

**ROLE OF AIR POLLUTION
AT GASOLINE STATIONS
IN
ALLERGIC DISORDERS**

**BY
GEORGE ALBERT TAWFILIS**

M.B.B.Ch., Ain Shams University (1981)
Master in Dermatology and Venereology, Cairo University (1987)

**A Thesis Submitted in the Fulfillment for
DOCTOR OF PHILOSOPHY
In Environmental Sciences
Department of Medical Science**

**Institute of Environmental Studies & Research
AIN SHAMS UNIVERSITY**

2005

Approval Sheet

**ROLE OF AIR POLLUTION
AT GASOLINE STATIONS
IN
ALLERGIC DISORDERS**

BY

GEORGE ALBERT TAWFILIS

M.B.B.Ch., Ain Shams University (1981)

Master in Dermatology and Venereology, Cairo University (1987)

**A Thesis Submitted in the Fulfillment for
Ph. D.
In Environmental Sciences
Department of Medical Science**

This thesis has been approved by:

PROF. DR. GABR METWALLY SAYED AHMED

Prof. of Community, Environmental and Public Health
Faculty of Medicine, Al-Azhar University

PROF. DR. SALEH MOHAMED HASSAN EL SHIEMY

Prof. of Dermatology and Venereology
Faculty of Medicine, Ain Shams University.

PROF. DR. MOHAMED SAYED MANSOUR EL GEWAILY

Prof. of Community, Environmental and Occupational Medicine
Faculty of Medicine, Ain Shams University.

PROF. DR. MAHMOUD SERY MOHAMED EL BOUKHARY

Assistant Prof. in Medical Science Department
Institute of Environmental Studies & Research, Ain Shams University.

2005

ROLE OF AIR POLLUTION AT GASOLINE STATIONS IN ALLERGIC DISORDERS

BY

GEORGE ALBERT TAWFILIS

M.B.B.Ch., Ain Shams University (1981)

Master in Dermatology and Venereology, Cairo University (1987)

**A Thesis Submitted in the Fulfillment for
DOCTOR OF PHILOSOPHY
In Environmental Sciences
Department of Medical Science**

Under The Supervision of:

PROF. DR. MOHAMED SAYED MANSOUR ELGEWAILY

Prof.of Community, Environmental and Occupational Medicine
Faculty of Medicine, Ain Shams University

PROF. DR.MOUSTAFA MOKHTAR MOHAMED KAMEL

Prof.of Dermatology and Venereology
Faculty of Medicine, Ain Shams University

PROF. DR. MAHMOUD SERY Mohamed EL BOUKHARY

Assistant Prof. in Medical Science Department
Institute of Environmental Studies&Researches, Ain Shams University

PROF. DR. MAHMOUD AHMED IBRAHIM HOWAIHY

Assistant Prof. in Biological and Physical Sciences Department
Institute of Environmental Studies&Researches, Ain Shams University

**Institute of Environmental Studies & Research
AIN SHAMS UNIVERSITY**

2005

Acknowledgement

Thanks to God before and after. I would like to express my sincere gratitude and appreciation to Prof. Dr. Mohamed Sayed Mansour El-Gewaily □ Prof. of Community, Environmental and Occupational Medicine, Faculty of Medicine, Ain Shams University □ for his unlimited help, continuous advice, guidance, valuable remarks and great support throughout this study.

My deep thanks and appreciation to Prof. Dr. Mostafa Mokhtar Mohamed Kamel □ Prof. of Dermatology and Venereology, Faculty of Medicine, Ain Shams University □ for his kind assistance, meticulous supervision and generous help.

I am indeed indebted to Prof. Dr. Mahmoud Serry El Boukhary □ Ass. Prof. in Medical Science Department, Institute of Environmental Studies and Research, Ain Shams University □ for his great help and guidance during the preparation of this work as well as following up of every step in this thesis.

My sincere thanks to Prof. Dr. Mahmoud Ahmed Howaihy □ Ass. Prof. in Biological and Physical Sciences Department, Institute of Environmental Studies and Research, Ain Shams University □ for his valuable support specially in the environmental measures.

Also I would like to thank Dr. Magdy Allam and the members of the Egyptian Environmental Affairs Agency (EEAA) / Ministry of state for Environmental Affairs, for their great effort in measuring the air pollutants inside the gasoline stations, in areas around them and in control areas.

My sincere thanks and appreciation for Prof. Dr. Mohamed Abd El Kader El khafif, the Dean of the Institute of Environmental Studies and Research, and Prof. Dr. Mostafa Hassan Ragab, the head of the Medical Department, Institute of Environmental Studies and Research, for their generous help and support letters to facilitate my field work.

I want to express my thankfulness to Dr. Monir Saad, lecturer of statistics, Desert Research Institute for his tremendous effort in the statistical analysis for this work.

Lastly, I would like to thank my wife for her great help to create enough time for this thesis.

ABSTRACT

In this study, we investigated the relationship between gasoline-related air pollutants namely total hydrocarbons, carbon monoxide, sulfur dioxide, particulate matter and methyl tertiary butyl ether (MTBE), at the gasoline service stations, and allergic disorders. One hundred and eleven workers who represented all available exposed labors inside ten service stations (Occupational group), and 60 subjects that were living or working in close proximity to gasoline stations (Environmental group), were compared with 60 none exposed subjects (Control group). All individuals were subjected to complete general, dermatological and chest examinations. Investigations included pulmonary function testing (FEV1: Forced expiratory volume exhaled in the first second) and skin patch test. A significant relationship was noticed among the four types of allergy (skin, chest, nasal and eye allergies). Most cases had been suffering from more than one type of allergy at the same time. The concentrations of these gasoline-related air pollutants were measured in the ambient air of the gasoline stations, surrounded regions and the control areas. It was found that the higher the levels of MTBE, SO₂, and hydrocarbons, in ambient air, the higher the number of subjects suffering from allergic disorders, however the most significant factor was MTBE.

CONTENT	Page
-Abstract	
-Acknowledgement	
-List of abbreviations -----	I
-List of tables -----	III
-List of charts -----	VI
-Introduction -----	1
-Aim of the work -----	4
-Review of literature -----	5
Allergy -----	5
Allergic reactions -----	5
Hypersensitivity disorders -----	8
Occupational and environmental exposure -----	18
Occupational skin disorders -----	21
Eczema -----	25
Irritant contact dermatitis -----	26
Allergic contact dermatitis -----	27
Contact dermatitis from airborne agents -----	34
Occupational contact dermatitis -----	35
Photosensitivity -----	37
Phototoxic reactions -----	38
Photo-allergic reactions -----	39
Contact urticaria -----	40
Allergic skin tests -----	43
Prevention of allergic dermatitis -----	46

Asthma -----	49
Pathophysiology -----	53
Clinical features -----	55
Laboratory finding -----	56
Occupational asthma -----	57
Allergic rhinitis -----	60
Allergic conjunctivitis -----	63
Gasoline -----	65
Composition of gasoline -----	67
Additives for gasoline -----	69
Pollutant emissions -----	71
Oxygenated gasoline -----	72
Leaded gasoline -----	74
Hydrocarbons -----	77
Carbon monoxide -----	80
Particulate matter (PM10) -----	85
Sulfur dioxide -----	88
Methyl Tertiary Butyl Ether (MTBE) -----	91
Gasoline without Methyl Tertiary Butyl Ether -----	101
Ambient air standards -----	104
-Subjects and methods -----	106
-Results -----	112
-Discussion -----	154
-Summary and conclusion -----	166
-Recommendations -----	170

-References	-----	172
-Appendices		
-Arabic Abstract		

LIST OF ABBREVIATIONS

MTBE: Methyl tertiary butyl ether

ETBE: Ethyl Tertiary butyl ether

TAME: Tertiary amyl methyl ether

THC: Total hydrocarbons

CD: Contact dermatitis

UV: Ultra violet

T.R.U.E.: thin layer rapid use epicutaneous test

FVC: Forced vital capacity

FEV1: Forced expiratory volume exhaled in the first second

RV: Residual volume

RADS: Reactive airways dysfunction syndrome

PM: Particulate matter

WHO: World health organization

EPA: Environmental protection agency

NAAQS: National ambient air quality standards

mcg: micrograms

µg: micrograms

PPM: parts per million

MHC: Major Histocompatibility Complex

DTH: Delayed type hypersensitivity

LIST OF ABBREVIATIONS (cont.)

CAMs: Cellular adhesion molecules

IL-1: Interleukin-1

APC: Antigen processing cells

SPSS: Statistical Package for Social Science (Computer program for statistical analysis)

ENL; Erythema nodosum leprosum , in leprosy

NIOSH: National institute for occupational safety and health

CD: contact dermatitis

MMEFR: Maximal midexpiratory flow rate

SO₂: Sulfur dioxide

CO: Carbon monoxide

O₃: Ozone

Pb: Lead

Hb: Hemoglobin

EEAA: Egyptian Environmental Affairs Agency

RFG: Reformulated gasoline

CDC: Center for disease control and prevention

NAAQS: National ambient air quality standards

RON: Research octane number

TBA: Tertiary butyl alcohol

List of Tables	Page
Table-1: Total No. of Allergic Subjects	112
Table-2: Age distribution among the occupational group	113
Table-3: The relation between age and allergy (occupational)	113
Table-4: Age distribution among the environmental group	114
Table-5: The relation between age and allergy (environmental)	114
Table-6: Age distribution among the control group	115
Table-7: The relation between age and allergy (control group)	115
Table-8: Mean concentrations of pollutants	116
Table-9: Education levels of the workers	117
Table-10: Work duration of the labors	117
Table-11: The relation between work duration and frequency of allergy	118
Table-12: The relation between work duration and allergic symptoms	118
Table-13: Work period of workers	119
Table-14: Duration of sun exposure per day	119
Table-15: Allergic photocontact dermatitis	119
Table-16: History of allergy before working in gasoline stations	120
Table-17: Follow up of allergy after working in gasoline stations	120
Table-18: Family history of allergy	121

