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# Do greenhouse gases impact our respiratory system? A study of the effect of greenhouse gas emissions on respiratory disease related mortality in Ireland

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**Abstract:** Respiratory-related deaths are one of the major causes of morbidity and mortality every year in the developed world. Previous research outlines that greenhouse gas emission levels have a negative effect on respiratory health and can cause worsening of symptoms. This study examines the impact of greenhouse gas emissions on respiratory disease related mortality in Ireland from 2007-2017 using Statbank data from Central Statistics Office, Ireland. Analysis shows that over the last decade, while greenhouse gases emissions in Ireland have reduced by 1.1%, respiratory disease related mortality has increased on an average by 2.1%. Results indicate that greenhouse gas emissions have no significant relationship ( $p > 0.05$ ) with deaths as a result of respiratory diseases, indicating that the increasing levels of respiratory disease related mortality in Ireland cannot be attributed to greenhouse gas emissions.

**Keywords:** GHG emissions; Respiratory diseases; Mortality

## 1. Introduction

### 1.1. The global burden of respiratory disease.

The World Health Organisation (WHO) defines ‘chronic’ or ‘non-communicable disease’ as diseases of ‘long duration and are the result of a combination of genetic, physiological, environmental and behaviour factors’ and state that chronic diseases are currently at epidemic proportions being responsible for 40,545 deaths worldwide in 2016, responsible for 1.5 million Disability Adjusted Life Years (DALYS) in 2016 [1] and nearly two thirds of all deaths globally [2]. The number of people living with and dying from chronic diseases is expected to increase along with the increase in the geriatric population. While people are living longer, more people are dying of chronic diseases than ever before.

Along with the possibility of immense morbidity and mortality, chronic diseases have even more acute, widespread effects on society as a whole with many of them accounting for huge losses in corporate productivity amongst other things. The world health economic forum estimated that between the years 2011 and 2030 there will be a cumulative output loss of 47 trillion US dollars due to non-communicable diseases [3].

Among such chronic diseases, respiratory disease poses a major threat to global health [4]. By 2017, around 544.9 million people worldwide had some form of chronic respiratory disease, this is almost an increase of 40% on the 1990 figure [5]. Among respiratory diseases Asthma and Chronic Obstructive Respiratory Disease (COPD) are amongst the biggest causes of mortality. It is estimated that some 339 million people and 251 million people respectively are living with the conditions worldwide [6-7]. In 2015, about 3,17 million people died of COPD, accounting for 5% of the total deaths that year. Similarly, in 2016 there were 417,918 deaths attributed to Asthma [5]. One of the main

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contributors to respiratory morbidity and mortality is greenhouse gas (GHG) emissions and air pollution. Many of the chemicals found in GHGs have been found to cause significant harm to patients with pre-existing lung conditions [8].

### *1.2. Respiratory disease and GHG emissions.*

The growing burden of global air pollution as a result of greenhouse gases is major public health concern. In 2012 alone, about 3.7 million people died of conditions related to ambient global air pollution. This figure is a 3-fold increase from its 2008 equivalent [9]. Air pollution can be further subdivided into indoor and outdoor pollution depending on the location of the gases produced. Indoor air pollution can stem from tobacco combustion, fuel combustion, remodeling and demolition of surfaces, coal combustion, fumes from cooking consumer products and construction materials. Such sources of pollution can produce numerous forms of pollutants such as fine particles, carbon monoxide, sulphur oxides, arsenic, aldehydes, asbestos, lead, radon and nitrogen oxide [10]. Outdoor pollutants are present on a much larger scale and often originate from industrial and agricultural activities. Examples of common outdoor pollutants include: Carbon monoxides, sulphur oxides, ozone, Nitrogen oxides, volatile organic pollutants and bioaerosols [11].

Air pollution as a result of greenhouse gases can affect every part of the human body and can result in a wide range of diseases and disorders affecting various organs and organ systems [12]. Air pollution is particularly triggering for respiratory conditions including Asthma, COPD and even lung cancer and because of this global governments, including Ireland, have made reducing air pollutants a primary goal for their respective countries. In recent years there has been a growing need for the improved management of chronic conditions due to the immense personal, societal and economic strain they place on individuals and governments alike and as such, the negative impact of GHGs on chronic lung conditions is a prime focus of research and legislation [3] with policy makers placing heavy priority on it [13]. As the link between respiratory mortality and increasing GHG emissions has been widely established [14] this study aimed to examine that potential association in more detail in Ireland.

