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Possible Effects of X-Ray Films Processing on Respiratory Functions of Medical Radiographers in Gaza Governorates: Case-Control Study

Submitted by
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Dedication

I would like to dedicate this work to the soul of the first teacher my great father, to the merciful mother, to my lovely wife, son, daughters, brothers, and sisters for their patience and support.

Signed ……..

Yasser S. Alajerami

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 or institution.

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Abstract

As early as 1980s, there were an increasing reports and concerns about diverse health problems and complains among medical radiographers (MRs) who are involved in processing X-ray films in darkroom of the radiological departments. The present case control study was designed and aimed at the investigation of possible effects of X-ray film processing on the respiratory function tests, complete blood count, and IgE levels of MRs as compared to a control group of physiotherapists (PTs).

Questionnaires were distributed to the 84 MRs and 100 PTs. Appreciatively, 76 MRs and 91 PTs filled the questionnaire which indicated a response rate of 90.5% and 91.0% respectively.

Results showed a significant proportion (73.7%) of MRs who reported current health problems mainly (91.1%) in terms of respiratory complains. About 76.8% of the complained MRs significantly related their current health problems to work demands, which reduced in holidays in about 89.7% of them.

The mean health complains score percentage (MHCSP) of MRs (53.95 ± 27.60%) was significantly higher than MHCSP of PTs (21.06 ±19.53%). The most predominant health complains addressed by MRs were discomforted breathing in closed/smoky/dusty rooms (98.7%), recurrent headache (78.9%), difficulties in nose breathing (73.7%), wakeup symptoms (68.4%), intermittent sleep (65.8%), eye symptoms (65.8%), and sneezing during working hours (63.2%). A significantly higher MHCSP was reported in MRs who are working at primary health care canters (PHC) as compared to MRs who are working at governmental hospitals, and in MRs of experience range of 25-32 years. Direct and significant correlations were reported between MHCSP and both the years of experience of MRs and number of weekly processing hours at darkrooms.

For complete blood count (CBC) results, statistically significant differences were reported only in platelets count (PLT) and platelet-related indices. PLT count and platelets distribution width (PDW) of MRs showed significantly decreased values as compared to PTs, while mean platelets volume (MPV) showed significantly higher levels in MRs as compared to the control group of PTs.

MRs showed a significantly higher concentration of IgE as compared to the PTs. Significantly higher IgE concentrations were reported in MRs who have additional working schedule with private sector; in MRs where darkroom ventilation systems is not available; and in MRs who do not use fume hood during chemical preparations. Highly significant correlation ($r = 0.671$ and $p < 0.0001$) was reported between MRs IgE serum concentration and the weekly hours he/she spent at darkrooms.

Almost all spirometric parameters revealed better value for control group as compared to MRs group, while respiratory restrictions were the major MRs spirometric diagnosis. MRs with experience group (25-32 years) showed the worst spirometric results as compared to other less experience groups. A significantly inversed correlations were reported between % of the predicted spirometric parameters and number of weekly hours at processing darkrooms.

Poor designs together with operational deficiencies were major features of the radiology departments. Safety and quality control measures in darkrooms are usually unavailable, or inapplicable or not used by MRs, where 98.7% of them reported health complains during chemical preparations.

In conclusion, the present assessment study revealed an exaggerated health status of the of Palestinian MRs at the Gaza strip. The responsibility about the deviation in MRs health could be attributed on one hand to the irresponsible practices and less awareness of the MRs towards the problems and risks of the x-ray processing darkrooms, while on the other hand the responsibility is attributed to poor design of radiographic departments and darkrooms operational and ventilation deficiencies. The present health status of the Palestinian MRs at the Gaza governorates justifies the necessity for a comprehensive revision and evaluation of radiology departments in general and darkrooms in specific. The proposed evaluation should include all parties that considerably interested and concerned in public and occupational health problems.

الخلاصة

منذ ثمانينات القرن الماضي لوحظ زيادة في أعداد و حجم الدراسات والاهتمامات المتعلقة بالمشاكل و الشكاوى الصحية عند مصوري الأشعة الطبية (فنيو الأشعة) الذين يعملون في غرف التحميض الخاصة بأقسام الأشعة.
هدفت الدراسة الحالية إلى فحص تأثير تحميض الأفلام الإشعاعية على اختبارات وظائف الجهاز التنفسي, التعداد الدموي الكامل و على مستوى الأجسام المضادة من نوع (IgE) لدى مصوري الأشعة الطبية و مقارنتهم مع مجموعة ضابطة من فنيو العلاج الطبيعي.

قام الباحث بتوزيع استبانه الدراسة على 84 من مصوري الأشعة الطبية و كذلك على 100 أخصائي علاج طبيعي كمجموعة ضابطة. وبكل امتنان قام 76 من مصوري الأشعة الطبية و 91 من أخصائي العلاج طبيعي بتعبئة الاستبانة و بنسبة استجابة 90.5% و 91.0% على التوالي.

أظهرت نتائج هذه الدراسة بأن هناك نسبة عالية (73.7%) من مصوري الأشعة الطبية يعانون من مشاكل صحية حالية و كانت غالبية (91.1%) هذه المشاكل الصحية تتعلق بالجهاز التنفسي وهناك ما يقارب من 76.8% من هذه الشكاوى مرتبطة بشكل كبيير بطبيعة عمل مصوري الأشعة الطبية مع العلم أن هذه المشاكل الصحية تنخفض أو تختفي عند 89.7% منهم في الإجازات و أيام العطل.

سجلت النسبة المؤوية لمعدل الشكاوى الصحية لدى مصوري الأشعة الطبية (53.94 ± 27.60 %) قيما اكبر و ذات دلالات إحصائية جوهرية مقارنة مع ذات القيم (21.0 ± 19.53%) لدى أخصائيي العلاج الطبيعي.
و كانت أكثر الشكاوى الصحية لدى مصوري الأشعة الطبية على النحو التالي : عدم ارتياح في عملية التنفس في الغرف المغلقة/المدخنة/المغبرة (98.7%), صداع متكرر بنسبة (78.9%), صعوبة التنفس من الأنف (73.7%), مشاكل خاصة بالجهاز التنفسي عند الاستيقاظ من النوم (68.4%), تقطع في النوم بنسبة (65.8%), العطس المتكرر خلال ساعات العمل (63.2%). من ناحية أخرى كان هناك نسه عالية و ذات دلالة إحصائية جوهرية للنسبة المؤوية لمعدل الشكاوى الصحية لدى مصوري الأشعة الطبية الذين يعملون في أقسام الرعاية الأولية مقارنة مع المستشفيات, و لدى مصوري الأشعة الطبية ذوي سنوات العمل ما بين (25 إلى 32 سنة). كما و وجدت علاقة طردية عالية و جوهرية بين النسبة المؤوية لمعدل الشكاوى الصحية لدى مصوري الأشعة الطبية وكل من سنوات العمل وساعات العمل الأسبوعية في غرف التحميض المظلمة.

بالنسبة لنتائج التعداد الدموي الكامل وجد أن هناك اختلافات ذات أهمية إحصائية فقط في تعداد الصفائح الدموية ومؤشرات هذه الصفائح، فكانت أعدد الصفائح الدموية و مقدار توزيع عرض الصفائح (PDW) كانت أقل بشكل كبير لدى مصوري الأشعة الطبية مقارنة بأخصائيي العلاج الطبيعي, بينما كان معدل حجم الصفائح الدموية (MPV) أعلى عند مصوري الأشعة الطبية مقارنة مع أخصائيي العلاج الطبيعي.

كما و أظهرت الدراسة أن هناك زيادة كبيرة و ذات قيمة إحصائية جوهرية في مستوى الأجسام المضادة من نوع IgE عند مصوري الأشعة الطبية مقارنة مع أخصائيي العلاج الطبيعي. كما و كان هناك زيادة كبيرة و ذات قيمة إحصائية جوهرية في مستوى IgE لدى مصوري الأشعة الطبية الذين يعملون عمل إضافي في القطاع الخاص, و لدى مصوري الأشعة الطبية الذين يعملون في غرف تحميض رديئة التهوية وكذلك عند مصوري الأشعة الطبية الذين لا يستخدمون أدوات و سبل الوقاية إثناء عملية تحضير الأحماض. من ناحية أخرى كان هناك علاقة مباشرة و ذات دلالة إحصائية جوهرية بين مستوى IgE عند مصوري الأشعة الطبية وعدد ساعات العمل الأسبوعية في غرف التحميض ($r = 0.671$ and $p < 0.0001$) .

أما فيما يخص قراءات كفاءة الجهاز التنفسي (Spirometric parameters) فكانت هذه القراءات و النتائج أفضل عند أخصائيي العلاج الطبيعي مقارنة بمصوري الأشعة الطبية, بينما لوحظ أن اغلب التشخيص عند مصوري الأشعة الطبية حسب جهاز قياس كفاءة الجهاز التنفسي كان درجات مختلفة من ضيق المجرى التنفسي. أما بالنسبة لمصوري الأشعة الطبية ذوي سنوات العمل الطويلة (25-32 سنة) كانت نتائج التشخيص حسب الجهاز سيئة مقارنة مع نظرائهم الأقل في سنوات العمل. كما و أظهرت النتائج علاقة عكسية بين النسبة المئوية لقراءات جهاز كفاءة الجهاز التنفسي المتوقعة وعدد ساعات العمل الأسبوعية في غرف التحميض.

إن التصميم السيئ لأقسام الأشعة بالإضافة إلى النقص في المتطلبات التشغيلية لعمليات التحميض كانتا الطابع المميز لأقسام الأشعة قيد الدراسة, بالإضافة إلى أن معايير ضبط الجودة والأمان غالبا ما كانت غير متوفرة أو غير مطبقة في غرف التحميض وان توفرت فإنها لاستخدم من قبل مصوري الأشعة الطبية, حيث أن 98.7 % من مصوري الأشعة الطبية يعانون من أعراض ومشاكل صحية خلال تحضير الأحماض.

وفي المحصلة, فإن الدراسة التقيمية الحالية كشفت عن وجود تدهور أو تردي في الحالة الصحية لمصوري الأشعة الطبية العاملين في قطاع غزة. إن المسئولية في تدهور صحة مصوري الأشعة الطبية تعزى في احد أبعادها إلى الاستهتار و عدم الحرص في ممارسات مصوري الأشعة الطبية والى قلة الوعي تجاه المخاطر والمشاكل التي تحدثها غرف تحميض الأفلام كما أن المسئولية تعزى في بعد أخر إلى التصميم السيئ والرديء لأقسام الأشعة و النقص و عدم كفاءة أجهزة و أنظمة التهوية و الأنظمة التشغيلية في غرف التحميض المظلمة.

إن الوضع الصحي الحالي لمصوري الأشعة الطبية في محافظات قطاع غزة لابد و أن يكون مبررا و دافعا لمراجعة ولإعادة تقيم شاملة لأقسام الأشعة بشكل عام وغرف التحميض بشكل خاص. هذا التقييم الشمولي المقترح لا بد أن يشمل جميع الأطراف المعنية والتي لها علاقة الصحة العامة و بمصوري الأشعة الطبية والمؤسسات التي تهتم بالصحة المهنية.

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List of Abbreviations:

ATS : American Thoracic Society.

COPD : Chronic Obstructive Pulmonary diseases.

CBC : Complete Blood Count

DR: Dark room.

ERS : European Respiratory Society.

FEF : Forced Expiratory Flow

FET : Forced Expiratory Time

FEV_1 : Forced Expiratory Volume in 1 Sec.

FIF : Forced Inspiratory Flow

FVC : Forced Vital Capacity

GA : Glutaraldehyde.

GS : Gaza Strip

Hb : Hemoglobin

Hct : Hematocrit

HSE: Health and Safety Executive.

IC : Ion Chromatography

IgE : Immunoglobulin E

ILO: International Labor Organization.

MCH : Mean cell hemoglobin

MCHC: Mean cell hemoglobin concentration

MCV : Mean cell volume

MOH : Ministry Of Health.

MPD : Maximum Permissible Dose.

MR : Medical Radiographer.

MVV : Maximum Voluntary Ventilation

NIOSH : National Institute for Occupational Safety and Health.

NOHSC : National Occupational Health and Safety Commission.

NSBHR: Non-Specific Bronchial Hyper Responsiveness.

OHSAS: Occupational Health and Safety management Specifications.

ORs : odds ratios

PEF : Peak Expiratory Flow

PFTs : Pulmonary Function Tests

PHC : Primary Health Care.

PNA: Palestine National Authority.

PPM: Parts Per Million

RBC : Red cell count

RD: Radiographic Department.

RDW: Red cell distribution width

SOR: Society of Radiographers.

SPSS : Statistical Package for the Social Sciences

SVC : Slow Vital Capacity

TV : Tidal Volume

UNRWA : United Nation Relief and Works Agency

WB : West Bank

WBC : White blood cell count

WCB: Worker's Compensation of British Columbia.

WHO: World Health Organization.

Chapter One

Introduction

Chapter One
Introduction

1.1 Background

The processing of radiographic films to produce the pictures involves the same methods as that of photographic film developments. In radiography, X-rays rather than visible light create a latent image on the film surface by reducing silver halide crystals to elemental silver. The image is amplified and stabilized during the developing process using reducing agents such as hydroquinone. The image is fixed by agents which dissolve and remove the unused silver halides. Automated X-ray film processing machines achieve short development times (seconds to minutes) by using elevated temperatures (28-35 °C), by including glutaraldehyde as a hardening agent within the developer solution, and by actively drying the fixed and washed films with heated air (Hewitt, 1993).

Medical radiographers (MRs) process the X-ray films in a special room called darkroom (DR), this room must contain a special machine with a specific characteristics. The solvents used in DR, to amplify and stabilize the X-ray films, are developers and fixers solutions, which contain hazards chemicals such as gluteraldehyde, hydroquinone, potassium hydroxide, potassium sulphite, formaldehyde, thiosulphate, acetic acid, aluminum sulphate, ammonium thiosulphate, and others. Most of these chemicals have been shown to cause a variety of severe health problems to the MRs (Cullinen *et al*.,1992; Trigg *et al*,1992; Chan-Yeung *et al,* 1993; Gannon *et al*.,1995; Di Stefano *et al*,1999; Smedley *et al*.,1999).

A wide variety of symptoms have been reported and noticed on MRs including, asthma, nasal discharge, sore throat, sinus problems, sore eyes, headache, fatigue, oral ulcers, tight chest, skin rash, dyspnea, chest pain, and heart arrhythmias (Gordon, 1989; Gannon *et al*.,1995; Smedley *et al*.,1999; Wymer *et al*., 2000). Several studies have investigated the effectiveness of safety measures and good design of the darkroom as means to play a great importance to reduce and minimize the hazardous exposures of MRs (Hayes and Fitzgerald, 1994; Teschke *et al*.,2002; Dimich-Ward *et al*, 2003). Other studies titled such research points under a general term known as darkroom diseases, which deals with the

standard criteria and different ways of processing, practical hygiene, technical maintenance of machine, periodic control and storage of chemical solvents.

1.2 Problem Statement:

Different international societies of radiographers have highlighted the potential threats on the health of radiology workers who constantly exposed to X-ray processing chemicals. These potential threats, risks, and symptoms are considered and categorized under the general term 'darkroom disease' . The darkroom disease is a term used to describe unexpected multiple symptoms attributed by medical imaging personnel to their working environment (British Society of Radiographers ,1991).

Although the hazards of processing chemical reagents are well documented in the literature and well addressed in safety preventative measures of the international health organizations like the WHO, however, the MRs in different countries do not considered these chemical as potent hazards among their working environments and preventive or safety measures. Different scientific studies in different countries described more or less clinical symptoms among MRs due to processing at darkrooms (Gordon, 1989; Hewitt, 1993; Teschke *et al*., 2000; Susan *et al*., 2004).

The Gaza Strip is considered as one of the most populated areas in the world ($4054/km^2$) with an estimated population of about 1.48 million according to July 2007 estimates (Palestinian Central Bureau of Statistics, 2008). In Gaza Strip, 11 out of 22 hospitals and 12 out of 129 primary health care centers are providing radiological services. Unfortunately, most of these radiological departments suffer from operational problems, the most of which is the lack of quality control and occupational safety programs and preventive measures. (MOH, 2005). Moreover, the increments and overloads on the daily radiological services and the insufficiency in the personnel force the MRs to extended the time period they stay at the radiological departments. Accordingly, this leads to increase the risks of exposure to chemical fumes that may enter the body by inhalation and in some cases by direct contact with these chemicals (Personal communication with MRs).

The problems of radiological departments are aggravated due to the inappropriate design and construction of these departments which mainly related to the ventilation systems.

Other quality assurance problems are the absence of monitoring and arrangement of priority in the radiographic department to present a good quality of services to patients at the same time minimize, as much as possible, the hazards of radiographic department (Gordon, 1989 and Hewitt, 1993).

All the above mentioned threats and risks produce great problems to the general health of MRs at the Gaza Strip and make them under occupational health hazards.

1.3 Justifications of the Study:

The justifications for the present work could be summarized in four main points:

1- Unawareness to the risks of X-ray film processing room (Darkroom) by the Palestinian MRs at Gaza Strip.

1. The impacts of the chemicals used in X-ray processing room on the general health and especially on respiratory system of MRs at Gaza Strip.
2. An attempt to deliver a scientific-based study and hence a message to the decision-makers to improve the radiographic departments in general and X-ray rooms processing in particular.
3. Economically, this issue falls under the occupational health and the solutions of these problems will improve the quality of radiological services, protect the general health of the MRs and reduce the burden on the budget of the in Ministry of Health.

Accordingly, we designed the present study in order to address and evaluate the possible effects of X-ray films processing on the respiratory function tests of MRs working with the governmental health centers at the Gaza Strip. Also it aims at the recommendation of preventive measures that could improve the quality of the radiological services at the Gaza Strip.

1.4 The objectives of the study:

This study aimed at the investigation of possible association between health status of MRs and the exposure to chemical fumes, in X-ray film processing room of radiographic departments. Meanwhile evaluation of the structural and operative issues in radiographic departments and recommendation of preventive measures that could improve the quality of the radiological services at the Gaza Strip. The specific objectives of the study could be summarized in the following points:

1- To asses the health status (health complains, respiratory function tests, CBC, and serum IgE of the MRs as compared to PTs.
2- To determine the clinical symptoms that appear during the working in X-ray processing room of radiographic departments.
3- To comparatively assess the health status of MRs according the different variables of the study such as age, years of experience, governorate, workplace, weekly working hours, etc.
4- To explore any significant association between the health status of the MRs and the study variables.
5- To evaluate the process of preparing and diluting the chemicals in radiographic department.
6- To evaluate the effectiveness of ventilation system (general and local), in the X-ray film processing room (darkroom) and radiographic department.
7- To evaluate the design of X-ray processing room and the preparation process of chemicals used in this processing room.
8- To evaluate the knowledge and practices of the MRs during X-ray film processing

1.5 Research Questions:

1- Is there any significant difference in the health status and complains of MRs as compared to the control group of PTs.
2- Are there any significant differences in the health status and complains of MRs according to the grouping variables of the present study.
3- Is there any significant association or correlation between the health status of the MRs and the study variables.