List of Tables (cont.)	Page
Table-19: Using of protective devices during work	121
Table-20: Taking shower after work	122
Table-21: Relation between degree of education and using the protective ways	122
Table-22: Relation between degree of education and taking shower after work	123
Table-23: Number of allergic subjects (Occupational)	123
Table-24: Number of allergic subjects (intersecting)	124
Table-25: Allergic symptoms	125
Table-26: Degree of asthma	126
Table-27: Types of allergic dermatitis	127
Table-28: Number of allergic subjects (Environmental)	128
Table-29: Number of allergic subjects (Control)	128
Table-30: Allergic symptoms in long leave	129
Table-31: Relation between air pollutants and allergic disorders Logistic Regression Equation (occupational)	130
Table-32: Odds ratio for MTBE	130
Table-33: Relation between air pollutants and allergic disorders Logistic Regression Equation (environmental)	131
Table-34: Odds ratio for SO ₂	131
Table-35: Hydrocarbons concentrations and allergic disorders (occup.)	132

List of Tables (cont.)	Page
Table-36: SO ₂ conc. and allergic disorders (occupational)	133
Table-37: MTBE conc. and allergic disorders (occupational)	133
Table-38: Hydrocarbons concentrations and allergic disorders (environmental)	134
Table-39: SO ₂ conc. and allergic disorders (environmental)	134
Table-40: MTBE conc. and allergic disorders (environmental)	135
Table-41: The correlation between MTBE conc. and allergic disorders (occupational)	135
Table-42: The correlation between THC conc. and allergic disorders (occupational)	136
Table-43: The correlation between SO ₂ conc. and allergic disorders (occupational)	136
Table-44: The correlation between MTBE conc. and allergic disorders (environmental)	136
Table-45: The correlation between THC conc. and allergic disorders (environmental)	137
Table-46: The correlation between SO ₂ conc. and allergic disorders (environmental)	137
Table-47: Pulmonary functions testing (FEV ₁)	138
Table-48: FEV ₁ – ANOVA	138

List of Charts	Page
Chart-1: MTBE conc. and no. of asthmatics (Occupational)	139
Chart-2: MTBE conc. and allergic dermatitis subjects (Occup.)	139
Chart-3: MTBE conc. and allergic rhinitis (Occup.)	140
Chart-4: MTBE conc. and allergic conjunctivitis (Occup.)	140
Chart-5: MTBE conc. and total no. of allergic subjects (Occup.)	141
Chart-6: Hydrocarbons (THC) conc. and asthmatics (Occup.)	141
Chart-7: THC conc. and allergic dermatitis subjects (Occup.)	142
Chart-8: THC conc. and allergic rhinitis (Occup.)	142
Chart-9: THC conc. and allergic conjunctivitis (Occup.)	143
Chart-10: THC conc. and total no. of allergic subjects (Occup.)	143
Chart-11: SO ₂ conc. and no. of asthmatics (Occup.)	144
Chart-12: SO ₂ conc. and allergic dermatitis subjects (Occup.)	144
Chart-13: SO ₂ conc. and allergic rhinitis (Occup.)	145
Chart-14: SO ₂ conc. and allergic conjunctivitis (Occup.)	145
Chart-15: SO ₂ conc. and total no. of allergic subjects (Occup.)	146
Chart-16: MTBE conc. and no. of asthmatics (Environmental)	146
Chart-17: MTBE conc. and allergic dermatitis subjects (Environ.)	147
Chart-18: MTBE conc. and allergic rhinitis (Environ.)	147
Chart-19: MTBE conc. and allergic conjunctivitis (Environ.)	148
Chart-20: MTBE conc. & total no. of allergic subjects (Environ.)	148

List of Charts (cont.)	Page
Chart-21: Hydrocarbons (THC) conc. and asthmatics (Environ.)	149
Chart-22: THC conc. and allergic dermatitis subjects (Environ.)	149
Chart-23: THC conc. and allergic rhinitis (Environ.)	150
Chart-24: THC conc. and allergic conjunctivitis (Environ.)	150
Chart-25: THC conc. and total no. of allergic subjects (Environ.)	151
Chart-26: SO ₂ conc. and no. of asthmatics (Environ.)	151
Chart-27: SO ₂ conc. and allergic dermatitis subjects (Environ.)	152
Chart-28: SO ₂ conc. and allergic rhinitis (Environ.)	152
Chart-29: SO ₂ conc. and allergic conjunctivitis (Environ.)	153
Chart-30: SO ₂ conc. and total no. of allergic subjects (Environ.)	153