latencia tienen una correlación positiva expresada estadísticamente como recuentos de casos de COVID-19 y recuentos totales de COVID-19 ($p < 0.001$) con coeficientes de correlación que van desde 0.24 - 0.28. Las tasas de mortalidad también se asociaron con PM2.5 diario ($p < 0.001$); sin embargo, las tasas de mortalidad diaria no se evaluaron estadísticamente relacionadas con PM2.5. Este análisis proporciona evidencia preliminar simple de que el aumento de la forma de aire (PM2.5) está asociado con tasas más altas de casos confirmados de COVID-19. Sin embargo, se requiere más investigación para determinar el potencial de los factores en esta relación.

Palabras clave: PM2.5. Contaminación del aire Cambio climático. COVID-19. Enfermedad respiratoria.

Résumé

Le comté de Yakima, dans l'État de Washington, a connu une grave saison d'incendies de forêt en 2020, au cours de laquelle le bruit (PM2,5) a persisté pendant 14 jours. Cette longue saison de feu et de fumée a commencé en même temps que la pandémie de COVID-19. Le virus SARS-CoV-2, lorsque ses particules sont inhalées, est connu pour provoquer des maladies ou des blessures respiratoires. Cette étude visait à déterminer, grâce à des données accessibles au public, si des niveaux élevés de PM2,5 étaient associés à une augmentation des cas de COVID-19. À l'aide d'une analyse de données sur 12 jours, le coefficient de corrélation de Pearson entre les moyennes de PM2,5 sur 24 heures dans le comté de Yakima à Washington et les cas confirmés quotidiens de COVID-19 a été utilisé pour les données disponibles le 1er mars 2020 et le 15 octobre 2020. En outre, les cas momentanés confirmés de COVID-19, la mortalité et les taux de mortalité ont été comparés dans les analyses de décalage. Chaque jour (PM2,5) dans l'analyse à haute latence a une corrélation positive statistiquement exprimée en nombre de cas de COVID-19 et en nombre total de COVID-19 ($p < 0,001$) avec des coefficients de corrélation allant de 0,24 à 0,28. Les taux de mortalité étaient également associés aux PM2,5 quotidiennes ($p<0,001$); cependant, les taux de mortalité quotidiens n'ont pas été évalués statistiquement liés aux PM2,5. Cette analyse fournit des preuves préliminaires simples que l'augmentation de la forme aérienne (PM2,5) est associée à des taux plus élevés de cas confirmés de COVID-19. Cependant, des recherches supplémentaires sont nécessaires pour déterminer le potentiel des facteurs dans cette relation.

Mots-clés : PM2,5. Pollution de l'air Changement climatique. COVID-19 [FEMININE. Maladie respiratoire.

1 Introduction

The summer wildfires of 2020 in Washington state occurring during the first spring/summer season of the COVID-19 pandemic placed significant burden on the region. Both notable events disproportionately impacted Yakima County, Washington. At several points in the pandemic Yakima County has been highlighted as a community with higher per capita rates of infection than state and federal averages, despite being a rural county (Geranos, 2020). Additionally, Yakima County, Washington has been on the United States Environmental Protection Agency's (EPA) federal watchlist for air quality non-attainment – a designation characterized by having too many days of unhealthy air determined by the measure of PM2.5. The American Lung Association's (2021) state of the air reports for the past three years have named Yakima (city) as having the 5th or 6th worst short-term particle pollution in the US. Because of the theorized compounded effects of inhaled smoke and excess PM2.5 on respiratory outcomes, this study sought to examine any association between excess PM2.5 and increased cases of COVID-19 disease through a lag analysis of publicly available data during the wildfire season of 2020.

2 Material and Methods

2.1 Study Design

This study is a correlational study of publicly available data on total daily and total running COVID-19 confirmed cases and mortalities, and total daily average PM2.5 collected by government organizations. The study timeframe was March 1, 2020-October 15, 2020, which captured the 2020 fire season in Washington State during the COVID-19 pandemic. Because of the question of seasonality of COVID-19 akin to seasonal flu or other respiratory viruses, the research team only studied the wildfire season to reduce the confounding factors associated with winter viral cases (Liu et al, 2021).

Data Collection: COVID-19 daily and total running confirmed cases and confirmed mortality rates were made publicly available on the Washington State Department of Health and Yakima County Health District's COVID-19 case data dashboards. The Washington State Department of Ecology Collects and Reports 24-hour daily average readings of PM2.5 in Yakima County Washington. There are currently four monitors operating in Yakima County, Washington that are monitored by the Department of Ecology. Readings from all four monitors were requested by the research team and were made available upon request. Of the four monitors, only one monitor had no missing data values for the time, which was stationed in Sunnyside, Washington. The Washington State Department of Ecology regularly calibrates the particle collectors to EPA standards.

2.2 Data Analysis

Descriptive data about the number of daily cases total cases of COVID-19 and mortality rates in Yakima County, Washington were determined. For air quality, the research team used the 24-hour average PM2.5 measure as it is considered more reliable than a 24-hour max reading.

The range of PM2.5 readings, along with the number of unhealthy days during this period of investigation were reported. Unhealthy days of air quality are defined by the EPA (2021) as having a 24-hour average of PM2.5 ppm concentration of 50 or over as leaving the "healthy" designation.

A 12-day lag analysis using a Pearson correlation was conducted between exposure (PM 2.5) and outcome (COVID-19 new cases: days 1-12) to determine

whether exposure to PM2.5 was significantly associated with new cases of COVID-19. Previous studies associating PM2.5 to respiratory disease have used 0-6 (Zhang et al, 2014), 0-8 days (Sinclair et al., 2004), and even 0-15 (Taj et al., 2016) of lag between the exposure to PM2.5 and the development of disease.

There is currently little to no evidence on the appropriate lag between PM2.5 exposure and COVID-19 suspected or confirmed cases, so conservative estimates of using 12 days post exposure was used. This study was exempt from IRB review/approval.

3 Results and Discussion

Overall, the dates between March 1, 2020-October 15, 2020, provided (n=229) points of data for each variable included in this analysis. Daily PM2.5 in the EPA calibrated monitor ranged from 0.7-396.7 with a mean of 17.1, SD¤49.3. In the period of monitoring there were 10 days with PM2.5 levels that exceeded 50ppm, and new daily cases of COVID-19 ranged from 0-390, the average number of daily cases was 52.4, SD¤51. There were (n=20,255) total confirmed cases of COVID-19 and (n=263) total confirmed COVID-19 related mortalities.
Daily confirmed cases of COVID-19 were found to be positively, significantly associated with PM2.5 levels for all days 0-12 in the lag analysis ($p<.001$, 0.24-0.26), while PM2.5 was not significantly associated with daily COVID-19 mortality. However, PM2.5 had a moderately, positive, statistically significantly association with total running daily confirmed cases and total running mortality rates of COVID-19 for all lag analysis days ($p<.001$, 0.26-2.8).

The findings of this study should be considered preliminary but do provide some evidence that the respiratory impacts of particulate matter exposure and COVID-19 disease could be synergistic. Many variables are missing from this study that could further shed light on individual or household level factors that could explain the association between PM2.5 exposure and an increased number of daily cases of COVID-19, total number of COVID-19 cases and total COVID-19 mortality rates. As it is known, correlation does not imply causation, but it provides evidence that further investigation is needed to understand the association between the exposure and outcome variables in this study.

These findings have brought up more questions than answers. PM2.5 exposure itself does not operate like an infectious disease or is not known to spread infectious disease, so why are we seeing increased daily and total cases of COVID-19 and increased total COVID-19 mortality rates associated with these exposures? It could be that the wildfires forced people back into indoor spaces, creating more congregate living or working conditions known to facilitate the spread SARS-CoV-2 virus. It could be that PM2.5 exposure exacerbated or caused individuals to have new respiratory symptoms, causing those individuals to seek medical attention, which included being screened for COVID-19 disease. Increases in screening for all respiratory concerns during intense smoke events could explain the increased number of confirmed cases of COVID-19. This situation should continue to be investigated as COVID-19 disease is not likely to be eradicated and this disease will continue to impact areas such as Yakima County, Washington that have persistently poor air quality.

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