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The Comparative Effect of Air Pollution Caused by Greenhouse Gases Emissions on the Health of Men and Women in the Upper Middle-Income Countries

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Abstract

Greenhouse gas emissions and air pollution is a heterogeneous, complex mixture of gases, liquids and particulate matter and one of the major problems in the world which threatens the health of individuals and although this factor alone does not lead to death, it is very dangerous by affecting the progress and the progress speed of some diseases. Given the importance of health, in this paper, the effect of greenhouse gas pollution will be examined on the health of men and women in 33 upper middle-income countries from 2000 to 2016 in the form of panel data. The research results show that during the period studied, greenhouse gas pollution had a negative and significant effect on the health of men and women in the countries studied, but its effect on women's health was more than that of men.

Keywords: air pollution, Greenhouse Gas Emissions, Health, Panel Data Model

JEL Classifications: I10, Q01, Q53

1. Introduction

Air pollution include a heterogeneous mixture of solid and liquid particles suspended in air that varies continuously in size and chemical composition in space and time (Brook, Robert D., et al. 2004) And process that introduces different pollutants into the atmosphere that reason harm to humans, other living organisms, and the natural environment (Kinney, 2008; Brauer et al., 2012. Kim et al. 2015). These pollutants are associated with increased hospitalization (Poloniecki, Jan D., et al.1997) and mortality due to cardiovascular disease (Pope III, C. Arden, et al. 2002, Pope, C. Arden, et al. 2004, Samet, Jonathan M., et al. 2000) especially in persons with congestive heart failure, frequent arrhythmias, or both (Mann, Jennifer K., et al. 2002).

Air pollution has deleterious effects on both physical and mental health. (Fotourehchi, 2016) More than two million deaths per year are the direct result of air pollution through damage to the lungs and respiratory system (Shah et al. 2013). they were strongly associated with the industrial structure and development stage of a country. the economic recession period could function as a perfect timing for the reduction in air pollution level and the mortality induced by pollution (Chen et al. 2016).

Particulate matter (PM) is a key indicator of air pollution brought into the air by a variety of natural and human activities.

Carbon dioxide is responsible to %58.8 of greenhouse gas emission that has adversely influences on health status, it is toxic to the heart and causes diminished contractile force. (Muchopadhyay and Forssell, 2005, Davidson, 2003)

great in number scientific studies have explained particle exposure as the source of various health problems including premature death in people with lung disease and decreased lung function, irregular heartbeat, nonfatal heart attacks, aggravated pursiness, and increased respiratory symptoms such as coughing, irritation of the airways, or difficulty breathing (Atkinson et al. 2010; Cadelis et al. 2014; Correia et al. 2013; Fang et al. 2013; Meister et al. 2012)

2. Literature Review

Fang et al. (2013) estimated that about 5% of lung cancer deaths and 3% of cardiopulmonary are ascribable to Particulate matter globally. Correia et al. (2013) suggested a possible relation between decrease in fine particulate matter and improved life expectancy based on data collected from 545 counties in the U.S. During the 2000- 2007. Their studies represent that a decline of 10 μ g m−3 of PM2.5 should have led to an increase of life expectancy by 0.35 years on average. Cao et al. (2011) perform a study to investigate the association between air pollution and mortality in 70,947 middle-aged men and women of the China National Hypertension Survey and its follow-up study.

Substantial associations were found between air pollution levels and mortality from lung cancer and cardiopulmonary diseases. Krewski (2009) indicate that Exposure to PM2.5 reduce the life expectancy of the population by about 8.6 months on average.

The similar research was estimateed reflect the very significant role air pollution plays in cardiovascular illness and death. More and more, evidence demonstrating the linkages between ambient air pollution and the cardiovascular disease risk is becoming available, including studies from highly polluted areas.