4- Do design and operative issues of radiology departments play integral part in the health status of the MRs?
5- Do knowledge and practices of MRs about darkrooms play integral part in their health status ?.
6- What are the safety, preventive, and operative measures that could be recommended to improve the X-ray processing at Gaza Strip.

1.6 Study Hypotheses:

The principle hypotheses of the present study were built to include the health status of the MRs, the design and operative issues of the radiology departments, and knowledge and practice of the MRs, these hypotheses were as follows:

1- There are no significant differences between the health status or complains of the MRs and control group of PTs.
2- The health status of the MRs is not affected by the study variables.
3- No correlations are exist between the health status or complains of the MRs and the study variables.
4- All radiographic departments together with their associated processing darkrooms are designed and constructed according to the international standers.
5- MRs have a good or satisfactory level of knowledge about the risks and dangers of X-ray film processing and darkroom disease.
6- The practices of MRs at the radiology department in general and darkroom in particular are concomitant with the international radiographic safety and preventive measures and occupational health standers.

1.7 The structure of the Thesis:

The thesis is composed of six chapters: introduction, literature review, conceptual framework, materials and methods, results and discussion and finally the conclusions and recommendations.

The first chapter was assigned as an introduction to the overall work, where the researcher provided a brief background about the subject. Also he mentioned the problem statement

and the justifications of the study. A list of the research main questions and the study hypotheses are specified in the first chapter as well.

In the second chapter which deals with scientific revision of the available literature about the topic, variables and interfering factors, the researcher tried to provide an up-to-date information about the risk factors associated with X-ray film processing, the definition and principles darkroom diseases, symptoms of exposure to film-processing chemicals at darkroom, the main chemicals hazards and their reported health effects on living systems, the design and facilities of the radiographic departments, and precautions and control measures at radiographic departments.

The conceptual framework of the study was mentioned in the third chapter of this thesis. In chapter 3 the researcher provided a schematic representation of the conceptual framework of the study, and he also provided theoretical information and description about the items included in the scheme and how these items are utilized and interfered in the practical part of the thesis.

The fourth Chapter "material and methods" contains more detailed information and procedures about the methodologies underlining the present work. In this chapter the researcher provided full description and information about the study design, target group, ethical considerations, research tools, study population, sampling, and data treatment and statistical analysis.

The bulk of data and the core of the work are presented in results and discussion section which aligned to chapter 5. in this chapter the researcher presented and discussed his results and outcomes with respect to the available published previous studies. He mentioned these results as self explanatory tables which make it easy for the readers to understand and comment on the results.

The major conclusions and recommendations that harvested from the present work are mentioned in the last chapter, chapter 7. All conclusions and recommendations are formulated upon the results of the present study with evidences from the current situation of the MRs and radiographic departments at the Gaza Strip.

Chapter Two

Literature Review

Chapter Two

Literature Review

2.1 Introduction

Diagnostic radiography is a fast moving and continually changing health profession. Evidence, published in the literature, indicates that medical imaging is playing an ever-increasing role in medicine, contributing significantly to improving health outcomes for the population (American Society of Radiologic Technologists, 2001). The medical imaging procedure which the MR performs or is involved in, is part of the overall diagnostic pathway for the patient. Close liaison and collaboration with a wide range of other health practitioners is therefore vital (Spicer *et al*., 1986). The X-ray exposure necessary to produce a radiograph of satisfactory diagnostic quality, commensurate with minimum exposure to the patient, depends not only on the exposure technique and film-screen combination employed but also on the handling and processing of the film. These require a good darkroom and proper developing techniques (Chandrasekaran, 1988).

2.2 The Darkroom

Most modern X-ray departments use automatic film processors for film development. Nevertheless, good darkrooms are still an essential requirement whether they are used for manual processing of films or for loading automatic film processors. While specific details may vary from installation to installation, all darkrooms should include certain basic features and standards necessary for the safety and occupational health preventive measures related to MRs (British Society of Radiographers, 1991).

2.3. Chemical components of X-ray film processing solutions:

2.3.1. Developer Solutions:

Developing is the first step in processing the X-ray film. At this stage silver is deposited at the latent image sites and an image becomes visible (Anslow, 1991). The developer solutions include the followings:

1. Reducing Agent: Hydroquinone: Reduce exposed silver halide to black metallic silver
2. Activator (Sodium Carbonate): Softens gelatin, maintains alkaline pH (increase pH)
3. Hardener (Glutaraldehyde): Prevents over swelling of gelatin in automatic developer.
4. Preservative (Sodium Sulfite): Antioxidant – prevents oxidation of developer.
5. Restrainer (Potassium Bromide): Prevents chemical fog in new developer.
6. Solvent: Water.

The developer functions to convert the latent (invisible) image into the manifest (visible) silver image by reducing the exposed silver bromide crystals to black metallic silver. Important factors affecting the development process are time (length of development), temperature (of the developer solution), and solution activity (strength, concentration). The developer solution has an alkaline nature for optimal function of the reducing agents. Sodium or potassium carbonate provides the necessary alkalinity and serves as an activator (or accelerator) by swelling the gelatin emulsion so that the reducing agents are better able to penetrate the emulsion and reach the exposed silver bromide crystals (Carroll, 2003)

The reducing agents are hydroquinone, which works slowly to build up blacks in the film areas of greater exposure, and phenidone, which quickly produces the gray tones in areas of lesser exposure. The developer solution, particularly the hydroquinone, is especially sensitive to oxygen. If the developer oxidizes, it becomes weaker and less effective. The preservative, sodium sulfite, or cycon, is added to the developer to prevent its rapid oxidation. A hood always covers the developer tank and replenisher solution. The solvent for the concentrated chemicals is water, used to dilute the concentrate to the proper strength (Ball & Price, 1995).

Rapid processing is achieved through the use of high temperatures that accelerate the development process; however, high temperatures can cause excessive emulsion swelling. Since excessive swelling can result in roller transportation problems a hardener, traditionally Glutaraldehyde, is added to the developer to control the amount of emulsion swelling (Anslow, 1991). A restrainer, or antifog agent, is added to the developer to limit its activity to only the exposed silver crystals. The typical restrainer is potassium bromide.

Without the restrainer, the developing agents would attack the unexposed crystals, creating chemical fog. Potassium bromide is frequently referred to as “starter solution” because it is added only to fresh, new developer. As films are developed, bromine ions are released from the emulsion into solution; thus, potassium bromide is not found in replenisher solution (Fodor *et al*., 1989).

2.3.2. Fixer Solutions:

The primary agent of the fixer is the clearing agent. Automatic radiographic fixer solutions also include an activator, preservative, hardener, and water as a solvent (Anslow, 1991). The fixer solutions include the followings:

1. Clearing Agent (Ammonium): Thiosulfate Dissolves undeveloped silver halides
2. Tanning Agent (Aluminum Salt): Shrinks, hardens, preserves emulsion
3. Activator (Acetic Acid): Neutralizes developer, maintains acid pH (decrease pH)
4. Preservative (Sodium Sulfite):Prevents oxidation, prolongs solution life
5. Solvent: Water

The function of the fixer (hypo) is to clear the film of the unexposed, undeveloped silver bromide crystals, and to neutralize any residual developer carried over and provide the required acid medium for the hardener This process serves to protect the film from further exposure. The fixing or clearing agent is ammonium Thiosulfate. Acetic acid provides the required acidic medium. The fixer contains a hardener whose function it is to shrink and re-harden the gelatin emulsion, thus protectin it from abrasion and promoting archival quality. The most commonly used hardeners are potassium alum or aluminum chloride. Fixer preservative sis the same as that found in the developer, ie, sodium sulfite (Carroll, 2003)

Beside developing and fixing X-ray file , washing is an important step during x0ray film processing. The function of the wash is to ride the film of residual chemicals. Should chemicals remain in the emulsion (eg, as a result of defective wash cycle), the film will discolor with age. Since radiographic records are kept for a number of years, it is important that they have sufficient archival quality. Cold water processors are, in general, less efficient in removing chemicals than warm water processors. Agitation during the

wash process and large quantities of water help to rid the emulsion of chemical residue (Anslow, 1991).

2.4 Darkroom disease

Since its inception in 1948, the Word Health Organization (WHO) has focused on factors that impact on the health status of working populations' worldwide. The WHO and collaborative role-players, such as the International Labor Organization (ILO) regularly publish reports on occupational health risks. Early publications suggesting a causal link between symptoms and exposure to processing chemistry includes one by William Rea in Annals of Allergy, 1978, where he described a 38 year old physician who, after each exposure to X-ray processor fumes, had a broad spectrum of symptoms related to smooth muscle sensitization, including gastro-intestinal upset, urinary urgency, chest tightness and peripheral arterial spasm. Withdrawal from this environment resulted in cessation of the arrhythmias, while at least 20 separate re-exposures resulted in premature ventricular contractions (Rea, 1978).

In the early 1980s, radiographers - the (mostly woman) technicians who take X-rays in the governmental hospitals and clinics - began complaining of a range of confusing symptoms. Some became so ill they were forced to give up their profession. The radiographer Mrs Marjorie Gordon was one of the first affected by the mysterious illness and she dubbed it as "darkroom disease", the cause was eventually identified as glutaraldehyde, a chemical in the solution used to develop X-ray films. Glutaraldehyde was introduced with fast automatic processing machines in 1967, but Gordon discovered the amount added to the developer was significantly increased in 1980, after which radiographers began falling ill. In 1982, Marjorie Gordon started to get bad attacks of tinnitus, the awful ringing in the ears that can drive sufferers crazy. Next she developed a painfully sore throat and terrible hoarseness. She became so weak she couldn't pick a baby up. All this was in addition to a heart arrhythmia she'd developed the year before which kept her awake at rights as her heart raced at 170 beats a minute. A cardiologist had put it down to nervous tension. An ear, nose and throat specialist couldn't find the cause of her tinnitus and raw throat (Gordon, 1987, 1989, 1994).

Hodgson and Parkinson, 1985 reported a reversible airways obstruction occurred in a photographer after long-term exposure to sulfuric and acetic acid fixers. They suggested the use of fume hoods or increasing rates of air-exchange to prevent symptoms and disease in radiographic workers. The study of Gordon,1986, indicated the need for further investigation into various aspects of the problems of radiographers' health. In his study Gordan presented four case reports to substantiate claims that health professionals exposed to X-ray processing chemicals suffer a variety of symptoms (respiratory problems, dry eyes, skin irritation,…etc). It also addressed points for more detailed investigations into particular aspects of the problem-processor design, darkroom ventilation, safety in chemical handling, awareness of the chemical hazards in radiographic departments (Hodgson and Parkinson, 1985).

In 1989, Bakke *et al*, published two articles concerning a Norweigan X-ray department where 24 out of 30 employees experienced workplace symptoms involving the eyes, upper and lower respiratory tract, as well as headache and fatigue. Analysis of the work environment showed a constant extensive exposure of the employees to chemicals over a long period. After making improvements, health problems were reduced appreciably, but not nullified. Some personnel had acquired permanent impairments. Bronchial hyperreactivity was discovered in 19 of the personnel, 13 of who had subjective symptoms of obstruction and asthma but no manifestation of allergy (Bakke *et al.*,1989).

In 1992, Cullinan *et al*., in Lancet reported occupational asthma in two radiographers, one apparently caused by glutaraldehyde, the other to fixer containing acetic and hydrochloric acids and ammonium thiosulphate (Cullinan *et al*., 1992).

In 1993 Kodak published several articles in response to alleged adverse health effects. They created worse-case scenarios by disconnecting room ventilation and processor exhaust ducts but found that measured air concentrations remained below Permissible Exposure Limits (PELs). They conclude that when used properly "Kodak X-ray processing chemicals used to process Kodak films should not present a health or safety risk," but noted that "some employees may have specific medical conditions, such as asthma or other respiratory diseases, that may require special consideration (Kodak Company, 1993).

2.4.1 Symptoms of exposure to film-processing chemicals at darkroom:

MRs are usually pronounce a variety of symptoms or complains due to exposure to film-processing chemicals, which are collectively known as multiple-chemical sensitivity (MCS), and included: asthma., skin rashes, headaches, sore eyes and throat, tinnitus, painful joints, nausea, numb extremities.(Goncalo *et al*, 1984; Spicer *et al*., 1986; Gordon, 1987; Smedley *et al*., 1996; Wymer *et al*., 2000).

Processing chemicals enter the body via different routes that include skin, inhalation or ingestion. MRs can be exposed to these chemicals through manual film processing, cleaning of the internal components of the film processor or by fumes from the normal processing procedure. Symptoms associated with darkroom disease are well-documented in the literature. Table 2.1 illustrates the most common symptoms and their route of exposure (Merget and Korn, 2005; Takigawa and Endo, 2006)

Table 2.1. Routes of exposure and symptoms of Darkroom Disease.

Route of Exposure	Symptoms
Inhalation	Occupational/glutaraldehyde induced-asthma, chemical/metallic taste, sore throat, sinusitis, catarrh, nose bleeds, rhinitis.
Contact – direct	Dermatitis, skin rash.
Contact – indirect (vapor)	Eye irritation.
Ingestion	Sore throat, abdominal pain, cramps, vomiting, diarrhea, coma, liver and kidney damage.
Inhalation/ingestion	Memory loss, difficulty in concentrating, fatigue, tiredness, headache, nausea.

Relevant to the radiography profession is exposure to glutaraldehyde, identified as the principal cause of most symptoms. Sensitization to glutaraldehyde can occur after any number of exposures, even below recognized occupational standard levels. Glutaraldehyde is included in most processing chemicals to act as a film hardening agent, and its content has been increased since the mid-1980s with the advent of softened film emulsions due to the introduction of low-silver-content films (Leinster *et al*, 1993;Ong *et al*., 2004;).

2.5 Chemicals Descriptions and Hazards

Fumes from these chemicals, as well as chemicals sticking to newly-processed film, can trigger symptoms of multiple chemical sensitivity. MRs risk exposure especially when automatic processing machines malfunction or where ventilation or chemical disposal problems exist (Kippen *et al*., 1986). The solvents used in darkrooms, to amplify and stabilize the X-ray films, are developers and fixers solutions, which contain chemicals such as Glutaraldehyde, hydroquinone, potassium hydroxide, potassium sulphite, sodium, formaldehyde, thiosulphate, acetic acid, aluminum sulphate, ammonium thiosulphate, and others. Some of these chemicals have shown to cause varieties of chronic and severe health problems mainly to the respiratory system (Cullinen *et al*.,1992; Trigg *et al*,1992; Chan-Yeung *et al*, 1993; Gannon *et al*.,1995; Di Stefano *et al*,1999; Smedley *et al*.,1999). The study of Byrns *et al*., 2000 considered all chemicals used in X-ray film processing as a major potential hazards that adversely affect the health status of the MRs even at low concentrations or exposure (Byrns *et al*., 2000).

2.5.1. Glutaraldehyde:

Glutaraldehyde is used as a cold sterilant to disinfect and clean heat-sensitive equipment such as dialysis instruments, surgical instruments, suction bottles, bronchoscopes, endoscopes, and ear, nose, and throat instruments. This chemical is also used as a tissue fixative in histology and pathology labs and as a hardening agent in the development of X-rays. Glutaraldehyde is a colorless, oily liquid with a pungent odor. Hospital workers use it most often in a diluted form mixed with water. Exposure to glutaraldehyde is not confined only to radiography departments, and similar symptoms have occurred with endoscopy, dental and operating theatre staff where glutaraldehyde is utilized as a cold sterilizer of medical equipment (Center for disease control and prevention, 2001).

Leinster *et al.* (1993) work on the assessment of exposure to glutaraldehyde in cold sterilization and X-ray development process was undertaken in 14 locations at six hospitals in south east England. The results obtained indicate that routine exposures of hospital workers to airborne concentrations of the compound are within the current United Kingdom occupational exposure limit of 0.7 mg/ m^3. There was the potential for skin

contact in many of the activities observed and alternative sterilization and disinfection procedures would have been more appropriate in some situations. Recommendations are made on reducing exposures as the current occupational exposure limit for this compound may not be appropriate (Leinster *et al*, 1993).

Palczynski *et al*. (2001) found in his study that there was a significant increase in eosinophil number and percentage, and albumin, eosinophil cationic protein (ECP), and tryptase concentrations in nasal lavage fluid (NLF) from patients with occupational asthma and rhinitis when compared to controls. The results of this study indicate that the immunologic mechanism of GA-induced asthma and the applicability of the ‘‘nasal pool’’ technique as the diagnostic procedure in GA-induced airway allergy (Palczynski *et al*., 2001).

Gannon *et al*., (1995) describe a further seven cases of occupational asthma due to glutaraldehyde in endoscopy and X-ray departments, together with exposure levels measured during the challenge tests and in 19 endoscopy and x ray departments in the region. Three of the workers investigated with occupational asthma came from departments where glutaraldehyde air measurements had been made; the others came from other hospitals or departments. The mean level of glutaraldehyde in air during the challenge tests was 0.068 mg/m3, about one tenth of the short term occupational exposure standard of 0.7 mg/m3. The levels obtained in the challenge chamber were similar to those measured in 13 endoscopy suites and six x ray darkrooms where median short term levels were 0.16 mg/m3 during decantation in endoscopy suites and < 0.009 mg/m3 in darkrooms (Gannon *et al*., 1995).

Pickering *et al*., (2000) examine the effect of exposure concentrations of glutaraldehyde (GA) vapors in endoscopy units. To characterize any exposure-response relations between airborne GA and the occurrence of work related symptoms (WRSs). Positive indications of one GA specific IgE and 4.1% latex specific IgE occurred. A significant relation existed between peak GA concentrations and work related chronic bronchitis and nasal symptoms (after adjustment for types of local ventilation) but not to other Work Related Symptoms. Peak GA concentrations were significantly higher in units that used both negative pressure room and decontaminating unit ventilation. This study documents a significant level of

symptoms reported in the absence of objective evidence of the physiological changes associated with asthma (Pickering *et al*., 2000).

A study carried out by Di Stiefano in 1999 on health-care workers with respiratory symptoms suggestive of occupational asthma due to glutaraldehyde exposure. The history of asthmatic symptoms was investigated with peak expiratory flow rate (PEFR) monitoring, and in eight of the subjects, the specific bronchial provocation test (SBPT) was applied as reference standard for diagnosis of occupational asthma. Specific IgE antibodies to glutaraldehyde were measured with a series of glutaraldehyde modified proteins. This report indicates the importance of glutaraldehyde as an occupational hazard among exposed health-care workers. Intervention in the workplace, training of personnel handling this chemical, and accurate health surveillance may reduce the risk of developing occupational asthma due to Glutaraldehyde (Di Stiefano, 1999).

Chan-Yeung in 1993, explore the diagnosis of occupational asthma in a respiratory technologist, the following tests were performed: preshift and post shift Spirometry, serial measurements of peak expiratory flow rate and nonspecific bronchial hyper responsiveness, and workplace challenge test. Improvements in forced expiratory volume in 1 second (FEV1) and provocative concentration causing a 20% fall in FEV1 were also observed. A workplace challenge test showed a progressive fall in FEV1 when the subject was exposed to glutaraldehyde in a sterilizing agent used to clean bronchoscopes at her workplace. This case study illustrates the usefulness of a workplace challenge test in confirming the diagnosis of occupational asthma. It also indicates the importance of preventing or reducing exposure to sterilizing agents such as glutaraldehyde by means of effective ventilation and proper storage and enclosure during use (Chan-Yeung, 1993).

Curran *et al*., (1996) determine the immunologic responses of subjects exposed to glutaraldehyde (GA) who were diagnosed as having occupational asthma, or who described work-related respiratory symptoms. A series of GA-modified proteins was characterized, and used to analyze sera from 20 GA-exposed workers and 21 unexposed workers for IgE antibodies. Inhibition studies were used to determine the specificity of binding. A significant difference between exposed and unexposed subjects with serum IgE less than 150 kU/l could be detected for GA-specific IgE antibodies (P - 0.026), and 31% of exposed workers with occupational asthma had antibody levels greater than the

unexposed population (mean +2.5 SD). This study report that GA may behave like many other low-molecular-weight chemicals in that specific antibodies can be detected in only a small percentage of exposed workers who report work-related respiratory symptoms (Curran *et al*., 1996).

Waters *et al*., (2003) investigate work practices and glutaraldehyde exposure in relation to symptoms and lung function. A questionnaire was administered to 76 nurses. Exposed nurses (n = 38) also completed lung function tests and visual analogue scales before and after a work session in which glutaraldehyde exposure occurred. Disinfection activities were timed and counted, personal exposures established, and control measures documented. There were significant cross-shift reductions in FVC and FEV(1) in the exposed group. No evidence of a dose-response relationship for symptoms or lung function was found (Waters *et al*., 2003).

Smith and Wang in 2006, revealed that glutaraldehyde (GA) remains one of the few substances capable of high-level instrument disinfection in modern health care. Workers commonly affected include operating room nurses, radiographers, X-ray technicians and cleaners. Widespread hospital usage combined with its well-known irritant properties, has ensured an increase in occupationally-related illnesses during recent years. Workplace exposure is usually dependent on job tasks, ventilation levels and the use of protective equipment (Derek and Rui-Sheng, 2006).

2.5.2. Formaldehyde:

Formaldehyde is moderately toxic by skin contact and highly toxic by inhalation and ingestion. Formaldehyde is highly irritating to eyes and mucous membranes, and repeated exposure can cause severe allergies, including asthma. Chronic exposure to formaldehyde, even at low levels, may result in symptoms of dyspnea, eye and skin irritation, headaches, dizziness, nausea, vomiting and severe nosebleeds. Prolonged exposure to high concentrations can cause tachycardia, inflammation of respiratory passages and in some cases it has even caused death. Formaldehyde is a suspected carcinogenic hazard (U.S. Environmental Protection Agency, 1997).

The occupational risks of exposure to formaldehyde have been investigated and addressed by different studies. Wieslander and colleagues, 1997 investigated the health effects of formaldehyde emission on workers involved in formaldehyde handling and manipulation. A significantly increased prevalence of symptoms related to asthma was observed in relation to workplace where formaldehyde was manipulated (Wieslander *et al.*, 1997).

Franklin and colleagues, (2000) showed that the exposure to domestic levels of formaldehyde has been associated with adverse respiratory symptoms in both adults and children. The underlying mechanisms responsible for these findings have not been established. These results suggest that exposure to formaldehyde in homes may invoke a subclinical inflammatory response in the airways of healthy children. While, the Swedish study done by Norbäck and coworkers, 1995 about correlation of the asthmatic symptoms and volatile organic compounds, formaldehyde, and carbon dioxide in houses. This study comprised 88 subjects, aged 20-45 years, from the general population in Uppsala, a mid-Swedish urban community. The subjects underwent a structured interview, Spirometry, peak expiratory flow (PEF) measurements at home, the results indicate significant relations between breathlessness and indoor concentration of formaldehyde (Franklin and el al., 2000).

2.5.3. Hydroquinone:

Hydroquinone (para-hydroxy benzene) is moderately toxic by skin contact and inhalation, and highly toxic by ingestion. Skin contact can cause irritation and allergies. After repeated eye contact with hydroquinone, depigmentation and eye injury may occur. Inhalation and ingestion may cause ringing in the ears (tinnitis), dizziness, nausea, muscular twitching, increased respiration, headaches, cyanosis (blue lips and nails), delirium and coma (U.S. Environmental Protection Agency, 1999).

The occupational risks of exposure to hydroquinone are well documented in the literature. Makropoulos and Alexopoulos, 2006 who worked at National School of Public Health of Athens, Greece, reported a severe effects of hydroquinone on the general health of the exposed subjects. In their report, Makropoulos and Alexopoulos attributed an induced acute myeloid leukaemia to the exposure of hydroquinone and/or glutaraldehyde.

Hydroquinone and in a lesser degree glutaraldehyde are hypothesized to be the causal factors (Makropoulos and Alexopoulos, 2006).

Adams in 1990 determined the hazards of hydroquinone that may affects the eyes, the respiratory system, skin, and central nervous system. In their study Adams and coworkers showed hydroquinone as a dermal sensitizer that may case leukoderma (absence of pigment, partial or total, in the skin) upon repeated exposure (Adams, 1990).

2.5.4. Sulphur Dioxide:

The occupational risks of exposure to SO_2 are reported by several researchers who investigated the health status of workers in copper smelter works in the United States of America and Poland respectively (Agarwal and Yadav, 2004). Smith and Wang, (2006) measured the pulmonary function of 113 copper smelter workers to assess the effects of chronic exposure to SO_2 The study indicated that exposure to 1.0-2.5ppm of SO2 was associated with excessive loss of one second forced expiratory volume and an increase in respiratory symptoms. Workers with one second forced expiratory volume below normal and initial measurements showed evidence of even greater losses of pulmonary function related to SO_2 exposure (Smith and Wang, 2006).

In contrast to the above finding, Kolarzyk and colleges in (2000) reported during their study in 1994-1998 that more compensation claims for disease related to occupational hazards were registered. They conducted a research where 851 cases from 1396 cases were certified as occupational–related diseases, of this number 481 cases (56,5%) were diagnosed as pulmonary diseases. Chronic bronchitis was diagnosed in patients exposed to industrial dust containing SO_2. It is noted by Kolarzyk *et al*., 2000 that during 4 years of the study, chronic bronchitis and lung cancer and asthma were more frequently diagnosed in the workers who exposed to SO_2 (Kolarzyk *et al*., 2000). Spicer *et al*., 1986, reported on a survey of 367 New Zealand radiographers work-place symptoms, which correlated with the time spent in the darkroom (Spicer *et al*., 1986).

The effects of SO_2 on humans are divided into short and long term. Exposures to very high levels of SO_2 such as 100ppm can be life threatening. Burning of nose and throat, breathing difficulties, severe airway obstruction may be the results of short term exposure

(NIOSH Pocket Guide, 2005). The long-term effects are due to generally low repeated occupational exposure to SO2 over many years. These effects included bronchitis, emphysema and permanent lung damage (NIOSH Pocket Guide, 2005).

2.6 Precautions and control measures at radiographic departments

This section discusses the major precautions and control measures that should be considered at radiographic departments, which included operation controls, engineering controls, administrative controls, and personal protective equipment for the most effective removal of atmospheric contaminants as mentioned by the Occupational Safety and Health Service, 1992:

2.6.1. Isolation:

Isolation involves separating employees from the hazardous substance by distance or barriers to prevent or reduce exposure. Separating radiographers from fume-generating film processors is strongly recommended that film processors and associated mixing systems are isolated from other work areas within the radiology department. If the processor is installed for 'through the wall' film-feed, then the side used to feed the film (darkroom side) must be at a positive pressure with respect to the processor side (light side) to prevent fumes being drawn back through the film-feed slot.

2.6.2. Engineering Controls:

Engineering controls are the physical controls used to eliminate or reduce the generation of substances, suppress or contain substances, or limit contamination areas in the event of spills and leaks. General room ventilation must work in synergy with local exhaust ventilation for successful removal of atmospheric contaminants. It is essential that all air conditioning and venting systems be designed and installed by air conditioning engineers to ensure that all specifications are met. (Carroll, 2003)

Most automatic X-ray processors provide an exhaust system that serves to remove chemical and moisture vapors via a safe external vent. The key necessities for successful installation are:

- The exhaust system must be vented to an external environment, independent of general building air-conditioning;
- It needs to provide fan extraction so that the processor manufacturer's specifications are met;
- The fan extraction must operate continuously when chemicals are present in the processor, irrespective of whether it is being used;
- For tabletop and non-vented processors, a fume hood/extraction system should be used and operated whenever the processor contains chemicals.

It is recommended that a fume hood or extraction system be provided above the processor for escaping fumes. The design of the system should ensure that the fumes are not drawn over the worker's breathing zone.

Exhaust ventilation for the entire room should also be used to minimize exposure to processing fumes. The total air movement in the room should be balanced to maintain the room at a slight negative pressure, which helps to keep any fume vapor contained within the room. The room inlet and outlet should be situated so that the air can circulate completely through the room before being drawn out again. It is suggested that a fresh airflow rate of at least 2.5 liters per second per meter of room size be used.

When mixing chemicals, it is recommended that an exhaust hood and extraction system, similar to that used for processors, be placed above each mixing device. (Ide, 1993)

2.6.3. Administrative Controls:

Administrative controls are safe work practice systems that reduce employee exposure to chemical fumes. Specific measures taken should include:

- keeping containers of processing chemicals tightly lidded when not in use;
- cleaning up spills immediately;

- prompt cleaning of residues of processing chemicals from empty containers;
- prohibiting eating, drinking and smoking in potentially contaminated areas;
- providing suitable cleaning facilities;
- ensuring that processor and ventilation systems undergo periodic checks to ensure they are properly maintained;
- making first aid facilities readily available; and
- administering possible job rotation away from areas where processing fumes are being emitted.

An employer has a responsibility to ensure that control measures and all other parameters are properly used and maintained. The use of periodic atmospheric monitoring may be employed to ensure that employees are not exposed to an atmospheric glutaraldehyde concentration of more than the exposure standard (0.1 ppm). However, this concentration level is irrelevant to those individuals who have become sensitized to glutaraldehyde, as risk of reaction is not proportional to the concentration and can occur with extremely small exposures. (Carroll, 2003)

2.6.4. Personal protective equipment (PPE):

Adequate PPE must be worn when pouring or mixing processing chemicals. The international Guidelines for the safe use of chemical hazards in the health Industries recommend the use of a half-face respirator with appropriate organic vapors cartridges as the minimal degree of protection. The use of a surgical mask or a charcoal impregnated disposable dust mask is totally inadequate protection. (James and Patrick, 2003).

When handling film-processing chemicals, gloves should be worn to prevent skin contact. Gloves made from nitrile, neoprene rubber or butyl rubber provide adequate protection. Glutaraldehyde and other chemicals can penetrate surgical latex gloves, and therefore these are inadequate. Impervious aprons should be worn to protect against chemical splashes. When pouring quantities of processing chemicals, eye protection should be worn to

prevent eye irritation. Eye protection is especially important for staff with contact lenses as glutaraldehyde can become trapped between the eye and the lens, causing irritation. (Scobbie , 1998; Liss, 2002; Nallon, 2000)

2.7. Spirometry and respiratory Function Test:

The Spirometry is one of the most useful instruments for office practice. Primary care physician, pulmonary , and cardiac specialist are usually use Spirometry in their practice. Today the modern Spirometry must find its rightful place alongside the sphygmomanometer and the electrocardiograph. Abnormal Spirometry is an indicator of increased risk for premature death from all causes. This fact has been known since the time of its invention in 1846 by John Hutchinson, a surgeon, and the coining of the term "vital capacity. Spirometry has a wide application throughout general medicine and pulmonology (Buffels *et al*., 2004)

The main parameters of pulmonary function test are FEV1 and FEV1/FVC these parameters are known to be indicators of the state of airway disease. Decreased FEV1/FVC and FEV1 were found in patients with airway constriction. Patients with pulmonary fibrous changes or respiratory muscle weakness had an FEV1 reduction but had normal FEV1/FVC (Ying-Chu *et al.*, 2002).

Spirometry is a powerful tool that can be used to detect, follow, and manage patients with lung disorders. Technology advancements have made spirometry much more reliable and relatively simple to incorporate into a routine office visit. However, interpreting Spirometry results can be challenging because the quality of the test is largely dependent on patient effort and cooperation, and the interpreter's knowledge of appropriate reference values. A simplified and stepwise method is key to interpreting Spirometry. The first step is determining the validity of the test. Next, the determination of an obstructive or restrictive ventilator Patten is made. If a ventilator pattern is identified, its severity is graded (American College of Occupational and Environmental Medicine, 2005).

Although a complete respiratory function test provides the most accurate objective assessment of lung impairment, Spirometry is the preferred test for the diagnosis of COPD

because it can obtain adequate information in a cost-effective manner. A great deal of information can be obtained from a Spirometry test; however, the results must be correlated carefully with clinical and roentgenographic data for optimal clinical application. This article reviews the indications for use of Spirometry, provides a stepwise approach to its interpretation, and indicates when additional tests are warranted (Gold *et al.*, 2000)

Spirometry measures the rate at which the lung changes volume during forced breathing maneuvers. Spirometry begins with a full inhalation, followed by a forced expiration that rapidly empties the lungs. Expiration is continued for as long as possible or until a plateau in exhaled volume is reached. These efforts are recorded and graphed thorough specific output screen (Sood and Redlich, 2001).

Spirometry is designed to identify and quantify functional abnormalities of the respiratory system. The National Lung Health Education Program (NLHEP) recommends that primary care physicians perform Spirometry in patients 45 years of age or older who are current or former smokers; in patients who have a prolonged or progressive cough or sputum production; or in patients who have a history of exposure to lung irritants (Petty, 2001).

Other indications for Spirometry are to determine the strength and function of the chest, follow disease progression, assess response to treatment, and obtain baseline measurements before prescribing drugs that are potentially toxic to the lungs, (Flaherty and Martinaze, 2000; Alhamad *et al*., 2001). Spirometry also is helpful in preoperative risk assessment for many surgeries and often is used in workers' compensation and disability claims to assess occupational exposure to inhalation hazards (Dunn and Scanlone, 1993)

2.8 IgE and Respiratory System Allergies:

The immune system produces at least five major kinds of immunoglobulin (Ig) or antibodies (IgA, IgD, IgE, IgG and IgM), but the principal one that participates in allergic reactions is immunoglobulin E, or IgE. Every individual has different IgE antibodies, and each allergic substance stimulates production of its own specific IgE. When the antibodies encounter the allergen they are programmed against, they immediately signal the

basophiles or mast cells to unleash histamine or other mediating chemicals into the surrounding tissue. It is these chemicals - mainly histamine - that cause the familiar allergic reactions (Kuntz *et al*., 2002)

Immunoglobulin E, a class of immunoglobulin that includes the antibodies elicited by an allergic substance (allergen). A person who has an allergy usually has elevated blood levels of IgE. IgE antibodies attack and engage the invading army of allergens. The E in IgE stands for erythema (Kuntz *et al*., 2002). An IgE antibody made to respond to ragweed pollen, for example, will react only against ragweed, and not oak tree or bluegrass or any other kind of pollen (Kerkhof *et al*., 2003).

Although for some chemical respiratory allergens (including the acid anhydrides) there exists a strong correlation between symptoms and the presence of specific IgE antibody, for other respiratory sensitizers (and notably the diisocyanates) such an association is variable or absent. Although inhalation exposure is probably the most common and most important route through which allergic sensitization of the respiratory tract is achieved, there is evidence also that respiratory sensitization to chemicals may be acquired also by dermal contact; observations that have important implications for occupational health management (Kimber and Dearkman, 2002)

Chapter Three

Conceptual Framework

Chapter 3

Conceptual Framework

3.1 Introduction

MRs involved in X-ray film processing are exposed to a variety of chemical fumes hazards that produced during developing and fixing X-ray films. As early as 1980s, there were an increasing reports and concerns about diverse health problems and complains among MRs who are involved in processing X-ray films in darkroom of the radiological departments. X-ray film processing involves exposure to a complex mixture of substances, some of which are well known to have adverse health effects. Glutaraldehyde, formaldehyde, sulphur dioxide, and acetic acid have been associated with health complains related to the respiratory system and airways. Moreover, these processing chemicals are considered as sensitizing agents that have given rise to cases of occupational asthma (Gordon, 1989; Scobbie *et al*., 1996; Liss *et al*., 2003).

The medical radiographer Mrs Marjorie Gordon was the first in 1980 who dubbed "darkroom disease" for the wide range of confusing symptoms and mysterious illness she complained due to her work in X-ray film processing (Genton, 1998).

Descriptively, the term "darkroom disease" has been coined for the miscellaneous symptoms experienced by the workers involved in developing films, principally X-ray films which is developed by MRs. Therefore, much efforts and safety measures have been introduced and adopted for the minimization of the adverse effects of theses chemical hazards which included the using of automated processors, safer designs, powerful and effective local exhaust ventilation systems, educating MRs for the safer use and handling of such chemicals, and incorporation of legislative directives into working practices. Despite of the previous preventive and safety measures, darkroom disease remains a well recognized health status among X-ray department personnel (Dimich-Ward *et al.,* 2003).

The present case control study was designed and conducted at the five governorates of the Gaza Strip and aimed at the investigation of the effect of X-ray film processing on the respiratory function tests, complete blood count, and IgE levels of MRs as compared to a control group of PTs. Meanwhile it further aimed at the evaluation of the knowledge and practices of MRs toward the use of X-ray processing chemicals and darkroom diseases. Also it aimed at the evaluation of structure, design, and work set up at the radiology departments and recommendation of preventive measures that could improve the health situation of the MRs. The tools of the present work included close ended questionnaire, spirometric analysis, complete blood count, and determination of serum IgE levels. A schematic representation of the theoretical framework of the present study is mentioned in Fig 3.1.

3.2. Medical Radiographer:

The Medical Radiographer is a health professional who works as part of a multidisciplinary health care team, having responsibility for the production of medical images to assist medical diagnosis and medical decision making. The procedures undertaken aim to achieve optimal outcomes for the patient with minimal occupational risks for the MRs. (James and Patrick, 2003)

3.3 Darkroom

Is a workspace, usually a separate area in a building or a vehicle, made dark to allow medical radiographers to use light-sensitive materials to develop X-ray films, operating, monitoring and maintaining the film processing equipment used in radiographic department (James and Patrick, 2003)

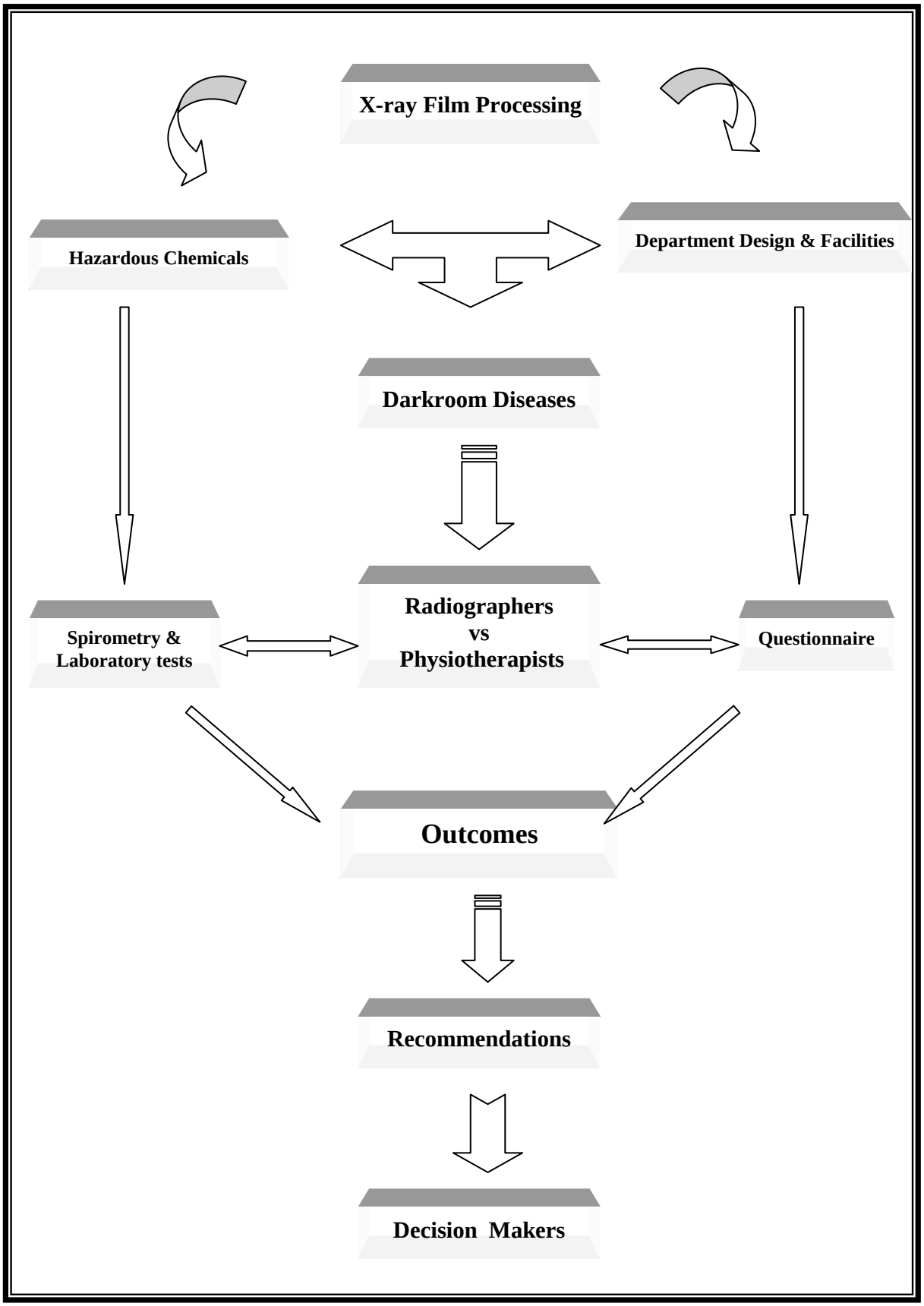


Fig 3.1. Schematic Representation of the Theoretical Framework of the Study

3.4 X-ray Film Processing Machine

Is a complex machine introduced in 1957 by Eastman Kodak, that utilizes several subsystem (transport system, dryer system, replenishment system, circulation system, and temperature control system) to facilitate and rapid the production of X-ray films. Modern processors are much more compact and they process a film in 25-120 seconds (Kodak Company, 1993; Carroll, 2003).

3.5 Physiotherapist

A physiotherapist is a recognized professional who demonstrates advanced competencies in the promotion of safe physical activity participation, provision of advice, and adaptation of rehabilitation and training interventions, for the purposes of preventing injury, restoring optimal function, and contributing to the enhancement of sports performance, in athletes of all ages and abilities, while ensuring a high standard of professional and ethical practice (Jette *et al*., 2003).

3.6 Case Control Design

Case-control studies are one type of epidemiological study design. They are used to identify factors that may contribute to certain condition by comparing a group of cases who have that condition with a group of controls who do not have. Case-control studies are most common in medical-based researches and are relatively inexpensive and frequently used in epidemiological studies that can be carried out by small teams or individual researchers (Schlesselman, 1982).

3.7 Close-Ended Questionnaire

A questionnaire is a series of inquires or questions that could be asked to the study subjects to obtain statistically useful information about a given topic. When properly constructed and responsibly administered, questionnaires are considered as a vital instrument by which statements can be made about specific groups or people or entire populations. Good questionnaire construction is critical to the success of the study. Inappropriate questions,

incorrect ordering of questions, incorrect scaling, or bad questionnaire format could negatively affect the validness of the study making it valueless. The two major types of questionnaire are close-ended and open-ended questionnaires. A closed-ended question is a form of question which normally can be answered with a simple "yes/no", scaled questions or a selection from multiple choices. While An open-ended question is a form of question, opposite to the closed-ended one, where the respondent answers the relevant questions or items with his own words (Reja *et al*., 2003).

The closed-ended questionnaire of the present work included items that addressed: Socio-demographic and general characteristics of the subjects; health characteristics and complains of the subjects; general and technical evaluation of the radiology departments as well as the radiographers.

3.8. Spirometry and Respiratory Function Test:

Spirometry, which means the measuring of breath, is group of tests that can help the medical professionals to diagnose various lung and pulmonary conditions and diseases as well as to monitor the severity of certain lung conditions, and their response to treatment. Spirometry is the commonest of pulmonary function tests (PFTs) that measures lung and respiratory functions, specifically the measurement of the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled (Johns and Pierce, 2003).

As with any biological test, the results of spirometry need to be evaluated in relation to "normal" or reference values. One step is to compare results of the individual to published reference values that have been measured in a similar population of healthy individuals without lung disease and who do not smoke. The most important determinants of respiratory function test results are: height, weight; age: sex, and ethnic group (Barbara, 2007) . The main parameters measured and provided by the in Spirometry are mentioned in Table 3.1.

Table 3.1: The Main Parameters of Spirometry lab.

Parameter	Description
Forced Vital Capacity (FVC) **L**	This is the total amount of air that can forcibly be blown out after full inspiration, measured in liters.
Forced Expiratory Volume in 1 Sec (FEV1) **L**	This is the amount of air that you can forcibly blow out in one second, measured in liters. Along with FVC it is considered one of the primary indicators of lung function.
Forced Expiratory Volume % FEV1 %	This is the ratio of FEV 1 to FVC.
Peak Expiratory Flow (PEF) **L/s**	This is the speed of the air moving out of your lungs at the beginning of the expiration, measured in liters per second.
Forced Expiratory Flow at 25%, 50%, 75% (FEF)	This is the average flow (or speed) of air coming out of the lung during the middle portion of the expiration (also sometimes referred to as the MMEF, for maximal mid-expiratory flow).

3.9. Respiratory Disease:

Clinically, most of noninfectious lung diseases are representing one of two patterns of breathing: restrictive or obstructive. These terms refer only to how a respiratory problem affects a patient's breathing pattern; they say nothing about cause, treatment, X-ray appearance, or prognosis of his condition. Furthermore, the two breathing patterns frequently are seen together in one disease. At best they are merely descriptive of many respiratory problems (Sutton and Young, 1995).

3.9.1. Restrictive Respiratory Disease:

This is any respiratory condition where the patient is unable to take in a full, deep breath. It can be due to lung, chest cage, or nervous system disease.(Venables *et al*., 1993; Johns and Pierce, 2003)

3.9.2. Obstructive Respiratory Disease:

Asthma, chronic bronchitis, and emphysema are examples of obstructive lung disease. Characteristic of this group is difficulty getting all the air out. Obstructive lung diseases are the greatest cause of respiratory morbidity in the United States. Obstructive lung disease is best diagnosed by a simple pulmonary function test of the forced vital capacity. The obstructed patient can take a deep breath but the rate of exhalation is slowed. This is contrasted with a restricted patient, who cannot inhale as much air but can exhale it readily .(Venables *et al*., 1993; David and Rob, 2003)

3.10 Complete Blood Count

A complete blood count (CBC) which is also known as hemogram gives important information about the quality and quantity of blood, both cellular and noncellular, components in health and disease cases. A CBC helps the health professional check any symptoms, such as weakness, fatigue, or bruising on human health, and therefore the interpreting the correct diagnosis. Abnormally in CBC may indicate the presence of many forms of disease, and hence blood counts are amongst the most commonly performed blood tests in medicine, as they can provide an overview of a patient's general health status. CBC test include the counting of the red blood cells, white blood cells and platelets, together with their related indices (Hoffbrand & Pettit, 1993).

A phlebotomist collects the specimen, in this case blood is drawn in a test tube containing an anticoagulant (EDTA, sometimes citrate) to stop it from clotting, and transported to a laboratory. In the past, counting the cells in a patient's blood was performed manually, by viewing a slide prepared with a sample of the patient's blood under a microscope (a blood film, or peripheral smear). Nowadays, this process is generally automated by use of an automated analyzer, with only specific samples being examined manually (Haen and Young, 1995).

3.11 Immunoglobulin E (IgE)

The immune system produces five major kinds of immunoglobulin (Ig) or antibodies (IgG, IgM,, IgA, IgD, IgE). Immunoglobulin E, a class of immunoglobulin that includes the antibodies elicited by an allergic substance (allergen). A person who has an allergy usually has elevated IgE blood levels. IgE antibodies attack and engage the invading army of allergens (Kuntz, 2002). Every individual has different IgE antibodies, and each allergic substance stimulates production of its own specific IgE. An IgE antibody made to respond to ragweed pollen, for example, will react only against ragweed, and not oak tree or bluegrass or any other kind of pollen (Kerkhof, 2003). Measurements of total IgE serum concentration may reflect the allergic or hypersensitivity status of the susceptible individual how is subjected to different kinds of allergic substances or allergens (Haen and Young, 1995).

Chapter Four

Materials and Methods

Chapter Four

Materials and Methods

4.1 Introduction

The present study was conduced in order to investigate the effect of X-ray films processing on the respiratory functions and related laboratory tests of MRs in the Gaza governorates. Physiotherapists who are working at the main hospitals and health centers were included as controls for the present work, which minimizes or diminishes any interrupting factors that may affect the reliability of the results. The tools of the present study included close ended questionnaire, Spirometric analysis, complete blood count, and determination of serum IgE levels.

4.2 Study design

The present work was designed as a case control study aiming at the investigation of the possible risks of chemical fumes that use in X-ray film processing room on respiratory functions and some hematological and biochemical parameters of MRs as compared with a control group of physiotherapists.

4.3 Target Population:

The targets of the present study were all the MRs who are working at the radiographic department of governmental hospitals and primary health care (PHC) centers at the Gaza governorates. While, the controls of the present study were included form the physiotherapy technicians who are working at governmental hospitals and PHC and they were matched to cases based on governorate.

4.4 Setting

This study was carried out in the five governorates of the Gaza Strip: North, Gaza, Mid Zone, Khanyounis, and Rafah, with sample size relatively compatible, as much as possible, with the population size of each governorate. Sampling, field works, and laboratory investigations of the study were conducted at the governmental hospitals and PHC in Gaza governorates, between May 2008 to August 2008.

4.5 Ethical considerations:

The approval for the topic and methodology of the present study was obtained from the Helsinki committee (Annex 2) at the Palestinian ministry of health (MOH). Another approval was also obtained from the MOH to allow the researcher to carry out the study on MRs and PTs who are working at the governmental hospitals and PHC of Gaza governorates. The researcher borrowed Spirometry portable lab for respiratory function test from the department of Occupational Health in the MOH. The laboratory tests of this study were performed at the central laboratory of MOH according to official agreement with director of the central laboratory.

The researcher purchased the kit for IgE determination and he withdrawn and communicated the blood and serum samples to the central laboratory for the required tests. All approvals and agreements are attached to Annexes 3,4, and 5.

The researcher explained the purpose and objectives, and methodology of the study as well as his name and occupation to all subjects included in the present study. He also declared and committed to the participant about the confidentiality of the study. After the free acceptance, the subjects were asked to fill and sign the proper questionnaire which included the consent statement of the study. After filling and signing the questionnaire, the subjects who agree were subjected to the spirometry test to asses respiratory functions and venous blood sampling for CBC and IgE determination. The inclusion in the study was optional and confidential. Neither name nor personal data were published. All ethical considerations were maintained, including respect of people, truth and confidentiality.

4.6 Research Tools

In order to achieve the objectives of the present work, the researcher relied on questionnaire together with laboratory and experimental analysis as the main tools of the research. These tools included close ended questionnaire, Spirometric analysis, complete blood count, and determination of serum IgE levels.

4.6.1. Questionnaire:

Important part of data was collected by using close-ended questionnaire which was constructed and conducted in Arabic language. Details about the components of the questionnaire are included in Annex 6 . The questionnaire was designed to include five major components with 46 items

1- Socio-demographic and general characteristics of the subjects, MRs and PTs (7 items).
2- Health characteristics of the subjects, MRs and PTs (5 items).
3- Health complains of the subjects, MRs and PTs (12 items).
4- General and technical evaluation of the radiology departments (12 items).
5- General and technical evaluation (knowledge and practice) of the radiographers (10 items)

The items and components of the questionnaire were arbitrated and validated at three levels. The first was criterion related validity that depended on the construction of questionnaire items after reviewing the related literature. The Second was content validity; the questionnaire was checked by university scientists and experts (Annex 7). The objectives of the study were attached with the questionnaire form. Some of the items were added, some modified and some were excluded. The third level is through piloting procedure, where the 10 copies where distributed to MR volunteers and the questionnaire content was also modified for confusion, redundancy and time factors.

The questionnaire was distributed to the subjects at the hospitals and PHC centers where they are work. The researcher explained the purpose and objectives of the study and he

declared and committed to the participant about the confidentiality of the study. After the free acceptance, the subjects were asked to fill the proper questionnaire. The average time for filling the questionnaire was about 10-15 minutes.

The data of the questionnaire related to health complains of the subjects were summarized as single parameter that reflects the number of complains of the subjects and then calculated as percentage. The subject who mentioned 12 complains was scored as 100 % complain, while who mentioned no complains was scored as 0 % complain. The remaining categories were percentages of the number of complain to 12..

4.6.2. Spirometry Tests:

4.6.2.1. Spirometry:

Spirometry, which means the measuring of breath, is group tests that can help the medical professionals to diagnose various lung and pulmonary conditions and diseases as well as to monitor the severity of certain lung conditions, and their response to treatment. Spirometry is the commonest of pulmonary function tests (PFTs) that measures lung and respiratory functions, specifically the measurement of the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled (Johns and Pierce, 2003).

4.6.2.2. Spirometer:

The Spirometry tests are performed using a device called a Spirometer. A Spirometer is a device that measures the amount of air that you can blow out. There are various Spirometer devices made by different companies, but they all measure the same thing. They all have a mouthpiece that used to blow into the device and common parameters are measured with all types of Spirometer. The most common measurements used and displayed by most Spirometer are:

- ***Forced Vital Capacity (FVC) L***
- ***Forced Expiratory Volume in 1 Second (FEV1) L***
- ***Forced Expiratory Volume % (FEV1 / FVC) FEV1%***
- ***Peak Expiratory Flow (PEF) L/s***
- ***Forced Expiratory Flow at 25% (FEF25) L/s***
- ***Forced Expiratory Flow at 50% (FEF50) L/s***
- ***Forced Expiratory Flow at 75% (FEF75) L/s***

A Spirometry reading usually shows one of four main patterns or their combinations :

- Normal
- An obstructive pattern (mild, moderate, moderate to severe, and severe)
- A restrictive pattern (mild, moderate, moderate to severe, and severe)
- A combined obstructive / restrictive pattern

In the present work the researcher used the Spirolab II Spirometer (Medical international research, Rome, Italy). Spirolab II makes breathing pattern tests and calculates an index of test acceptability (test quality control) and a measure of reproducibility; and also gives functional interpretation following the latest American Thoracic Society (ATS) and European Respiratory Society (ERS) classification and standards. The evaluation and interpretation of test results are given by comparing the measured parameters with specific 'normal' Spirometry values (known as predicted values) which are calculated from subject data: age, height, weight, sex and ethnic group.

4.6.2.3. Spirometric Results:

The results of each test session are compared to the relevant predicted values and the percentage ratio between measured and predicted is shown for each parameter.

% Predicted = Measured/Predicted X 100

Following the international ATS and ERS standards, it is recommended to repeat at least 3 times every FVC test to ensure the reliability of the Spirometry test results. The device

helps the user through the reproducibility control check. Between one test and another, the reproducibility of the Spirometric parameters are calculated as Δ (delta) which indicates the difference between two measured values.:

- ***FVC is reproducible if ΔFVC < 5 % or < 200 mL***
- ***FEV1 is reproducible if ΔFEV1 < 5 % or < 100 mL***
- ***PEF is reproducible if ΔPEF < 10 %***

At the end of the test, the reproducibility of a single parameter is indicated alongside the numerical value by a + sign (reproducible) or a - sign (not reproducible).

4.6.2.4. Spirometry Procedure:

Each subject was tested while standing, using Spirolab II Spirometer. Spirometric measurements were performed between 08:00 am and 4.00 pm. Standing height and body weight were measured in all subjects without wearing shoes by a calibrated weighting scale and stadiometer. Three experiments (measurements) were performed using sterile disposable calibrated mouth pieces to prevent any contamination during the experiments.

Experiment 1: Measuring Expiratory Reserve Volume (ERV):

Measures the amount of air that can be forcibly breathed out after normal expiration (ERV). The subject stands, breathing normally for a minute or so, then, after a normal exhalation puts the mouthpiece between the lips, and forcibly exhales all the additional air possible.

Experiment 2: Measuring Inspiratory Reserve Volume (IRV):

Measures the amount of air that can be inhale following normal inhalation. While standing, the subject breathes normally for a minute; then breathes as deeply as possible. With the mouthpiece inserted, the subject then exhales normally, without forcing the air out.

Experiment 3: Measuring Vital Capacity (VC):

Measures the maximum amount of air which can be forcibly exhaled immediately following a maximal inhalation (VC) VC = Tidal volume (TV) + IRV + ERV
While standing, the subject slowly and deeply breathes in and out for awhile, then breathes in as deeply as possible, places the Spirometer mouthpiece in position, and breathes out as forcibly as possible.

4.6.3. Complete Blood Count (CBC):

Complete blood count was determined for all subjects who agreed to provide venous blood sample. Venous blood samples were collected in K3-EDTA tubes and transported in ice box. Complete blood counts using Sysmex KX-21N electronic counter (Sysmex Corporation, Kobe , Japan) were performed within 2-4 hours of collection and included the following parameters and indices: white blood cell (WBC) count, red blood cell (RBC) count, haemoglobin (Hb) concentration, haematocrit (Hct) percentage, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), red cell distribution width (RDW), platelets (PLT) count, mean platelets volume, and platelets distribution width.

4.6.4. Serum Immunoglobulin E (IgE):

A commercial enzyme-linked immunosorbent assay (ELISA) kit (DRG international Inc., USA) was used for quantitative determination of IgE concentration in human serum samples. Blood samples that collected in serum tube were centrifuged 2-4 h after sampling at 3500 r.p.m. for 20 min, re-centrifuged, and stored in sealed glass ampoules at 2–4 C to be used within one week for IgE quantitation.

4.6.4.1 Principle of the IgE test:

The IgE Quantitative Test is based on a solid phase enzyme-linked immunosorbent assay (ELISA). The test specimen (serum) is added to the IgE antibody coated microtiter wells and incubated with the Zero Buffer at room temperature for 30 minutes. If human IgE is

present in the specimen, it will combine with the antibody on the well. The well is then washed to remove any residual test specimen, and IgE antibody labeled with horseradish peroxidase (conjugate) are added. The conjugate will bind immunologically to the IgE on the well, resulting in the IgE molecules being sandwiched between the solid phase and enzyme-linked antibodies. After incubation at room temperature for 30 minutes, the wells are washed with water to remove unbound-labeled antibodies. A solution of color reagent is added and incubated at room temperature for 20 minutes, resulting in the development of a blue color. The color development is stopped with the addition of Stop Solution, and the color is changed to yellow and measured spectrophotometrically at 450 nm. The concentration of IgE is directly proportional to the color intensity of the test sample (DRG international, 2005).

4.6.4.2. Materials provided with the IgE test kits:

- Antibody-coated microliter wells, 96 wells per plate.
- IgE Reference standards 0, 15, 50, 100, 400 and 800 IU/ml, liquid, ready for use.
- Zero buffer, 13 ml.
- Enzyme Conjugate Reagent, 18 ml.
- Color Reagent (One-Step), 11ml.
- Stop Solution (1N HCl) , 11ml.

4.6.4.3 Materials required:

- Precision pipettes: 20 µl, 100 µl, 200 µl, and 1.0 ml.
- Disposable pipette tips
- Distilled water.
- Vortex mixer.
- Absorbent paper or paper towel.
- Graph paper.
- Microtiter well reader at 450 nm wavelength, with a bandwidth of 10 nm or less and an optical density (OD) range of 0-2 or greater.

4.6.4.4. IgE Assay Procedure:

Serum should be prepared from a whole blood specimen obtained by acceptable medical techniques. This kit is for use with serum samples without additives only. The assay procedure was followed precisely as mentioned in the manufacturer instruction manual (DRG international, 2005) which was a s follow:

1. Secure the desired number of coated wells in the holder.
2. Dispense 20 µl of standard, specimens, and controls into appropriate wells.
3. Dispense 100 µl of Zero Buffer into each well.
4. Thoroughly mix for 10 seconds. It is very important to have complete mixing in this setup.
5. Incubate at room temperature (18-25^{o}C) for 30 minutes.
6. Remove the incubation mixture by flicking plate content into a waste container.
7. Rinse and flick the microtiter wells 5 times with distilled water or deionized water.
8. Strike the wells sharply onto absorbent paper or paper towels to remove all residual water droplets.
9. Dispense 150 µl of Enzyme Conjugate Reagent into each well. Gently mix for 10 seconds.
10. Incubate at room temperature for 30 minutes.
11. Remove the incubation mixture by flicking plate contents into sink.
12. Rinse and flick the microtiter wells 5 times with distilled water or deionized water.
13. Strike the wells sharply onto absorbent paper or paper towels to remove all residual water droplets.
14. Dispense 100 µl TMB reagent into each well. Gently mix for 5 seconds.
15. Incubate at room temperature in the dark for 20 minutes.
16. Stop the reaction by adding µl 100 of Stop Solution to each well.
17. Gently mix for 30 seconds. It is important to make sure that the blue color changes to yellow color completely.
18. Read optical density at 450 nm with a microtiter reader within 15 minutes.

4.6.4.5. Calculation of Results:

1. Calculate the average absorbance values (A450) for each set of reference standards, control, and samples.
2. Constructed a standard curve by plotting the mean absorbance obtained from each reference standard against its concentration in lU/ml on linear graph paper, with absorbance values on the vertical or Y-axis and concentrations on the horizontal or X-axis.
3.Using the mean absorbance value for each sample, determine the corresponding concentration of IgE in lU/ml from the standard curve (DRG international, 2005).

4.6.4.6 Expected Values and Sensitivity:

The total IgE level in a normal, allergy-free adult is less than 100 IU/ml of serum. This procedure provides a rapid, sensitive, and reliable assay for total serum IgE, with minimal sensitivity of this assay of about 5.0 IU/ml.

4.7 Pilot Study

Ten MRs were assigned for the piloting stage of the present work. The 10 volunteers MRs are not eligible for the present study due to the experience < 10 years or who exceeding maximum permissible dose (MPD) of radiation. They were asked freely to answer the questionnaire and to perform the Spirometry test. The questionnaire content was modified for confusion, redundancy and time factors, while Spirometry set up and calibration were maintained in the piloting stage. Ethically, venous blood sampling is neither recommended nor appreciated for piloting purposes.

4.8 Study Population and Sampling

The target population of the present work was MRs and PTs who are working at the governmental hospitals and PHC centers in the different governorates of the Gaza Strip.

4.8.1 Eligibility Criteria:

Because of the case-control design of the present work both inclusion and exclusion criteria should be identified for both case subjects and control subjects.

4.8.1.1 Eligibility criteria for the cases:

Inclusion Criteria:

Any MR who is working at the radiographic departments of governmental hospitals and primary health care of the Gaza governorates is included if he has at least ten years working experience, no family history of respiratory problems, and not exceeding maximum permissible dose (MPD) of radiation.

Exclusion Criteria:

Any MR working at the radiographic departments of governmental hospitals and primary health care of the Gaza governorates is excludes if he has less than ten years working experience, family history of respiratory problems, exceeding maximum permissible dose (MPD) of radiation. In this study we excluded all MRs of non-government sectors, because the difference in their working conditions and situation.

4.8.1.2. Eligibility criteria for the controls:

Inclusion Criteria:

Any physiotherapy technician working at the physiotherapy departments of governmental hospitals and primary health care of the Gaza governorates is included in the control group if he has at least ten years of working experience, and no family history of respiratory problems.

Exclusion Criteria:

Any physiotherapy technician working at the physiotherapy departments of governmental hospitals and primary health care of the Gaza governorates is excludes if he has less than ten years of working experience and he has a family history of respiratory problems.

Table (4.1) demonstrated the numbers and governorate distribution of the MRs who met the eligibility criteria of the present work The Annual report of MOH, 2005). Accordingly, 93 MRs met the eligibility criteria and could be included in the present study.

Table (4.1): Numbers and governorate Distribution of MRs who met eligibility criteria.

Region	Number of MR	Number of MR who met eligibility criteria
Gaza North	**25**	**15**
Gaza City	**59**	**29**
Mid Zone	**13**	**7**
Khan Younis	**42**	**34**
Rafah	**18**	**8**
Total	**157**	**93**

4.8.2. Sample Size:

The sample size of the present study was calculated according to the published tables by the University of Florida, USA, which provides the sample size for a given set of criteria. In determining the sample size, we calculate it under 10% Precision Level. In our study, 157 MRs are working at the governmental and PHC centers of the Gaza Strip governorates. While, 93 MRs passed the eligibility criteria and they represent the target population of the present study. Accordingly, our samples size should be at least 51 MRs. For no-responsive expectations, and to avoid low number of cases and hence low

frequencies per cell our provisional sample size has been increased and 84 questionnaires were distributed to the MRs (Glenn , 2003).

4.8.3. Type of sampling:

The researcher distributed the questionnaire to the MRs and PTs thorough meeting interview, and he kindly and freely asked the MRs and the PTs to fill and answer the items of the questionnaire and signed the consent form at the end of the questionnaire which also demonstrated the acceptance or rejection of the subjects for Spirometry and blood sampling procedures. The researcher explained the purpose and objectives, and methodology of the study as well as his name and occupation to all subjects included in the present study. He also declared and committed to the participant about the confidentiality of the study. After filling and signing the questionnaire, the subjects who agreed were subjected to the Spirometry test to asses pulmonary functions and venous blood sampling for CBC and IgE determination. The inclusion in the study was optional and confidential. Neither name nor personal data were published. All ethical considerations were maintained, including respect of people, truth and confidentiality.

4.9 Data treatment and Statistical analysis:

The data from the questionnaire, Spirometry, CBC, and IgE quantitation were tabulated, encoded and statistically analyzed using the Statistical Package for the Social Sciences (SPSS) version 13. The following measurements and tests were performed aiming at the description, identification of significant relationship, correlations and differences between the MRs and PTs of the present study items that include variables and parameters (Daniel, 1991).

4.9.1 Runs test:

The runs test is considered to determine the randomness of a distribution of the sampled data. The runs test of randomness is used to assess whether data are truly random or have some sort of pattern. The age of the subjects and the years of experience were used as a determinant variables for the randomness of the sampled data. In the runs test, the null

hypothesis Ho is that the pattern of occurrence of observation is determined by a random process, while the pattern of occurrence in not random. Therefore, A finding of significance means the rejection of Ho that the series of data does differ significantly from random. The assumption of randomness would be upheld by a finding of no significance, p >0.05 (SPSS, 2004).

4.9.2. Frequency tables:

The crosstabs procedure was followed to present the frequencies of the different items of the questionnaire. Moreover all p-values were mentioned on each table where appropriate.

4.9.3. Chi square test:

The chi square test was used to determine whether the difference in frequency (percentage) among the same groups is significant or not, which means significancy between row percentages in a single column of a table.

4.9.4. Z-test:

For significancy determination of the difference between two population proportion (differences between column percentages in a single row of a table), the Z-test was used and calculated according to the following equation:

$$Z \cong \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\hat{p} \cdot (1 - \hat{p}) \cdot \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \qquad \text{where } \hat{p} \equiv \frac{X_1 + X_2}{n_1 + n_2}$$

X1 and X2 are the numbers in the first (n1) and second (n2) population samples respectively, while, P value = 1- Z (Daniel, 1991).

4.9.5. The independent-samples t-test:

For parametric variables, the independent-samples t-test procedure was followed which compares means for two groups of cases. Ideally, for this test, the subjects should be randomly assigned to two groups, so that any difference in mean of variable is due to the nature of the group of interest either case group or control group.

4.9.6. One-Way analysis of variance (ANOVA):

One-way ANOVA procedure produces a one-way analysis of variance for a quantitative dependent variable by a single factor (independent) variable. Analysis of variance was used to test the hypothesis that several means are equal which is considered as an extension of the independent-samples t-test. For all parametric quantitative variables the one-way ANOVA test was used to compare the means of more than two groups of cases.

4.9.6. Correlation Coefficients:

For parametric variables, the Pearson's correlation coefficient r is used and it measures how variables or observations are related. Pearson's correlation coefficient is a measure of linear association. However, for nonparametric data, the correlation between two variables was determined using the spearman rank correlation coefficient rs (also known as Spearman's rho) which yields a statement of the degree of interdependence or correlation of the scores of the two rank-ordered scales (Daniel, 1991).

4.9.7 The Kruskal –Wallis test:

The Kruskal –Wallis test is one-way analysis of variance by ranks and was used for testing equality of population medians among groups.

Chapter Five

Results and Discussion

Chapter Five

Results and Discussion

5.1 Introduction

The present study was conducted in the five governorates of the Gaza Strip and aimed at the investigation of the effect of X-ray film processing on the respiratory functions, complete blood count, and IgE levels of medical radiographers as compared to the control group of physiotherapist. Meanwhile it further aimed at the evaluation of the knowledge and practices of MRs toward the use of X-ray processing chemicals and darkroom diseases. Also it aimed at the evaluation of structure, design, and work set up at the radiology departments and recommendation of preventive measures that could improve the health situation of the MRs. Up to our best knowledge and available published resources, our study could be considered as the first ever study that address the health status of MRs in Palestine.

5.2 Data collection and statistical analysis:

5.2.1 Tools of the Study:

The objectives of the present work were achieved by main tools that included self explanatory data together with experimental and laboratory analysis These tools included close ended questionnaire, spirometric analysis, complete blood count, and determination of serum IgE levels.

5.2.2 Statistical Analysis:

The SPSS version 13 program was used for treatment of data and statistical analysis. Differences and correlation were considered significant at $p<0.05$. The following measurements and tests were performed aiming at the description, identification of significant relationship, correlations and differences among the different variables of interest of the respondent MRs as compared to PTs:

- Runs test to determine the randomness of a distribution of the sampled data.
- Cross tabulation to present the frequencies of the different items of the questionnaire.
- Chi square test to determine whether the significancy of the difference in frequency (percentage) among the same groups
- Z-test to determine significancy of the difference between two population proportion.
- The independent-samples t-test procedure to compare means for two groups of cases.
- One-way analysis of variance to compare the means of more than two groups of cases.
- Pearson's correlation coefficient ***r*** was used to measure how parametric variables or observations are related, while Spearman rank correlation coefficient r_s was used to measure the correlation between two nonparametric variables.
- The Kruskal –Wallis test for testing equality of population medians among groups.

Details about the statistical tests performed were mentioned in the previous chapter (chapter 4 the Methodology).

5.3 Presentation of the Results:

5.3.1 Respondent Rates:

The sample size of the present study was calculated under 10% precision level, and at least 51 MRs should be included. For no-responsive expectations, and to avoid low number of cases and hence low frequencies per cell our provisional sample size has been increased. Eighty five questionnaires were distributed by the researcher to the MRs at their working radiology departments. Appreciatively, 76 of the 85 MRs filled the questionnaire which indicated a response rate of 90.5 %. In addition 100 questionnaires were distributed to the PTs at their physiotherapy departments, thankfully, 91 of the 100 PTs filled the questionnaire which indicated a response rate of 91 %. The distribution of the respondent MRs in the different governorates is mentioned in Table (5.1). Concomitantly, 74 (97.4 %

of the questionnaire respondents) MRs and 72 (79.1 % of the questionnaire respondents) PTs agreed to perform the Spirometry test. However, for venous blood sampling the response rates were 47.4 % and 46.2 % respectively.

Table (5.1): Distribution of the Subjects According to Governorate.

Governorate	**Overall**		**MRs**		**PTs**	
	N	%	N	%	N	%
Northern	32	19.1	14	18.4	18	19.7
Gaza	55	33	24	31.6	31	34.1
Mid Zone	26	15.5	7	9.2	19	20.9
Khanyounis	40	24	25	32.9	15	16.5
Rafah	14	8.4	6	7.9	8	8.8
Total	**167**	**100 %**	**76**	**100 %**	**91**	**100 %**

The relatively high response rates of the MRs to be included in the present study questionnaire and Spirometry tests reflect a considerable level of awareness and responsiveness to the topic, aims and objectives behind performing the present work. The low response rate of the subjects toward the venous blood sampling is not surprising because great number of people considering venous blood sampling as unfavorable invasive technique (Hartge, 1999; Hansen *et al*., 2007; Kramer *et al*., 2008).

5.3.2. Randomness of the sampled data:

Randomness and reliability are two interdependent factors that affect the validity of research results. Randomness of the sampling leads to reliability and validity of the results. The age and the years of experience of the subjects were used as determinant variables of the randomness of the sampled data. The runs test performed on the age and years of experience of the subjects revealed a truly random data with p value equals 0.595 and 0.448 respectively, meaning that we are not able to reject the null hypothesis *Ho* that the pattern of occurrence of observation is determined by a random process.

Our data that collected through the close-ended questionnaire showed an acceptable and satisfactory levels of randomness which reflect good reliability of the research outcomes.

5.3.3 General Characteristics of the Subjects:

The respondent subjects (167) were classified according to their profession into two groups: case group (76 MRs) and control group (91 PTs). The general characteristics of the overall subjects as well as the general characteristics of the MRs and PTs are mentioned in Table (5.2). The mean age of the overall subjects was 39.06 ± 6.58 years, while for the case and control groups it was 40.68 ± 6.86 and 37.70 ± 6.04 years respectively. The majority (68.3 %)of the subjects were in the age group 30-40 years. Fortunately, smoking was reported only in 18.6 % of the overall subjects, which minimizes or diminish the interference and confliction of smoking on the respiratory function results and parameters of the case and control group. Because of the possible interruption of smoking on Spirometry (De Torres *et al.,* 2006; Wilt *et al.,* 2005) and CBC parameters (Centers for Disease Control and Prevention, 1998; Yun *et al.,* 2002; Tarazi *et al.,* 2008), and to secure as much as possible controlled results and outcomes, the smokers data were excluded from the Spirometry and CBC statistical analysis.

Table (5.2): General Characteristics of the Subjects.

		Overall N (%)	MRs N (%)	PTs N (%)
Gender				
	Males	112 (67.1)	62 (81.6)	50 (54.9)
	Females	55 (32.9)	14 (18.4)	41 (45.1)
Age Group				
	30-40 years	114 (68.3)	47 (61.8)	67 (73.6)
	41-50 years	38 (22.8)	19 (25.0)	19 (20.9)
	51-60 years	15 (9.0)	10 (13.2)	5 (5.5)
Marital Status				
	Single	18 (10.8)	5 (6.6)	13 (14.3)
	Married	149 (89.2)	71 (93.4)	78 (85.7)
Smoking Habit				
	Smoker	31 (18.6)	18 (23.7)	13 (14.3)
	Non smoker	136 (81.4)	58 (76.3)	78 (85.7)
Working Place				
	Hospitals	128 (76.6)	64 (84.2)	64 (70.3)
	Primary health care	39 (23.4)	12 (15.8)	27 (29.7)
Community Geographic location				
	Urban	102 (61.1)	51 (67.1)	51 (56.0)
	Rural	22 (13.2)	8 (0.5)	14 (15.4)
	Camp	43 (25.7)	17 (22.4)	26 (28.6)
House Structural Material				
	Concrete	157 (94.0)	74 (97.4)	83 (91.2)
	Asbestos	10 (6.0)	2 (2.6)	8 (8.8)

Data are expressed as number of subjects and percentage in parentheses

5.3.4. Health Characteristics of the Subjects:

The responses to the questionnaire items about the health characteristics of the subjects are mentioned in Table (5.3). The majority of the MRs (81.6 %) and PTs (75.8%) did not report any previous health problems that may interfere with the results and reliability of the present study. However, a significant ($p<0.0001$) proportion (73.7 %) of the MRs reported current health problems compared to PTs (31.9 %).

Table (5.3): Health characteristics of the subjects.

Health Characteristics	MRs		PTs		Chi sq	*P value*
	N	(%)	N	(%)		
Previous health problems						
Yes	14	18.4	22	24.2	0.811	0.368
No	62	81.6	69	75.8		
Current health problems						
Yes	56	73.7	29	31.9		
Respiratory	51	91.1	6	20.7		
Skeletal	0	0.0	7	24.1	28.975	0.000
Others	5	8.9	16	55.2		
No	20	26.3	62	68.1		
Current health problems related to work						
Yes	43	76.8	12	41.4	21.47	0.000
No	13	23.2	17	58.6		
Current health problems related to house?						
Yes	7	12.5	2	6.9	3.99	0.460
No	49	87.5	27	93.1		
Are health problems disappear or reduce in holidays						
Yes	52	89.7	10	58.8	8.71	0.003
No	6	10.3	7	41.2		

The vast majority of MRs (91.1 %) with current health problems significantly ($p < 0.0001$) defined their current problems in terms of respiratory complain or difficulties. While 76.8 % of the complained MRs significantly ($p = 0.001$) related the current health problems to work as compared to PTs. Moreover, a significant proportion of MRs (89.7 %) mentioned that the current health problems are disappeared or reduced in holidays. The significantly higher percentage of MRs who reported current health problems with respiratory problems as a main complain is concomitant with the findings of scientific studies carried out in different settings. The results of the case-control study that performed by Smedely and co-workers in 1996 at the university of Southampton, UK, showed a clear excess of work related symptoms among MRs than PTs with respiratory problems as a major complain that worsen at wok and ameliorated on off days. Moreover, a similar study which was conducted by Prabhakara and Lakshman, 2005, showed that Respiratory symptoms among MRs were several times higher than PTs, with intensified respiratory complains during working hours (Smedely *et al.,* 1996; Prabhakara and Lakshman, 2005).

5.3.5. Specific Health Complains of the Subjects:

In order to assess the specific health complains that could be addressed by the MRs due to their working environment, the researcher summarized and categorized the common health complains that mentioned in the relevant published scientific studies (Hewitt, 1993; Smedely *et al*., 1996; Prabhakara and Lakshman, 2005; Dimich-Ward *et al*, 2003).

One question was assigned for related symptoms. For example, symptoms and complains related to skin such as reddish, rash, itching were grouped in one question. Moreover, the data related to health complains of the subjects were summarized as single parameter that reflects the number of complains of the subjects and then calculated as percentage. The subject who mentioned 12 complains was scored as 100 % complains, while who mentioned no complains was scored as 0 % complain. The remaining categories were percentages of the number of complain to 12..

The specific health complains of the MRs and PTs are mentioned in Table (5.4). Expect for complains related to heart disruption during working hours and tiredness when quickly

striding the stairs (p =0.21 and 0.09 respectively), all other health complains showed significantly higher percentages in MRs compared to PTs.

The mean health complains score percentage of MRs (53.95 ± 27.60 %) was significantly higher than the mean health complains score percentage of PTs (21.06 ±19.53 %) with mean ranks of 113.72 and 59.18 respectively and p<0.0001. The most predominant health complain, in decreasing order, addressed by the MRs were discomfort breathing in closed/smoky/dusty rooms (98.7%), recurrent headache (78.9%), difficulties in nose breathing (73.7 %), wake up symptoms (68.4%), intermittent sleep (65.8%), eye symptoms (65.8%), and sneezing during working hours (63.2%).

Significantly higher mean health complain score percentage was reported in MRs who are working at PHC centers as compared to MRs who are working at governmental hospitals (70.14 ± 23.96 % vs 50.91± 27.34 %) with mean ranks of 51.71 and 36.02 respectively, p =0.023. Additionally, significant differences (p =0.040) were reported in the health complain score percentage with respect to working experience, with MRs of the experience range of 25-32 years showed higher complains as compared to the other experience ranges 17-24, and 9-16, with mean ranks of 39.55, 32.36 and 26.24 respectively, p = 0.040.

Correlation coefficient analysis showed a direct and significant correlation between the mean health complain score percentage and the years of experience of the MRs (r_s = 0.244, p=0.034) and between the mean health complain score percentage and the number of weekly processing hours at darkroom (r_s = 0.430, p <0.0001).

Non significant difference was reported in the mean health complain score percentage between smokers and non smokers MRs (55.17 ± 25.59 % vs 50.00± 33.82 % with mean ranks of 39.34 and 35.78 respectively, p = 0.547). Also non significant difference was reported in the mean health complain score percentage between males and females MRs (54.84 ± 28.17 % vs 50.01± 25.53 % with mean ranks of 39.17 and 35.54 respectively, p = 0.576).

Table (5.4): Health complains of the subjects.

Questionnaire item		MRs		PTs		Chi	*P*
		N	(%)	N	(%)	sq	*value*
Do you have skin symptoms/complains during day hours (Reddish Rash Itching Mixture)							
	Yes	31	40.8	6	6.6	20.08	0.000
	No	45	59.2	85	93.4		
Do you have eye symptoms/complains during working hours							
	Yes	50	65.8	11	12.1	51.51	0.000
	No	26	34.2	80	87.9		
Do you complain recurrent headache during working hours							
	Yes	60	78.9	25	27.5	43.91	0.000
	No	16	21.1	66	72.5		
Do you feel tired when step the stairs quickly							
	Yes	17	22.4	13	14.3	1.84	0.175
	No	59	77.6	78	85.7		
Are you suffering from intermittent sleep?							
	Yes	50	65.8	29	31.9	19.11	0.000
	No	26	34.2	62	68.1		
are you suffering from wheezy chest							
	Yes	28	36.8	6	6.6	23.37	0.000
	No	48	63.2	85	93.4		
Are you suffering from wakeup symptoms or complains							
	Yes	52	68.4	27	29.7	24.95	0.000
	No	24	31.6	64	70.3		
Do you feel discomfort in closed/smoky/or dusty rooms							
	Yes	75	98.7	75	82.4	39.84	0.000
	No	1	1.3	16	17.6		
Are you suffering from winter dyspnea							
	Yes	16	21.1	8	8.8	5.06	0.024
	No	60	78.9	83	91.2		
Are you suffering difficulties in nose breathing							
	Yes	56	73.7	33	36.3	23.30	0.000
	No	20	26.3	58	63.7		
Are you sneezing during working hours							
	Yes	48	63.2	24	26.4	22.84	0.000
	No	28	36.8	67	73.6		
Do you suffer from heart disruption during working hours							
	Yes	34	44.7	35	38.5	0.673	0.412
	No	42	55.3	56	61.5		

The health complain results which demonstrated an increased prevalence of respiratory related symptoms among MRs concur with the results provided by other workers who addressed the health status of MRs as compared to PTs in developed countries (Hewitt, 1993; Smedely *et al*., 1996; Prabhakara and Lakshman, 2005; Dimich-Ward *et al*, 2003; Tarlo *et al*., 2004). These increased respiratory related symptoms were attributed mainly to the exposures of MRs to chemical fumes in darkroom that resulted mainly from processing the glutaraldehyde in the developer solution and therefore the emission of formaldehyde fumes during heavy workloads in the closed ill-ventilated processing darkrooms (Hewitt, 1993; Scobbe et al., 1996; Dimich-Ward *et al*, 2003). Other developing and fixing chemical solutions that used in X-ray film processing are powerful candidates that harmfully affecting the health status of the MRs, specially that related to the respiratory system and eye and skin integrities. Sulphur dioxide, diethylene glycol, acetic acid, hydroquinone, potassium and sodium sulphites, aluminum sulphites, and ammonium thiosulphates are among the X-ray film processing chemical hazards which destructively deteriorate the health status of the developers (Teschke *et al.*, 2002; Tarlo *et al.*, 2004) .

5.3.6. Complete blood count analysis and IgE quantitation:

As of possible effects of chemicals used in X-ray film processing on the hematological and immunological parameters, the researcher compared the CBC parameters (Meo, 2004) and the quantitation of IgE (Liss *et al.*, 2000; Curran *et al*., 1996) of MRs to the related values of the control group of PTs. Table (5.5) presents the CBC parameters and the concentration of IgE for overall subjects MRs and PTs. Because of the possible interruption of smoking on CBC parameters (Centers for Disease Control and Prevention, 1998; Yun *et al.*, 2002; Tarazi *et al.*, 2008), we statistically analyzed the CBC and IgE values for the nonsmokers MRs and PTs subjects which were presented in Table (5.6).

For CBC results, statistically significant differences were reported only in platelets count and platelets related indices. Platelets count (PLT) and platelets distribution width (PDW) in nonsmoker MRs showed a significantly decreased value as compared to nonsmoker PTs, while mean platelets volume (MPV) showed significantly higher levels in MRs as compared to the control group of PTs. The reduction in PLT count (thrombocytopenia) of the MRs of the present study (17.5 %) was concomitant to the study results of Meo, 2004

who carried out the study on apparently healthy 40 X-ray technicians at the College of Medicine, King Saud University, Saudi Arabia. In his study, PLT count was 16.6 % lower in X-ray technicians than that of the control group (Meo, 2004).

Meo attributed this reduction to the effect of X-ray ionizing radiation only. However, it is important for future studies to find the correct factor (X-ray radiation or chemicals used in film processing) behind the reduction in the PLT count and the alternation in PLT indices of the MRs. Recently, Ntaios *et al.,* 2008, showed that reduction in platelets count together with increased MPV and PDW are a reliable and predictive results for the diagnosis of idiopathic thrombocytopenic purpura. Whatever the diagnosis, it is so important for future sties to find the contributing factor behind the abnormalities in the haemostatic pathway of MRs (Ntaios *et al.,* 2008).

Expectantly, the nonsmoker MRs showed a significantly ($p = 0.001$) higher concentration of IgE (145.17 ± 109.67 IU/ml) as compared to the PTs control group (69.94 ± 61.71IU/ml). Significantly higher IgE concentrations were reported in MRs who have additional working schedule with private sector, in MRs where darkroom ventilation systems is not available, and in MRs who do not use fume hood vacuum apparatus during chemical preparations. Moreover, a highly significant correlation was reported between the MRs IgE serum concentration and the weekly hours he/she spent at darkroom , with Persons correlation coefficient $r = 0.671$ and $p < 0.0001$. The IgE immunologic response and the higher IgE levels in MRs and workers in radiographic and photographic film processing is mainly attributed to the immunogenic nature of the chemical fumes of the processing solutions (fixer and developer) which mainly consist of glutaraldehyde.

Different studies with different settings supported this hypothesis and classified glutaraldehyde solely or with other fixing and developing chemical solutions as the candidate triggers for IgE production (Curran *et al.,* 1996; Vyas *et al.,* 2000; Smith and Wang 2006). Glutaraldehyde may behave like many other low-molecular-weight chemicals in that specific antibodies can be detected in only a small percentage of exposed workers who report work-related respiratory symptoms. Therefore, the determination of IgE concentration could be used as predictive or evaluation parameter to assess the exposure of MRs to the processing chemical solutions. In addition, it could be also reflect the level of

ventilation and safety measures that available at the radiographic departments (Chan-Yeung *et al.*, 1993; Liss *et al.*, 2000; Teschke *et al.*, 2002).

Table (5.5): Mean ± standard deviation of the CBC parameters and IgE of all medical radiographers (MRs) and physiotherapists (PTs).

	MRs **N= 36**	**PTs** **N= 42**	***P value***
WBC X 10^9 /l	7.08 ±2.11	6.86 ± 2.27	***0.658***
RBC X 10^{12} /l	4.80 ± 0.53	4.89 ± 0.54	***0.469***
Hb g/dl	13.67 ± 1.59	13.29 ± 1.75	***0.315***
HCT %	41.31 ± 4.17	41.26 ± 5.12	***0.964***
MCV fl	84.70 ±11.95	81.54 ± 12.37	***0.257***
MCH pg	28.59 ± 2.79	27.24 ± 2.66	***0.032***
MCHC g/dl	33.04 ± 1.33	32.21 ± 1.10	***0.004***
PLT X 10^9	219.89 ± 48.66	266.92 ± 96.30	***0.010***
MPV	10.81 ± 1.15	10.12 ± 1.43	***0.029***
PDW	15.01 ± 2.48	16.32 ± 2.16	***0.018***
RDW %	13.04 ± 0.95	14.51 ± 2.63	***0.002***
IgE	130.81 ± 106.19	76.17 ± 66.55	***0.007***

Table (5.6): mean ± standard deviation of the CBC parameters and IgE of the nonsmokers medical radiographers (MRs) physiotherapists (PTs).

	MRs N=29	**PTs N=36**	***P value***
WBC X 10^9 /l	6.98 ± 1.97	6.99 ± 2.42	***0.998***
RBC X 10^{12} /l	4.77 ± 0.57	4.88 ± 0.54	***0.441***
Hb g/dl	13.44 ± 1.65	13.22 ± 1.80	***0.616***
HCT %	40.71 ± 4.39	41.14 ± 5.33	***0.729***
MCV fl	83.58 ± 12.92	81.34 ± 12.91	***0.489***
MCH pg	28.29 ± 2.93	27.13 ± 2.78	***0.109***
MCHC g/dl	32.74 ± 1.29	32.11 ± 1.08	***0.070***
PLT X 10^9	221.17 ± 35.35	268.10 ± 102.06	***0.021***
MPV	10.83 ± 1.22	10.14 ± 1.44	***0.048***
PDW	15.11 ± 2.54	16.57 ± 2.05	***0.015***
RDW %	13.07 ± 1.03	14.65 ± 2.80	***0.005***
IgE	145.17 ± 109.67	69.94 ± 61.71	***0.001***

5.3.7. Spirometry and Respiratory Function Tests:

Spirolab II Spirometer (Medical international research, Rome, Italy) was used in the present study to assess the respiratory function tests of the MRs as compared to the control group of PTs. Following the latest ATS and ERS classification and standards, Spirolab II evaluates and interprets the test results by comparing the measured parameters with specific 'normal' Spirometry values (known as predicted values) which are calculated from subject data: age, height, weight, sex and ethnic group. Therefore, it is not applicable or suitable to categorizes the Spirometric results of the subjects according to the gender or age group.

Tables (5.7) and (5.8) respectively present the Spirometric respiratory function tests and the diagnosis of the overall MRs and PTs. While, Tables (5.9) and (5.10) respectively present the Spirometric respiratory function tests of nonsmokers MRs and PTs.

For data analysis, statistical comparison, significancy and discussion and because of the possible interfering effects of smoking on the Spirometric and respiratory function tests of the subjects we relayed only on the results presented in Tables (5.9) and (5.10) which comprise the nonsmokers parameters (Fletcher & Peto, 1977; Gold *et al*., 1996; Wilt *et al*., 2005; Pratter *et al*., 2006).

Table (5.7): Mean ± standard deviation of the Spirometric parameters of all medical radiographers and physiotherapists.

	MRs N=74	PTs N= 72	*P value*
Forced Vital Capacity (FVC) **L**	3.73 ± 0.88	4.33± 0.80	***0.000***
% of the predicted FVC	78.78 ± 15.01	91.26 ± 11.96	***0.000***
Forced Expiratory Volume in 1 Second (FEV_1) **L**	3.17 ± 0.81	4.18 ± 3.85	***0.029***
% of the predicted FEV_1	80.85 ± 15.63	95.00 ± 11.12	***0.000***
Forced expiratory volume % (FEV_1 / FVC) FEV1%	85.40 ± 11.71	86.79 ± 7.13	***0.391***
% of the predicted FEV_1 / FVC	103.19 ± 13.83	104.54 ± 8.58	***0.481***
Peak Expiratory Flow (PEF) **L/s**	6.33 ± 2.41	7.85 ± 2.20	***0.000***
% of the predicted PEF	70.27 ± 23.81	87.04 ± 22.32	***0.000***
Forced Expiratory Flow at 25% (FEF_{25}) **L/s**	5.29 ± 2.19	6.62 ± 1.68	***0.000***
% of the predicted FEF_{25}	63.70 ± 24.00	79.39 ± 18.50	***0.000***
Forced Expiratory Flow at 50% (FEF_{50}) **L/s**	4.03 ± 1.42	4.64 ± 1.22	***0.006***
% of the predicted FEF_{50}	81.49 ± 28.09	93.51 ± 24.86	***0.007***
Forced Expiratory Flow at 75% (FEF_{75}) **L/s**	1.99 ± 0.80	2.16 ± 0.71	***0.176***
% of the predicted FEF_{75}	97.16 ±35.95	105.69 ± 34.41	***0.145***

Table (5.8): diagnosis of all MRs and PTs according to Spirometric results.

	MRs N= 74		Chi sq	P value	PTs N= 72		Chi sq	P value	Z test	*P value*
	N	%			N	%				
Normal	17	23.0			49	68.1			- 5.47	***0.000***
Mild restriction	26	35.1			15	20.8			1.92	***0.027***
Moderate restriction	13	17.6			5	6.9			1.97	***0.024***
Moderate–severe restriction	2	2.7			0	0			1.40	***0.081***
Sever restriction	4	5.4	73.41	***0.000***	0	0	75.78	***0.000***	2.00	***0.023***
Mild obstruction	2	2.7			3	4.2			- 0.50	***0.309***
Moderate obstruction	1	1.4			0	0			1.03	***0.154***
Moderate-severe obstruction	2	2.7			0	0			1.40	***0.081***
Moderate Restriction with Moderate-severe obstruction	7	9.5			0	0			2.69	***0.004***

Table (5.9): Mean ± standard deviation of the Spirometric parameters of the nonsmoker medical radiographers and the physiotherapists.

	MRs N=57	PTs N= 62	*P value*
Forced Vital Capacity (FVC) **L**	3.76 ± 0.83	4.35 ± 0.76	***0.000***
% of the predicted FVC	79.98 ± 13.40	91.55 ± 11.31	***0.000***
Forced Expiratory Volume in 1 Second (FEV_1) **L**	3.15 ± 0.78	4.28 ± 4.14	***0.044***
% of the predicted FEV_1	80.51 ± 15.06	95.31 ± 10.66	***0.000***
Forced expiratory volume % (FEV_1 / FVC) FEV1%	84.14 ± 12.25	86.74 ± 6.93	***0.152***
% of the predicted FEV_1 / FVC	101.42 ± 14.21	104.45 ± 8.24	***0.154***
Peak Expiratory Flow (PEF) **L/s**	6.13 ± 2.49	7.81 ± 2.27	***0.000***
% of the predicted PEF	68.26 ± 24.57	86.21 ± 22.62	***0.000***
Forced Expiratory Flow at 25% (FEF_{25}) **L/s**	4.98 ± 2.20	6.59 ± 1.70	***0.000***
% of the predicted FEF_{25}	60.28 ± 23.77	78.77 ± 18.34	***0.000***
Forced Expiratory Flow at 50% (FEF_{50}) **L/s**	3.83 ± 1.43	4.65 ±1.22	***0.001***
% of the predicted FEF_{50}	77.25 ± 27.46	93.47 ± 24.59	***0.001***
Forced Expiratory Flow at 75% (FEF_{75}) **L/s**	1.97 ± 0.75	2.16 ± 0.72	***0.163***
% of the predicted FEF_{75}	95.61 ± 32.60	105.29 ± 34.82	***0.121***

Table (5.10): Diagnosis of nonsmokers MRs and PTs according to Spirometric diagnostic results.

Spirometric diagnostic results	**MRs N= 57**		**Chi sq**	**P value**	**PTs N= 62**		**Chi sq**	**P value**	***Z test***	***P value***
	N	%			N	%				
Normal	11	19.3			44	71.0			- 5.65	***0.000***
Mild restriction	23	40.4			15	24.2			2.10	***0.022***
Moderate restriction	9	15.8			3	4.8			1.99	***0.023***
Moderate–severe restriction	2	3.5	66.32	***0.000***	0	0	76.19	***0.000***	1.48	***0.069***
Sever restriction	1	1.8			0	0			1.07	***0.142***
Mild obstruction	2	3.5			0	0			1.48	***0.069***
Moderate obstruction	1	1.8			0	0			1.07	***0.142***
Moderate-severe obstruction	2	3.5			0	0			1.48	***0.069***
Moderate Restriction with Moderate-severe obstruction	6	10.6			0	0			2.64	***0.004***

Except for FEV1% and FEF_{75}, all other Spirometric parameters and respiratory function tests revealed better value for the control group of PTs as compared to the MRs group. Accordingly, a significantly ($p < 0.001$) higher percentage (80.7%) of the MRs showed more or less respiratory abnormalities as compared to PTs (29.0 %). Respiratory restrictions were the major (76.1 %) diagnosis of the MRs. Respiratory obstructions were reported in 10.8 % of MRs, while restrictive-obstructive respiratory abnormalities were found in 13.1 % of the MRs.

According to the severity of the Spirometric results and diagnosis (Table 11), mild Spirometric results were reported in 43.9 %, while 17.5 % for moderate, 7.0 % for moderate –severe, and 12.3 % for severe Spirometry.

Table (5.11): Spirometric classification of the nonsmoker MRs and PTs

Spirometric classification	**MRs N= 57**		**Chi sq**	**P value**	**PTs N= 62**		**Chi sq**	**P value**	***Z test***	***P value***
	N	%			N	%				
Normal Spirometry	11	19.3			44	71.0			- 5.65	***0.000***
Mild Spirometry	25	43.9	22.91	***0.000***	15	24.2	43.01	***0.000***	2.27	***0.012***
Moderate Spirometry	10	17.5			3	4.8			2.22	***0.013***
Moderate–severe Spirometry	4	7.0			0	0			2.12	***0.017***
Sever Spirometry	7	12.3			0	0			2.85	***0.002***

No significant ($p > 0.05$) differences were reported in the Spirometric results of MRs between hospitals and PHC as working place, between governorates, or between locality (urban, rural, camp). However, for the MRs with experience group (25-32 years) the MRs of this group showed the worst Spirometric results as compared to the other less experience groups.

The correlation coefficient analysis revealed a significantly inversed correlation between the % of the predicted Spirometric parameters (FVC, FVC1, PEV, FEF25, FEF50) and the number of weekly hours at the processing darkroom, the values were -0.40, -0.47, -0.273, -0.312, -0.305 respectively. While no correlation was reported with respect the number of

weekly hours at the radiology department. These findings attributed the worsening in the respiratory functions of MRs mainly to the factors related to the processing darkroom.

Up to our best knowledge and after full searching the electronic literature, only one scientific study partially dealt with Spirometric measurements of MRs. Dimich-Ward and her coworkers performed Spirometric measurements for FVC, GEF1, and FEV1/FVC% on 62 MRs and 34 PTs as control group at the Vancouver hospital, Canada. In their study Dimich-Ward and her colleagues revealed no significant differences in the measured Spirometric parameters between the MRs and the PTs control group, however, they mentioned nonspecific bronchial hyper-responsiveness three times higher in MRs than PTs (Dimich-Ward *et al.,* 2003).

Our present scientific study could be considered as the first ever study that presents a case control comparative Spirometric measurements to assess the respiratory function tests of MRs, which could also provides the Spirometric tests to evaluate and assess the functionality of the respiratory system of MRs and workers who continuously subjected to chemical fumes.

5.3.8. General and Technical Evaluation of the Radiology Departments:

Main part of the questionnaire of the present study was associated to evaluate the radiology departments of the MRs. The responses to the items of this part are mentioned in Table (5.12), which collectively revealed a poor and unfortunate outcomes.

The majority of MRs mentioned the inapplicability of safety measures in darkrooms (82.9 %), deficiency of quality control measures for darkroom processing (80.3 %), lack of effective departmental ventilation system (73.7 %), lack of special darkroom ventilation system (78.9 %), absence of local exhaust for waste fumes (90.8%), and irregular maintenance and safeguarding for the processor machines (56.6%). Concomitant to the poor or weak structural design of the ventilation systems of radiology departments, the majority of MRs mentioned the daily detection of odor of film processing chemicals either in the radiographic department (73.7%) or in the processing room (86.8%).

Table (5.12): General and Technical Evaluation of the Radiology Departments.

	No	%	Chi sq	P value
Are safety standards applied in darkroom				
Yes	8	10.5	84.18	***0.000***
No	63	82.9		
I don't know	5	6.6		
Is there any quality control measures on darkroom processing				
Yes	10	13.2	75.81	***0.000***
No	61	80.3		
I don't know	5	6.6		
Is Radiographic department provided with effective ventilation system?				
Yes	15	19.7	57.66	***0.000***
No	56	73.7		
I don't know	5	6.6		
Is Darkroom provided with special ventilation system?				
Yes	14	18.4	74.18	***0.000***
No	60	78.9		
I don't know	2	2.6		
Do you smell acute or bad odor in radiographic department?				
Yes	56	73.7	62.08	***0.000***
Sometimes	19	25.0		
No	1	1.3		
Do you smell acute or bad odor in processing room				
Yes	66	86.8	74.00	***0.000***
Sometimes	10	13.2		
No	0	0.0		
Is Darkroom provided with a stack or a special pipeline to exhaust waste fume?				
Yes	4	5.3	112.92	***0.000***
No	69	90.8		
I don't know	3	3.9		
Is there a periodic maintenance and safeguarding for the processor machine				
Yes	25	32.9	24.18	***0.000***
Sometimes	8	10.5		
No	43	56.6		
Is Darkroom adjacent to the resting or waiting room of MRs?				
Yes	59	77.6	23.21	***0.000***
No	17	22.4		
How you assess the efficiency of processor machine?				
Good	5	6.6	57.65	***0.000***
Fair	56	73.7		
bad	15	19.7		
Is there any administrative monitoring on the preparation of chemicals?				
Yes	7	9.2	41.40	***0.000***
Sometimes	18	23.7		
No	51	67.1		
Is the fume hood vacuum apparatus used during the preparations of chemicals				
Yes	12	15.8	30.74	***0.000***
Sometimes	16	21.1		
No	48	63.2		

Moreover, the regular administrative monitoring on chemical preparations was reported by only 9.2 % of the MRs. The poor design together with operational deficiencies were the major characteristics that lead to occupational health problems not only for radiographic departments and darkrooms, but also for all working places where any type environmental hazards are expected or present in the processing protocols or procedures (Hewitt, 1993). In our study, the health complains and problems of the MRs could be attributed in part for the weak structural design and the deficiencies in operational materials and equipments. Concur to our study results, the study of Tarlo *et al.,* 2004, showed significant correlations between the darkroom diseases of MRs and the poor design of the radiographic departments and operational deficiencies which included tools, instruments, safety and quality control measures.

5.3.9. General and Technical Evaluation of the MRs Knowledge and practice:

The general and technical evaluation of the MRs knowledge and practice are mentioned in Table 5.13. In addition to their official work at the governmental hospitals and PHC centers, small percentage (21.1 %)of the MRs are occupying part-time positions with radiographic centers of the private sector. The majority (75.0%) of the MRs are spending the average normal weekly hours (30-40) at radiographic departments, while 25.0 % of the MRs are spending above 41 hours per week at radiographic departments. Unexpectedly, only 34.2 % of the MRs spend maximally 10 hours per week at the processing darkrooms, while 21.1 % of the MRs spend 11-20 hours per week at the processing darkrooms. Unacceptably, 44.7 % of the MRs spend more than 20 hours per week at the processing darkrooms. The international radiographic association standards assigns a maximum of 40 weekly hours at radiographic department with a maximum of 10 hours weekly at the processing darkroom. As mentioned in table 12, one fourth of the MRs are spending above the standard weekly hours at the radiographic departments, which may attributed to the commitments with other private sector radiological departments.

The most serious and crucial point is the above standard hours (> 10 hours per week) that spend at the processing darkroom by about two-thirds of the MRs of the present study. In the study of Tarlo *et al*., 2004, about 8 % of the MRs who reported darkroom diseases are spending an average of 8.8 hours per week at the processing darkroom.

Table (5.13): general and technical evaluation of the radiographers

	No	%	Chi sq	P value
Are you working also with private sector				
Yes	16	21.1	25.47	0.000
No	60	78.9		
How many hours spent in radiographic department weekly				
30-40	57	75.0	60.34	0.000
41-50	13	17.1		
>50	6	7.9		
How many hour spent in darkroom weekly				
1-10	26	34.2	6.42	0.040
11-20	16	21.1		
>20	34	44.7		
Are there Periodic examinations for radiographers				
Yes	0	0.0	64.47	0.000
Sometimes	3	3.9		
no	73	96.1		
Do you know the chemical composition and their possible risk on you health				
Yes with details	31	40.8	2.58	0.108
Little bit	45	59.2		
no	0	0.0		
Do you think that there are health problems resulting from darkroom				
Yes	63	82.9	84.03	0.000
No	6	7.9		
I don't know	7	9.2		
Are you familiar with safety standards necessary for Darkroom?				
Yes in details	19	25.0	21.34	0.000
Little bit	44	57.9		
No	13	17.1		
Do MR clean the processor machine after use?				
Yes	36	47.4	22.21	0.000
Sometimes	6	7.90		
No	34	44.7		
Do you use personal protective equipments (PPE) during processing of X-ray films				
Yes	7	9.2	46.92	0.000
Sometimes	16	21.1		
No	53	69.7		
Complains (itching, cough, sneezing, dyspenia) during the preparations of chemicals?				
Yes	75	98.7	58.47	0.000
No	1	1.3		

In our study and as mentioned above in the sections of health complain score percentage, IgE, and Spirometry, significant correlation were reported between the mentioned variables and the number of weekly hours at the processing room, while no significant correlations were reported with respect the number of weekly hours at the radiographic departments.

Periodic examinations for radiographers were not reported by any of the MRs of the present work, only 3.9 % of the MRs revealed occasional examinations for radiographers.

Fortunately, all the MRs have some sort of knowledge about the composition of the processing chemicals and their possible risk, 40.8 % have a detailed knowledge while 59.2 have a little bit knowledge. Moreover, the majority (82.9%) of the MRs believe of the darkroom diseases. One-fourth of the MRs are familiar with the safety standards of the darkroom, however, 69.7 % of the MRs don't use personal protective equipments (PPE), and 63.2 % do not use the fume hood vacuum apparatus during chemical preparations. Unsurprisingly, 98.7 % of the MRs reported health complains during chemical preparations.

The reported health complains and the abnormal Spirometric and laboratory results of the MRs of the present study could be attribute to a combination of factors that in part related to poor design of radiographic departments and darkrooms operational and ventilation deficiencies, while in other part related to the improper practice and reduced awareness of the MRs themselves toward the risks of the X-ray film processing and darkroom diseases (Hewitt, 1993; Genton, 1998; Tarlo *et al*., 2004).

The present health status of the Palestinian MRs at the Gaza governorates justifies the necessity for a comprehensive revision and evaluation of radiology departments in general and darkrooms in specific. The proposed evaluation should include all parties that considerably interested and concerned in public and occupational health problems.

Chapter Six

Conclusion and Recommendations

Chapter Six

Conclusions and recommendations

6.1 Conclusions

This present study was designed as a case control study and aimed at the investigation of the possible risks of X-ray film processing on respiratory function tests and some hematological and biochemical parameters of MRs as compared with a control group of physiotherapists. The main tools of the study included close ended questionnaire, Spirometric analysis, complete blood count, and determination of serum IgE levels.

Appreciably, 167 of 184 subjects filled the questionnaire which reflected a response rate of about 90.8 %. However, the response rate for Spirometry and venous blood sampling were 87.4 % and 46.7 % respectively.

Our data showed an acceptable and satisfactory levels of randomness which were verified by performing the runs test on the age and years of experience of the subjects. The following points summarize the outcomes of the study:

- No significant differences in previous health problems were reported between MRs and control group. While a significant proportion of the MRs reported current health problems mainly in terms of respiratory complain or difficulties.
- More that three-fourth of the complained MRs significantly related their current health problems to work demands, with health problems disappeared or reduced in holidays.

- The assessment of the specific health complains (12 major health complains) that could be addressed by the MRs showed significantly higher proportions of MRs for 10 out of 12 major health complains.
- The mean health complains score percentage MRs was significantly higher than that of control group, with discomfort breathing in closed/smoky/dusty rooms,

recurrent headache, and difficulties in nose breathing were the most predominant health complains.

- Significantly higher mean health complain score percentage was reported in MRs who are working at PHC centers as compared to MRs who are working at governmental hospitals, and in MRs of the experience range of 25-32 years. While no significant differences were reported in the mean health complain score percentage between smokers and non smokers MRs or between males and females.
- Direct and significant correlations were reported between the mean health complain score percentage and both the years of experience of the MRs and the number of weekly processing hours at darkrooms.
- Platelets count (PLT) of MRs showed a significantly decreased value as compared to PTs, while mean platelets volume (MPV) showed significantly higher levels in MRs as compared to the control group of PTs.
- MRs showed a significantly higher concentration of IgE as compared to the PTs control group. Significantly higher IgE concentrations were reported in MRs who have additional working schedule with private sector, in MRs where darkroom ventilation systems is not available, and in MRs who do not use fume hood vacuum apparatus during chemical preparations.

- Highly significant correlation was reported between the MRs IgE serum concentration and the weekly hours he/she spent at darkroom s.
- All, except FEV1% and FEF_{75}, Spirometric parameters and respiratory function tests revealed better value for the control group of PTs as compared to the MRs group. A significantly higher percentage of the MRs showed more or less respiratory abnormalities as compared to PTs, with Respiratory restrictions were the major Spirometric diagnosis of the MRs.
- MRs with experience group (25-32 years) showed the worst Spirometric results as compared to the other less experience groups. A significantly inversed correlation was reported between the % of the predicted Spirometric parameters (FVC, FVC1, PEV, FEF_{25}, FEF_{50}) and the number of weekly hours at the processing darkroom, no correlation was reported with respect the number of weekly hours at the radiology department.

- No significant differences were reported in the Spirometric results of MRs between hospitals and PHC as working place, between governorates, or between locality (urban, rural, camp).
- The poor design together with operational deficiencies are a major features of the radiology departments. Safety and quality control measures in darkrooms are usually unavailable, or inapplicable or not used by the MRs. About 98.7 % of the MRs reported health complains during chemical preparations.
- Surprisingly, about two-thirds of the MRs exceeding the maximum permissible 10 hours per week at the processing darkrooms. while, Periodic examinations for radiographers were not reported by any of the MRs of the present work.

In conclusion, the present assessment study revealed an exaggerated health status of the of Palestinian MRs at the Gaza Strip. The responsibility about the deviation of MRs health could be attributed on one hand to the irresponsible practices and less awareness of the MRs towards the problems and risks of the X-ray processing darkrooms, while on the other hand the responsibility is attributed to poor design of radiographic departments and darkrooms operational and ventilation deficiencies. The present health status of the Palestinian MRs at the Gaza governorates justifies the necessity for a comprehensive revision and evaluation of radiology departments in general and darkrooms in specific. The proposed evaluation should include all parties that considerably interested and concerned in public and occupational health problems.

6.2 Recommendations

Medical radiographers have potential exposure to the processing chemicals (developers and fixer) involved in developing and fixing X-ray films at the darkrooms. There have been reports of an unexplained medical syndromes among MRs. the term darkroom disease has been coined for the miscellaneous symptoms experienced by MRs involved in the development of X-ray films. In the present work the researcher assessed and compare the health status, in terms of respiratory function tests and some laboratory tests, of MRs with a control group of physiotherapists. Among the aims of the study was the recommendation of preventive measures that could improve the health situation of the Palestinian MRs at the Gaza governorates. Therefore, the researcher, hereby, provides some recommendations that could help in improving the public and occupational health at the radiographic departments. These recommendations are formulated based on the results of the present study and on the occupational health and safety laws and standards relevant to radiography and darkroom disease. (James and Patrick 2003)

6.2.1. Design and engineering control recommendations:

- Air conditioning and venting systems must be reviewed and re-designed if necessary, by specialized air conditioning engineers to ensure that all specifications are met.
- For X-ray processors, the exhaust system must be vented to the outside environment and independent of the general building central air conditioning. The design of the exhaust or extraction system should ensure that the fumes are not drawn over the worker's breathing zone
- General room ventilation must work in synergy with local exhaust ventilation for successful removal of atmospheric contaminants.
- The darkroom inlet and outlet should be situated so that the air can circulate completely through the room before being drawn out again. For adequate darkroom ventilation and to prevent any fumes accumulation or dispersion in the X-ray department, the darkroom must be ventilated at a minimum rate of 10 room air changes per hour or fresh airflow rate of at least 2.5 liters per second per meter of room size be used.

- Elimination of hazardous chemicals and instruments form the working place. The best option is the implementation of digital radiography systems (Picture Archiving and Communication Systems [PACS]).
- If a hazardous substance cannot be eliminated, practical measures must be implemented to minimize employee exposure. Also, automated processors and silver recovery units could help in reducing the levels of exposure.

6.2.2. Administration Related Recommendations:

- Employers, employees and the radiology representative association must be involved in the formulation, implementation and monitoring of health and safety standards and quality control measures at radiographic departments.
- Radiology administration should ensure that all MRs must be checked regularly through clinical and laboratory tests.
- Ensuring that processor and ventilation systems undergo periodic checks.
- Committing to the international standards and regulations about occupational health and safety .
- Administrating possible job rotation away from areas where processing fumes are being emitted.
- The manufacturer of the processing chemical must provide the Material Safety Data Sheet (MSDS) with each delivery of film-processing chemicals so that it is readily available to the medical radiographer.

6.2.3. MRs related recommendations:

- Under the power of law and occupational responsibility, all MRs must worn the adequate personal protective equipments (PPE) when pouring or mixing or handling processing chemicals under the fume hood. These PPE include: half-face respirator with organic vapor cartridge, nitrile-based gloves, neoprene rubber gloves or butyl rubber gloves, eye protection tools. The use of surgical masks and surgical latex gloves are inadequate for protection.
- For tabletop and non-vented X-ray processors, a fume hood or extraction system must be used and operated whenever the processor contains chemicals.

- For chemical mixing, exhaust hood and extraction system must be placed above the mixing device.
- Keeping the containers and bottles of processing chemicals tightly lidded when not in use.
- Cleaning up splits and residues of processing chemicals.

6.2.4. Decision makers related recommendations:

After the formal approval, a copy of the present study will be distributed to the decision makers and radiology representative associations aiming at the improvement of the radiographic sector at our hospital together with NGO's and private radiological sectors.

6.2.5. Recommendations for further studies:

Further research studies are encouraged to:

- Address the level of air pollution among radiographic departments in Gaza governorates.
- Clinically and comprehensively investigate the impact of chemical fumes of X-ray film processing on the general health status of medical radiographers.
- Identify the satisfaction of the medical radiographers in the Gaza governorates to the working condition with concentration on the satisfactory relationship between the performance of medical radiographers and working conditions.

References:

- Adams R, (1990):"Job Descriptions with their irritants and allergens". **Occupational Skin Disease**, 11(4).pp.649-651.

- Alhamad EH, Lynch JP, Martinez FJ, (2001):"Pulmonary function tests in interstitial lung disease: what role do they have?". **Clin Chest Med**, 22.pp.715-720.

- American College of Occupational and Environmental Medicine (2005). Evidence Based Statement on Spirometry in the Occupational Setting. Available in 17.02.2008.
  (http://www.acoem.org under, http://www.acoem.org/guidelines/evidence)

- American Society of Radiologic Technologists, safety processing and monitoring. Radiological Technology and Management, 2001. Available in 23.07.2008.
  (**http://www.enotes.com/nursing-encyclopedia/radiologic-technology**)

- Agarwal A, Yadav N, (2004):" Effect of sulphur dioxide inhalation on serum Na+ and K+ ion concentration in albino rat". **J Environ Bio**, 25(3).pp. 321-323.

- Anslow L, (1991):"Silver recovery-an evaluation of existing disposal methods in a district general hospital". **Radiography Today**, 57(653).pp 24-28.

- Bakke JV, Bjerkvik PS, Pedersen IL, Eldoen G, Seim H. (1989):"Occupational diseases among personnel at a radiology department," **Clinical Radiology**, 30 (3).pp.345-349.

- Ball J., and Price T, (1995). Chesneys' radiographic imaging. Sixth edition, Oxford: Blackwell Scientific.

- *Barbara P. Yawn, Paul L. Enright, Robert F. Lemanske, Jr, Elliot Israel, Wilson Pace, Peter Wollan, and Homer Boushey, (2007):" Spirometry Can Be Done in Family Physicians' Offices and Alters Clinical Decisions in Management of Asthma and COPD". **Chest**, 132.pp.1162-1168*

- British Society of Radiographers ,1991:"X-ray departments, darkroom designs and management". Available in 28.06.2008 **http://www.sciencedirect.com/science?_ob=ArticleListURL&_method=list&_ArticleListID=761583401&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=5813755f7cd9d0ff0ffa5699f9f30c35)**

- Buffels J, Degryse J, Heyrman J, (2004):"Office spirometry significantly improves early detection of COPD in general practice". **Chest,** 125.Pp.1394–1399.

- Byrns G.E., Ciacco P, Shands L.A., Fennelley K., Cammon C, Boudreau A, Breyesse P, Mitchell C, (2000):"Chemical Hazards in Radiology". **Appllied Ocupational and Environmental Hygiene,** 15(2).pp. 203-208.

- Carroll Q. B. (2003): **Fuch's radiographic exposure, processing, and quality control**, 7 th ed.. Springfield, IL: Charles C Thomas. USA.

- Centers for Disease Control and Prevention (CDC). (1998): Recommendations to prevent and control iron deficiency in the United States. MMWR Recomm Rep;47:1–36.

- Center for disease control and prevention (CDC). (2001): "Glutaraldehyde Occupational Hazards in Hospitals. National Institute for Occupational Safety and Health (NIOSH) Publication No. 115 pp. 1-16.
-

- Chandrasekaran, P. (1988) *Some aspects of darkroom technique influencing the quality of miniature X-ray picture.* NTI Newsletter, 24 (4). pp. 81-84.

- Chan-Yeung M, McMurren T, Catonio-Begley F, Lam S. (1993): "Occupational asthma in a technologist exposed to glutaraldehyde". **Allergy Clinical Immunology, 91.** Pp.974-978.

- Cullinan P, Hayes J, Cannon J, Madan I, Heap D, Newman Taylor AJ. (1992): "Occupational asthma in radiographers". **Lancet**, 340. p.1477.

- Curran AD, Burge PS, Wiley K. (1996):" Clinical and immunologic evaluation of workers exposed to glutaraldehyde". **Allergy,** 51.pp.826–832.

- Daniel W. (1991): **Biostatistics: a foundation for analysis in the health sciences**. 5th ed. New York: John Wiley and Sons,. pp. 576-624.

- David P. Johns & Rob Pierce.(2003): **The Measurement and Interpretation of Ventilatory Function in Clinical Practice**, Second Edition. McGraw-Hill, Australia.

- Derek R. Smith and Rui-Sheng Wang, (2006):" Glutaraldehyde Exposure and its Occupational Impact in the Health Care Environment". **Environmental Health and Preventive Medicine,** 11.pp.3-10.

- De Torres JP, Cordoba-Lanus E, López-Aguilar C, Muros de Fuentes M, Montejo de Garcini A, Aguirre-Jaime A, (2006):"C-reactive protein levels and clinically important predictive outcomes in stable COPD patients". **European Respiratory Journal**, 27(5).pp.902-907.

- Di Stefano F, Siriruttanapruk S, McCoach J. (1999): "Glutaraldehyde: an occupational hazard in the hospital setting". **Allergy, 54**. Pp.1105–9.

- Dimich-Ward H, Wymer M, Kennedy S, Teschke K, Rousseau and M. Chan-Yeung, (2003):"Excess of symptoms among radiographers". **American Journal of Industrial Medicine,** 43(2).pp.132-141.

- Dunn WF, Scanlon PD, (1993):" Preoperative pulmonary function testing for patients with lung cancer". **Mayo Clinic Procedures**, 68.pp.371-375.

- Eastman Kodak Company, (1993) : Applied and Regulatory Toxicology, Corporate Health and Environment Laboratories. Air Quality in Kodak X-ray Processing. Results of Air Sampling Studies Around X-ray film Processors Conducted at Hospital Sites in The US and Canada. Available in 21.07.2008. **(http://www.hpnonline.com/dailyupdates/May_07.html)**

- Flaherty KR, Martinez FJ, (2000):" The role of pulmonary function testing in pulmonary fibrosis". **Curran Opine Pulmonary Med**, 6.pp.404-407.

- Fletcher CM, Peto R, (1977):"The Natural History of Chronic Airflow Obstruction". **Brand Med Journal**,1.pp.1645-1648.

- Franklin P, Dingle P, Stick S, (2000):" Raised exhaled nitric oxide in healthy children is associated with domestic formaldehyde levels". **Am J Respir Critical Care Med,** 161 (5).pp.1757-9.

- Fodor J, Malott J.C, Sweeny R.J., (1989):"Acommon artifact". **Radiologic Technology,** 60(4).pp 325.

- Gannon PFG, Bright P, and Campbell M. (1995): "Occupational asthma due to glutaraldehyde and formaldehyde in endoscopy and x ray departments". **Thorax,** 50.pp.156–159.

- Genton M. (1998):"Shedding light on darkroom disease-progress and challenges in understanding radiology workers' occupational illness". **The Canadian Journal of Medical Radiation Technology,** 29.pp.60–65.

- Gold DR, Wang X, Wypij D, Speizer FE, Ware JH, Dockery DW, (1996):"Effects of cigarette smoking on lung function in adolescent boys and girls". **England Journal Med**,335(13).pp.931-937.

- Gold WM. Murray JF, Nadel JA, (2000):" Pulmonary function testing". 3d edition. Philadelphia: pp.781-871.

- Goncalo S, Brando FM, Pecegueiro M, Moreno JA, Sousa I.(1984): "Occupational Contact Dermatitis to Glutaraldehyde". **Contact Dermatitis,** 10.pp.183-184.

- Gordon Marjorie, (1989): "Dangers in the darkroom". **The Radiographer,** 36.pp.114–115.

- Gordon, Marjorie (1987):"Reactions to Chemical Fumes In Radiology Departments," **Radiography,** 52(607).pp. 85-89.

- Haen, P., Harris-Young, L, (1995): **Principles of Hematology**. 1st edn, McGraw-Hill Professional Publishing. New York.

- Hansen T, Simonsen M, Nielsen F, and Hundrup Y, (2007):"Collection of Blood, Saliva, and Buccal Cell Samples in a Pilot Study on the Danish Nurse Cohort: Comparison of the Response Rate and Quality of Genomic DNA". **Cancer Epidemiol Biomarkers Prev**, 16(10).pp.2072-2076.

- Hartge P, (1999):"Raising Response Rates: Getting to Yes". **Epidemiology**,10(2).pp.105-107.

- Hayes J, Fitzgerald M. (1994): "Occupational asthma among hospital health care personnel: a cause for concern?" **Thorax,** 49.pp.198-200.

- Hewitt PJ.(1993): "Occupational health problems in processing of X-ray photographic films". **Annals of Occupational Hygiene, 37**.pp.287-295.

- Hodgson M, Parkinson H, (1985):" Indoor environmental exposures and symptoms". **Environ Health Perspect**, 110 (l 4).pp.663–667.

- Hoffbrand AV, Pettit JE. (1993):" Essential haematology, 3rd edn.". **Blackwell. Scientific Publications**. Oxford, UK.

- Ide C. W.(1993): "Developments in the darkroom: work-related symptoms and environmental monitoring of darkroom technicians in a hospital in Glasgow". **Occupational Medicine (London), 43**.pp.27-31.

- James B. Patrick N. (2003): " Legal Issues in Radiography: Darkroom Disease**". Allied Health Professions,** 5.pp.146-157**.**

- Jette, Diane U.; Kimberly Bacon, Cheryl Batty, Melissa Carlson, Amanda Ferland, Richard D Hemingway, Jessica C Hill, Laura Ogilvie and Danielle Volk (2003-09). "Evidence-Based Practice: Beliefs, Attitudes, Knowledge, and Behaviors of Physical Therapists". **Physical Therapy,** 83 (9).pp.786-805.

- Kerkhof, M., Dubois, J., Postma, S., Schouten, P. & Monchy, R. (2003):"Role and interpretation of total serum IgE measurements in the diagnosis of allergic airway disease in adults". **Allergy,** 58 (9).pp. 905-911.

- Kimber Ian and Dearman Rebecca J. (2002):" Chemical respiratory allergy: role of IgE antibody and relevance of route of exposure". **International Congress of Toxicology**, 9.pp.311-315.

- Kipen, Howard M, Lerman, Yehunda. (1986):"Respiratory abnormalities among photographic developers: A report of three cases." **American Journal of Industrial Medicine,** 9(1).pp. 341-347.

- Kolarzyk G, Lenndan Y, Bouran M, Qgi T, (2000):"Occupational Exposed to SO2". **Chest**, 12(3).pp.145-149.

- Kramer M, Uitenbroek D, Ujcic-Voortman J, Pfrommer C, Spaargaren J, Coutinho RA, Dukers-Muijrers N, (2008):" Ethnic differences in HSV1 and HSV2 seroprevalence in Amsterdam, the Netherlands". **Euro Surveill**,13(24).p.18904

- Kuntz K, Wu A, Paltiel A, Weiss S, Fuhlbrigge A, (2002):"Cost-effectiveness of omalizumab in adults with severe asthma: Results from the Asthma Policy Model". **Journal of Allergy and Clinical Immunology**, 120(5).pp.1146 – 1152.

- Leinster P, Baum JM, Baxter PJ.(1993): "An assessment of exposure to glutaraldehyde in hospitals: typical exposure levels and recommended control measures". **British Journal of Medicine, 50.**pp.107-111.

- Liss GM, Tarlo SM, Doherty J, Purdham J, Greene J, McCaskell L,Kerr M.(2002): "Induced sputum in new onset asthma among medical radiation technologists (MRTs) and physiotherapists". **American Journal of Respiratory and Critical Care Medicine,** 165.pp.522.

- Liss GM, Tarlo SM, Doherty J, Purdham J, Greene J, McCaskell L,Kerr M.(2003): "Physician diagnosed asthma, respiratory symptoms,and associations with workplace tasks among radiographers in Ontario". **Occupational and Environmental Medicine, 60.pp.254**–261.

- Marjorie Gordon. (1994):"Crying in the Dark–Marjorie Gordon's X-ray Vision". **North and South**, 21. p. 129.

- Meo S A, (2004):"Dose response of years of exposure on lung functions in flour mill workers". **Journal of Occupational health**, 40.pp.187-191.

- Merget R. and Korn M. (2005):" Metabisulphite-induced occupational asthma in a radiographer". **Eur Respir Journal**, 25.pp.386-388.

- Nallon AM, Herity B, Brennan PC, (2000):" Do symptomatic radiographers provide evidence for 'darkroom disease". **Occup Med (Lond),** 50(1).pp.39-42.

- National Institute for Occupational Safety and Health (NIOSH), Guidelines for protecting the safety and health of health care workers. Washington DC (2005). Available in 09.09.2008.
  (http://www.osha.gov/SLTC/etools/hospital/references.html 09.09.2008 at10:00 AM)

- Ntaios G, Papadopoulos A, Chatzinikolaou A, (2008):" Increased values of mean platelet volume and platelet size deviation width may provide a safe positive diagnosis of idiopathic thrombocytopenic purpura". **Acta Haematol**,119(3).pp.173-177.

- Ong TH, Tan KL, Lee HS, Eng P, (2004):" A Case Report of Occupational asthma Due to Glutaraldehyde Exposure". **Ann Acad Med Singapore**, 33.pp275-278.

- Occupational Health and Safety Service, The Safe Occupational Use of Glutaraldehyde In the Health Industries (1992) Department of Labor, Wellington, New Zealand. Available in 14.07.2008. **http://www.osh.dol.govt.nz/order/catalogue/index.shtml/fulltext.**

- Pałczyn´ ski C., J. Walusiak, U. Ruta, P. Go´ rski, (2001):" Occupational asthma and rhinitis due to glutaraldehyde: changes in nasal lavage fluid after specific inhalatory challenge test. Allergy, 56.pp.1186–1191.

- Palestine, Ministry Of Health (2005), Annual Report, Ministry Of Health, Gaza Strip.

- Palestinian Central Bureau of Statistics, small area population in West bank and Gaza Strip: revised estimates for 2008.Ramalla,2008.(access at 20.2.2008)

- Petty TL. (2001):" Simple office spirometry". **Clin Chest Med**, 22.Pp.845-859.

- Pickering C, Anees W, Robertson A, Burge A, and Mclniven R, (2000):"Glutaraldehyde induced asthma in endoscopy nursing staff". **Occup. Environ, Med**., 58:8.pp.544.

- Pratter, Melvin R. MD, Bartter, Thaddeus MD, Akers, Stephen M. MD, Kass, Jonathan MD, (2006):" A Clinical Approach to Chronic Dyspnea: Obstructive Airways Disease". **Clinical Pulmonary Medicine**. 13(3).pp.149-163.

- Prabhakara P.V.S., Lakshman Rao K.V., (2005):"Assessment of risk at work place: A Study on Radiographers Work Practices in Vizag Steel". **Indian Journal of Occup and Env Med,** April (9).pp26-30.

- Rea, William, (1978):"Environmentally triggered cardiac disease," **Annals of Allergy.** 40.pp.243-251.

- Rebecca J. Dearman, Catherine J. Betts, Neil Humphreys, Brian F. