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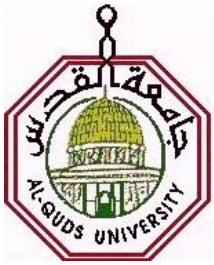

Health Impact Assessment of People Living Near Wastewater Treatment Plant in Beit Lahia: Case Study

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Health Impact Assessment of People Living Near Wastewater Treatment Plant in Beit Lahia: Case Study

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Dedication

I dedicate this study
To the Palestinian people who are steadfast and patient on
the beloved land of Palestine
To my mother and father, my brothers, sisters, my wife and my kids
Without their support this work could not have been done
Thank you all. From the deepest of my heart, I express to you all my sincere love and appreciation

Maher Y. AL Madhon

Declaration

I certify that this thesis submitted for the degree of master is the result of my own research, except where otherwise acknowledged, and that this thesis or any part of the same has not been submitted for a higher degree to any other university.

Signed
Maher Y. AL Madhon
Date: January 2011

Acknowledgement

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Warm thanks to all *people* living in the study area for their co- operation during data collection

Abstract

*This study titled **"Health Impact Assessment of People Living near Waste Water Treatment Plant in Beit Lahia**, **Case Study"** was conducted in the year 2010 at Beit Lahia in the north of the Gaza Strip. The study aimed at assessing the adverse health impact on the health status of the human population on the targeted areas due to the wastewater use in crop irrigation, contact directly with polluted soil and exposure to gases and aerosols emitted from wastewater treatment plant. The adverse health impacts include respiratory tract diseases, gastro-intestinal tract threats, nervous system threats, eyes and skin diseases.*

Method: *A descriptive analytic cross sectional study design was used to implement this research. The study population was 357 individuals chosen by random systematic selection. The study area had been divided into three areas according to the location from the wastewater treatment plant. A self- administered questionnaire was distributed according to the population density in the area. The response rate was 87% (311 subjects of 357). The Statistical Package for Social Science was used to analyze the collected data.*

Results: *The results revealed that about 62.3% of respondents had suffered from poor appetite and 44.8% have had weight loss, about 34.5% suffered from intestinal parasites continuously, 52.3% agreed that their family have had multi-types of parasites and 5.5% had suffered or still suffering from Hepatitis A. Also headache represent 68.1%, dizziness 51.0%, tremors on limbs is 24.8%, imbalance 27.7 % , weak memory 39.4%, nervousness 72.6% anxiety 70.6% and sleep disturbance 59.4 % respectively. About 39% of the sample population complained from breathing difficulties and 17.4% had complained from chest pain. Respiratory diseases were as follows: bronchial asthma 18.5%, chronic bronchitis 33.3%, pneumonia 14.8% and 33.3% were reported as others medical conditions. For eye diseases, the results show that 36.1% were suffering from eye irritation and redness, 41.6% had vision problems, 50.9 % have had eye infections, 28.9% suffered from irritation and redness, and 20.2% have had excessive tears. Finally, the majority of the respondents 93.9% were exposed to mosquitoes and other insects' bites and 52.6% suffered from some skin allergies and 38.4% from dermatitis. About 62.2% of those who suffered from dermatitis have had frequent attacks of dermatitis.*

conclusion *: The main recommendations include; removal of the wastewater treatment plant from its current place, using advanced wastewater treatment technologies and launching awareness campaign on wastewater adverse health and environmental impacts in all areas of Gaza Strip.*

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List of Abbreviation

ALAD	Amino Laevulinic Acid Dehydrase
ATSDR	Agency for Toxic Substances and Disease Registry
BLWWTP	Biet Lahia Waste Water Treatment Plant
BOD	Biological Oxygen Demand
CMWU	Coastal Municipalities Water Utility
CNS	Central Nervous System
COD	Chemical oxygen demand
CPWR	Center to Protect Workers Right
DO	Dissolved Oxygen
EPA	Environment Protection Agency
EQA	Environment Quality Authority
GIT	Gastro Intestine Tract
GS	Gaza Strip
H_2S	Hydrogen Sulphide
MENA	Ministry of Environmental Affairs
MOH	Ministry Of Health
MOPIC	Ministry Of Planning and International Co-operation
OCHA	Office for the Coordination of Humanitarian Affairs
OPT's	Occupied Palestinian Territories
OSHA	Occupational Safety and Health Administration
PCBS	Palestinian Central Bureau of Statistics
PNA	Palestinian National Authority
PPB	Part per billion
PPM	Part per million
PWA	Palestinian Water Authority
SO_2	Sulfur Dioxide
SPSS	Statistical Package for Social Sciences
SRB	Sulfate-Reducing Bacteria
SS	Suspended Solids
TDS	Total dissolved solid
TOC	Total organic carbon
TRS	Total Reduced Sulfur
TSS	Total Suspended Solid
VOCs	Volatile Organic Compounds
UNEP	United Nation Environmental Programme
UNRWA	United Nation for Relief and Work Agency
UT	Urinary Tract
WB	West Bank
WW	Wastewater
WWTP	Wastewater Treatment Plant
WHO	World Health Organization

Chapter 1 : Introduction

1.1 Background

Since the beginning of the industrial revolution in the late 18th and early 19th century that has begun in Britain and spread throughout the world, a huge and endless dangerous environmental problems have emerged and grew very rapidly in a way that made it very difficult to control (UNEP, 2000).

The environment is an integral part of human life, and the quality of which plays a critical role in human health. Human health is very closely linked to environmental quality, as the etiology of most of the human diseases being related to the status of the living environment of man. According to statistics, 25% of all preventable illnesses are caused by detrimental environmental factors (UNEP, 2004).

In Africa, the environmental influence on disease incidence is even higher, being about 35%**.** Both the developed and developing countries are faced with the problems related to environmental pollution, sourced in air, water or soil, and caused by anthropogenic man activities, disturbing the habitat around. Indoor air pollution, polluted ambient air, poor sanitation and contaminated water play acrucial role in causing ill health (Gopalan,2003).

Environmental pollution is a contamination of air, water or food in such a manner as to cause real or potential harm to human health or well being or to damage or harm non – human nature without justification (Peirce, et al., 1998).

The Middle East is a meeting point of many escalating environmental threats. The Occupied Palestinian Territories (Opts), represent the most environmentally suffering spot in the region, where long-term environmental degradation and deterioration has occurred over the last six decades of the Israeli occupation. The United Nations Environment Program (UNEP) highlighted the main environmental issues of the Opts to include the crisis of ground and surface water resources, wastewater, solid and hazardous waste mismanagement (UNEP ,2003).

Every community produces liquid waste, solid waste and gas emissions. The liquid waste is usually termed wastewater. Therefore, wastewater can be a combination of the liquid or the water-carried wastes removed from residence, institutions, commercial and industrial establishments, ground water, surface water and storm water.
(Asan and Levine, 1996).

The principal physical characteristics of wastewater include solid contents, color, odor and temperature. The total solids in a wastewater consists of the insoluble or suspended solids and the soluble compounds dissolved in water. The suspended solids content is found by drying and weighing the residue removed by the filtering of the sample. When this residue is ignited the volatile solids are burned off. Volatile solids are presumed to be organic matter, although some organic matter will not burn and some inorganic salts break down at high temperatures. The organic matter consists mainly of proteins, carbohydrates and fats. The determination of odor has become increasingly important, as the general public has become more concerned with the proper operation of wastewater treatment facilities. The odor of fresh wastewater is usually not offensive, but a variety of odorous compounds are released when wastewater is decomposed biologically under anaerobic conditions. The principal odorous compound is hydrogen sulphide (the smell of rotten eggs). Other compounds, such as indol, skatol, cadaverin and mercaptan are formed under anaerobic conditions. hydrogen sulphide, mercaptan, dimethylsulphide etc., may also cause a rather offensive odor.
Chemically, wastewater contains organic compounds (carbohydrates, proteins, fats, oils and pesticides…etc) and nonorganic compounds (heavy minerals, nitrogen, phosphorous, sulphur and toxicants …etc), it also contains a variety of gases,(hydrogen sulphide, ammonia, and methane). Biologically, wastewater contains micro organisms including Bacteria, protozoa, helminthes and viruses. in addition to many other pathogenic organisms that come from an infected human source. The presence of the coliform group of organisms in the wastewater proves the presence of pathogenic organisms but not necessarily all of them. (PWA, 2000).

Untreated wastewater discharge causes public health risks through direct exposure, as well as through being reused in irrigating crops. Waterborne diseases are the diseases that spread through contaminated water. Contamination of water may be direct (point source pollution), such as an aquifer recharged with poor quality wastewater effluent. Indirect point source contamination comes from wastewater reuse in agriculture or sewage from networks or open systems. Though many diseases are spread either directly through flies or fishes, all diseases that spread through water are termed as waterborne diseases. Most enteric diseases are infectious and get transmitted orally through water. (EQA, 2002a).

The major source of both human and fecal coliform in drinking water in Gaza Strip is the direct and indirect contamination by raw or treated wastewater. Poor treatment allows the coliform to persist. Contaminants in the network come both from specific point sources such as leakage from wastewater pipes and from non-specific sources such as negative pressure in old networks that supply water. Some pathogens will survive for only a short time in the water, so the chance of them causing an illness is small. Others may survive for months like *Giardia*, Amoeba and *Cryptosporidium*. If the water is not treated or poorly treated for pathogens, a susceptible person drinking this water will suffer from illness. Pathogens and diseases spread by the fecal-oral route (waterborne diseases) can be caused by bacteria (salmonellas, typhoid fever and cholera), viruses (viral gastroenteritis and hepatitis-A) and protozoa (amoebic dysentery and *cryptosporidiosis*). Many pathogenic bacteria, viruses and protozoa are passed from one host to another by the fecal- oral route. Water usually serves as carrier for these organisms. Many viruses can be transmitted by water, such as poliovirus, rotaviruses, Norwalk viruses and hepatitis A and E. The Protozoa pathogens that can be transmitted by water include *Giardia*, *Cryptosporidium*, and *Amoeba*. Contamination of soil often causes groundwater pollution, where most of the rural area in the Gaza Strip dumped their wastewater without any sanitary measures. This increases the risk of soil pollution (EQA, 2003).

Hydrogen sulphide is the most commonly known and prevalent odorous gas associated with domestic wastewater collection and treatment systems. It has a characteristic rotten egg odor, is extremely toxic, and is corrosive to metals such as iron, zinc, copper, lead

and cadmium. Hydrogen sulphide is also a precursor to sulfuric acid formation, which corrodes lead-based paint, concrete, metals and other materials (Carman, 2003).

The toxicity of H_2S is comparable with that of hydrogen cyanide. It forms a complex bond with iron in the mitochondrial cytochrome enzymes, thereby blocking oxygen from binding and stopping cellular respiration. Since hydrogen sulphide occurs naturally in the environment and the gut, enzymes exist in the body are capable of detoxifying it by oxidation to harmless sulfate. Hence, low levels of hydrogen sulphide may be tolerated indefinitely. Exposure to lower concentrations can result in eye irritation, a sore throat and cough, nausea, shortness of breath, and fluid in the lungs. These symptoms usually disappear in a few weeks. Long-term, low-level exposure may result in fatigue, loss of appetite, headaches, irritability, poor memory, and dizziness. Chronic exposures to low level H_2S (around 2 ppm) has been implicated in increased miscarriage and reproductive health issues amongst Russian and Finnish wood pulp workers, but the reports have not been replicated. Higher concentrations of 700–800 ppm tend to be fatal (ATSDR, 2006) .

In this study the health impacts of Beit Lahia wastewater treatment plant on the people living near and around the facility will be assessed.

1.2 Problem Statement:

North Gaza Governorate is one of the five governorates of Gaza Strip with an area of 62 km^2 which represents about 17% of the total area of Gaza Strip. The total population of North Gaza governorate was estimated at about 270,245 by the year 2007 representing about 7.2% of the Palestinian population (PCBS, 2006).

Due to many factors, particularly political and financial, north Gaza Governorate has suffered from so many different environmental and heath problems. Environmental problems are the most dangerous that threatened and still threatening the population as a result of not good enough and improper treatment of such problems. Due to the lack of fund and absence of good management of wastewater treatment plants, many adverse human health impact have presented. Wastewater treatment plants are located very close to densely populated areas which in turn affect the human health through soil and water contamination, and emission of several gases specially hydrogen sulphide.

Emission of gases especially hydrogen sulphide, biological hazards and heavy metals in wastewater impact on human health of the population will be the theme of this study.

1.3 Justification of the study:

Beit Lahia is a small area with high population density and the wastewater plant is located near human habitat. The people are exposed to pollutants from this source, specially hydrogen sulphide which is a very poisonous and dangerous air pollutant spreading for long distances from the point of generation (wastewater treatment plants) and those associated with water and soil biological and chemical pollutions causing very serious health problems on the inhabitants.

Due to lack of resources and technical support needed to proper management of wastewater treatment to prevent adverse effects on people's health, the researcher has tried to assess the magnitude of the health impacts on the people living near wastewater treatment facilities, especially in the absence of monitoring systems. Beit Lahia wastewater treatment plant will be taken as a case study for the assessment.

1.4 Purpose:

To assess health impacts on people living near waste water treatment plant in Beit Lahia, mainly those associated with the exposure to hydrogen sulphide as the main air pollutant, and those associated with water and soil biological and chemical pollutions.

1.5 Objectives:

- To demonstrate the relationship between wastewater contaminants and human health impacts in selected areas near Beit Lahia wastewater treatment plant (BLWWTP).
- To assess the clinical sings and symptoms of exposure to gases emitted from wastewater plant specially hydrogen sulphide in selected areas in Beit Lahia.
- To assess the public awareness towards the negative health impacts of wastewater.

- To assess the clinical sings and symptoms of diseases associated with polluted soil and groundwater.
- To suggest possible solutions to gases emitted from the wastewater plant specially hydrogen sulphide generation problem**.**
- To suggest suitable recommendations to control and/or mitigate the adverse health impacts of wastewater on humans.

1.6 Research questions:

- Is there a relationship between wastewater and gastrointestinal tract parasitic diseases?
- Is there a relationship between wastewater contaminants and loss of appetite?
- Is there a relationship between wastewater and diseases of respiratory system?
- Is there a relationship between gas emitted from wastewater and breath shortness and cough?
- Is there a relationship between wastewater and headache, ocular diseases?
- Is there a relationship between wastewater and neurobehavioral problems?
- Is there a relationship between wastewater contaminants and irritability, poor memory?
- Is there a relationship between wastewater contaminants and dizziness?
- Is there a relationship between wastewater and skin diseases?
- What are the main health impacts of H_2S on the population?
- What are the possible recommendations for the decision makers to reduce the negative health impact of wastewater and improve the current situation

1.7 Geography:

Palestine is one of the most ancient homelands of human kind. It lies to the west of Asia continent between longitudes 15-34 and 35-40 to the east, and between latitudes 30-40 and 15 -33 to the north. The entire area of historical Palestine is about 27,000 Km2, stretching from Ras Al- Nakoura in the north to Rafah in the south. Palestine is bordered by Lebanon in the north, the Gulf of Aqaba in the south, Syria and Jordan in the east and by Egypt and Mediterranean Sea in the west. Now Palestine is limited to two geographically separated areas, Gaza Strip (GS), and West Bank (WB). The total area of both is 6257 km2, which represents 23.17% of historical Palestine (MOH, 2006 and UNEP, 2003).

The population of the Palestinian territory is estimated to about 3,761,646 million therefore 2,345,107 million (62.3%) in West Bank (41.6%) are refugees, and 1,416,539 million (37.7%) in GS (58.4%) of them are refugees (MOH, 2009).

GS is a narrow strip of land, located on the south of Palestine on the coast of the Mediterranean Sea. GS is a highly crowded area, where approximately 1.5 million people live in 378 km^2, estimated density is about 4,000 people per square kilometer, and the population is concentrated in 7 towns, 10 villages, and 8 camps (PCBS, 2007).

GS is divided into five governorates, North of Gaza, Gaza, Mid-Zone, Khan-younis and Rafah. The population under 15 year old percentage in GS is 49% and 2.5%of age 65 years, North Gaza Governorate is one of the five governorates of GS with 62 km2 area forming about 17% of total area of GS. Total population of North Gaza governorate is estimated to be 270,245 by the year 2007 representing about 7.2% of the Palestinian population. Localities of the governorate are divided to two areas; one is urban consisting of Beit Lahia, Beit Hanoon, and Jabalia including Jabalia Camp, the second area is a rural one consisting of Um- Anasser village and Ezbet- Beit Hanoon (PCBS, 2009).

Beit Lahia is a Palestinian town of about 40,000 people in the northern Gaza Strip. It is located north of Jabalia, near Beit Hanoun. The word Lahia is Syriac and means desert or fatigue. It is surrounded by sand dunes, renowned for its many large sycamore fig trees. The city is known for its fresh, sweet water, berries and citrus trees.

1.8 Palestinian Environmental Status :

Palestinian environment is facing serious threats, such as the alarming population growth, limited land resources, long term isolation as a result of the regional political

circumstance and the undeveloped environmental system. This had caused serious deterioration, fast depletion and contamination of the environmental resources which in turn lead to health risks among citizens (Lubbad, 2006).

Handling of both hazardous waste and infectious waste mixed up with municipal waste water is a critical problem which causes environmental and health risks in the Palestinian territories (UNEP, 2003).

1.9 Environmental Management in Palestine:

Environmental management in Palestine has been supervised in the last decades by several institution. Since 1994, Environmental Planning Directorate had been established within the Ministry of Planning and International Co- operation (MOPIC), to deal with environmental issues in Palestine at all levels. In the same time some ministries of the Palestinian Authority had established environmental departments to deal with environ mental activities.

Ministry of Health has a department of environment which is responsible for licensing activities to ensure more quality of food and water, Ministry of Agriculture whose role is to overcome agriculture pollution hazards, and Ministry of Local Governments which is responsible for supporting the municipalities in dealing with the environmental issues in cooperation with UNRWA which provides environmental services to the refugee camps in the WB and GS. This had created responsibilities distributed among too many departments and institution.

In 1996 Palestine Environment Authority had been established to be the focal point for all environmental issues in Palestine .On August 1998 the Ministry of environment has assumed all the responsibilities in the field of planning, monitoring , licensing, and enforcement to promote a sustainable environmental development and protect the environment to prevent the risks on public(MENA, 2000).

In August 2002, the Ministry of Environmental Affairs has changed to the Environment Quality Authority without any change in the responsibilities.

1.10 Status of Wastewater in The Gaza Strip:

GS produces more than 30 million cubic meters of wastewater every year. The level of Biological Oxygen Demand for the wastewater may reach 600 mg/liter in Gaza, whereas it reaches 200 to 300 mg/liter in the developed countries, which means an increase in the organic content and salinity in the wastewater produced in the GS. This is due to the Palestinian citizens' consumption of fresh water, which ranges from 70 to 90 liters per day. It is reported also that more than 60% of Gaza Strip population receives sewage water services through sewage networks. There are three sewage treatment plants in the Gaza Strip, one in Beit Lahia in the north, the second is Sheikh Ejleen in Gaza city and the third is in Rafah. Some other plants are under constructions.(Afarra A. and Lubad S. 2006)

Wastewater treatment plants in The Gaza Strip depend on the secondary treatment, sometimes the process is limited to the primary treatment. Due to the continuous population increase and so the quantities of produced wastewater and the failure of treatment plants, huge quantities of raw or semi treated wastewater is discharged into the marine environment, the fact that doubles the negative impact of waste water on environment and public health. Therefore, wastewater is considered the main source of polluting Gaza Shore because of the many points of sewage water discharge along the costal line. Discharging 80% of the produced untreated wastewater in the sea is a very alarming hazard imposed by such reality on the marine environment, marine life, public health and development of the tourism sector. The three water treatment plants in the Gaza Strip do not function effectively. Approximately 70-80% of the domestic wastewater produced in Gaza is discharged into the environment without treatment, either directly, after collection in cesspits, or through leakage and over loaded treatment plants. Most wastewater is discharged into the Mediterranean via 18 different pipelines (UNEP, 2003).

1.11 Status of Wastewater in Northern Governorate:

The existing wastewater plant was designed as a lagoon system with polishing ponds, without any treatment facility. About 80% of the total population of the governorate are connected to the sewage system and as well to the north wastewater treatment plant, the other 20% of residents use local systems which are collected when required by municipal cars. The plant is located1.5 km east of the town of Beit Lahia in the northern part of Gaza. It serves the town of Jabalia as well as nearby refugee camp and the communities of Beit Lahia and Beit Hanoon. The area's total population amounts to 270,000 people. The plant has no pre-treatment facilities and a peak flow capacity of 5,000 m3/ day. At present, about 15,000m3 passes through it each day. The treatment plant is located in a closed depression without a natural outlet to sea, although the distance to the coast is only 4.5 kilometers. The original design of the wastewater treatment plant included four effluent ponds that would recharge the aquifer or evaporate. However, as time passed the high volume of effluent overflow has formed a lake covering 40 hectares. This has become a significant pollutant of the aquifer and a major environmental health problem for the population surrounding the lake. As a result of the existence of the lake, 14 groundwater wells are no longer being in use.

A new wastewater treatment plant for the Northern Governorate is planned at another location some five kilometers to the east of the existing plant. The new plant's capacity is designed to provide treatment for 40,100 m^3 of water each day. The groundwater wells in Beit Lahia are especially prone to pollution from the wastewater treatment plant, since they are located only 240-300 meters to the west of lake. In the western area, it has been found that certain wells are more polluted than other areas. This can be attributed to the closeness of these wells to the wastewater ponds, the flow direction of the wastewater, and the sandy nature of soil which allows quick infiltration of wastewater to the aquifer (MENA 2000).

Chapter 2: Literature review

2.1 Wastewater definition:

It's the water that is changed in its quality through domestic, commercial and agricultural use. It contains both dissolved and solid contaminants collected in sewers that all together compose the sewage system.

Wastewater may be contaminated by various contaminants such as: suspended particles , biodegradable organic compounds, pathogens, plant nutrient materials, nonbiodegradable organic compounds, heavy metals and dissolved minerals. (Mesdaghinia, et al.,2009).

The quality of waste water varies according to several determinants which may include population conditions and characteristics, type of industry in the place, land characteristics used for the wastewater treatment, levels of ground water, extent of separation between wastewater and storm water.

2.2 Wastewater Treatment Types:

The objective of wastewater treatment is to reduce the concentration of specific pollutants to the level at which the discharge of the effluent will not adversely affect the environment or pose a health threat.

In a treatment plant, the waste is passed through a series of screens, chambers, and chemical processes to reduce its bulk and toxicity. The three general phases of treatment are primary, secondary, and tertiary.

2.2.1 Primary Treatment:

In primary treatment, floating and suspended solids are settled and removed from sewage. Flow from the sewers enters a screen/bar rack to remove large, floating material such as rags and sticks. It then flows through a grit chamber where heavier inorganic materials such as sand and small stones are removed. Grit removal is usually followed by a sedimentation tank clarifiers where inorganic and organic suspended solids are settled out.

2.2.2 Secondary Treatment:

Secondary treatment is a biological process, removes 85 percent or more of the organic matter in sewage compared with primary treatment, which removes about 50 percent. The basic processes are variations of what is called the "activated sludge" process or "trickling filters," which provide a mechanism for bacteria, with air added for oxygen, to come in contact with the wastewater to purify it. In the activated sludge process, flow from the sewer or primary clarifiers goes into an aeration tank, where compressed air is mixed with sludge that is recycled from secondary clarifiers which follow the aeration tanks. The recycled, or activated, sludge provides bacteria to consume the "food" provided by the new wastewater in the aeration tank, thus purifying it. In a trickling filter the flow trickles over a bed of stones or synthetic media on which the purifying organisms grow and contact the wastewater, removing contaminants in the process. The flow, along with excess organisms that build up on the stones or media during the purification, then goes to a secondary clarifier. Air flows up through the media in the filters, to provide necessary oxygen for the bacteria organisms. Clarified effluent flows to the receiving water, typically a river or bog, after disinfection. Excess sludge is produced by the process and after collection from the bottom of the secondary clarifiers it is dewatered, sometimes after mixing with primary sludge, for use as fertilizer, disposed of in a landfill, or incinerated. (Peirce, et al., 1998).

2.2.3 Advanced or Tertiary Treatment:

As science advanced the knowledge of aquatic life mechanisms and human health effects, and the need for purer water was identified, technology developed to provide better treatment. Heavy metals, toxic chemicals and other pollutants can be removed from domestic and industrial wastewater to an increasing degree. Methods of advanced treatment include microfiltration, carbon adsorption, evaporation, distillation and chemical precipitation. Disinfection is often the final step after secondary or tertiary treatment and helps to kill most remaining viruses and bacteria. (Peirce, et al., 1998)

2.3 Characteristic of wastewater:

Physically, wastewater has gray color and offensive odor; it contains solid substances that reach 0.1% (about 30% in a solid form and 70% dissolved).

Chemically, wastewater contains organic compounds (carbohydrates, proteins, fats, oils and pesticides…etc) and none organic compounds (heavy minerals, nitrogen, phosphorous, sulfur and toxicants). It also contains a variety of gases (hydrogen sulphide, ammonia, methane) .Biologically, wastewater contains microorganisms including moss and bacteria, in addition to many other pathogenic organisms that come from an infected human source (Annex 13). The presence of the coliform group in the waste water proves the presence of pathogenic organisms but not necessarily all of them (Mesdaghinia, et al.,2009).

2.3.1 Physical Characteristics Of Wastewater:

The principal physical characteristics of wastewater include solid contents, color, odor and temperature. The total solids in a wastewater consists of the insoluble or suspended solids and the soluble compounds dissolved in water. The suspended solids content is found by drying and weighing the residue removed by the filtering of the sample. The organic matter consists mainly of proteins, carbohydrates and fats. The determination of odor has become increasingly important, as the general public has become more concerned with the proper operation of wastewater treatment facilities. The odor of fresh wastewater is usually not offensive, but a variety of odorous compounds are released when wastewater is decomposed biologically under anaerobic conditions. The principal odorous compound is hydrogen sulphide (the smell of rotten eggs). Other compounds, such as indol, skatol, cadaverin and mercaptan, formed under anaerobic conditions or present in the effluents of pulp and paper mills (hydrogen sulphide, mercaptan, dimethylsulphide etc.), may also cause a rather offensive odor. Odor is measured by successive dilutions of the sample with odor-free water until the odor is no longer detectable.

2.3.2 Chemical Characteristics Of Wastewater:

Chemically, wastewater contains organic compounds (carbohydrates, proteins, fats, oils and pesticides…etc) and none organic compounds (heavy minerals, nitrogen, phosphorous, sulfur and toxicants). It also contains a variety of gases (hydrogen sulphide, ammonia, methane and others).

2.4 Hydrogen sulphide in Wastewater Collection Systems:

A mechanism of its production in collection systems, H_2S is produced when bacteria consume sulfate oxygen for organic processes. Sulfate-reducing bacteria grow in a "slime layer" that coats the sewer's wetted perimeter. These bacteria use oxygen in the most readily available form: first, from elemental oxygen; then, nitrate oxygen; then, sulfate oxygen. As nitrate is usually not available in wastewater, bacteria will consume sulfate oxygen after depleting elemental oxygen, leaving bi-sulphide ions to combine with hydrogen to form aqueous H_2S which is converted to atmospheric H_2S. Turbulent wastewater also facilitates the release of H_2S to the atmosphere.
(Churchill and Elmer,2004).

Hydrogen sulphide formation in wastewater systems occurs primarily in the gelatinous slime layer that accumulates on pipe walls and in the sludge blankets of clarifiers and other solids processing units. The rate of sulphide production is dependent upon the concentrations of sulfate ions, organic matter, and dissolved oxygen, as well as other factors such as pH, temperature, retention time, stream velocity, and surface area. (CPWR, 2004)

Hydrogen sulphide is considered a broad-spectrum poison, meaning that it can poison several different systems in the body, although the nervous system is most affected. The toxicity of H_2S is comparable with that of hydrogen cyanide. It forms a complex bond with iron in the mitochondrial cytochrome enzymes, thereby blocking oxygen from binding and stopping cellular respiration. Since hydrogen sulphide occurs naturally in the environment and the gut, enzymes exist in the body capable of detoxifying it by oxidation to (harmless) sulfate. Hence, low levels of sulphide may be tolerated indefinitely. Exposure to lower concentrations can result in eye irritation, a sore throat and cough, nausea, shortness of breath, and fluid in the lungs. These symptoms usually disappear in a few weeks. Long-term, low-level exposure may result in fatigue, loss of appetite,

headaches, irritability, poor memory, and dizziness. Chronic exposures to low level H_2S (around 2 ppm) has been implicated in increased miscarriage and reproductive health issues amongst Russian and Finnish wood pulp workers, but the reports have not been replicated. Higher concentrations of 700–800 ppm tend to be fatal (ATSDR, 2006).

2.4.1 Toxicity of hydrogen sulphide:

- 0.0047 ppm is the recognition threshold, the concentration at which 50% of humans can detect the characteristic odor of hydrogen sulphide, normally described as resembling "a rotten egg".
- Less than 10 ppm has an exposure limit of 8 hours per day.
- 10–20 ppm is the border line concentration for eye irritation.
- 50–100 ppm leads to eye damage.
- At 150–250 ppm the olfactory nerve is paralyzed after a few inhalations, and the sense of smell disappears, often together with awareness of danger.
- 320–530 ppm leads to pulmonary edema with the possibility of death.
- 530–1000 ppm causes strong stimulation of the central nervous system and rapid breathing, leading to loss of breathing; 800 ppm is the lethal concentration for 50% of humans for 5 minutes exposure (LC50).
- Concentrations over 1000 ppm cause immediate collapse with loss of breathing, even after inhalation of a single breath (ATSDR, 2004-a).

2.4.2 Acute toxicity:

It has been estimated that symptoms of discomfort, including headaches and nausea, are experienced when the air concentration approaches five-times the odor detection threshold; assuming a detection threshold of 8 ppb this would mean that symptoms should be expected at 40 ppb (55.6 mg/m^3). This relationship is based on multiple studies and is consistent with observations of odor detection and symptoms of discomfort around geyser emissions of hydrogen sulphide. Hydrogen sulphide gas has been lethal to humans at acute concentrations generally exceeding 500 ppm (695 mg/m^3). Conditions associated

with mortality include pulmonary edema, hemorrhagic bronchitis, and asphyxiation (Campagna et al., 2004).

2.4.3 Subchronic and chronic toxicity:

Residents near a pulp mill in southern Finland, for example, reported increased eye symptoms, lower respiratory tract symptoms, and headaches on days when the total reduced sulfur (TRS) concentration was 10-30 mg/m^3 (medium) or >30 mg/m^3 (high). The authors report that two-thirds of TRS in this area is H_2S (Marttila et al., 1995).

Residents of Dakota City and South Sioux City, Nebraska were exposed to reduced sulfur Emissions from beef slaughter house, leather tanning, and waste treatment facilities. ATSDR and EPA conducted residential air monitoring of total reduced sulfur (TRS) and hydrogen sulphide in the area in 1996 and again in 1999-2000. Time-series analyses of daily hospital visits for selected health outcomes and measures of TRS and hydrogen sulphide were performed (Campagna et al., 2004).

TRS and hydrogen sulphide levels were categorized as high if at least one of the daily 30-min rolling averages was 30 ppb (41.7 mg/m^3) and as low if every rolling average was < 30 ppb. A Chinese study of an occupational cohort found a significant increase in the risk of spontaneous abortion in association with exposure to hydrogen sulphide (Xu et al., 1998).

This study did not include exposure estimates and the degree of potential simultaneous exposure to other chemicals is unclear.

2.4.4 Health effects of hydrogen sulphide:

Hydrogen sulphide is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Repeated exposure can result in health effects occurring at levels that were previously tolerated without any effect. Low concentrations irritate the eyes, nose, throat and respiratory system (e.g., burning/ tearing of eyes, cough, shortness of breath). Asthmatics may experience breathing difficulties. The effects can be delayed for several hours, or sometimes several days, when working in low-level

concentrations. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances and weight loss. Moderate concentrations can cause more severe eye and respiratory irritation (including coughing, difficulty breathing, and accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering and excitability. High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death. Effects can occur within a few breaths, and possibly a single breath (ATSDR, 2004-b).

Because hydrogen sulphide is a gas, inhalation is the major route of exposure to hydrogen sulphide. Most human data are derived from acute poisoning case reports, occupational exposures, and limited community studies. In confined spaces, human acute poisonings continue to occur. Single inhalation exposures to high concentrations of hydrogen sulphide cause health effects in many systems. Health effects that have been observed in humans following exposure to hydrogen sulphide include death and respiratory, ocular, neurological, cardiovascular, metabolic, and reproductive effects.

Respiratory, neurological, and ocular effects are the most sensitive end-points in humans following inhalation exposures. There are no adequate data on carcinogenicity. A summary of human health effects resulting from exposure to hydrogen sulphide presented (**Annex 9)**

2.4.5 Effects on Adults:

In its acute form, hydrogen sulphide intoxication is mainly the result of action on the nervous system. At concentrations of 15 mg/m^3 and above, hydrogen sulphide causes conjunctival irritation, because sulphide and hydrogen sulphide anions are strong bases (Steudler et al., 1984).

Hydrogen sulphide affects the sensory nerves in the conjunctivae, so that pain is diminished rapidly and the tissue damage is greater. Serious eye damage is caused by a concentration of 70 mg/m^3. At higher concentrations (above 225 mg/m^3), hydrogen sulphide has a paralyzing effect on the olfactory perception, so that the odor can no longer be recognized as a warning signal. At higher concentrations, respiratory irritation is the predominant symptom, and at a concentration of around 400 mg/m^3 there is a risk of pulmonary edema. At even higher concentrations there is strong stimulation of the

central nervous system (CNS), with hyperpnoea leading to apnea, convulsions, unconsciousness, and death. At concentrations of over 1400 mg/m^3 there is immediate collapse. In fatal human intoxication cases, brain edema, degeneration and necrosis of the cerebral cortex and the basal ganglia have been observed.

If respiration can be maintained, the prognosis in a case of acute hydrogen sulphide intoxication, even a severe one, is fairly good. There are reports of neurasthenic symptoms after severe acute intoxication, such as amnesia, fatigue, dizziness, headache, irritability, and lack of initiative . A decrease of delta-Aminolaevulinic Acid Dehydrase (ALAD) syntheses' and haem synthase activity in reticulocytes one week after hydrogen sulphide intoxication has been reported, together with low levels of erythrocyte protoporphyrin. The ALAD and haem synthase activities returned to normal two months after the accident, erythrocyte protoporphyrin remaining low. Changes in the electrocardiogram have been reported after acute hydrogen sulphide intoxication, these changes being reversible. No tolerance to the acute effects of hydrogen sulphide has been reported to develop. The mortality in acute hydrogen sulphide intoxications seems to be lower than that reported in 1977; according to a recent Canadian report it is now 2.8%, whereas formerly it was 6%. This may be a result of improved first-aid procedures and increased awareness of the dangers of hydrogen sulphide.

Information about longer-term exposures to hydrogen sulphide is scanty. Eighty-one Finnish pulp mill workers who were exposed to hydrogen sulphide concentrations of less than 30 mg/m^3 and to methyl mercaptan concentrations of less than 29.6 mg/m^3 (15 ppm), displayed loss of concentration capacity and chronic or recurrent headache more often than a non exposed control group of 81 workers. Restlessness and lack of vigor also appeared more often, but the findings were not statistically significant. There was also a tendency towards more frequent sick leave among the exposed group. One report cites decreased activity of heme synthesizing enzymes in reticulocytes of pulp mill workers exposed for years to organic and inorganic sulphides, with hydrogen sulphide concentrations of between 0.075 mg/m^3 and 7.8 mg/m^3. No information is available as to whether the observed effect was related to peak concentrations or average concentrations. It can, however, be assumed that average exposure was considerably higher than 0.075

mg/m^3 (around 1.5-3 mg/m^3). Furthermore, there is no firm proof that hydrogen sulphide was the causative agent, as there may be confounding factors (other substances).

Epidemiological data concerning longer-term exposures are limited. Seventy per cent of workers exposed to hydrogen sulphide daily, often at 30 mg/m^3 or more, complained of such symptoms as fatigue, somnolence, headache, irritability, poor memory, anxiety, dizziness, and eye irritation. In a Finnish mortality study workers in a sulfate pulp mill showed excess mortality from cardiovascular diseases (standardized mortality rate 140), and especially from heart infarction (standardized mortality rate 142). The findings were statistically significant. In the same study population, cancer incidence was not significantly different from that of the general Finnish population (Zhu et al, 2009).

Fuller and Suruda (2000), who reviewed Occupational Safety and Health Administration (OSHA) investigation records from 1984 to 1994, reported 80 deaths in the United States from occupational exposure to hydrogen sulphide, out of a total 18559 occupational death during this period. Twenty-two of the 80 deaths were in the oil and gas industry. These deaths occurred as a result of workers' exposure to accidental releases of hydrogen sulphide in high concentrations. The authors concluded that portable H_2S meters or alarms could have prevented these deaths.

In their 1997 study, Hessel et al. submitted a questionnaire about health effects from hydrogen sulphide exposure to 175 oil and gas workers in Alberta, Canada, a known region of sour gas. Of the 175 workers, one third reported having been exposed to H_2S, and 14 workers (8%) experienced knockdown, a term for the loss of consciousness due to inhaling high concentrations of hydrogen sulphide. The workers who had experienced knockdown exhibited the respiratory symptoms of shortness of breath, wheezing while hurrying or walking up hill, and random wheezing attacks. The investigators found no measurable pulmonary health effects as a result of exposure to H_2S that were intense enough to cause symptoms but not intense enough to cause unconsciousness. In other words, the workers who reported initially experiencing symptoms from H_2S exposure did not report exhibiting any lingering respiratory symptoms at the time of the study.

However, other kinds of long term effects could exist; indeed, the study itself acknowledged that long term effects of acute short term exposure have not been studied enough, and finds this lack "noteworthy."

Another study by Kilburn (2003) reported long term effects of hydrogen sulphide exposure. Kilburn performed physiologic and psychological measurements on nineteen exposed and 202 unexposed subjects. Ten of the nineteen subjects were exposed at work, including four at oil and gas sites, while the other nine were exposed in their residences, which were near various sources of H_2S. The concentrations to which the subjects were exposed are not known. Exposure times ranged from twenty minutes to nine years, and Kilburn examined the subjects from 1.7 to 22 years after their exposures.

The study methods consisted of a questionnaire and a series of neuro physiological and neuropsychological tests. The neurophysiologic tests measured simple reaction time, visual two-choice reaction time, balance, color recognition, and hearing,

and the neuropsychological tests measured immediate memory recall, mood, and vocabulary. Tension, depression, anger, fatigue, and confusion were all significantly elevated in the exposed subjects compared to the control group. In addition, respiratory symptoms were more prevalent among the exposed subjects. Even subjects who did not experience unconsciousness at the time of their exposure exhibited permanent neurobehavioral damage (Kaye and Kilburn, 2004).

2.4.6 Effects on Children:

The effect of toxic pollution such as H_2S on growing children is recognized by experts as particularly severe. Dr. Carman explains, “Children are more vulnerable than adults to hydrogen sulphide, first because they breathe more rapidly, taking in significantly more pollution per pound of body weight than do adults. A resting infant, for example, inhales twice as much, relative to its size, as does a resting adult. Second, a US national data show that children spend an average of about 50% more time outdoors than adults. Third, children are three times more active while outdoors than, those engaged in sports and other vigorous activities; this increased activity raises breathing rates and significantly increases inhalation and in some cases swallowing of pollutants. Fourth, children are particularly vulnerable to toxic substances because their bodies are immature and rapidly growing. Fifth, children are in their prime learning years and H_2S exposure causes brain

damage. The impairment of mental faculties in a child amounts to a lifetime of harm." (Carman, 2003)

2.4.7 Chronic Exposure To Hydrogen Sulphide:

Literature is also available on the human health impacts of chronic exposure to relatively low concentrations of hydrogen sulphide. Generally, chronic exposure to low level concentrations of hydrogen sulphide is associated with neurological symptoms that include fatigue, loss of appetite, irritability, impaired memory, altered moods, headaches, and dizziness. At persistent concentrations of 0.250 to 0.300 ppm (250 to 300 ppb), the rotten egg odor of H_2S creates a nuisance to communities, and exposure to such concentrations has been documented to affect quality of life by causing headaches, nausea, and sleep disturbances.

Legator et al. (2001) investigated the effects of chronic, low levels of hydrogen sulphide by surveying two exposed communities, Odessa, Texas, and Puna, Hawaii, and comparing the health findings with several control communities. Due to emissions from industrial wastewater, ambient concentrations of H_2S in Odessa, Texas, registered at 335 to 503 ppb over 8 hours, 101 to 201 ppb over 24 hours, with an annual average of 7 to 27 ppb. Puna, Hawaii, is situated in a volcanically active area. There were no reliable measurements of H_2S levels at Puna—they ranged from less than 1 ppb to periodic highs of 200 to 500 ppb. The study relied on a multi-symptom health survey and found various adverse health effects associated with hydrogen sulphide exposure in the study populations. The health symptoms included CNS impacts (fatigue, restlessness, depression, short term memory loss, balance, sleep problems, anxiety, headaches, dizziness, tremors), respiratory system impacts (wheezing, shortness of breath, coughing), and various ear, nose, and throat symptoms (Legator, Marvin S., et al 2001)

Xu et al. (1998) conducted a retrospective epidemiological study to assess the association between spontaneous abortion and exposure to petrochemicals. By reviewing the plant employment records, which also contain medical information, the researchers identified over 3000 women from the Beijing Yanshan Petrochemical Corporation who had been pregnant. Trained interviewers administered a questionnaire to gather information on the

subjects' reproductive history, pregnancy outcomes, employment history, occupational exposure, smoking habits, alcohol consumption, indoor air pollution, diet, and demographic variables. The study found that "exposure to petrochemicals, specifically benzene, gasoline, and hydrogen sulphide is significantly associated with increased frequency of spontaneous abortion." Each chemical was individually found to have a statistically significant effect on the frequency of spontaneous abortion. Although the exposures mainly occurred in maintenance operations or due to accidental leaks and spillages, rather than being chronic low level exposures, this study is nevertheless important for the link it established between hydrogen sulphid effects on the reproductive system. According to one personal account, hydrogen sulphide exposure is associated with spontaneous abortions in cattle as well as other reproductive effects in animals. (Xiping, Xu. et al 1998).

2.5 Ammonia(NH_3):

Ammonia is the initial product of the decay of nitrogenous organic wastes, and its presence frequently indicates the presence of such wastes. It is a normal constituent of some sources of groundwater and is sometimes added to drinking water to remove the taste and odor of free chlorine. Since the pka of the ammonium ion, NH^{4+}, is 9.26, most ammonia in water is present as NH^{4+} rather than NH_3

Ammonia is found throughout the environment in the air, soil, and water, and in plants and animals including humans. Exposure to high levels of ammonia can cause irritation and serious burns on the skin and in the mouth, throat, lungs, and eyes. At very high levels, ammonia can even cause death. Ammonia has been found in at least 137 of the 1,647 current or former National Priority Sites list identified by the Environmental Protection Agency (EPA). Ammonia chemical symbol NH3, can take the form of a strong smelling liquid or gas. Most popularly, consumer and commercial products use the alkaline substance to clean grime or fertilize crops. Even in low concentrations, inhaling ammonia or getting the solution on your skin can cause burning, fainting, or death, so always use caution when handling this chemical. It has one nitrogen atom and three hydrogen atoms tightly bonded. A tiny amount of ammonia forms when organic matter decomposes, so the gas can be found naturally in our atmosphere. Most of the ammonia

used is produced through artificial means, however, by bonding the four atoms together by sheer force. Then the gas can be pressurized to form a liquid for easy distribution to manufacturing plants (ATSDR, 2004-c).

2.5.1 Ammonia Health Effects :

No health effects have been found in humans exposed to typical environmental concentrations of ammonia. Exposure to high levels of ammonia in air may be irritating to skin, eyes, throat, and lungs and cause coughing and burns. Lung damage and death may occur after exposure to very high concentrations of ammonia. Some people with asthma may be more sensitive to breathing ammonia than others. Swallowing concentrated solutions of ammonia can cause burns in your mouth, throat, and stomach. Splashing ammonia into your eyes can cause burns and even blindness. Children are less likely than adults to be exposed to concentrated levels of ammonia because most exposures occur at work. The effects on children are likely to be the same as for adults. We do not know if exposure to ammonia causes birth defects, or if it can pass to the fetus across the placenta or to infants via breast milk. (ATSDR, 2004-b).

2.6 Nitrogen Oxides (NO_X):

Nitrogen oxides may be released from wastewater treatment plant. Certain nitrogen compounds may cause adverse health effects to the human respiratory system . The primary concerns with no emission are their contribution to the formation of ground level ozone and acid rain. To a lesser extent, some NO_X compounds contribute to stratospheric ozone layer depletion and global warming (Kaynar, 2010).

2.6.1 Health Effects of Nitrogen Oxides:

NO_x react with ammonia, moisture and other compounds to form nitric acid (HNO_3), vapor and related particles . Small particles can penetrate deeply into sensitive lung tissue and damage it causing premature death in extreme cases. Inhalation of such particles may cause or worsen respiratory diseases such as emphysema (a lung disease characterized by an abnormal, permanent enlargement of air spaces distal to the terminal bronchioles). The

disease is coupled with the destruction of walls but without obvious fibrosis (Kaynar, 2010) and bronchitis (inflammation of the mucous membranes) of the bronchi, the airway that carry airflow from the trachea into the lung. Bronchitis can be classified into two categories, acute and chronic:

Acute bronchitis. is characterized by the development of a cough, with or without the production of sputum that is expectorated from the respiratory tract.

Chronic bronchitis. A type of chronic obstructive pulmonary disease, is characterized by the presence of a productive cough that lasts for 3 months or more per year for at least 2 years . Chronic bronchitis most often develops due to recurrent injury to the airway caused by inhaled irritants. Cigarette smoking is the most common cause , followed by air pollution (EPA, 1999).

2.7 Volatile Organic Compounds (VOCs):

Refers to a large Group of compounds which may be released from wastewater treatment plant of almost any kind of organic material including fats, meat, coffee, and other materials . Many VOCs are know to have effects on humans, ranging from cancer risk to nervous system disorder. VOCs also contribute to the formation of ground level ozone smog. Elevated ozone level have been shown to cause adverse health effects on the human respiratory system and are strongly suspected of playing a roles in the long term development of the chronic lung diseases . Ozone effect on vegetation damage are well documented with millions of dollars in crop damage in certain areas of Canada due to elevated ozone levels. Because of volatile organics has high vapor pressures and low solubilities , volatile organics compounds are observed in wastewater emitted gases.
(poulsen , et al , 1995) .

One study identified 92 different volatile organic compounds in the space area of waste water collection plant , including alcohols , aldehydes , ketones, carboxylic acids and esters . Total volatile organic compounds concentration varied from 0.9 to 8.1 mg/m^3 in the space area . Futhermore, sudden peaks in exposure are likely to occur when the winds present. Some of the volatile organic compounds are believed to be potentially carcinogenic (Elliott et, al 1996).

2.8 Heavy Metals In Wastewater:

It can be seen that of all of the heavy metals chromium is the most widely used and discharged to the environment from different sources. However, it is not the metal that is most dangerous to living organisms. Much more toxic are cadmium, lead and mercury. These have a tremendous affinity for sulfur and disrupt enzyme function by forming bonds with sulfur groups in enzymes. Protein carboxylic acid ($-CO_2H$) and amino ($-NH_2$) groups are also chemically bound by heavy metals. Cadmium, copper, lead and mercury ions bind to cell membranes, hindering transport processes through the cell wall. Heavy metals may also precipitate phosphate bio-compounds or catalyze their decomposition.

2.8.1 Cadmium:

Cadmium in water may arise from industrial discharges and mining wastes. Cadmium is widely used in metal plating. Chemically, cadmium is very similar to zinc, and these two metals frequently undergo geochemical processes together. Both metals are found in water in the +2 oxidation state.

Health Effects 0f Cadmium:

The health effects of acute cadmium poisoning in humans are very serious. Among them are high blood pressure, kidney damage, destruction of testicular tissue, and destruction of red blood cells. Cadmium may replace zinc in some enzymes, thereby altering the stereo-structure of the enzyme and impairing its catalytic activity. Cadmium and zinc are common water and sediment pollutants in harbors surrounded by industrial facilities. Concentrations of more than 100 ppm dry weight sediment have been found in harbor sediments (Sperling,2007).

2.8.2 Mercury *(Hg)* :

Mercury is a heavy metal pollutant. It is found as a trace component of many minerals, with continental rocks containing an average of around 80 ppb, Organic mercury compounds are widely applied as pesticides, particularly fungicides. Mercury enters the environment from a large number of miscellaneous sources related to human use of the element. These include discarded laboratory chemicals, batteries, broken thermometers, lawn fungicides, amalgam tooth fillings and pharmaceutical products. Sewage effluent sometimes contains up to 10 times the level of mercury found in typical natural waters (Sensese, F.,2007).

Health Effects of mercury :

Its toxicity was tragically illustrated in the Minamata Bay area of Japan during the period of 1953-1960. A total of 111 cases of mercury poisoning and 43 deaths were reported among people who had consumed seafood from the contaminated bay. Among the toxicological effects of mercury were neurological damage, including irritability, paralysis, blindness, insanity, chromosome breakage and birth defects. The unexpectedly high concentrations of mercury found in water and in fish tissues result from the formation of soluble monomethylmercury ion, CH_3Hg^+, and volatile dimethylmercury, $(CH_3)_2Hg$, by anaerobic bacteria in sediments. Mercury from these compounds becomes concentrated in fish lipid (fat) tissue and the concentration factor from water to fish may exceed 103 (Lesikar, 2006).

2. 9 Biological Characteristics Of Wastewater:

Biologically, wastewater contains microorganisms including moss and bacteria, in addition to many other pathogenic organisms that come from an infected human source. The presence of the coliform group in the waste water proves the presence of pathogenic organisms but not necessarily all of them. Wastewater contains bacteria, fungi, parasites and viruses that can cause intestinal, lung and other infections. (CPWR, 2004)

Bacteria. may cause diarrhea, fever, cramps, and sometimes vomiting, headache, weakness, or loss of appetite. These bacteria include: E-coli, shigellosis, salmonella, typhoid fever and cholera.

Parasites. *Cryptosporidium* and *giardia lamblia* may cause diarrhea and stomach cramps, and even nausea or a slight fever. Roundworm *Ascaris* , most people have no symptoms. With a lot of roundworms, the person may cough and have trouble breathing or may have pain in the belly and blocked intestines.

Viruses. Hepatitis A causes liver disease. The patient may feel tired, pain in the belly and jaundice (yellow skin).

Fungi. often grow in compost. These can lead to allergic symptoms (such as runny nose) and sometimes can lead to lung infection or make asthma worse. As shown in the figure (2.1).

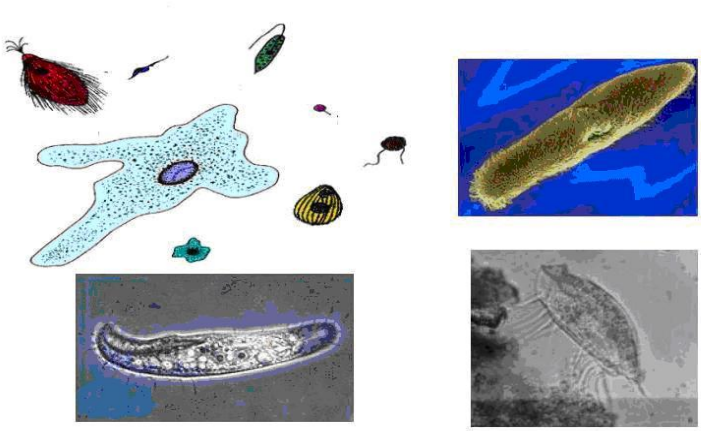


Figure 2.1 Wastewater Microbial Life - Protozoa

2.10 Wastewater and Waterborne diseases:

Waterborne diseases are the diseases that spread through contaminated water. Contamination of water may be direct (point source pollution), such as an aquifer recharged with poor quality wastewater effluent. Indirect point source contamination comes from wastewater reuse in agriculture or sewage from networks or open systems. Though many diseases are spread either directly through flies or fishes, all diseases that spread through water are termed as waterborne diseases. Most enteric diseases are infectious and get transmitted orally through water. The common waterborne diseases can be divided into the following three categories:

2.10.1 Acute diseases:

These have effects which occur within hours or days of the time that a person consumes contaminated water. People can suffer acute health effects if they are exposed to extraordinarily high level of contaminated water, as in the case of a sewage spill. In drinking water, parasites, bacteria and viruses are the largest contaminants that cause acute health effects. Though acute contaminants do not have permanent effects, when high level occurs, they can make people seriously ill and can be dangerous for persons whose immune systems are already weak due to HIV/AIDS.

2.10.2 Chronic diseases:

These have a strong effect after people consume contaminated water at levels over safety standards for many years, mainly from disinfectant by-products, pesticides and chemical solvents. Chemicals' accumulation in human body can cause chronic diseases like cancer, liver cirrhosis, renal failure, kidney problems and reproductive difficulties(Melad, 2002).

2.10.3 Infectious diseases:

Waterborne infectious diseases are the diseases caused by a number of different bacteria, viruses and protozoa, which spread through contaminated drinking water. These take the form of diarrhea, dysentery, hepatitis and giardiasis. The most common symptoms in Gaza of these diseases include nausea, vomiting and bloody stool with or without fever (Melad, 2002).

2.11 Relationship between Pathogens in wastewater and diseases:

Pathogens and diseases spread by the fecal-oral route (waterborne diseases) can be caused by bacteria (salmoellosis, typhoid fever and cholera), viruses (viral gastroenteritis and hepatitis-A) and protozoa (amoebic dysentery and cryptosporidiosis). Many pathogenic bacteria, viruses and protozoa are passed from one host to another by the fecal- oral route. Water usually serves as carrier for these organisms. Many viruses can be transmitted by water, such as poliovirus, rotaviruses, Norwalk viruses and hepatitis A and E. The Protozoan pathogens that can be transmitted by water include *Giardia*, *Cryptosporidium* and amoeba. Many people who live in Beit Lahia suffer from chronic gastrointestinal diseases. Randa El Khodary, head of Laboratories and Blood Banks in the Palestinian Ministry of Health, observed that during the summer, meningitis cases increased. This is a direct result of more people swimming in the beach camp shore (Alfarra and Lubbad, 2006). **(Annex 10)**

2.12 Wastewater and Intestinal Parasitic Infection:

Intestinal parasitic infection (IPIs) are widely distributed throughout the world and especially prominent in developing countries and rural communities. The low socioeconomic status and the poor standards of public and personal hygiene promote IPIs in such a geographic location. In the Gaza Strip , the prevailing water shortage and wastewater mismanagement promote IPIs. Depending on a number of studies concerning IPIs in the Gaza Strip, the prevalence rate was found to range between 27.6% and 32.4% (Yassin et al1998 ,El _Kishawi et al.,2004 and El -Astal, 2005)

Ten intestinal parasites (3 protozoa and 7 helminthes) have been detected. Where the *Entamoeba histolytica, Giardia Lamblia and Ascaris* are the most common ones (Olsen et al.,2001).

According to Al-Zain (2009) the overall prevalence rate of intestinal parasites at the Um-Anasser village, which surrounds the BLWWTP, was higher than other localities in the Gaza Strip, and it accounted for 46.9%. This high prevalence rate could be attributed to many factors such as the presence of domestic animals that may play as possible reservoir for intestinal parasites and the contamination of drinking water, home environment. The blowing dust of local sewage environment may contain parasite eggs, cyst, and mature forms. During many visits, the author noticed that children of Um-Anasser Village and Beit Lahia playing with sands and or agricultural soil that are often contaminated with wastewater which usually contain pathogenic microorganisms (Al-Zain, 2009) . (Annex 11)

Another study had been done in India on intestinal nematode infections which have been identified as the main health risk associated with use of sewage or wastewater in agriculture that has been becoming increasingly common as a result of a global water scarcity. The study presents the findings of a study on the risk of intestinal nematode infections in farming families occupationally exposed to untreated and partially treated wastewater in Hyderabad, India. The study found an increased risk of hookworm(odds ratio [OR] 3.5, 95% confidence interval [CI] = (2.2–5.5), *Ascaris lumbricoides* (OR = 5.3, 95% CI = 2.0–14), and *Trichuris trichiura* (OR = 5.6, 95% CI = 1.8–18) infection when untreated wastewater (150 intestinal nematode ova/liter) was used for crop production. Use of partially treated wastewater (28 intestinal nematode ova/liter) was only associated

with an increased risk (OR = 3.2, 95% CI = 1.2–8.6) of *A. lumbricoides* infection. The findings of the study suggest that the current WHO intestinal nematode guideline of 1 ova/liter is sufficient to protect farmer health.

Among all persons, use of untreated wastewater, when controlled for confounding variables, was associated with an almost four-fold increased risk of hookworm and heavy hookworm infection This result was in contrast to the use of partially treated wastewater, which showed no significant association with hookworm infection when controlled for confounding variables. Use of untreated wastewater further showed a greater than five-fold increased risk of *A. lumbricoides* and *T. trichiura* infection. Use of partially treated wastewater was associated with a greater than three-fold risk of A lumbricoides infection. However, no significant association was found for *T. trichiura* infection when controlled for confounding variables.

This study found a significantly increased risk of *A. lumbricoides,* hookworm, and T. *trichiura* infection in farming communities irrigating with wastewater. The highest risks were associated with use of untreated wastewater, and use of partially treated wastewater was associated only with an increased risk of A. lumbricoides infection. Use of untreated wastewater was also associated with a higher intensity of infection, especially for hookworm infection **(**Jeroen et al., 2008**).**

Experimental studies in north-east Brazil and Leeds, England, investigated the risk of nematode infection (*Ascaris lumbricoides* and *Ascaridia* galli respectively) from lettuce irrigated with treated wastewater. In Brazil, the wastewater was treated in a series of waste stabilization ponds which comprised anaerobic, facultative and maturation ponds. When effluent from the facultative pond (<0.5 egg/l) was used for spray irrigation, no eggs were detected on crop surfaces. Lettuce irrigated with maturation pond effluent (0 eggs/l) was also not contaminated despite being grown during wet weather in heavily contaminated soil (>1200 *Ascaris* eggs/100 g). In the trials in England, spray-irrigation of lettuce with water containing 10 eggs/l resulted in a maximum of 1.5 eggs/plant, and when wastewater with $\leq$ 1 egg/l was used for irrigation, only very slight contamination was found (0.3 egg/plant). Thus, irrigation with wastewater that meets the WHO quality guideline limit resulted in no contamination of lettuce at harvest or very slight

contamination of a few plants (6%) with eggs that were either degenerate or not infective. However, a few nematode eggs on harvested plants were viable but not embryonated (20% *A. lumbricoides* in crops irrigated with water containing >100 eggs/l; <0.1 *A. galli* egg/plant in crops irrigated with 1–10 eggs/l). Crops with a long shelf life might represent a potential risk to consumers if the eggs had time to become infective. (Blumenthal and Peasey, 2002).

Epidemiological studies in central Mexico of risk factors for *Ascaris* infection related to wastewater showed that there was an increase in infection among men who ate crops that had been surface-irrigated with raw wastewater when compared with men who did not eat such crops; there was no increased risk when crops were irrigated with sedimented wastewater (from a reservoir) containing $\leq$ 1 nematode egg/l. However, children younger than 15 years old who ate crops from local fields irrigated with either raw wastewater or sedimented wastewater had a twofold increase in *Ascaris* infection compared with those who did not eat such crops. Increased risk in these circumstances may have been influenced by the irrigation method (surface rather than spray) and the lower mean temperature (caused by high altitude and semi-desert conditions).

It would be sensible, therefore, to adopt a stricter guideline limit of $\leq$ 0.1 egg/l to prevent transmission of *Ascaris* infection in circumstances where conditions favor the survival of helminth eggs (at lower temperatures and when surface irrigation is used); this stricter guideline limit would also address the risks to farm workers who cultivate the vegetables In situations in which crops with a short shelf-life are grown in hot and dry conditions, and where workers are adequately protected from direct contact with wastewater or soil, the original guideline limit of $\leq$1 nematode egg/l seems adequate. However, using the revised guideline limit may be prudent even in these circumstances, adding a greater margin of safety (Peasey, 2000).

Risk assessment studies in Israel used the drinking-water model of Haas et al. to assess infection risk. This was combined with laboratory data on the degree of viral contamination of lettuce and cucumber irrigated with wastewater of differing quality. The annual risk of infection with hepatitis(A) from eating lettuce which had been irrigated with untreated wastewater was estimated at 10-3, but when the lettuce was irrigated with

treated wastewater meeting the WHO guideline limit of 1000 fecal coliform bacteria/100 ml the estimated risk was in the range 10^{-5} to 10^{-7}; for rotavirus infection the predicted risk ranged from 10^{-5} to 10^{-6}, and for cholera the risk was 10^{-6}. The results of these studies are consistent with those obtained by Asano et al. they estimated the risk of infection with three enteric viruses (poliovirus 1 and 3, and echovirus 12) associated with the use of chlorinated tertiary effluents to irrigate horticultural produce. The annual risk of infection associated with consuming irrigated market-garden produce was estimated to be between 10^{-6} and 10^{-11} when the effluent contained 1 viral unit/100 L and between 10^{-4} and 10^{-9} when wastewater with a maximum concentration of 111 viral units/100 L was used (Shuval et al, 1999).

Data from waste stabilization ponds in north-east Brazil suggest that rotavirus numbers are likely to be <30/100 l when the fecal coliform content is below 104 /100 ml; however, other enteric viruses, such as adenovirus, may significantly out-number rotaviruses and enter viruses Therefore extrapolation from these data indicate that using wastewater that meets the WHO guideline limit of 1000 fecal coliform bacteria/100 ml is likely to produce an annual risk of viral infection of $<10^{-4}$. Even when unchlorinated secondary effluents were investigated, risk assessments using data from wastewater treatment plants in California showed that for food crop irrigation, the estimated annual risk of enteroviral infection was 10^{-3} to 10^{-5} The American microbial standards for drinking-water are based on the assumption that humans should not be subjected to a risk of infection by enteric disease that is $>10^{-4}$; the WHO guidelines appear to offer a similar level of protection.

The results of these studies of risks to those who consume these crops taken together do not provide any evidence to suggest a need to change the WHO guideline limit on exposure of $\leq$ 1000 fecal coliform bacteria/100 ml for irrigation of vegetable and salad crops eaten uncooked (Crook,1998).

Data from prospective epidemiological studies in Israel and the USA on situations in which spray or sprinkler irrigation was used suggest that a level of $\leq$ 105 fecal coliform bacteria/100 ml would protect both farm workers and the nearby population from infection transmitted through direct contact or aerosols from wastewater .

Shuval et al. showed that episodes of enteric disease were similar in Israeli kibbutzim (communal farming settlements) most exposed to effluent from waste stabilization ponds

as aerosols from sprinkler irrigation (104 –105 faecal coliform bacteria/100 ml) and in those not exposed to wastewater effluents. This was the case both for workers who had contact with wastewater and their families and the general population living near the fields.

In Lubbock, Texas, USA, a rural community was exposed to sprinkler application of partially treated wastewater that came from a much larger urban community In the first year, mainly primary effluent and trickling filter effluent were used to irrigate cereals and industrial crops (quality 106 fecal coliform bacteria/100 ml and enteroviruses 100–1000 plaque-forming units (pfu)/l), and in the second year, the effluent was stored in reservoirs before use (quality 103–104 fecal coliform bacteria / 100 ml and <10 pfu/l). There was no clear association between self-reported episodes of clinical illness and exposure to wastewater. However, in the data on serocon version to viral infections, a high degree of aerosol exposure was related to a slightly higher rate of viral infections (risk ratio 1.5–1.8); this effect was strongest in the first year (quality 106 fecal coliform bacteria / 100 ml) before the reservoirs had come into use. However, when allowance was made for alternative risk factors, eating at local restaurants was identified as an alternative explanation for viral infection.(Shuval,et al, 2003).

Analysis of clinical data on viral infection (from fecal specimens) also showed that high exposure to aerosol was associated with new viral infections in the summer of the first year of irrigation but the effect was of borderline significance ($P = 0.06$) In a specific study of rotavirus infection, wastewater spray irrigation had no detectable effect on the incidence of infection. Taken together, these results suggest that aerosol exposure to wastewater of a quality of 103–104 fecal coliform bacteria/100 ml does not result in excess infection with enteric viruses. There is some evidence that exposure to wastewater of a quality of 106 faecal coliform bacteria/100 ml results in excess viral infection (but not disease), but this is not conclusive since eating at local restaurants was an alternative explanation in this case (Ward, 2001).

However, data from Mexico in an area where flood and furrow irrigation are used suggested that in cases in which school-aged rural children and adults are in direct contact during irrigation or play with the partially treated wastewater that originated in an urban area, there may still be a risk of diarrheal disease when quality is at 103–104 faecal

coliform bacteria/100 ml. Early studies indicated that there was an increased risk of diarrheal disease among those over 5 years (particularly children aged 5–14 years) in contact with partially treated wastewater retained in one reservoir and containing 105 faecal coliform bacteria/ 100 ml compared with those in a control group who practiced rain-fed farming (Cifuentes , 1998).