3. Materials and Methodology

In this research an empirical model was used to examine the comparative effect of air pollution caused by greenhouse gases on the health indicators of Men and Women as below:

$\mathbf{LMRM = \alpha_i + \beta_1\, LPM2.5_{it} + \beta_2\, LCO_{2\,it} + \beta_3\, OTG_{it} + \beta_4\, SCM_{it} + U_{it}}$	**(1)**
$LMRW = \alpha_i + \beta_1\, LPM2.5_{it} + \beta_2\, LCO_{2\,it} + \beta_3\, OTG_{it} + \beta_4\, SCW_{it} + U_{it}$	**(2)**

i = 1, 2,..., N and t = 1, 2,..., T denote number of countries (i = 1, 2,…, 33 (N)) and time period (t =2000, 2001,…., 2016 (T)), respectively. α are constants and β1, β2, β3, β4 are coefficients. U is the error term that are normally distributed with zero mean and homoscedastic variance $U_{it} \sim d(0,\sigma_{\varepsilon}^{2})$. All the variables in Eq. (1, 2) are in logarithmic form. The main health status proxy variables in the both equations are Adult mortality rate men (MRM) and women (MRW), is the probability of dying between the ages of 15 and 60-that is, the probability of a 15-year-old men (women) dying before reaching age 60, if subject to age-specific mortality rates of the specified year between those ages.

There are three different air pollution proxy variables that their data are available for the analysis: 1. Carbon dioxide CO2 emissions (metric tons per capita) that are mostly stemming from the burning of fossil fuel and manufacture of cements that through releasing toxic substance into environment lead to negative health effects. 2. Particulate matter PM2.5 country level concentrations (micrograms per cubic meter). Particulate matter concentrations refer to fine suspended particulates less than 2.5 microns in diameter that are capable of penetrating deep into the respiratory tract and causing significant health damage. 3. Other greenhouse gas (HFC, PFC and SF6) emissions are by-product emissions of hydro fluoro carbons, per fluoro carbons, and sulfur hexafluoride (OTG). In the both equations social factors such as education levels are represented for the estimation and school enrollment, tertiary (% gross), respectively. School enrollment, tertiary (% gross) of men in equation 1 (SCM) and women in equation 2 (SCW) are defined as total enrollment in tertiary educations, regardless of age, expressed as a percentage of population of official tertiary education age. It is seen that, levels of Gross enrollment ratio, significantly influence on CO2 emission and PM2.5 and other gas concentration of the countries (world Bank, 2016).

For this paper, data collected from 33 countries upper middle-income level in the period 2000-2016.This data obtained from World Bank and countries are Contains:

Albania, Algeria, Argentina, Azerbaijan, Belarus, Belize, Botswana, Brazil, Bulgaria, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, Equatorial Guinea, Fiji, Guyana, Iran Islamic Rep, Jamaica, Kazakhstan, Lebanon, Macedonia, Malaysia, Mexico, Namibia, Panama, Paraguay, Peru, Romania, South Africa, Suriname, Thailand, Venezuela.

In this study we estimate the model by using panel data method. For using panel data model particular test method are used which will be discussed in this section. Before discussion about estimation and model analysis, it is necessary that why this study try to use the panel data method. In other words, are the countries -which are going to be studied- homogeneous or not? If the countries are homogeneous Pool Data method can be easily used by ordinary least squares otherwise, the necessity of using panel data is required. In other words, based on statistical concept we have:

$Y_i = Z_i\delta + U_i$ Conditional Model

$Y_i = Z_i\delta_i + \mathrm{U_i}$ Non-Conditional Model

i = 1, 2, …, N

The statistics for testing the hypothesis is as follows:

$$F_{(N-1,NT-N-K)} = \frac{(R_{UR}^2 - R_R^2)/(N-1)}{(1-R_{UR}^2)/(NT-N-K)}$$

Which *N* represents the number of country, *K* the number of explanatory variables, *T* the number of observations over the time. In this test (which is called as significance effects of group test) when null hypothesis rejected, using of panel data is required. For decision about using of Fixed Effects method or Random Effects method, it must be considered that fixed effect method is usually used when total population is considered and if samples selected from big population, random effect method will be better method (Baltagi, 2005, 2008).