## **2. Methods**

In order to examine this association between GHG emissions and respiratory mortality this study examines the impact of GHG emissions on respiratory disease related mortality in Ireland from 2007-2017. Statbank data on GHG emissions and on mortality due to respiratory diseases in Ireland during the aforementioned period is used for the analysis.

## **3. Results and Discussion**

Correlation analysis demonstrates that over the last decade, while GHG emissions in Ireland have reduced by 1.1%, respiratory disease related mortality has increased on an average by 2.1%. Respiratory deaths recorded a notable increase in figures from 2015-2017 with previous year's figures remaining notably more stable (Table 1). Overall, female deaths were recorded in higher numbers every year with female deaths recording a 9% higher figure than male deaths in 2017 despite previous studies recording no significant difference between genders [15]. Total emissions were at their highest in 2016 and 2017 and at their lowest in 2011. A bivariate Pearson correlation demonstrated no significant relationship ( $p>0.05$ ) with deaths as a result of respiratory diseases from overall GHG emissions (GHG 000 Tonnes CO<sub>2</sub> Equivalents) (Table 2). Similarly, a bivariate Pearson correlation demonstrated no significant relationship ( $p>0.05$ ) between respiratory deaths between 2007 and 2017 for any of the primary GHG emission levels recorded including Methane, Nitrous Oxide or Carbon Dioxide (Table 3).

**Table 1.** Respiratory Deaths and from 2007-2017.

<i>Year</i>	<i>Number Respiratory Deaths</i>	<i>GHG 000 Tonnes CO2 Equivalents</i>
2007	3324	68,537
2008	3522	64,038
2009	3606	61547
2010	3280	61105
2011	3438	56989
2012	3497	57612
2013	3504	57410
2014	3492	57099
2015	3865	59212
2016	3935	61270
2017	4059	60744

**Table 2.** The Pearson Bivariate Correlation of Respiratory deaths and GHG emissions.

		RESPIRATORY DEATHS	GHG 000 TONNES CO2 EQUIVALENTS
RESPIRATORY DEATHS	<b>Pearson Correlation</b>	1	-0.127
	<b>Sig (2-tailed)</b>		0.709
	<b>N</b>	11	11
GHG 000 TONNES CO2 EQUIVALENTS	<b>Pearson Correlation</b>	-0.127	1
	<b>Sig (2-tailed)</b>	0.709	
	<b>N</b>	11	11

**Table 3.** The Pearson Bivariate Correlation significance values (2-tailed) for all three gases and the corresponding death numbers between 2007-2017.

	<i>Respiratory deaths and Carbon dioxide Tonnes CO2 Equivalent</i>	<i>Respiratory deaths and Nitrous Oxide Tonnes CO2 Equivalent</i>	<i>Respiratory deaths and Methane Tonnes CO2 Equivalent</i>
<i>Pearson Significance (2-tailed) p-value</i>	0.351	0.786	0.536

While previous studies [13;16] indicate a clear relationship between respiratory mortality and GHG emission levels this study demonstrates that in Ireland, between the 10-year period of 2007-2017 there is no significant statistical correlation between the two. This, however, does not mean that GHGs do not play a notable, negative role in respiratory health but instead, in this case likely demonstrates that GHGs alone cannot account for respiratory deaths during the period. In order to gain a more in-depth understanding of the relationship between GHG emissions and respiratory death, other variables will have to be taken into account and further analysed. Such variables may include: other health risk factors, lifestyle factors, relative, total GHG emissions and respiratory deaths broken down by region. Such factors should not be overlooked as indoor air pollution has been demonstrated to have an effect in lung cancer rates as well as acute respiratory infection rates [17] and indoor air pollution figures have not been included in this analysis. Studies can also examine the specific breakdown of the GHG emissions to get a clearer

understanding of which elements of GHGs may be attributed to increased respiratory death [18].

#### 4. Conclusion

While many respiratory deaths can and are attributed to GHG emissions, no statistical significance can be established between the two in Ireland during the 10-year period examined here and henceforth we cannot say that these deaths were attributed to an increase in GHG emissions alone. Further studies are required to examine any potential correlations more closely including a range of internal and external variables.

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