Later studies found a significant excess of diarrheal disease in children aged 5–14 years and a fourfold increase in serological response to human Norwalk-like virus/Mexico in adults who had had a high level of contact with the effluent from two sequential storage reservoirs (containing partially treated wastewater with 103–104 faecal coliform bacteria/100 ml) when compared with those who had had no contact with this effluent. There was also an excess of diarrheal disease in adults (odds ratio = 1.5), but this did not reach significance (P = 0.12) probably due to the sample size. A stricter guideline limit of $\leq$103 faecal coliform bacteria/100 ml would be safer when adult farm workers are engaged in flood or furrow irrigation and when children are regularly exposed. This would also help to reduce the risks from epidemic infections which could be transmitted from an outbreak in the source community to communities that use the effluent for irrigation In cases in which there are insufficient resources to provide treatment to reach this stricter standard, a guideline limit of 105 faecal coliform bacteria/100 ml should be supplemented by other health protection measures (for example, health education about avoiding direct contact with wastewater and the importance of hand washing with soap after contact with wastewater (Blumenthal, et al. 1998).

There are little data available on the risks of viral infection from either direct contact or the consumption of crops. Nevertheless, the findings described below have implications for the evaluation of current guidelines with respect to viral risks.

The use of risk assessment approaches has shown that when the concentration of viruses (poliovirus 3, echovirus 12 and poliovirus 1) in chlorinated tertiary effluent reaches a maximum of 111 pfu/l, the estimated annual risk of enter viral infection from spray irrigation of food crops is in the range 10^{-4} to10^{-7} The use of chlorinated secondary effluents (3.9 log virus removal from untreated wastewater) to irrigate food crops results in an estimated annual risk of enter viral infection of 10^{-7} to 10^{-9}, and even the use of unchlorinated secondary effluents resulted in an estimated annual risk of enter viral

infection of 10^{-3} to 10^{-5} . The use of effluent containing 1000 fecal coliform bacteria/100 ml to irrigate salad crops resulted in an order-of-magnitude estimate for the annual risk of viral infection of <10-4 (*7*). However, these studies are recognized to have deficiencies when compared with those using more advanced modeling techniques.
(Asano, et al 1999).

Epidemiological studies have indicated that when effluent that contained fewer than 105 fecal coliform bacteria / 100 ml was used in spray irrigation there was no significant risk of enter viral infection to the surrounding population when there was surface irrigation with effluent containing 103–104 fecal coliform bacteria /100 ml, there was a significant risk of infection with human Norwalk-like virus/Mexico (Hu/NLV/MX) among farm workers who had high levels of contact with the wastewater however when there was surface irrigation with effluent containing 104 fecal coliform bacteria/100 ml there was little risk of infection with this virus associated with eating vegetable crops raw (Tanaka, et al 1998).

2.13 The effect of the wastewater treatment plant effluent on the groundwater in The Gaza Strip

There is a strong relationship between water quality and human health, as has been reported in many studies around the world.

Statistics from the Center for Disease Control and Prevention (CDC) reveal that there were more than 17,000 cases of water-related illnesses during the years in Gaza. However, since many symptoms are often confused with other sicknesses, some researchers feel as many as 25 outbreaks go unreported for every one reported, since many people are exposed to potentially harmful microbes and pesticides, through drinking tap water and taking showers.

One reason for these increasing health problems is that it is difficult to treat groundwater effectively by chlorine, after using it as a disinfectant. Researchers have seen a two-fold increase in the risk of cancer for people who drink an average of two and one half cups of chlorinated water daily for more than 30 years, compared to those who drink water disinfected by other processes. The most common contaminants water system are chlorine by-products, lead, microorganisms, and residual pesticides.(WHO. 1994).

Monitoring were performed in August 2008 by the Institute of Water and Environment at Al Azhar university; 25 underground wells in the nearby area of the wastewater plant, wells were examined physically, chemically and heavy metals measures once every four months. The physical examination results showed that in many wells total dissolved solids were higher than the maximum concentration level. Nitrates, chlorides, and sodium levels were at higher levels of maximum concentrations Results show that wells located near the plant were contaminated with iron, aluminum, and zinc separately or all together**.** Examinations results were some wells containing total coliform, but these wells were with larger borehole diameter and the area were agricultural one where sampling errors may occur **(Annex 12)**

In the Gaza Strip, a study by Nasser 2003 about the relationship between nitrate contamination of groundwater and met-hemoglobin levels among infants under six months of age shows that the high met-hemoglobin (mHb) level was strongly associated with nitrate concentrations in drinking water wells. The highest average of the observed nitrate concentrations level had been detected in Khan Younis. The study clearly demonstrates that drinking water resources are a main factor for high levels of met-hemoglobin (mHb). A strong relationship exists between the high level of mHb and poor quality tap water which ranged from 100 ppm in Gaza to 350 ppm in Khan Younis, whereas the WHO standard is 45 ppm.

Another study by K. Melad in 2000 about groundwater and health in Beit Lahia area indicates that the poor treatment of wastewater (which depends on aeration in wastewater lagoons, then effluent moved over sandy dunes to recharge the underground water) is the main cause of the high nitrates concentration (over 100 ppm), turbidity, nitrite, and ammonia. The water quality deteriorated rapidly. Poor treatment is the main cause of microorganisms, protozoa, fecal coliform, and fecal streptococci in the surrounding area. All of these have a direct affect on human health, causing diarrhea, gastroenteritis problems and typhoid fever.

An unpublished master thesis study by S. Lubbad in 2004 about the effect of the wastewater treatment plant effluent on the groundwater in the Gaza City indicated that poor treatment of wastewater directly effected the quality of groundwater in the area mainly with surfactants (Anionic Detergents LAS) and nitrates in the surrounding area (the infiltration basins have a cycle diameter 800 m.) which is very harmful to the human body and causes gastroenteritis troubles, as well as being a carcinogenic factor .

Another study in Gaza by I. Abed Rabou in 2003 looked at the impact of waste water on the seashore, by studying the microbial pollution on fish and beach sand. It indicates that the high pollution rate in most of the monitoring points was due to disposal of sewage and wastewater directly into sea. Pollution combined with over exploitation has reduced fish stocks in the area and threatens the survival of a posidonia plant bed.

A published study in Germany by B. Shomar in 2006 about the effect of wastewater on ground water in Gaza stripe indicates that more than 90% of the ground wells are not

suitable for drinking because of high concentration of NO^-_3, CL^- and F^- and some trace metals which exceed the WHO standards by 2-7 times. Fluorides' increase from the northern to the southern of the Gaza Strip (F=2.6mgL). (Shomar, 2006).

2.14 Wastewater and Mosquito Proliferation:

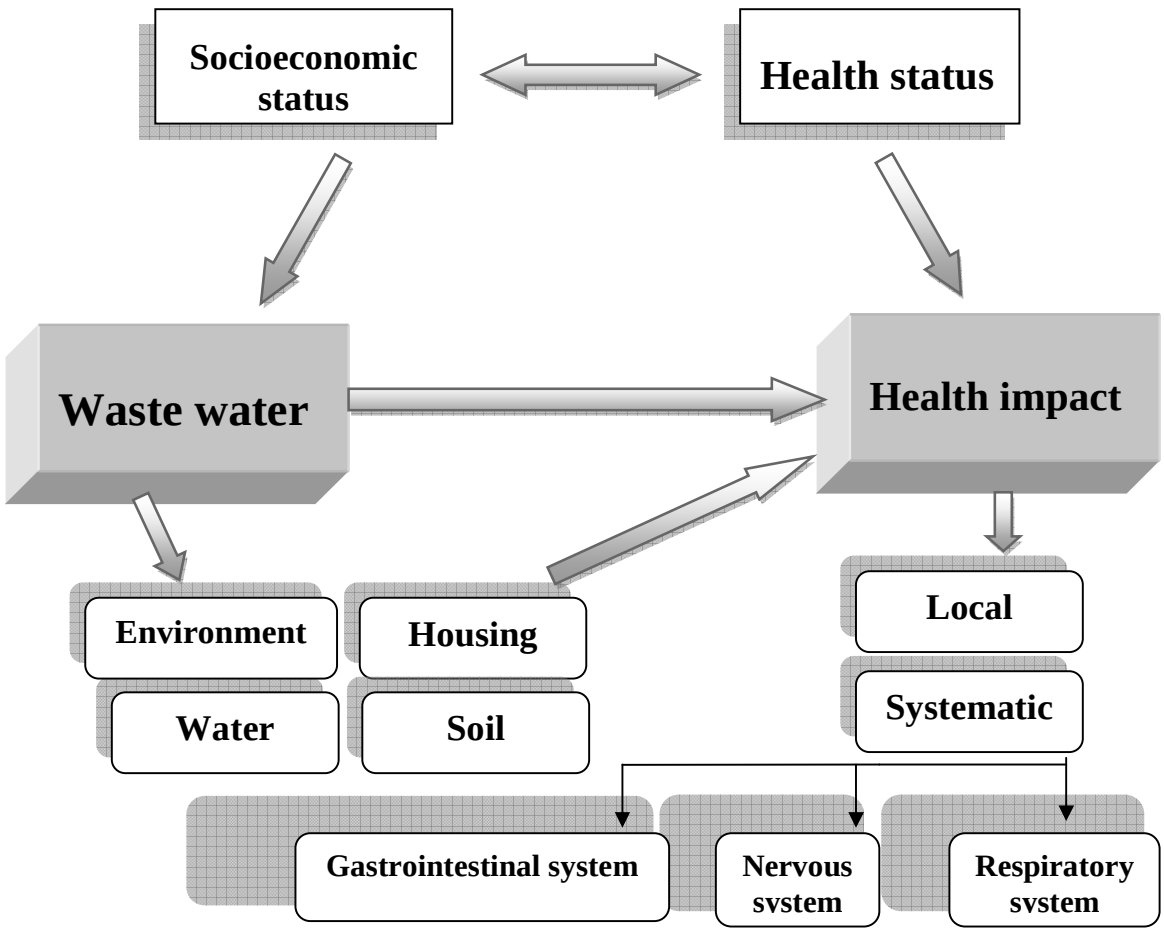
Wastewater-laden and wetland ecosystems have the capacity to harbor disease- infecting agents and annoying insects especially the families of higher *Diptera* e.g. mosquitoes which are considered by far the most important of the blood sucking arthropods worldwide.

The aquatic nature of these ecosystems provides good microhabitats for larval growth and production. With regard to the BLWWTP and its effluent lake, mosquito proliferation especially in the summer seasons constitutes a major public health threat to the neighboring inhabitants. This was clear from the magnitude of complains issued by the inhabitants of Um- Anasser Village, Al-Awda and Al-Nada residential towers and the other residential masses of Beit Lahia (Yassin et al.,2008).

Complains of the inhabitants were very painful as the inhabitants claimed that mosquito eat them up every night. They usually make association between mosquito proliferation and a number of health problems prevailing among them such as skin infection, rashes, itching, ulcers and allergies (Blumenthal et al., 2000).

2.15 Conceptual Framework:

The study framework illustrates the variables which in relation with wastewater as main point and these variables may be affect the human health through water, soil contamination and air pollution. The variables as all reflect the relations among them.



Chapter 3: Methodology

This chapter describes the methodology that was used in this research. The adopted methodology to accomplish this study uses the following techniques: the information about the research design, research population, questionnaire design, statistical data analysis, content validity and pilot study.

3.1 Study Design:

A descriptive analytic cross sectional study design was used to implement the research and to collect the data. This type of design is simple in describing the characteristics of the place, persons and time.

3.2 Method:

A questionnaire was prepared and used to collect the data on all sample subjects chosen for the study population. To save time and efforts, the questionnaire was answered by the subjects with the help of the researcher himself or the assistants.

3.3 Study Areas:

The inhabited area around Biet lahia wastewater plant, in the distance of 500 meters in all directions, The area have been exposed to wastewater pollutants from that plant for a long period of time, minimum five years for the selected area.

3.4 Study Population:

The sample had been chosen from the people living in the above mentioned area. The population in this area is approximately 5,000 (PCBS, 2006).

3.5 Study sample :

Random sample of 357 persons were chosen from the study population of that area, who are living around wastewater plant after stratification of the areas into rows and the subjects had been chosen by systematic random selection (every third house and so on) and then one member of the chosen family had been selected randomly.

3.6 Sample size

By using Epi Info program version 3.5.1 considering total population of 5000, the expected frequency of the factor under the study (diseased population) 50% and the worst acceptable result 45%, thus the sample size is 357 out of 5000 (which represents 7 % of the targeted population). Random sample had been chosen from the study population of that area, who are living around wastewater plant after stratification of the areas., and questionnaires were distributed to the research population and 311 questionnaires were filled and received.

3.7 Data Collection:

A Closed ended questionnaires had been administrated for all sample individuals by the researcher and his assistants on study population in order to get their opinions about health impact assessment of people living near waste water treatment plant in Beit Lahia. Research methodology depends on the analysis of data on the use of descriptive and analytic analysis, which depends on the poll and use the main program of statistical package for social science (SPSS)

3.8 Data Analysis:

After over-viewing the questionnaire, each one was coded, and the usable number of questionnaires had been determined. This step was followed by designing an entry model using the Statistical Package for Social Sciences (SPSS) program. The coded questionnaire had been entered using the computer software. Cleaning of data had been done, the data had be analyzed; frequency, percentage, sign test, and correlation tables had been conducted for the study variables.

3.9 Response rate:

The response rate reached about 87,9 % of surveyed people. This reflect population interest about the study.

3.10 Questionnaire:

A self well constructed questionnaire in Arabic language, easy to read, and translated to English (annex 2), containing questions covering the majority of clinical signs and factors related to the topic was used. The questionnaire had been sent to 10 experts to review it, 7 feedback which I received were helpful to reach the final design. The questionnaire was provided with a covering letter explaining the purpose of the study, the way of responding, the aim of the research and the authenticity of the information, in order to encourage a high response. The questionnaire included multiple choice questions which were used widely. The variety in these questions aims first to meet the research objectives, and to collect all necessary data that can support the discussion, results and recommendations in the research.

The sections in the questionnaire will verify the objectives in this research related to health impact assessment of people living near wastewater treatment plant in Beit Lahia as the following:

Part 1 : **Personal data** covered by12 questions.

Part 2 : **Nutritional data** covered by 7 questions**.**

Part 3 : **Personal hygiene** covered by 6 questions

Part 4: **Health environment awareness and environmental supervision** covered by 7 questions

Part 5 : **Odors & gaseous emissions** covered by 11 questions

Part 6 : **Threats of Gastro-intestinal tract diseases** covered by 8 questions

Part 7 : **Threats of nervous system diseases** covered by 9 questions

Part 8 : **Threats of chest diseases** covered by 5 questions

Part 9 : **Threats of eye diseases** covered by 5 questions

Part 10: **Threats of skin diseases** covered by 5 questions**.**

3.11 Period of the Study:

The study had been conducted during the period between the 1st. of April to end of October. 2010.

3.12 Pilot Study:

A pilot study was done for thirty one inhabitants who had been selected randomly from target area as a pretest to point out weaknesses in wording, predict response rate, determine the real time needed to fill the questionnaire and identify areas of ambiguity and to test the validity and suitability of the questionnaire. All of those pilot participants were excluded from the main study.

3.13 Limitations of the study:

The researcher faced some limitation during implementing this study such:

- Lack of resources i.e. literature related to the study in Palestine and neighboring countries.
- budget
- Absence of governmental medical data.
- Limited time available to conduct the study

3.14 Ethical Considerations:

- An official letter of approval to conduct the study had been obtained from Helsinki Committee. (annex 9)
- Every participant had been provided with an explanatory form about the study including the purpose of the study. Confidentiality of information had been insured.
- Consent form had been obtained from each participant in the study.
- All the ethical concepts had been considered.
- Each participant has the right to participate or no .

3.15 Validity of the Research:

We can define the validity of an instrument as a determination of the extent to which the instrument actually reflects the abstract construct being examined. "Validity refers to the degree to which an instrument measures what it is supposed to be measuring". High validity is the absence of systematic errors in the measuring instrument. When an instrument is valid; it truly reflects the concept it is supposed to measure. Achieving good validity required the care in the research design and sample selection .

3.16 Reliability of the Research:

Reliability of an instrument is the degree of consistency with which it measures the attribute it is supposed to be measuring . The test is repeated to the same sample of people on two occasions and then compares the scores obtained by computing a reliability coefficient. For the most purposes reliability coefficient above 0.7 are considered satisfactory. Period of two weeks to a month is recommended between two tests Due to complicated conditions that the contractors is facing at the time being, it was too difficult to ask them to responds to our questionnaire twice within short period. The statistician's explained that, overcoming the distribution of the questionnaire twice to measure the reliability can be achieved by using cronbach Alpha coefficient and Half Split Method through the SPSS software.

This method is used to measure the reliability of the questionnaire between each field and the mean of the whole fields of the questionnaire. The normal range of Cronbach's coefficient alpha value between 0.0 and + 1.0, and the higher values reflects a higher degree of internal consistency. As shown in Table 3.1 the Cronbach's coefficient alpha was calculated for the first field of the causes of claims, the second field of common procedures and the third field of the Particular claims. The results were in the range from 0.8098 and 0.8852, and the general reliability for all items equals 0.8569. This range is considered high; the result ensures the reliability of the questionnaire.

Table 3.1: Reliability Cronbach's Alpha

Section	No. of Items	Cronbach's Alpha
Part 2 : Nutritional data	7	0.8268
Part 3: Personal hygiene	6	0.8399
Part 4: Health environment awareness & environmental supervision	7	0.8563
Part 5: Odors & gaseous emissions	11	0.8098
Part 6: Threats of Gastro-intestinal tract diseases	8	0.8296
Part 7: Threats of nervous system diseases	9	0.8797
Part 8: Threats of chest diseases	5	0.8852
Part 9: Threats of eye diseases	5	0.8745
Part 10: Threats of skin diseases	5	0.8699
Average		0.8569

Chapter 4 : Results and Discussion

Three hundred fifty seven questionnaires where distributed among the randomly selected study sample. Three hundred ten persons had positively responded , giving a response rate of 87.9% and fourthy six questionnaires had been rejected. Thus about 88% of the responding forms had been accepted.

Data analysis which was a quantitative analysis using SPSS version13 showed frequencies, and the P value for result significance was = 0.05.

4.1 characteristics of the study sample:

4.1.1 Socio-demographic Characteristics:

1-Permanent address	**Frequency**	**Percentage**
Oum al Nasser village	116	37.4
Al Awda Towers	85	27.4
Faddous residence area and Al Mansheyah	109	35.2
Total	310	100.0
2-Length of stay at the Permanent address	**Frequency**	**Percentage**
Less than 10 years	54	20.1
10-15 years	163	60.8
More than 15 years	51	19.0
Total	268	100.0
3-Sex	**Frequency**	**Percentage**
Male	180	58.1
Female	130	41.9
Total	310	100.0
4-Age in Years	**Frequency**	**Percentage**
Less than 30 years	109	35.2
30-40 years	84	27.1
More than 40 years	117	37.7
Total	310	100.0
5-Marital status	**Frequency**	**Percentage**
Single	54	17.4
Married	246	79.4
Divorced	2	0.6
Widowed	8	2.6
Total	310	100.0

6-Number of family members	Category	Frequency	Percentage
Male	Less than 4 years	149	54.8
	4 years or more	123	45.2
Female	Less than 4 years	177	64.6
	4 years or more	97	35.4

7- Educational level	Frequency	Percentage
primary	62	20.0
Preparatory	61	19.7
Secondary	95	30.6
University	92	29.7
Total	310	100.0

8- Occupation	Frequency	Percentage
Without	180	58.1
Agriculture	28	9.0
Industry	1	0.3
Commerce	5	1.6
General employee	62	20.0
Professional	8	2.6
Other	26	8.4
Total	310	100.0

9- Monthly income (in NIS)	Frequency	Percentage
Less than 1000 NIS	34	30.6
1000-2000 NIS	37	33.3
More than 2000 NIS	40	36.0
Total	111	100.0

10- Does the monthly income cover your monthly needs?	Frequency	Percentage
Yes	51	20.6
No	197	79.4
Total	248	100.0

11- Are you smoker?	Frequency	Percentage
Yes	82	26.5
No	228	73.5
Total	310	100.0

Permanent Residency:

Figure 4.1 shows that 38 % of the sample permanent address was at Um Anasser village**,** 27% was at Al Awda Towers**,** and 35% was at Faddous and Mansheyah.

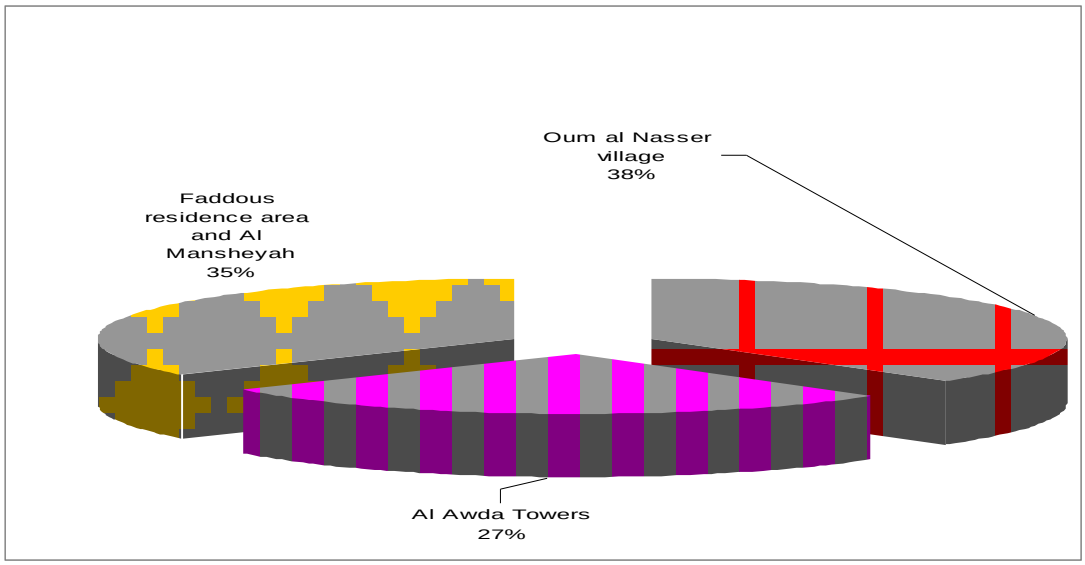


Figure 4.1. Distribution of the Study Population According to Residency

Years of living in the same area show that 20% of the sample length of stay at the Permanent address was for less than 10 years **,** 61% for 10-15 years **,** 19 % were more than 15 years (Figure 4.2).

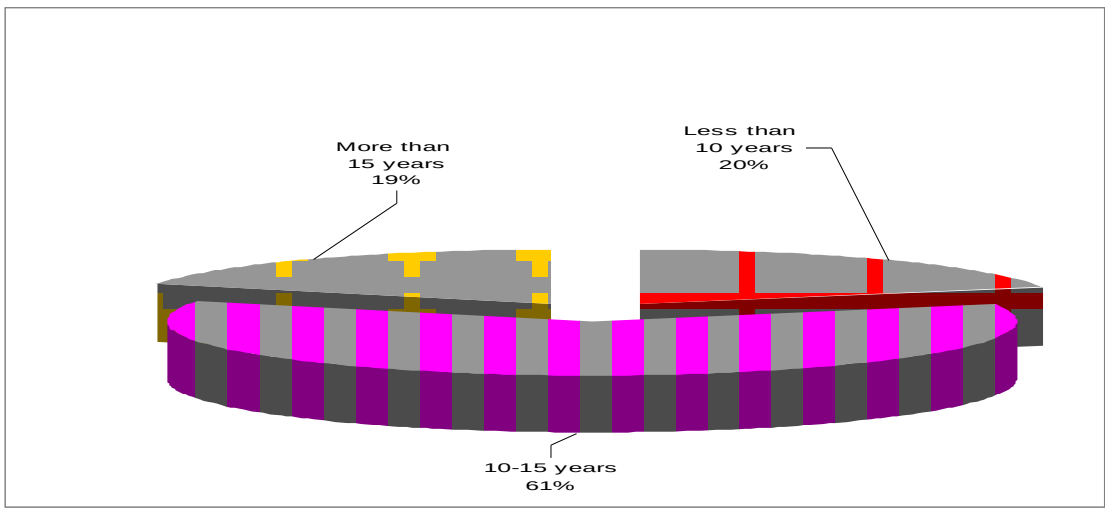


Figure 4.2. Distribution of the Study Population According to Years of Living at the Permanent Address

The above figure shows that the majority (about 61%) of the studied population was exposed to the pollutants resulting from wastewater treatment plant for long time which may be strongly related to the health status deterioration.

Gender :

Figure 4.3 shows that 58% of the sample are Male , and 42% are Female.

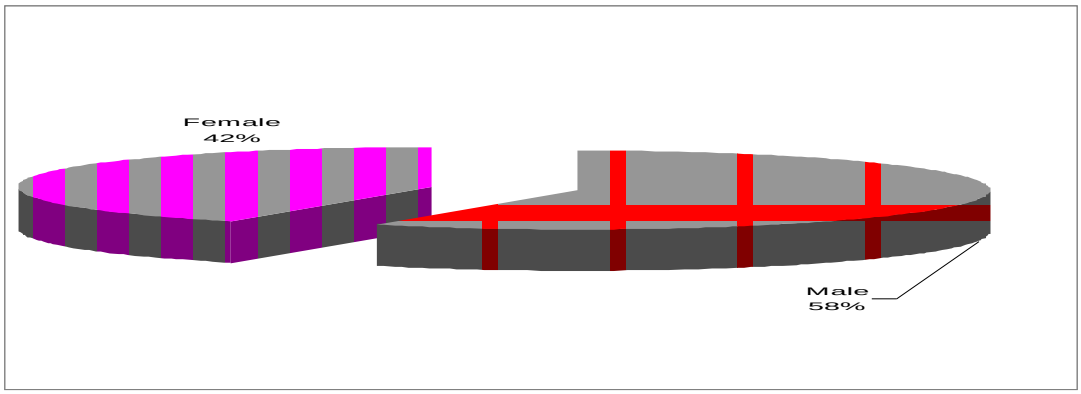


Figure. 4.3. Distribution of the Study Population According to Gender

Age :

The following figure (4.4) shows that about 35% of the respondents are Less than 30 years of age, 27% from 30 to 40 years, and 38% are more than 40 years**.**

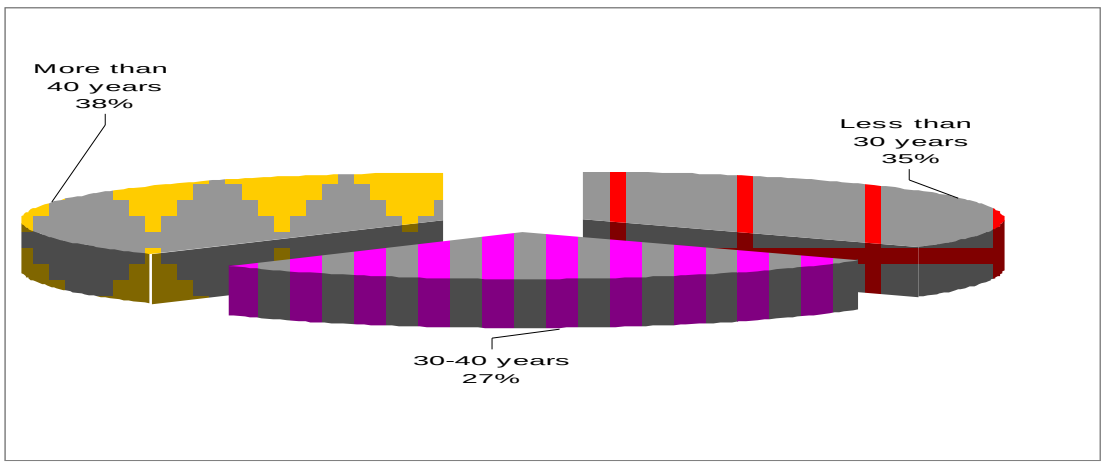


Figure 4.4. Distribution of the study population according to age group

Marital status

Figure 4.5 shows that 17 % of the sample are Single, 79% are married, 1.0 % are Divorced**,** and 3% are Widowed.

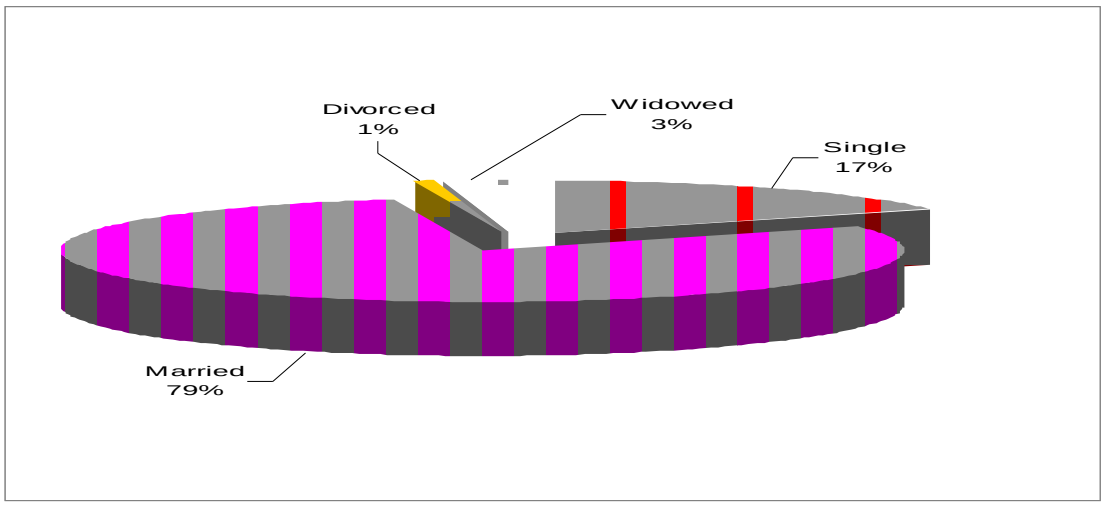


Figure No.4.5 Distribution of the study population according to Marital status

Gender Distribution 0f Family Members:

Table 4.1 shows that **54.8%** of the sample males family members are less than 4 years, 45.2% are 4 years or more**,** and 64.6% of the sample are female less than 4 years , and 35.4% are 4 years or more**.**

Table No. 4.1 Gender Distribution 0f Family Members

Gender	Category	Number of Population	Percentage
Male	Less than 4 years	149	54.8
	4 years or more	123	45.2
Female	Less than 4 years	177	64.6
	4 years or more	97	35.4

Educational level:

Figure 4.6 shows that 20.0 % of the sample has a primary level of education, and 20% preparatory education. 30% secondary, and 30% have a university. This shows that the majority (60%) of the study population is educated secondary and above which is good for questionnaire understanding.

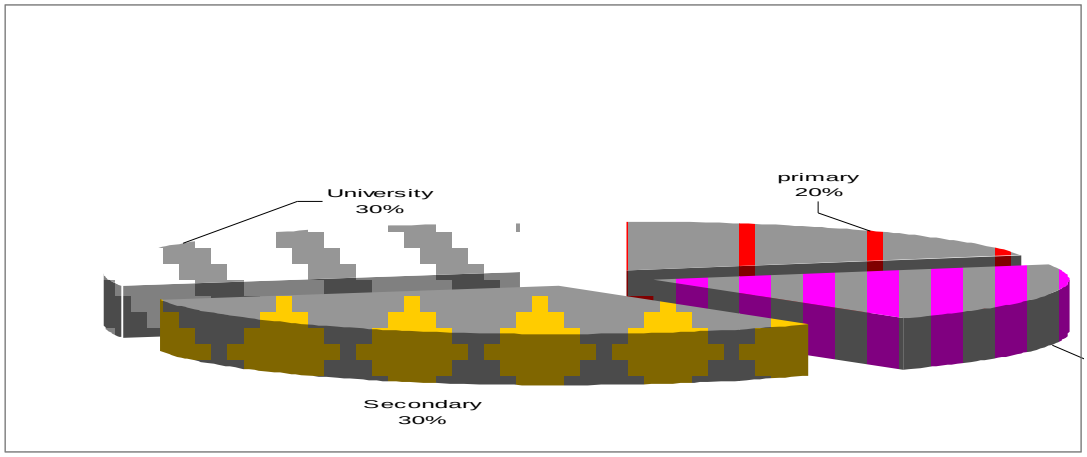


Figure 4.6: Distribution of the Study Population According to Educational Level

Occupation :

The majority of the study population are jobless as shown in figure 4.7 where 58 % of the sample is jobless due to deterioration of political, military, and economical situation in the Gaza Strip, which may influence the health status. About 9.0% of the sample works in agriculture, and 0.3% work in industry, 2% work in commerce, 20.0% are public employees, 3% of the sample are Professional, and 8% of the sample is classified (Others).

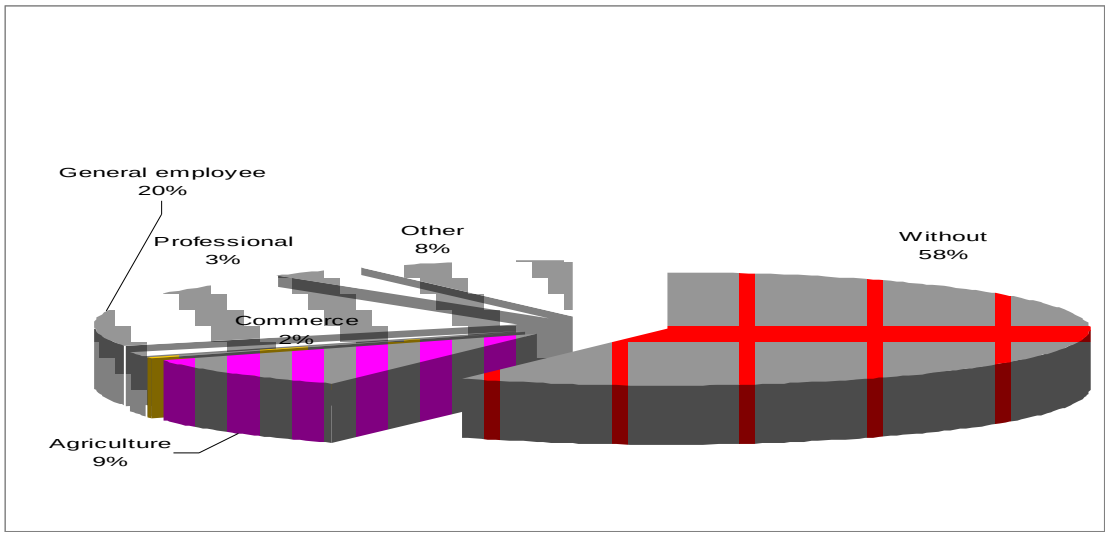


Figure 4.7: Distribution of the Study Population According to Occupation

Monthly Income

The average monthly income of about two third (69%) of target population is 2000 NIS and other 1/3rd (30.6%) of them is less than 1000NIS. With poverty level of about 2US$/capita/day, (united nation) 30.6% of the sample falls under the poverty line which may be responsible for health status deterioration among them. Accordingly, (51) participants (20.6%) only feel that their monthly income meets their needs while the majority(197) of the participants (79%) of the same population feels not as shown in figure 4.8 below.

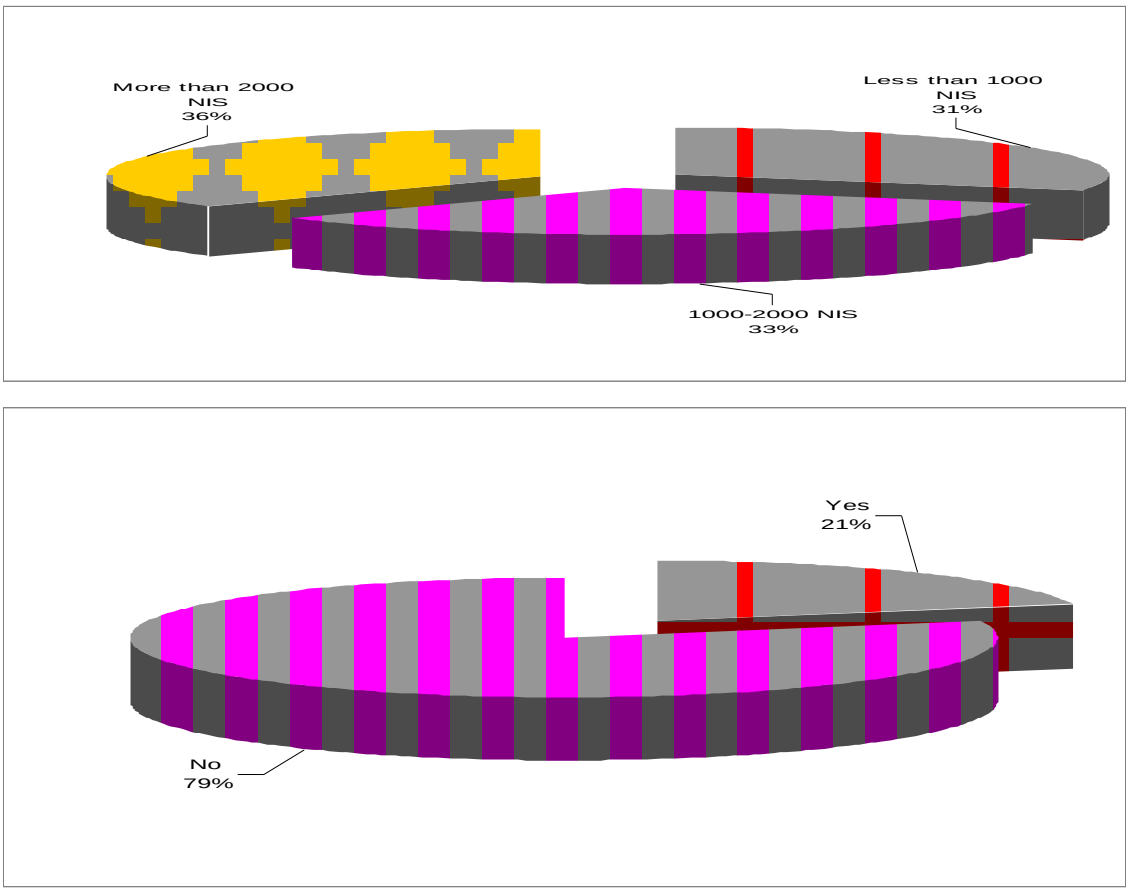


Figure 4.8: Distribution of the Study Population According to Monthly Income

Smoking :

The smokers among the study population were (82) persons representing (27%) while the nonsmokers were (228) persons **(**73%) as shown in the below mentioned figure. The majority (73%) of smokers has been smoking for more than ten years.

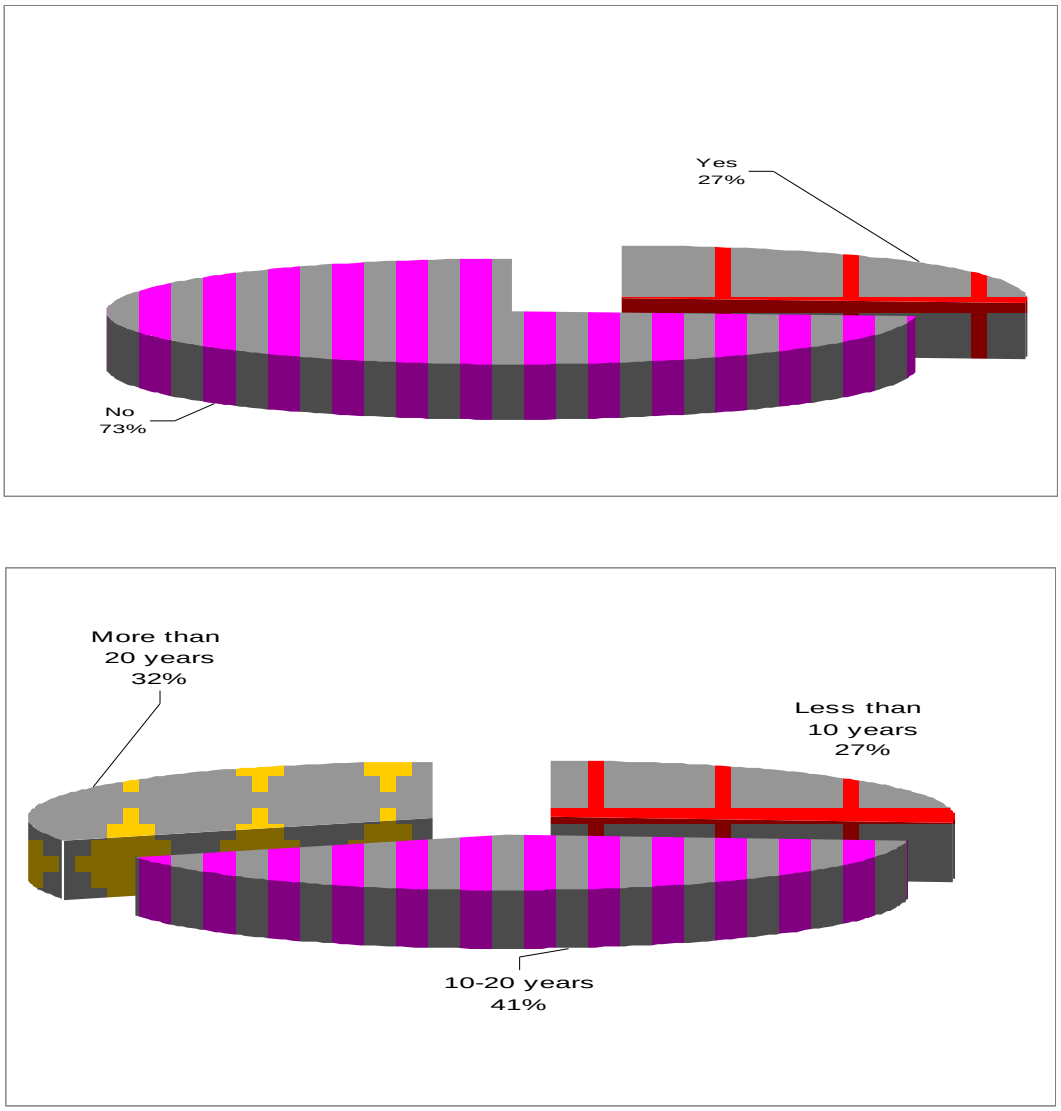


Figure 4.9. Smoking Habits among Study Population

4.2 Economic data:

Eating , Drinking habits:

Table 4.2 represents subjects who raise domestic animals and birds. It shows that 35.2% of the sample raise animals or birds, and the majority 64.8% of the sample do not raise animals or birds and 29.6 % feed the animals or birds from the crops of their residence area, and 70.4% do not. According to the results of Table 4.3 21.2% of the sample uses Local wells and 75.0% of them use municipality water and only 3.8% use untreated wastewater for corps irrigation.

All these results reflect the knowledge and attitude toward the hazardous of wastewater on public health where the majority of them have good knowledge about wastewater adverse health impacts.

Table No. 4.2 Raising and Feeding Animals and Birds

raising animals or birds	Frequency	Percentage
Yes	109	35.2
No	201	64.8
Total	310	100.0

feeding animals/birds from the crops of residence area	Frequency	Percentage
Yes	68	29.6
No	162	70.4
Total	230	100.0

Table No. 4.3 source of water irrigation system for the corps

source of water irrigation system for the corps	Frequency	Percentage
Local well	45	21.2
Municipality water	159	75.0
Waste water	8	3.8
Total	212	100.0

For drinking water about 63.9% drink municipality water, 9.0 % of the sample the source of drinking water is local wells, and 27.1% the source of drinking water is other as shown on table 4.4.

Table No.4.4. source of drinking water

source of drinking water	Frequency	Percentage
Local well	28	9.0
Municipality water	198	63.9
Other	84	27.1
Total	310	100.0

For the remaining items the sign test was used to test the response of the participants on the nutritional data, and the results are shown in table 4.5 as follows. About 49.7 % of the sample agree that, the source of the food from the same area of residence and 50.3 % use food not from the same area of residence with a p-value equal to 0.955 which is greater than 0.05 this means that the source of the food was from the same area of residence which may be polluted due to wastewater soil pollution. About 97.7% of the sample wash the vegetables and the fruits well before eating them and 2.3 % do not wash the vegetables and the fruits well before eating them, and the p-value was 0.000 which is less than 0.05 this means that the population have good practice toward washing the vegetables and the fruits well before eating them to protect their health from pollution threats.

As shown in table 4.5, 98.4 % of the population cock their food well and 1.6 % of the sample do not, and the p-value equal **0.000** which is less than 0.05, which means that the population cock the food well.

Table No.4.5: Participants Response on the Nutritional Items

Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Source of food from the same area of residence	Yes	154	49.7	0.5	0.955
	No	156	50.3		
Washing the vegetables and the fruits well before eating them	Yes	303	97.7	0.5	0.000
	No	7	2.3		
Cooking the food well	Yes	305	98.4	0.5	0.000
	No	5	1.6		

4.3 Personal hygiene:

The sign test was used to test the response of the sample participants to the Personal hygiene items that ranked from highest to lowest according to the percent of category "Yes" The results are shown in table 4.6 as follows:

In item of washing hands after going to the toilet, about 99.4% wash hands after going to the toilet and 0.6 % of the sample do not, the p-value equals 0.000 which is less than 0.05. about 96.1 % take a bath in regular frequent intervals and 3.9% do not and the p-value equals 0.000 which is less than 0.05. In the item of using the others towel or tooth brush, 21.6 % of the sample use the others towel or tooth brush and 78.4 % do not, p-value equals 0.000 which is less than 0.05, about 58.1 % of the sample touch the soil during work, the other 41.9% do not touch the soil during their work, and the p-value equals 0.005 which is less than 0.05, In item of washing hands before preparing or taking food, 98.4 % wash hands before preparing or taking food while 1.6 % of the sample do not , and the p-value equals 0.000 which is less than 0.05**.** Finally 94.2 % cut finger nails frequently and 5.8% do not, and the p-value equals 0.000 which is less than 0.05. These results reflect that the majority of the study population are aware toward personal hygiene and the importance of positive healthy behavior to avoid illnesses occurrence. The aims of these items in this study is to exclude them as confounding factors.

Table No.4.6: Personal Hygiene Indicators

Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Washing hands after going to the toilet	Yes	308	99.4	0.5	0.000
	No	2	0.6		
Taking bath in regular frequent intervals	Yes	298	96.1	0.5	0.000
	No	12	3.9		
Using the others towel or tooth brush	Yes	67	21.6	0.5	0.000
	No	243	78.4		
Touching the soil during work	Yes	180	58.1	0.5	0.005
	No	130	41.9		
Washing hands before preparing or taking food	Yes	305	98.4	0.5	0.000
	No	5	1.6		
Cutting finger nails frequently	Yes	292	94.2	0.5	0.000
	No	18	5.8		

4.4 Environmental Health Awareness and Environmental Supervision:

Table 4.7 using a sign test to test the respondence of the sample on the health environment awareness and environmental supervision ranked from highest to lowest according to the percent of category " Yes" illustrates that 98.7 % of the sample know that wastewater affects health and environment and 1.3 % do not, and the p-value equals 0.000 which is less than 0.05. This shows that the population have good knowledge about wastewater impacts . On other side 33.5% of the sample agree that there are some agencies using the media materials to educate the public about the dangers of wastewater and 66.5 % agree that there is no any agency using the media materials to keep them aware of dangers of wastewater, and the p-value equals 0.000 which is less than 0.05, that means there is a weakness of using the media materials to keep population aware of wastewater health and environmental impacts.

On the item that the head of family educate family members about the threats of wastewater the results found that 82.6 % of the sample educate the family members and 17.4% do not, and the p-value equals 0.000 which is less than 0.05.

On the other hand 11.9% of the sample agrees that, there is a responsible institution visiting them to investigate the problems caused by wastewater and 88.1% do not agree that there is responsible institution visiting them for the same aims, and the p-value equals 0.000 which is less than 0.05, this indicate that there is a shortage of responsibility toward the population living near wastewater treatment plant.

Concerning the promise of wastewater threats solving or eradication about 70.3 % of the sample have been promised to solve the problems caused by wastewater and 29.7 % of the sample have not been promised, and the p-value equals 0.021 which is less than 0.05, that means there is a plan to solve this environmental catastrophe.

Table No.4.7 Environmental Health Awareness and Environmental Supervision

Items	Category	Frequency	Valid Percent	Test Prop.	P-value
knowing that waste water affects the health and environment	Yes	306	98.7	0.5	0.000
	No	4	1.3		
Availability of any agency using the media materials to keep you aware of dangers of wastewater	Yes	86	27.7	0.5	0.000
	No	224	72.3		
Participation in sessions concerned about educating people of dangers of wastewater	Yes	104	33.5	0.5	0.000
	No	206	66.5		
keeping family members aware of dangers of wastewater	Yes	256	82.6	0.5	0.000
	No	54	17.4		
Availability of any responsible institution visiting you to investigate your problems which are caused by waste water	Yes	37	11.9	0.5	0.000
	No	273	88.1		
Promise to solve the problems caused by wastewater	Yes	26	70.3	0.5	0.021
	No	11	29.7		

4.5 Odors and Gaseous Emissions

In the whole study population 99% smell odors or gaseous emissions at their residence area but 1.0% of the sample do not smell odors or gaseous emissions as shown in table 4.8: This indicates that all population around Beit Lahia wastewater treatment plant are exposed to the gases emitted from it.

Table No.4.8 Smell Odors or Gaseous Emissions at Residence Area

Smelling odors or gaseous emissions at residence area	Frequency	Percentage
Yes	307	99.0
No	3	1.0
Total	310	100.0

On other side the majority of population in the study area 40.1% said that the peak period of that odors at all the time and 31.6% of the sample decides the peak period of that odor at evening, the other which represent 20.2 % smell the odors in the morning, and 5.9% of the sample decides the peak period of that odor at afternoon**,** finally 2.3% don't know

this is illustrated on table 4.9**,** all of the previously mentioned results are strongly related with the direction of wind at different seasons.

Table No 4:9 the Peak Period of Odor

decide the peak period of odor	Frequency	Percentage
Morning	62	20.2
Afternoon	18	5.9
Evening	97	31.6
All the time	123	40.1
I don't know	7	2.3
Total	307	100.0

The following table 4.10 illustrates the tolerance of these odors or gaseous emissions in study area. About 0.3 % of the sample agrees that these odors or gaseous emissions agreeable, and 16.9% tolerate it as unacceptable, and 81.1% of the population said that these odors or gaseous emissions are offensive , and 1.6% agree that these odors or gaseous emissions are without smell, in general the majority categorized the odors under offensive

Table No 4:10 Odors or Gaseous Emissions Category

odors or gaseous emissions category	Frequency	Percentage
Agreeable	1	0.3
Unacceptable	52	16.9
Offensive	249	81.1
Without smell	5	1.6
Total	307	100.0

4.6 Gastro-Intestinal Tract Threats

The current study shows that about 62.3% of all study population has suffered from poor appetite and 37.7 % did not suffer from poor appetite, and the p-value equals 0.000 which is less than 0.05, which is statistically significant indicating that there may be association between loss of appetite and exposure to odors of hydrogen sulphide this meets international studies which I, am mentioned in literature review. This is in agreement with Kaye and Kilburn (2004), conclusions that, exposure to hydrogen sulphide causes loss of appetite.

Table No.4.11 Threats of Gastro-intestinal Tract Threats

Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Suffering of poor appetite	Yes	193	62.3	0.5	0.000
	No	117	37.7		
Still suffering of poor appetite	Yes	94	48.7	0.5	0.773
	No	99	51.3		
Suffering of diarrhea	Yes	119	38.4	0.5	0.000
	No	191	61.6		
A acute or chronic	acute	111	93.3	0.5	0.000
	chronic	8	6.7		
Having stool analysis	Yes	161	51.9	0.5	0.532
	No	149	48.1		
Suffering of intestinal parasites	Yes	107	34.5	0.5	0.000
	No	203	65.5		
Stool analysis been positive for any of your family members	Yes	162	52.3	0.5	0.000
	No	118	38.1		
Feeling of weight loose	Yes	139	44.8	0.5	0.078
	No	171	55.2		
Suffered or still suffering of Hepatitis A	Yes	17	5.5	0.5	0.000
	No	293	94.5		

The above table (4.11) shows that 44.8% of the sample feel that they are loosing weight and 55.2% feel that they do not, and the p-value equals 0.078 which is greater than 0.05, this means that the participants feels that they are loosing weight moderately and this is statistically significant. The current study is supported by the study of ATSDR, 2006.

Also the table shows that 51.9% of the sample have did stool analysis and 48.1 % of the sample have not , and the p-value equals 0.532 which is more than 0.05, which means that the majority of the participants do not have stool analysis. About 34.5% of the sample has suffered from intestinal parasites and 65.5 % have not, and the p-value equals 0.000 which is less than 0.05, which indicates that the participants have not suffered intestinal parasites.

About 52.3% of the sample agree that the stool analysis has been positive for some family members and 38.1% of the sample agree that the stool analysis have been negative, and the p-value equals 0.000 which is less than 0.05, that means the sample agrees that the stool analysis has been positive for some of their family members and the majority is among children. The types of parasites are shown in table 4. 12 as the

following: 40.2% *Ameba***,** 21.5% *Giardia*, 15.0% *Ascaris***,** 7.5% *Pin worms* **,** and 15.8% of the sample have others **.** This indicates that the majority is suffering from *Ameba***,** *Giardia* and *Ascaris***.** These results are in agreement with the multi previous locally and international published studies that support the relationship between wastewater and parasitic infection (Al-Zain, 2009 and Jeroen et al., 2008).

Table No 4.12 Types of Intestinal Parasites

Types of intestinal parasites	Frequency	Valid Percent
Ameba	43	40.2
Giardia	23	21.5
Ascaris	16	15.0
Pin worms	8	7.5
Other	17	15.8
Total	107	100.0

Also as shown in table 4.11, about 38.4 % of the sample suffered from diarrhea and 61.6 % did not , the p-value equals 0.000 which is less than 0.05, that means the population in study area suffers from diarrhea which may be related to the polluted ground water from wastewater and this is supported in literature review by Alfarra and Lubbad, 2006.

Concerning hepatitis A, The table shows that 5.5 % of the sample suffered or still suffering of Hepatitis A and 94.5 % did not, and the p-value equals 0.000 which is less than 0.05, this means that participants did not suffer of Hepatitis A. These results do not agree with the international studies in the literature review and this could be attributed to the use of treated wastewater in crop irrigation (Asano, et al 1999 and Blumenthal, et al. 1998).

4.7 Nervous system threats

In the studied population, about 68.1% of the subjects have had headache while 31.9 % of the subjects have not. the p-value equals 0.000 which is less than 0.05, 87.7 % of the sample agree that their suffering of headache is frequent and 12.3 % rarely suffering from the headache, the p-value equals 0.000 which is less than 0.05, and that means

the sample agree that they are suffering from headache very frequent. This percentage of 68.1% is high. This result is supported by many studies worldwide which concluded that there is a positive association between the exposure to pollutants or odors from wastewater plant and developing of headache (Legator, Marvin S., et al 2001, and Campagna et al., 2004).

Table No 4.13 Threats to Nervous System

Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Suffering of headache	Yes	211	68.1	0.5	0.000
	No	99	31.9		
Is it frequent or rare	frequent	185	87.7	0.5	0.000
	rare	26	12.3		
Suffering of dizziness	Yes	158	51.0	0.5	0.776
	No	152	49.0		
Suffering of tremors of your limbs	Yes	77	24.8	0.5	0.000
	No	233	75.2		
Complaining of imbalance	Yes	86	27.7	0.5	0.000
	No	224	72.3		
Suffering of weak memory	Yes	122	39.4	0.5	0.000
	No	188	60.6		
Suffering of nervousness	Yes	225	72.6	0.5	0.000
	No	85	27.4		
Suffering of anxiety	Yes	219	70.6	0.5	0.000
	No	91	29.4		
Suffering of sleep disturbance	Yes	184	59.4	0.5	0.001
	No	126	40.6		

According to the above table (4.13), about 51.0% of the study population have had dizziness and 49.0 % have not, the p-value equals 0.776 which is greater than 0.05, and that means the majority of the sample is suffering of dizziness moderately and it is statistically not significant indicating that there is insignificant association between

exposure to hydrogen sulphide and dizziness which is notsupported by some studies (Kaye and Kilburn, 2004). And 24.8% of the sample has suffered of tremors on the limbs , 75.2% did not suffer of tremors of the limbs, and the p-value equals 0.000 which is less than 0.05, this means that the sample suffer of tremors mildly, 24.8% these results interpret the association between exposure to hydrogen sulphide emitted from wastewater treatment plant and its effect on nervous system.

About 27.7% of the sample feel imbalanced and 72.3% do not feel imbalanced, the p-value equals 0.000 which is less than 0.05, that means the sample feel imbalanced mildly. And these results indicate that there is no significant effect of hydrogen sulphide on these items and contradict some studies, (Kaye and Kilburn, 2004).

On item of weak memory suffering, 39.4 % have weak memory and 60.6 % do not have memory weakness, the p-value equals 0.000 which is less than 0.05, and that means the sample does not suffer from memory weakness. Continuously 72.6% of the sample suffer from nervousness and 27.4 % do not, the p-value equals 0.000 which is less than 0.05, and that means the sample is suffering from nervousness.

Concerning anxiety the result show that 70.6% of the sample suffers from anxiety and 29.4 % does not, and the p-value equals 0.000 which is less than 0.05, that means the sample is suffering from anxiety. Finally 59.4 % of the sample suffers from sleep disturbances and 40,6% do not, and the p-value equals 0.000 which is less than 0.05, which means that the sample participants suffer from sleep disturbances. The above mentioned results indicate a significant association between these items and hydrogen sulphide health impact. These results are supported by many studies in the literature review(Legator, Marvin S., et al 2001).

4.8 Respiratory diseases

As shown in table 4.14current study reveals that 39.0% of all studied population was complaining of breathing difficulties and 61.0 % have no difficulty in breathing, the p-value equals 0.000 which is less than 0.05, this indicate that the sample has no difficulty in breathing. Chest pain accounts for 17.4% of respiratory diseases where 18.4 % of the

sample was hospitalized for any of the chest disease and 81.6% was not hospitalized for any of the chest diseases, the p-value equals 0.000 which is less than 0.05.

In the absence of official Palestinian prevalence data of respiratory diseases, the WHO reports revealed that there are variations in the prevalence of respiratory diseases among different countries which range from 4.0% to 20.0% depending on many factors. The results of this study shows a range between 17% and 39% of the participant suffer from some respiratory diseases which agree with the WHO above mentioned figures.

Table No.4.14 Respiratory diseases

. Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Difficulty in breathing	Yes	121	39.0	0.5	0.000
	No	189	61.0		
Suffering of chest pain	Yes	54	17.4	0.5	0.000
	No	256	82.6		
Hospitalization for any of chest diseases	Yes	57	18.4	0.5	0.000
	No	253	81.6		
Any of your family members have been hospitalized for chest diseases	Yes	55	17.7	0.5	0.000
	No	255	82.3		

The above table 4.14 shows that 17.7 % of the sample agree that there is family member had been hospitalized for chest diseases and 82.3% had not, p-value equals 0.000 which is less than 0.05. This indicates hat the sample does not agree that there's a family member has been hospitalized for chest diseases. The respiratory diseases among family members of the subjects are shown in the table 4.15 including, bronchial asthma 18.5 %**,** chronic bronchitis 33.3%, pneumonia 14.8% and 33.3% for others.

Table No.4.15 Classification of Respiratory Diseases

Respiratory Diseases	Frequency	Valid Percent
Bronchial asthma	10	18.5
Chronic bronchitis	18	33.3
Pneumonia	8	14.8
Others	18	33.3
Total	54	100.0

4.9 The Eyes Diseases

The sign test was used to test the response of the participants to the effect of wastewater pollutants on eyes. The results are ranked from highest to lowest according to the category and the results are shown in table 4.16 as follows:
36.1 % of the sample are suffering of eye irritation and redness and 63.9 % are not with p-value equals 0.000 which is less than 0.05. Also about 41.6% of the sample complains of vision problems, and 58.4 % do not suffer from vision problems, the p-value equals 0.000 which is less than 0.05,and the difference is very highly significant.

According to the results mentioned previously it is concluded that the gases emitted from wastewater treatment plant affect the eyes and associated with vision disturbance, but this depends on the housing locality including the direction and distance from the source of pollution, the 36.1 % who are suffering from eye irritation and the 41.6% who complain of vision problems have been living for long time in their residency and their house are located in the down wind direction and not far from the treatment plant.

Table N0 4.16 Eyes Diseases

. Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Suffering of eye irritation and redness	Yes	112	36.1	0.5	0.000
	No	198	63.9		
Suffering of vision problem	Yes	129	41.6	0.5	0.000
	No	181	58.4		
Admitted to the ophthalmic hospital because of conjunctivitis	Yes	45	14.5	0.5	0.000
	No	265	85.5		
Any of your family members suffered or still suffering of eye diseases	Yes	114	36.8	0.5	0.000
	No	196	63.2		

About the admission or hospitalization because of conjunctivitis as mentioned in the above table shows that 14.5 % were hospitalized and 85.5% were not hospitalized. This low percentage of non- hospitalization is attributed to the fact that conjunctivitis some times does not need treatment, the p-value equals 0.000, which is less than 0.05 which means that the difference is very highly significant. About 36.8 % of the sample agree that someone of their family members suffered or still suffering of eye diseases and 63.2

% do not. The p-value equals 0.000 which is less than 0.05, which means the difference is very highly significant. The following table 4.17 illustrates the types of eye diseases and their percent among studied population where 50.9 % of the sample has or had infection, 28.9% have complained of irritation and redness, and 20.2% are suffering of excessive tears. Finally all of these results are supported by many researches related to this study (Savolainen and Nordiska, 1982).

. **Table No. 4.17 Types of Eyes Diseases**

Type of diseases	Frequency	Valid Percent
Infection	58	50.9
Irritation and redness	33	28.9
Excessive tears	23	20.2
Total	114	100.0

4.10 Skin Diseases

Table 4.18 below shows that the majority of the population in the study area (93.9%) are exposed to mosquito and other insects bites, 6.1 % are not exposed and the p-value equals 0.000 which is less than 0.05, also 52.6% of the sample have suffered skin allergy and47.4 % have not, and the p-value equals 0.394 which is greater than 0.05, that means the study population is suffering from skin allergy moderately. These results are supported by Kendlbacker, 2003 Yassin et al.,2008.On the other items related to the mosquito and other insects bites the study reveals that 38.4% of the sample suffered of dermatitis and 61.6% did not suffered of dermatitis, and the p-value equals 0.000 which is less than 0.05. This means that the sample did not suffer of dermatitis, of the subjects who suffered of dermatitis the majority 62.2% had frequent attacks of dermatitis and 37.8 % had not, the p-value equal 0.000 which is less than 0.05.This means that the sample has frequent attacks of dermatitis.

Table No 4.18 Threats of Skin Diseases

Items	Category	Frequency	Valid Percent	Test Prop.	P-value
Exposed to mosquito and other insects bites	Yes	291	93.9	0.5	0.000
	No	19	6.1		
Suffering of any skin allergy	Yes	163	52.6	0.5	0.394
	No	147	47.4		
Suffered from dermatitis	Yes	119	38.4	0.5	0.000
	No	191	61.6		
Frequent attacks of dermatitis	Yes	74	62.2	0.5	0.010
	No	45	37.8		
Any of your family members suffered or still suffering of frequent attacks of skin rash	Yes	92	29.7	0.5	0.000
	No	218	70.3		

Finally 29.7 % of the sample agrees that some of their family members suffered or still suffering of frequent attacks of skin rashes and 70.3% of the sample have not suffered or still suffering of frequent attacks of skin rashes, and the p-value equals 0.000 which is less than 0.05, these results meet with other locally and foreign researches by Yassin et al.,2008.

Chapter 5: Conclusion & Recommendations

The primary intended purpose of this descriptive analytic cross sectional study was to assess health impacts on people living near the wastewater treatment plant in Biet Lahia that may result due to long term exposure to its pollutants. In the following few pages, the conclusion of the study will be reviewed.

The socio-demographic data analyses showed that males are more than females in the study population (58.1% / 41.9% respectively). About 30.6% of the sample fall under the poverty line, 27% of the study population is educated and same percent are smokers. The most important demographic data is that 78.8% of the total population has been living in the same area for a period of time more than 15 years which may be one of the reasons that has lead to the increase of the effect of exposure to pollutants. About 21.2% of the total population uses the local wells for drinking where these wells have confirmed to be polluted according to many local studies.(B. Shomar 2006 and K. Melad 2000).

In addition 49.7 % of the sample depends on food that is locally produced in the same area. Also about 99% have reported smelling odors of gaseous emissions at their residence and these agents have a very offensive odor and annoying smell.

Those who suffer from gastro-intestinal tract threats, including poor appetite, represent 62.3% and 44.8% has weight loss with p-values of 0.000 and o.078respectively, which indicate some statistically significant differences for both loss of appetite and loss of weight. This might be an indication of a positive association between loss of appetite, weight loss and exposure to odors of hydrogen sulphide. This result is in agreement with some international studies mentioned in the literature review such as those of Kaye and Kilburn, 2004 ATSDR, 2006. Regarding diarrhea, around 38.4 % (p-value = 0.000) of the sample has suffered from diarrheal episodes. This means that the population in study area suffers from diarrhea which may be related to the polluted groundwater from wastewater. This result is supported by the study done by in Alfarra and Lubbad in 2006.

Also about 52.3 % (p-value = 0.000) of subjects confirmed that the stool analyses have been positive for any of their family members having some parasites, and the majority was among children. The types of parasites found are the following: 40.2% ameba,

21.5% *Giardia*, and 15.0% *Ascaris*, 7.5% Pin worms and 15.9% other types. It is concluded that the majority suffers from Ameba, *Giardia* and Pin worm. This is in agreement with the multi previous locally and internationally published studies which support the relationship between wastewater and parasitic infections such that of Al-Zain, 2009 and Jeroen et al., 2008**.**

Regarding nervous system diseases, the majority (68.1%) of respondents have had a headache. This high percentage is supported by many studies such as those of Legator, et al, 2001, and Campagna et al., 2004 which ascertain that there is a positive association between the exposure to pollutants or odors from wastewater plants and development of headache. Concerning dizziness, this study shows that there is a statistically significant percentage of the study population suffering from dizziness (51.0% and p-value = 0.000). This indicates that there is a significant association between exposure to hydrogen sulphide and dizziness which supported by some previous studies such as that of Kaye and Kilburn, 2004. The results for tremor (24.8% and p-value of 0.776) and for weak memory (39.4 % and a p-value of 0.000) indicate that the study population is not suffering of memory weakness and slightly suffers from tremors. All these results confirm the association between exposure to hydrogen sulphide emitted from wastewater treatment plants and its adverse effects on the nervous system.

Also about 72.6% has nervousness, (p-value equals 0.000), and 70.6% has expressed some levels of anxiety (p-value 0.000) which means that the study population are suffering from nervousness and anxiety. Finally the study results show that 59.4 % of the sample suffers from sleep disturbances and 40.6% not suffering of sleep disturbances with a p-value of 0.000 which indicates that a large proportion of the study population suffers from sleep disturbances. The above mentioned results indicate significant association between these items and hydrogen sulphide health impact, these results supported by many studies on my literature review (Holleman and Wiberg, 2001, and Legator)

Regarding respiratory diseases, 39.0% (p-value = 0.0000) of total population were complaining of breathing difficulties, chest pain accounts for 17.4% of respiratory diseases, 18.4 % (p-value = 0.000) of the sample were hospitalized for any of chest

diseases . In the absence of an official Palestinian prevalence data of respiratory diseases, WHO reports revealed that there is a variation in the prevalence of respiratory diseases among different countries which range from 4.0% to 20.0% depending on many factors. Finally 17.7 %, with a p-value = 0.000, of the sample agree that there are family members who have been hospitalized for chest diseases, which indicates that the sample does not agree that there are no family members being hospitalized for chest diseases. The respiratory diseases among family members of the subjects include bronchial asthma 18.5%, chronic bronchitis 33.3%, pneumonia 14.8% and others 33.3%.These results indicate an insignificant result relationship between chest diseases and wastewater treatment plant.

The study revealed that 36.1 % of the sample suffers from eye irritation and redness with a p-value of 0.000 and 41.6% (p-value = 0.000) has vision problems. According to these results it is concluded that the gases emitted from wastewater treatment plants affect the eyes and cause vision disturbance, but this depends on the housing locality including the direction and distance from the source of pollution. About 36.1 % of the sample has suffered from eye irritation and 41.6% have complained from vision problems, especially those who have been living for a long time in the area of the study and their houses are located in the wind direction and not far from the waste water treatment plant. About hospitalization because of conjunctivitis 14.5 % (p-value = 0.000) are hospitalized. This low percentage of hospitalization is due to the fact that conjunctivitis, sometimes, does not need treatment. But 36.8 % of the sample agreed that someone of their family members suffered or still suffering of eye diseases, the p-value equals 0.000" which is less than 0.05 and that means there is no statistically significant difference. The types of eye diseases and their percentages among studied population are as follows: 50.9 % eye infection, 28.9% irritation and redness and 20.2% excessive tears. All of these results are supported by many researches related to field of this study such as those of Savolainen and Nordiska, 1982).

The study shows that 93.9% (p-value = 0.000) of the study sample are exposed to mosquitoes and other insects bites, about 52.6% suffers from one or more of the skin allergies. This means that the sample population moderately suffers from skin allergy and these results are supported by Kendlbacker, 2003 and Yassin et al., 2008. In other items

related to the mosquitoes and other insects bites the study results reveal that 38.4% (p-value = 0.000) of the sample has suffered from dermatitis. Of the subjects who suffered from dermatitis, the majority (62.2% with p-value of 0.000) has had frequent attacks of dermatitis which indicates that the sample has frequent attacks of dermatitis. Finally 29.7% of the sample agrees that some of their family members had suffered or still suffering of frequent attacks of skin rash and 70.3% (p-value = 0.000) of the sample has no one of their family members had suffered or still suffering of frequent attacks of skin rash. These results agree with the results of some other local and foreign researches such as those done by Yassin et al., 2008 and Kendlbacker, 2003).

Recommendations

Several threats to human health have resulted from environmental pollution including air, water, and food contamination in such a manner to cause real or potential harm to human health by poor treated or un-treated domestic wastewater. This is the main and most important conclusion of this study.

To control or mitigate the negative adverse health impacts on human and environment, the Palestinian authority should adopt special strategies and policies aimed at decreasing the pollution arising from wastewater treatment plants and address the damage caused by such type of pollution. According to Palestinian environment protection law which had been enacted in 1999, these strategies and policies should be adopted by governmental, non- governmental. This goal can be achieved through the following main issues and practices;

Governmental level:

- Environmental risk assessment, as one of the principal environmental protection measure.
- Continuously monitoring, testing wastewater and ground water wells to detect any microbiological or chemical contamination.
- Free health services, early disease detection and increase preventive disease activity toward the people who suffer as a result of unplanned decisions to construct wastewater treatment plant.

- Installation of new engineered wastewater treatment plant with suitable places away from inhabited areas. .
- Closure of all wastewater plants which are non- engineering constructed.
- Enacting the legislations to prevent random disposal of wastewater.
- Enforcing the laws for the environment protection.
- Encouragement of more environmental studies.

Non-Governmental level:

- Play an active role in education activities to enhance the public health and environmental awareness.
- More attention and re-direction of the donors' activities to environmental health issues.
- Implementation of beneficial projects in environmental health issues.

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Annex 1: English Consent Form

Informed Consent Form

Health Impact Assessment of People Living Near Waste Water Treatment Plant in Biet Lahia: Case Study

Dear Participant ,

Thank you for participation in this research ; you were selected because you meet these requirements.
This study is carried out apart of requirement for the master degree in public health, Al-Quds university – Palestine .

The study aims to evaluate and describe the clinical signs of the adverse health impacts due to exposure to the pathogens and gases from waste water treatment plant in Beit Lahia .

The participation of the study is voluntary and each participant has the right to draw out of the study any time he wishes without giving any excuses.

All the information will be dealt with strictly confidential and will not be used except for scientific researches only .

I appreciate your cooperation in answering this questionnaire, which may take less than 15 minutes of your time.

If you have any inquiry about the questionnaire, do not hesitate in contacting me .

Researcher,
Maher Yasen Al-Madhon
Mobile: 059938440
Email : m-yasen@hotmail.com

Annex 2: questionnaire in English

Self administered questionnaire

Health impact assessment of people living near Wastewater treatment plant in Beit Lahia

Please put an (X) before the proper answer**:**

No	**Part 1 : Personal data**
1	Sex : ☐ Male ☐ Female
2	Age: …… years
3	Marital status : ☐ Single ☐ Married ☐ Divorced ☐ Widow
4	Monthly income (in IS)……
5	Does the monthly income cover your monthly needs? Yes ☐ ☐ No
6	Educational level: ☐ primary ☐ Preparatory ☐ Secondary ☐ University
7	Number of family members: Males ( ) Females ( )
8	Permanent address: ☐ OUm Anasser village ☐ Al Awda Towers ☐ Faddous and Al Mansheyah
9	Length of stay at the Permanent address……..
10	Occupation: ☐ Without ☐ Agriculture ☐ Industry ☐ Commerce ☐ General employee ☐ Professional ☐ Other
11	Are you smoker? ☐ Yes ☐ No
12	If the answer is Yes, how long have you been smoking?.....
	Part 2 : Nutritional data
13	Do you raise animals or birds? ☐ Yes ☐ No
14	Do you feed your animals/birds from the crops of your residence area?

	☐ Yes ☐ No
15	What is the source of water irrigation system for the corps at your residence area? ☐ Local well ☐ Municipality water ☐ waste water
16	What is the source of drinking water at your residence area? ☐ Local well ☐ Municipality water ☐ Other
17	Is the source of your food from the same area of residence? ☐ Yes ☐ No
18	Do you wash the vegetables and the fruits well before eating them? ☐ Yes ☐ No
19	Do you cook your food well? ☐ Yes ☐ No
20	Do you cover your food well after cocking? ☐ Yes ☐ No
	Part 3: Personal hygiene
21	Do you wash your hands after going to the bathroom? ☐ Yes ☐ No
22	Do you take bath in regular frequent intervals? ☐ Yes ☐ No
23	Do you use the others towel? ☐ Yes ☐ No
24	Do you use the others tooth brush? ☐ Yes ☐ No
25	Do you touch the soil during your work? ☐ Yes ☐ No
26	Do you wash hands before preparing or taking food? ☐ Yes ☐ No
27	Do you cut your finger nails frequently? ☐ Yes ☐ No
	Part 4: Health environment awareness & environmental supervision
28	Do you know that wastewater affects your health and environment? ☐ Yes ☐ No
29	Is there any agency using the media materials to keep you aware of dangers of wastewater?

	☐ Yes ☐ No
30	Have you participated in sessions concerned about educating people of dangers of waste water? ☐ Yes ☐ No
31	Do you keep your family members aware of dangers of waste water? ☐ Yes ☐ No
32	Is there any responsible institution visiting you to investigate your problems which are caused by waste water? ☐ Yes ☐ No
33	If the answer for question 32 is yes : Have you been promised to solve the problems caused by waste water? ☐ Yes ☐ No
34	If the answer for question 33 is yes Please mention the promised solutions: …… …… …… ……
	Part 5: Odors & gaseous emissions
35	Do you smell odors or gaseous emissions at your residence area? ☐ Yes ☐ No
36	If the answer for question 35 is yes please decide the peak period of that odor: ☐ Morning ☐ Afternoon ☐ Evening ☐ All the time ☐ I don't know
37	From your point of view are these odors or gaseous emissions: ☐ Agreeable ☐ Disagreeable ☐ Offensive ☐ gaseous emissions without smell
	Part 6: Threats of Gastro-intestinal tract diseases
38	Have you suffered of poor appetite? ☐ Yes ☐ No
39	If the answer for question 38 is yes, are You still suffering of poor appetite? ☐ Yes ☐ No
40	Are you suffering of diarrhea? ☐ Yes ☐ No

41	If the answer for question 40 is yes, is it acute or chronic? ☐ Acute ☐ Chronic
42	Did you have stool analysis? ☐ Yes ☐ No
43	Have you suffered intestinal parasites? ☐ Yes ☐ No
44	If the answer for question 43 is yes, please decide the type of parasite: ☐ Ameba ☐ Guardia ☐ Ascaris ☐ Pin worms ☐ Other
45	Has the stool analysis been positive for any of your family members? ☐ Yes ☐ No
46	If the answer for question 45 is yes, please mention the degree of relationship: Degree of relationship:…… Type of parasite:…… Degree of relationship:…… Type of parasite:……
47	Do you feel that you are loosing weight? ☐ Yes ☐ No
48	Have you suffered or still suffering of Hepatitis A? ☐ Yes ☐ No
	Part 7: Threats of nervous system diseases
49	Are you suffering of headache? ☐ Yes ☐ No
50	If the answer for question 49 is yes, is it frequent or rare? ☐ Frequent ☐ Rare
51	Are you suffering of dizziness? ☐ Yes ☐ No
52	Are you suffering of tremors of your limbs? ☐ Yes ☐ No
53	Do you feel imbalanced? ☐ Yes ☐ No
54	Are you suffering of weak memory? ☐ Yes ☐ No

55	Are you suffering of nervousness? ☐ Yes ☐ No
56	Are you suffering of anxiety? ☐ Yes ☐ No
57	Are you suffering of depression? ☐ Yes ☐ No
58	Are you suffering of sleep disturbance? ☐ Yes ☐ No
	Part 8: Threats of chest diseases
59	Do you have difficulty in breathing? ☐ Yes ☐ No
60	Are you suffering of chest pain? ☐ Yes ☐ No
61	Are you suffering of cough? ☐ Yes ☐ No
62	Are you suffering of other chest diseases/s? ☐ Yes ☐ No
63	If the answer of question 62 is yes please mention the disease/s: ☐ Bronchial asthma ☐ Chronic bronchitis ☐ pneumonia ☐ other
64	Please mention if any of your family members suffering of the following chest disease? ☐ Bronchial asthma ☐ Chronic bronchitis ☐ pneumonia ☐ other
65	Please mention the level of relationship and the disease: Relationship …… Disease ……
66	Have you been hospitalized for any of chest diseases? ☐ Yes ☐ No
67	Has any of your family member been hospitalized for chest diseases? ☐ Yes ☐ No
68	If the answer of question 65 is yes, please mention the level of relationship and the disease Level of relationship…….. Disease ……
69	If the answers of questions 67 and 68 were yes is he/she living with you in the same area? ☐ Yes ☐ No

70	Since when the sick family member is living with you in the same area? ……
71	What is the date of his disease? ……..
	Part 9: Threats of eye diseases
72	Are you suffering of eye irritation and redness? ☐ Yes ☐ No
73	Are you suffering of vision problem? ☐ Yes ☐ No
74	Have you been admitted to the ophthalmic hospital because of conjunctivitis? ☐ Yes ☐ No
75	Has any of your family members suffered or still suffering of eye diseases?
76	If the answer for question 75 is yes, is it: ☐ Infection ☐ irritation and redness ☐ Excessive tears
	Part 10: Threats of skin diseases
77	Are you exposed to mosquito and other insects' bites? ☐ Yes ☐ No
78	Are you suffering of any skin allergy? ☐ Yes ☐ No
79	Have you suffered of dermatitis? ☐ Yes ☐ No
80	If the answer of question 79 is yes, is it frequent attacks of dermatitis? ☐ Yes ☐ No
81	Has any of your family members suffered or still suffering of frequent attacks of skin rash? ☐ Yes ☐ No

Annex 3 : Arabic Consent Form

بسم الله الرحمن الرحيم

نموذج موافقة علي المشاركة في الدراسة

إستبيان حول تقييم الآثار الصحية للمياه العادمة على المواطنين القاطنين قرب أحواض معالجة المياه العادمة في بيت لاهيا

السلام عليكم ورحمة الله وبركاته وبعد .....

شكرا لك لمشاركتك في هذه الدراسة حيث تم اختيارك لأنك تحقق المعايير المطلوبة للمشاركة .

أفيدكم بأنني طالب دراسات عليا بكلية الصحة العامة / جامعة القدس " ابوديس " وأقوم حاليا بهذه الدراسة ضمن متطلبات الحصول على شهادة الماجستير في برنامج الصحة العامة / صحة البيئة ، جامعة القدس " ابوديس " القدس. الغرض من هذه الدراسة هو تقييم ووصف الأعراض المرضية الناتجة عن التعرض للمواد الناتجة من أحواض معالجة المياه العادمة في بيت لاهيا .

أرجو منكم التكرم بالمشاركة في تعبئة الاستبيان المرفق بالمعلومات المطلوبة والتي تشكل عنصرا مهما في نجاح البحث ولك حرية الاختيار في المشاركة أو الانسحاب في أي وقت علما بان جميع المعلومات المتحصل عليها سوف يتم تحليلها بصورتها الاجماليه وستعامل بسريه تامة وعلى أن تستخدم لغرض البحث العلمي فقط وسوف تنشر النتائج بصورة جماعية .

مع علمنا المسبق بحجم المسؤوليات المناطة بكم والتي تستحوذ على جل وقتكم ، إلا أن مشاركتكم في هذه الدراسة سيكون لها الأثر البالغ على النتائج المتحصل عليها ، مع تقديري لتعاونكم المتوقع في تعبئه الاستبيان والذي لن ياخد أكثر من 15 دقيقه من وقتكم الثمين .

شاكرين لكم مسبقا حسن تعاونكم معي وتقبلوا تحياتي

ملاحظة : أرجو الاتصال بالباحث للاستفسار عن أي معلومات تتعلق بالاستبيان

* الباحث : ماهر ياسين المدهون

* بريد الكتروني :m-yasen@hotmail.com

*جوال:0599384440

Annex 4: questionnaire in Arabic

استبانه

"تقييم الآثار الصحية للمياه العادمة على المواطنين القاطنين قرب أحواض معالجة المياه العادمة في بيت لاهيا"

من فضلك ضع علامة (X) قبل الإجابة المناسبة :

الجزء الأول : البيانات الشخصية	
1	الجنس: ☐ ذكر ☐ أنثى
2	العمر :.....
3	الحالة الاجتماعية : ☐ أعزب/عزباء ☐ متزوج/ة ☐ مطلق/ة ☐ أرمل/ة
4	الدخل الشهري مقدرا" بالشيكل :.....
5	هل الدخل الشهري يغطي الاحتياجات الشهرية؟ ☐ نعم ☐ لا
6	مستوى التعليم: ☐ ابتدائي ☐ إعدادي ☐ ثانوي ☐ جامعي
7	عدد أفراد الأسرة ذكور ( ) إناث ( )
8	مكان الإقامة الدائم : ☐ قرية أم النصر ☐ أبراج العودة ☐ سكنة فدعوس والمنشية ☐
9	مدة السكن في مكان الإقامة الدائم :.....
10	العمل: ☐ بدون ☐ زراعة ☐ صناعة ☐ تجارة ☐ وظيفة عامة ☐ مهني ☐ أخرى
11	هل أنت مدخن: ☐ نعم ☐ لا
12	إذا كان الجواب نعم ما هو عدد سنوات التدخين.....
الجزء الثاني: البيانات الغذائية	
13	هل تربى حيوانات أو طيور ؟ ☐ نعم ☐ لا
14	هل تعتمد الحيوانات أو الطيور التي تمتلكها على الغذاء من نفس المنطقة ؟ ☐ نعم ☐ لا
15	ما هو مصدر ري المزروعات لديك ؟☐ بئر داخلي☐ مياه البلدية ☐ المياه العادمة
16	ما هو مصدر مياه الشرب ؟ ☐ بئر داخلي ☐ مياه البلدية ☐ أخرى
17	هل مصدر طعامك من نفس منطقة السكن؟ ☐ نعم ☐ لا

18	هل تقوم بغسل الخضروات والفواكه جيدا قبل تناولها؟ ☐ نعم ☐ لا
19	هل تقوم بطهي الطعام جيدا وتغطيته بعد الطهي ؟ ☐ نعم ☐ لا
20	هل تقوم بتغطية الطعام جيدا بعد طهيه؟ ☐ نعم ☐ لا
الجزء الثالث: النظافة الشخصية	
21	هل تقوم بغسل الأيدي بعد الذهاب إلى دورة المياه ؟ ☐ نعم ☐ لا
22	هل تستحم بشكل دوري و على فترات متقاربة ؟☐ نعم ☐ لا
23	هل تستخدم منشفة تخص غيرك ؟ ☐ نعم ☐ لا
24	هل تستخدم فرشاة أسنان تخص غيرك ؟ ☐ نعم ☐ لا
25	هل تقوم بملامسة التربة بيديك أثناء عملك؟ ☐ نعم ☐ لا
26	هل تقوم بغسل الأيدي عند تحضير أو تناول الطعام؟ ☐ نعم ☐ لا
27	هل تقوم بقص أظافرك باستمرار؟ ☐ نعم☐ لا
الجزء الرابع: الوعي البيئي الصحي والمراقبة البيئية	
28	هل تعرف أن المياه العادمة تؤثر على صحتك وبيئتك؟ ☐ نعم ☐ لا
29	هل تقوم أي جهة باستخدام أي من المواد الإعلامية لتوعيتكم بمخاطر المياه العادمة ؟ ☐ نعم ☐ لا
30	هل شاركت في حضور محاضرات تهتم بالتوعية بأخطار المياه العادمة ؟☐ نعم ☐ لا
31	هل تقوم بتوعية أفراد أسرتك لمخاطر المياه العادمة ؟☐ نعم ☐ لا
32	هل تقوم جهات مسئوله بزيارتكم لتقصي مشاكلكم التي تسببها المياه العادمة ؟ ☐ نعم ☐ لا
33	إذا كانت الإجابة نعم هل وعدوكم بحلول مشاكلكم التي تسببها المياه العادمة؟☐ نعم ☐ لا
34	إذا كانت الإجابة نعم فاذكر الحلول التي طرحوها ....
الجزء الخامس: الروائح الإنبعاثات الغازية	
35	هل تشعرون بروائح إنبعاثات في مكان سكناكم ؟ ☐ نعم ☐ لا
36	إذا كانت الإجابة نعم بأي وقت تكون ذروتها ؟ ☐ الصباح ☐ الظهيرة ☐ المساء ☐ جميع الأوقات ☐ لا اعلم

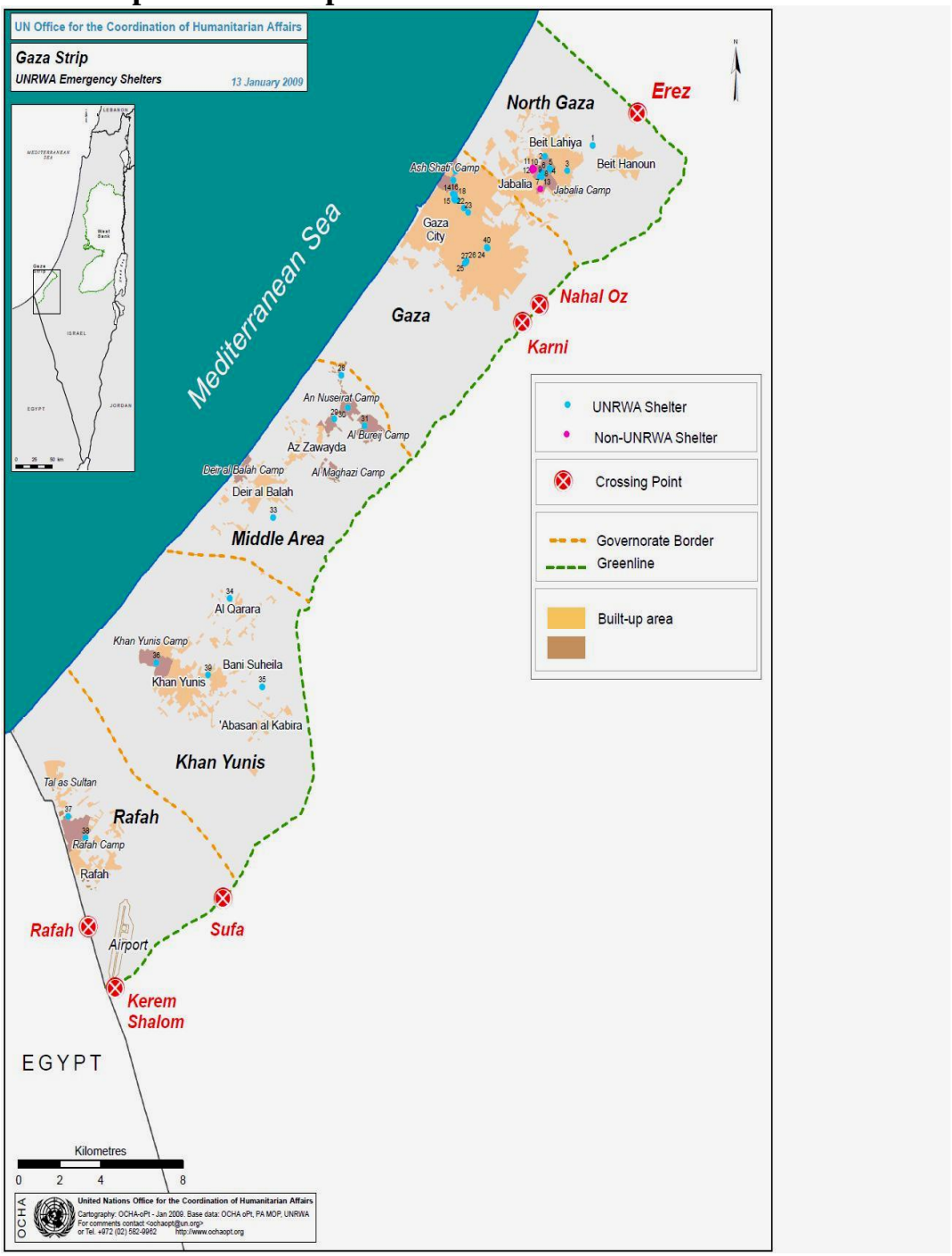
الجزء السادس: الإصابة بأمراض الجهاز الهضمي	
38	هل عانيت من فقدان الشهية؟ ☐ نعم ☐ لا
39	إذا كانت الإجابة نعم فهل ما زلت تعاني؟ ☐ نعم ☐ لا
40	هل تعانى من الإسهال؟ ☐ نعم ☐ لا
41	إذا كانت الإجابة نعم فهل هو؟ ☐ حاد ☐ مزمن
42	هل قمت بفحص البراز ؟ ☐ نعم ☐ لا
43	هل عانيت أو تعانى من الإصابة بالطفيليات المعوية ؟ ☐ نعم ☐ لا
44	إذا كانت الإجابة نعم حدد النوع : ☐ الانتميبيا ☐ الجارديا ☐ الإسكارس ☐ الدبوسيه ☐ أخرى
45	هل تم فحص البراز ايجابيا لأي من أفراد أسرتك؟ ☐ نعم ☐ لا
46	**إذا كانت الإجابة نعم حدد :** **درجة القرابة:..... نتيجة الفحص:.....** **درجة القرابة:..... نتيجة الفحص:.....**
47	هل تشعر أن هناك تناقص في وزنك ؟ ☐ نعم ☐ لا
48	هل تعانى أو سبق إصابتك بالتهاب الكبد الوبائي(A)؟ ☐ نعم ☐ لا
الجزء السابع: الإصابة بأمراض الجهاز العصبي	
49	هل تعانى من آلام في الرأس؟ ☐ نعم ☐ لا
50	إذا كانت الإجابة نعم فهل هو؟ ☐ متكرر ☐ نادر
51	هل تشكو من دوار أو دوخه؟ ☐ نعم ☐ لا
52	هل تعانى من رجفة في أطرافك؟ ☐ نعم ☐ لا
53	هل تعانى من خلل في التوازن؟ ☐ نعم ☐ لا
54	هل تعانى من ضعف الذاكرة؟ ☐ نعم ☐ لا
55	هل تعانى من العصبية ؟ ☐ نعم ☐ لا
56	هل تعانى من القلق ؟ ☐ نعم ☐ لا
57	هل تعانى من الإحباط؟ ☐ نعم ☐ لا
58	هل تعانى من انزعاج أو اضطرابات أثناء النوم؟ ☐ نعم ☐ لا

الجزء الثامن: الإصابة بالأمراض الصدرية	
59	هل تعانى من ضيق في التنفس؟ ☐ نعم ☐ لا
60	هل تعانى من ألام فى الصدر؟ ☐ نعم ☐ لا
61	هل تعانى من السعال؟ ☐ نعم ☐ لا
62	هل تعانى من مرض/أمراض صدرية أخرى؟ ☐ نعم ☐ لا
63	إذا كانت الإجابة السابقة نعم هل المرض هو :☐ ربو شعبي☐ التهاب الشعب الهوائية المزمن ☐ احتقان الرئتين ☐ أخرى
64	الرجاء تحديد ما إذا كان أحد أفراد أسرتك يعانى من الأمراض الصدري التالية: ☐ ربو شعبي ☐ التهاب الشعب الهوائية المزمن ☐ احتقان الرئتين ☐ أخرى
65	الرجاء تحديد درجة القرابة والمرض: درجة القرابة..... المرض.....
66	هل أدخلت المستشفى للعلاج من أية أمراض تتعلق بالجهاز التنفسي ؟ ☐ نعم ☐ لا
67	هل أدخل المستشفى أي من أفراد أسرتك للعلاج من أية أمراض تتعلق بالجهاز التنفسي؟ ☐ نعم ☐ لا
68	إذا كانت الاجابه نعم حدد : درجة القرابة..... نوع المرض.....
69	إذا كانت الإجابة نعم هل هو من سكان نفس المنطقة المحيطة بسكنك؟ ☐ نعم ☐ لا
70	إذا كان من سكان نفس المنطقة المحيطة بسكنك ما هو تاريخ السكن؟ .....
71	ما هو تاريخ الإصابة ؟.....
الجزء التاسع: الإصابة بأمراض العيون	
72	هل تعانى من حكه وتهيج في العيون؟ ☐ نعم ☐ لا
73	هل تعانى من غباشة في النظر؟ ☐ نعم ☐ لا
74	هل دخلت لمستشفى العيون بسبب أصابتك بالتهاب ملتحمة العين؟ ☐ نعم ☐ لا
75	هل عانى أو يعانى احد افراد الاسرة من أمراض العيون؟ ☐ نعم ☐ لا
76	إذا كانت الإجابة السابقة نعم هل المرض هو : ☐ التهابات ☐ احمرار و تهيج ☐ زيادة في إفراز الدمع

الجزء العاشر: الإصابة بالأمراض الجلدية	
77	هل تتعرض للسعات البعوض و الحشرات الأخرى ؟ ☐ نعم ☐ لا
78	هل تعاني من أي حساسية في الجلد ؟ ☐ نعم ☐ لا
79	هل تعاني أو عانيت من التهابات جلديه ؟ ☐ نعم ☐ لا
80	إذا كانت الاجابه نعم فهل هي متكررة ؟ ☐ نعم ☐ لا
81	هل عانى أو يعانى احد افراد الاسرة من طفح جلدي متكرر ؟ ☐ نعم ☐ لا

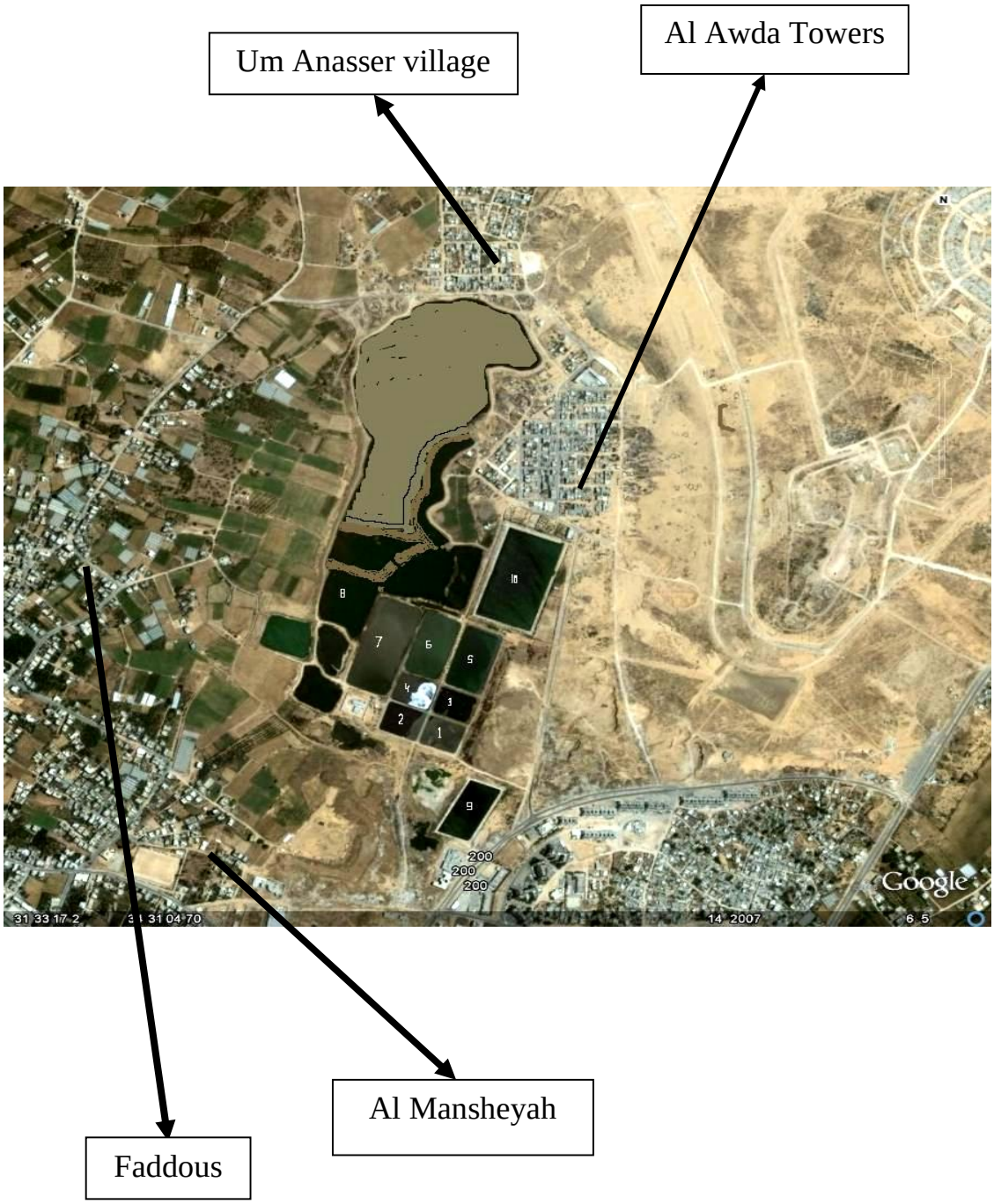
Annex 5: Map of Palestine

Annex 6: Map of Gaza Strip



Annex 7: Photo of Beit Lahia Wastewater Treatment Plant

Annex 8 :Aerial view of BLWWTP



Annex 9: Human Health Effect Due to Exposure to H_2S According to Concentration

Concentration (ppm)	Length of exposure	Effect
0.0057	Community/chronic	Eye and nasal symptoms, headaches and migraines
0.003-0.02	Immediate	Detectable odor
0.01	Community/chronic	Neurophysiological abnormalities
0.1-1	Not reported (n.r)	Abnormal balance, delayed verbal recall Decreased grip strength, impaired color discrimination
0.2	n.r	Detectable odor
0.250-0.300	Prolonged	Nuisance, Abnormal balance delayed verbal recall Decreased grip strength, impaired color discrimination, Abnormal trail making
1-5	n.r	
2-8	Community	Malaise ,Irritability, eye irritation ,diarrhea
10	10 minutes	Eye irritation ,chemical changes in muscle after 10 minutes
>30	Prolonged	Fatique ,paralysis of olfactation
50	n.r	Eye and respiratory irritation
50-100	prolonged	Eye irritation, painful conjunctivitis
150-200	n.r	Olfactory nerve paralysis
200	n.r	Respiratory irritation
250	n.r	,Damage to organs and nervous system
250	Prolonged	Possible pulmonary edema, pulmonary edema with risk of death
320-530	n.r	
500	30 minutes	Systematic symptoms after 30 minutes
500-1000	Immediate	Rapid breathing followed by cessation of breath
750	Immediate	Unconsciousness. Death
1000	Immediate	Collapse, respiratory paralysis
750-1000	Immediate	Fatal respiratory paralysis
1000-2000	n.r	Immediate collapse with respiratory paralysis
5000	Immediate	Death

(Source: Campagna et al., 2004).

Annex 10: Waterborne Pathogens and Their Associated Illnesses

Associated health effect	Organisms
	1. Viruses
Respiratory disease, aseptic meningitis	Echo
Gastroenteritis(vomiting,fever,diarrhea)	Norwalk
Fever, nausea, jaundice, liver failure	Hepatitis A
Fever, jaundice, death from diarrhea	Hepatitis E
	2. Bacteria
Gastroenteritis (diarrhea)	*Escherichia coli*
Enter colitis (fever,diarrhea, vomiting)	*Salmonella sp.*
Gastroenteritis, reactive arthritis	*Shigella sp.*
Gastroenteritis, Gullian –Barre synd,	*Campylobacter jejuni*
Diarrhea , reactive arthritis	*Yersinia sp.*
Legionnaires disease, Pontiac fever, death	*Legionella sp.*
Diarrhea, vomiting, death	*Vibrio Cholera*
	3. Protozoa
Diarrhea	*Cryptosporidium parvum*
Chronic diarrhea	*Giardia lamblia*

(Source: Melad, 2002)

Annex 11: Parasitic infection among children in Um Anasser Village

parasite	infection	Percentage %
Strongyloides stercoralis	**5**	**2**
Ascaris lumbricoides	**29**	**11.3**
Enterobious vermicularis	**7**	**2.7**
Hymenolepis nana	**16**	**6.2**
Trichuris trichiura	**1**	**0.3**
Entamoeba histolytica	**13**	**5.1**
Giardia lamblia	**21**	**8.2**
Total single infection	**92**	**35.7**
Double parasite	**28**	**10.9**
Total	**120**	**46.8**

Source: Al-Zain, 2009

Well no.	Water level meters	pH	EC µmho/cm	TDS mg/L	TS mg/L
14/A	N/P	6.60	943	531	630
28/A	N/P	7.90	1078	775	856
39/A	N/P	7.30	849	531	572
122/A	N/P	7.70	1509	902	1002
62/A	N/P	6.80	1028	749	861
46/A	27.70	7.55	1613	1047	1078
47/A	26.90	7.35	1587	1061	1073
119**/A	N/P	7.84	871	781	784
44/A	30.50	7.11	1561	982	1008
64/A	22.20	7.35	1195	875	922
127-A*/C	N/P	2.15	978	587	637
185*/A	N/P	7.05	1195	796	888
180*/A	N/P	7.00	1222	855	908
I-7/A	N/P	7.9	1587	1061	1076
MCL	==	6.5-8.5	N/A	1000	N/A

Annex 12: Water level and physical properties in all groundwater samples

Source; Institute of Water and Environment at Al Azhar university,2007

N/P: Not possible to measure water level
MCL: maximum contaminant level according to Palestinian Standard for drinking water ; by the Palestinian Standard Institution on June 1997 .
N/A : Not available.
* Municipal wells , always in operation .
** Well most of the times were in operation .

Annex 13: Characteristic of Wastewater

Constituents	Concentration		
	Strong	**Medium**	**Weak**
Total Solids	1250	800	450
TDS	890	560	350
TSS	360	240	100
Settleabl Solids(ml/l)	7	5	3
BOD_5	400	200	100
TOC	290	145	75
COD	910	455	230
Total Nitrogen	75	40	16
Organic Nitrogen	40	20	8
Ammonia	35	20	8
Total Phosphorous	15	8	4
Organic Phosphorous	5	3	1
Inorganic Phosphorous	10	5	3
Chlorides	83	42	21
Alkalinity($CaCO_3$)	200	100	50
Grease	40	20	5

(Source : Mesdaghinia,, 2009).

		Influent			Effluent	
Flow	BOD(mg/l)	COD(mg/l)	SS(mg/l)	BOD(mg/l)	COD(mg/l)	SS(mg/l)
9000	480	823	400	100	222	90
9000	480	823	400	70	168	94

(Source : Water and Environment Institute Al Azhar University, 2004).

Annex 14 : Helsinki Committee Approval

Palestinian National Authority
Ministry of Health
Helsinki Committee

السلطة الوطنية الفلسطينية
وزارة الصحة
لجنة هلسنكي

التاريخ7/6/2010

Name:

الاسم: ماهر ياسين المدهون

I would like to inform you that the committee has discussed your application about:

نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم حول:-

Health impact assessment of people living near waste water treatment plant in Biet Lahia : case study.

In its meeting on June 2010

and decided the Following:-

To approve the above mention research study.

و ذلك في جلستها المنعقدة لشهر 6 2010

و قد قررت ما يلي:-

الموافقة على البحث المذكور عاليه.

Signature
توقيع

Member
عضو

Member
عضو

Chairperson

Conditions:-

- Valid for 2 years from the date of approval to start.
- It is necessary to notify the committee in any change in the admitted study protocol.
- The committee appreciate receiving one copy of your final research when it is completed.

Annex 15: Panel of experts

Name of experts	Place of work
1. Dr . Yehia Abed	AlQuds University
2. Dr . Yousef Abu Safieh	AlQuds University
3. Dr. Jehad Al Hesey	Al Azhar university
4. Dr. Adnan Ayesh	Al Azhar university
5. Dr. Yousef Al Jaish	Islamic university
6. Dr. Abed.F.Abed Rabou	Islamic university
7. Dr. Ashraf El Jedey	Islamic university

Annex 16: Arabic Abstract

ملخص الرسالة

"تقييم الآثار الصحية للمياه العادمة على المواطنين القاطنين قرب أحواض معالجة المياه العادمة في بيت لاهيا_ غزة

إن هذه الدراسة تهدف إلى تقييم الآثار الصحية على صحة المواطنين القاطنين بالقرب من أحواض معالجة المياه العادمة في بيت لاهيا .وقد تمت في عام 2010 ميلادية في بيت لاهيا - قطاع غزة. كان حجم العينة 357 وتم اختيارها بالطريقة العشوائية المنتظمة (كل ثالث واحد) و تم تقسيم منطقة الدراسة إلى ثلاث مناطق حسب الموقع من أحواض المعالجة ووزعت الاستبيانات على كل من قرية أم النصر (130) وسكنة فدعوس والمنشيه (120) وأبراج العودة (107) وذلك حسب الكثافة السكانية وهدفت الدراسة إلى تقييم الآثار السلبية على صحة الإنسان وذلك نتيجة للتعرض للغازات المنبعثة من هذه الأحواض وكذلك استخدام البعض للمياه العادمة في الزراعة وكذلك عن طريق التلامس المباشر للتربة الملوثة في المنطقة و تتضمن التأثير على الجهاز التنفسي والهضمي و العصبي وكلاً من الجلد والعيون. لهذا الغرض صممت دراسة وصفية تحليلية لتطبيق البحث وجميع البيانات لقد تم توزيع الاستبيانات باللغة العربية على العينة وكانت نسبة الاستجابة 87% (310 من 357) ولتحليل البيانات تم استخدام برنامج المجموعة الإحصائية للعلوم الاجتماعية (SPSS).

أما بالنسبة للنتائج فكانت فيما يتعلق بالجهاز الهضمي أن 62.3% يعانون من فقدان الشهية و 44% من فقدان الوزن و 34,5% من العينة يعانون الطفيليات وأن 52% من أفراد أسرتهم يعانون من نفس الشيء و5.5% يعانون من التهاب الكبد الوبائي (وما يتعلق بالجهاز العصبي فإن 68.1% يعانون من آلام في الرأس و 51.1% يشكون من الدوخة وكذلك 24,8% من الرجفة في الأطراف و أيضاً 27.7% من ضعف التوازن و 39.4% من ضعف في الذاكرة 72,6% يعانون من العصبية القلق والأرق. أما بنسبة للجهاز التنفسي فكانت كالتالي أن 39.5% يعانون من صعوبة في التنفس و7,4% يعانون من حرقة في الصدر و18.5% من الربو و 33,3% من التهاب الشعب الهوائية المزمن و14,8% من انتفاخ في الرئتين و33,3% أخرى وهذه النسب تعتبر عالية بالنسبة لما أعلنت عنه منظمة الصحة العالمية في دول العالم وهو ما بين 4.0% إلى 20.0% وأخيراً أن 36.1% يعانون تهيج واحمرار في العيون و41.6% مشاكل في النظر و 20.2% من الإفراط في الدمع وأن 93.3% يتعرضون للسع البعوض وأن 52.6% يعانون من حساسية الجلد و 38.4% من التهاب في الجلد و 62% من المواطنين يعانون من التهاب الجلد المتكرر وكانت من أهم توصيات الدراسة العمل على توصيات الدراسة العمل على إعادة وضع هذه الأحواض بعيداً عن السكان و أيضاً استخدام طرق المعالجة للمياه العادمة وزيادة الوعي بمخاطر المياه العادمة لدى المواطنين.