Cairo University
Institute of Statistical Studies and Research
Department of Biostatistics and Demography

Water Pollution Impact on Human Health in Egypt

By

Hoda Mohamed Aly Abou Taleb

Supervised
By

Prof.
Hesham Makhloof
Department of Biostatistics & Demography
Institute of Statistical Studies and Research
Cairo University

Prof.
Amany Mousa
Department of Applied Statistics & Econometrics
Institute of Statistical Studies and Research
Cairo University

Prof.
Ahmed Amin Tantawy
Department of Environmental Research
Theodor Bilharz Research Institute

A Dissertation Submitted in Partial Fulfillment for the Requirement
of the Ph.D Degree from the Department
Biostatistics and Demography

2010

ACKNOWLEDGEMENTS

I greatly indebted to Prof. Dr. Hesham Makhlouf, Professor of Demographic Statistics, Demography and Biostatistics Department, who accepted to supervise this thesis in spite of his intense work program. His instructive supervision and excellent guidance were of great help to me.

I would like to express my deepest gratitude and sincere appreciation to Prof. Dr. Amany Mousa, Professor of Statistics, Department of Applied Statistics& Econometrics, who suggested and planned this work, for her instructive guidance, effective supervision and unlimited support. Because of her creative thinking, constructive criticism and sincere initiating power, this work was brought to light.

All my sincere and deepest thanks and gratitude goes to Prof. Dr. Ahmed Amin Tantawy, Professor of Environmental Research, Environmental Research Department, Theodor Bilharz Research Institute, for his effective guidance and valuable suggestions throughout the entire work of this thesis.

I would, also, like to express my sincere thanks to Prof . Dr. Hanaa El Khayat,Professor of Environmental Research, Environmental Research Department, Theodor Bilharz Research Institute, for her extreme help and continuous encouragement.

I am extremely grateful to Ass. Prof. Dr. Imam Waked, Assistant Professor of Nephrology, Nephrology Department, Theodor Bilharz Research Institute, for his valuable advice and unfailing support.

My deepest thanks, also extend to Prof. Dr. Bayoumy. B. Moustafa, Professor and Head of Environmental Research Department, Theodor Bilharz Research Institute, who always encouraged me to finish this thesis.

I would, also, like to express my profound gratitude and deep appreciation to Prof. Dr. Zeinab Shaker, Professor of Immunology, Theodor Bilharz Research Institute, who always guided me throughout my long journey in scientific research. Her fruitful instructions were always a guide line through the most critical times of my career. Although, she is not one of my official supervisors, her valuable assistance, beneficiary advice and indispensable help has been the rocking stone of this thesis.

My true thanks are conveyed to Prof. Dr. Anas M.A.El Mola, Prof. of Hydraulics, faculty of Eng. Al Azhar University ,Cairo. He offered me a lot of his time and experience.

All in all, I am really indebted to everyone who helped me to complete this thesis, with special stress on authorities at Water Research Lab. At MOH and Kidney Dialysis Units at Atfih General Hospital, Maghagha General Hospital and Benha Hospital.

To my beloved husband,
and sons

Hoda Abou Taleb
2010

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

Symbol	Meaning	Pages
Ar	Arsenic	13
Ag	Silver	13
AFP	Acute Flaccid Paralysis	23
BMPs	Best Management Practices	12
Ca	Calcium	1
Cd	Cadmium	13
CDC	Centers for Disease Control and Prevention	23
CKD	Chronic Kidney Disease	1
Cr	Chromium	13
Co	Cobalt	1
Cu	Copper	1
DSSWQM	Decision Support System Water Quality Management	13
FAO	Food and Agriculture Organization	5
Fe	Iron	13
GDP	Gross Domestic Product	5
GFR	Glomerular Filtration Rate	84
GOE	Government of Egypt	4
Ha	Hectares	4
HACA	Hierachical Cluster Analysis	35
HDI	Human Development Index	12
Hg	Mercury	14
HM	Heavy Metals	18
IBI	Index of Biotic Integrity	22
K	Potassium	1
Mg	Magnisum	1
Mn	Manganese	1
MOH	Ministry of Health	23
Na	Sodium	1
NPDES	National Pollution Discharge Elimination System	13
NHANES	National Health and Nutrition Examination Survey	13
Ni	Nicle	16
NPDES	National Pollution Discharge Elimination System	13
NTDs	Neglected Tropical Diseases	25
Pb	Lead	1
ppm	Parts per million	22
Pump in	Pum inside houses	49
Pump out	Pump outside houses	49
Se	Selenium	1
SEI	Stockholm Environment Institute	28
SIR	Standardized Incidence Ratio	27
SPM	Statistical Parametric Mapping	21

Symbol	Meaning	Pages
Tap in	Taps inside houses	49
Tapout	Taps common	49
UNDP	UN Development Programme	28
WHO	World Health Organization	2
Zn	Zinc	1

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND SCOPE OF THE STUDY

1.1. Introduction

Water is a critical issue in Egypt for a variety of reasons. Egypt is rich of River Nile resources. Traditional economic analysis rarely takes natural resources into consideration and thus water is usually not recognized as a factor of human health.