Hausman Test is used for determining the method of estimation in panel data approach which its statistic is (H) with χ^2 distribution with *K* degree freedom (number of explanatory variables). If the null hypothesis rejected in the first test, the second test (Hausman Test) for the method of estimation in panel data methods will be used. In the Fixed Effects method, time aspect is not considered and only the effects which belong to each section of the time will be consider as individual effects. In the Random Effects method, time aspect is considered and the effects which belong to each section of the time will be consider as individual effects in the model. Hausman test statistic is as follows:

$$\mathrm{H} = \frac{\dot{\beta}_{\mathrm{FE}} - \dot{\beta}_{\mathrm{RE(GLS)}}}{\mathrm{VAR}(\dot{\beta}_{\mathrm{FE}}) - \mathrm{VAR}(\dot{\beta}_{\mathrm{RE(GLS)}})}$$

This test is hypothesis testing of uncorrelated individual effects and the explanatory variables which based on this test the generalized least squares estimation (GLS) under the H_0 hypothesis is consistent and under H_1 hypothesis is inconsistent. These hypothesis are as follows:

H_0: E (u_{it}/x_{it}) =0

H_1: E (u_{it}/x_{it}) ≠0

The rejection of the null hypothesis implies that the test method is fixed effects (Baltagi, 2005, 2008).

Table 1.

Chow test results for men

Fixed Effect Test(Chow)	Significance level ×10^{-4}	F degree freedom	Calculated F	Result
Panel	(0.0000)	(29 , 68)	209.24	H_0 is rejected
Chow test results for women				
Fixed Effect Test(Chow)	Significance level ×10^{-4}	F degree freedom	Calculated F	Result
Panel	(0.0000)	(29 , 68)	112.33	H_0 is rejected

Source: Research calculations.

Table 2.

Hausman test for men

Hausman Test	Significance level ×10^{-4}	χ^2 degree freedom	Calculated χ^2	Result

Panel	)0.006(	4	18.26	H_0 is rejected
Hausman test for women				
Hausman Test	Significance level $\times10^{-4}$	χ^2 degree freedom	Calculated χ^2	Result
Panel	)0.000(	4	25.67	H_0 is rejected

Source: Research calculations.

Test results for both model indicate that a good model is panel data model with fixed effects.

Model Estimation Results:

Table 3.

Model results of the regression model for men

variable / Method	C	LPM2.5	LCO_2	LOTG	LSCM	R^2	F statistic
Fixed Effects Model	6.56	0.036	0.07*	0.01	0.32	0.84	272.6
	(0.000)	(0.48)	(0.09)	(0.000)	(0.000)		(0.000)

* indicates significance at 10%.

Model results of the regression model for women

variable / Method	C	LPM2.5	LCO_2	LOTG	LSCW	R^2	F statistic
Fixed Effects Model	5.8	0.003	0.12	0.01	-0.28	0.78	182.31 (0.000)
	(0.000)	(0.96)	(0.01)	(0.000)	(0.000)		

Source: Research calculations.

4. Results

As observed in Table (3), statistics value and probability level in the first model show that all coefficients, except PM2.5, are significant at 99% confidence level and carbon dioxide emissions, are significant at 90% confidence level. Particulate matter carbon dioxide emissions coefficient shows that, assuming other factors are constant, with an increase of 1 percent in Particulate matter carbon dioxide emissions, the mortality rate of men in the countries studied is 0.07%, and in addition, assuming other factors are constant, with 1 percent increase in the emissions of other greenhouse gases (HFC, PFC and SF6), the mortality rate of men increases by 0.01 percent.

The statistics value and probability level in the second model show that all coefficients, except for Particulate matter PM2.5 coefficient, are significant at the 99% confidence level. The carbon dioxide emission Coefficient shows that, assuming other factors are constant, with an increase of 1 percent in the carbon dioxide emissions, the mortality rate in women is 12 percent, and assuming other factors are constant, with 1 percent emission of other greenhouse gases (HFC, PFC and SF6), the mortality rate in women increases by 0.01 percent. In addition, indicating a good fit and the fact that the independent variables in the model's particles coefficient explain several percent of the dependent variable, the value of R^2 is 0.84 in the first model and 0.78 in the second model.

5. Conclusions and Discussion

Given the importance of health, this study aimed to investigate and compare the effects of air pollution from greenhouse gas emissions on the health of men and women in the upper middle-income countries including Iran.

Using panel data in the period 2000-2016, this study was conducted in which mortality rate of women and men was used as a health indicator. It was expected that as men stay longer outside and therefore are more exposed to air pollution it has a more damaging effect on their health, while the results showed that although greenhouse gas emissions significantly increase the mortality rate of women and men, its impact on women's mortality is more. Therefore, it can be said that environmental pollution, especially air pollution, will have a more negative effect on women due to their hormonal changes, regardless of skin, digestive, cardiovascular, pulmonary diseases and cancers.

Given the sensitivity of women, especially pregnant women, and the fact that air pollution will cause negative effects such as cardiac abnormalities, decreased IQ and fetal weight loss, and thus it will have negative consequences for the health of next generation; while the identification of health problems, including the effects of air pollution, should be prioritized, and fundamental measures should be taken to reduce pollutants, how to deal with this phenomenon should be taught especially to pregnant women and mothers and accurate information should be provided to them so that they refrain from going outside in urban open spaces on the days in which the air is polluted and consider fluids and foods including antioxidants and iron in their own diet. In addition, generally the identification and control of the sources of air pollution, urbanization control, the development of urban green space, the prevention of natural resource degradation, strict control and monitoring of the centers of technical inspection of vehicles, the development of public transport fleet, culture building and the development of equipment for measuring air pollutants can be effective in reducing air pollution and its harmful effects.

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Appendix

Redundant Fixed Effects Tests

Equation: Untitled

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	209.244405	(29,68)	0.0000
Cross-section Chi-square	459.248364	29	0.0000

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	18.264224	4	0.0011

Dependent Variable: LMORT_M
Method: Panel Least Squares
Date: 07/01/18 Time: 11:25
Sample (adjusted): 2000 2012
Periods included: 5
Cross-sections included: 30

Total panel (unbalanced) observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPM2_5	0.036441	0.051753	0.704121	0.4838
LCO2	0.071167	0.041822	1.701677	0.0934
LOTHER_GAS	0.010897	0.001692	6.439972	0.0000
LSC_M	-0.319606	0.021913	-14.58496	0.0000
C	6.567690	0.183347	35.82110	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.852498	Mean dependent var	5.219650
Adjusted R-squared	0.848857	S.D. dependent var	0.410668
S.E. of regression	0.043349	Akaike info criterion	-3.177843
Sum squared resid	0.127784	Schwarz criterion	-2.302852
Log likelihood	196.0700	Hannan-Quinn criter.	-2.823529
F-statistic	272.6157	Durbin-Watson stat	0.996592
Prob(F-statistic)	0.000000		

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	112.338447	(29,68)	0.0000
Cross-section Chi-square	396.776156	29	0.0000

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	25.676609	4	0.0000

Dependent Variable: LMORT_F
Method: Panel Least Squares
Date: 07/01/18 Time: 10:53
Sample (adjusted): 2000 2012
Periods included: 5
Cross-sections included: 30
Total panel (unbalanced) observations: 102

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPM2_5	0.003345	0.065160	0.051332	0.9592
LCO2	0.125363	0.051682	2.425674	0.0179
LOTHER_GAS	0.013620	0.002103	6.476425	0.0000
LSC_F	-0.284615	0.025463	-11.17772	0.0000
C	5.897152	0.234283	25.17103	0.0000

Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.798824	Mean dependent var	4.607342
Adjusted R-squared	0.783400	S.D. dependent var	0.419554
S.E. of regression	0.054055	Akaike info criterion	-2.736416
Sum squared resid	0.198694	Schwarz criterion	-1.861425
Log likelihood	173.5572	Hannan-Quinn criter.	-2.382102
F-statistic	182.3159	Durbin-Watson stat	0.597123
Prob(F-statistic)	0.000000		