Trace amounts of metals are common in water, and these are normally not harmful to our health. In fact, some metals are essential to sustain life. Calcium (Ca), Magnesium (Mg), Potassium (K), and Sodium (Na) must be present for normal body functions. Cobalt (Co), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Selenium (Se), and Zinc (Zn) are needed at low levels as catalysts for enzyme activities (Salem *et al*.,2000).

The development and the progression of Chronic Kidney Disease (CKD) have been associated with environmental Lead (Pb) burden in the general population and at individual level. Lead poisoning poses a serious public health problem especially in the developing countries and emerging economies of the world where efforts at reducing lead poisoning has not been as pronounced as in the developed countries Juberg *et al.*,(1997).

In 2006**,** the population of Egypt was about 78,627,057 millions (Central Agency for Public Mobilization And Statistics . July, 2008) live near the banks of the Nile River. In 2010, they reached about 79.523.629 millions (Central Agency for Public Mobilization And Statistics . December, 2010). At the same rate of growth, they may exceed 100 millions after 9 years. Thus, the growth rate of the population in Egypt is a very serious problem, which might be a threat to the future of this country (Sameeh, 2004). Subsequently, balance between population

increase and production of enough food is one of the most important and challenging problems facing Egypt today (Sameeh, 2004). One of the most important environmental problems is the scarcity of water in many reclaimed areas, abuse of water resources in the old valley and pollution of many water bodies. Besides misbehavior of crowded dwellers in villages and cities, water pollution is caused by break down of old and consumed water networks, as well as various problems in construction, designing and maintenance of sewage system resulting in appearance and prevalence of communicable and non-communicable diseases (Anwar, 2003).

The major rural problems in Egypt have been water-related; the importance of provision of potable water and latrines is reflected on limitation of transmission of parasites, some helminthic diseases and Kidney failure. However, planners have not linked water and sanitation related strategies to health planning, even though such interventions have been shown to have a health impact (Esrey *et al.*,1991). Environmental issues as they are related to health in the Nile Delta and Upper Egypt need to be seen in a holistic, dynamic context.

Industry, mining and transportation are considered the main sources of release of heavy metals into the environment. Pollution is the addition to the ecosystem of something which has a detrimental effect on it. One of the most important causes of pollution is the high rate of energy usage by modern growing populations. Water pollution is a large set of adverse effects upon water bodies (lakes, rivers, oceans, groundwater) caused by human activities. This process ranges from simple addition of dissolved or suspended solids to discharge of the most insidious and persistent toxic pollutants (such as pesticides, heavy metals, and non degradable bio-accumulative chemical compounds). http://en.wikipedia.org/wiki.chemical

Environmental health is reflected on aspects of human health, disease, and injury that are determined or influenced by factors in the environment. This includes the direct and indirect pathological effects of various chemical, physical, and biological agents, as well as effects on the broad social environment, which

includes housing, urban development, land-use, transportation, industry, and agriculture (WHO, 1997a). Poor environmental quality is estimated to be responsible for approximately 25 percent of all preventable ill health in the world (WHO, 1997b). A major challenge in Egypt is balancing the rapid development process and economic growth with minimizing the serious impact on environmental health.

1.2. Scope of the Study and Objectives

The present research aims at determining different variables affecting drinking water in rural and urban areas for some governorates using various data analysis and modeling techniques to predict and study relationship between water pollution and human health. The selected sampling sites are characterized by a gradient ranging from nearly natural situations to severely impacted (water pollution, chemical, physical habitat degradation) ones.

In this respect, the following issues are our objectives:

1-Studying the socio-economic characteristics of the respondents, measuring the awareness of the respondents about water pollution and suggest methods to control the serious effects of water pollution on human health, with special stress on urinary tract diseases.

2-Exploring the different factors that are expected to be associated with water pollution-infection axis as age, sex, occupation and education.

3-Estimating the risk factors and odds for different demographic factors in relation to heavy metals and water pollution.

This Contains in addition to this chapter,

Chapter 2. Demographic Background and Characteristics for the Population Under Study. Chapter 3. Water Polution. Chapter 4. Impact of Water Pollution on Human Health. Chapter 5. Study Design and Population. Chapter 6. Statistical Analysis for effects of water Pollution. Chapter 7. Summary, Conclusions and Recommendations. In addition to this chapter, References and Appendices.

CHAPTER 2

DEMOGRAPHIC BACKGROUND CHARACTERISTICS FOR THE POPULATION UNDER STUDY

2.1. Introduction

The history of formal environmental assessment in Egypt has been relatively short, but dynamic. Once man became aware that he was a part of the environment and not separate from it, many individuals became deeply involved in the cause to “save the environment”.

Overview of Egypt’s water resources, it will include the institutional responsibilities within the Government of Egypt (GOE) water quality community; legal basis for water quality regulations; sources of pollution; and a water quality assessment of the Nile system. Water quality management, which presents available data and information collected by the study and provides insight to where additional data resides.

This chapter fulfills the following objectives:

The geography, climate and population in Section 2. Section 3. Water is essential for life. In Section 4. Quality of surface water.

2.2. Geography, Climate and Population

Egypt lies in the north-eastern corner of the African continent, with a total area of about 1 million km². It is bordered in the north by the Mediterranean Sea, in the east by the Red Sea, on the south by Sudan and in the west by Libya (Kundell, 2008). In 1993, the total cultivated land was estimated to be 3.24 million hectares (ha), or 3.2% of the total area. In 1992, agriculture accounted for 17% of Egypt's gross domestic product (GDP) and provided employment to 38% of the labour force (http://www.eoearth.org/article/Water_profile_of_Egypt).

The mean annual rainfall is estimated at 18 mm. It ranges from 0 mm in the desert to 200 mm in the northern coastal region. The River Nile is the main source of water for Egypt. Under the 1959 Nile Waters Agreement between Egypt and Sudan, Egypt's share is 55.5 km³/year (Ezzat *et al*.,2002). Internal surface water resources are estimated at 0.5 km³/year. This brings the total (actual) surface water resources to 56.0 km³/year. The volume of groundwater entering the country from Libya is estimated at 1 km³/year. Internal renewable groundwater resources are estimated at 1.3 km³ /year. This brings the total renewable groundwater resources to 2.3 km³/year (FAO. 2000). In 1994, the quantity of agricultural drainage water flowing back into the River Nile and becoming available again for withdrawal downstream was estimated at 4 km³/year. In 1994, the treatment of domestic wastewater was estimated at 650 million m³/year and in 1993 about 200 million m³/year of treated wastewater was estimated to have been reused. The quantity of desalinated water was estimated at only 25 million m³ in 1990. In 1993 the total water input was 62.5 km³/year compared to a total water use of 56.9 km³/year. It was estimated that in the year 2000 the total water use approached 70 km³/year, which is more than the actual water availability. The additional water was expected to be provided by: the construction of the Jonglei canal in the Sudd swamps in Sudan (2 km³), non-renewable groundwater (2-2.5 km³), increasing use of agricultural drainage water (2-2.5 km³), an increase in treated waste water (1 km³), improved water management/irrigation efficiency (1km³) ("AQUASTAT Country Profiles") (www.fao.org/country profiles /water).

The Egyptian population were estimated at 83.083 millions (2009) with an average annual growth rate of 1.642%. The rural population is 58% of the total population. Overall population density is 73 inhabitants/km^2; however, with about 97% of all people living in the Nile Valley and Delta, population density reaches more than 1,165 inhabitants/km^2 in these areas, while in the desert it drops to only 1.2 inhabitants/km^2 (The encyclopedia of earth, content credibility community *Last Updated: August 24, 2008).* Percentage of the urban population residing in

each urban agglomeration with 750,000 inhabitants or more in 2007 from 36.9 to 36.7 in 2010 from Egypt and the growth showed no signs of slowing.

The rate of urbanization is greater in the developing world, particularly in Africa and Asia, and this, together with lower levels of safe water supply, makes these locations particularly vulnerable to the risk of water-related diseases. In 2000, 81% of Asians and only 64% of Africans had access to safe sources of drinking-water, despite worldwide efforts. (The encyclopedia of earth, 2008).

(htt://en.wikipedia.org/wiki/Egypt#Demograpraphics).

The fact that water flows to the lowest level uni-directionally is a very specific and useful property of water (Ming-Feng Hung and Shaw, 2005). Egypt has many environmental problems, and some of them complicate efforts to promote economic and social development. The primary issues are water quality and quantity (National Planning Institute, 2001).

The River Nile is more than 1,200 kilometers long, extending from Aswan to the Mediterranean Sea, while the main canals and drains serving the Valley and the Delta are about 50,000 kilometers long (20,000 kilometers of which are drains). This network distributes water among the various regions of the Country, fulfilling the requirements of the social and economic development plans. The River Nile is the main source of water, as it provides Egypt with 55.5 billion cubic meters of water annually, representing about 96% of Egypt's renewable water resources. This is in addition to about 6.1 billion cubic meters of renewable ground water in the Nile Valley and the Delta, and around one billion cubic meters of non-renewable ground water in the Eastern and Western Deserts and Sinai. Seasonal rainfall provides about 1.3 billion cubic meters of water (fig. 1&2).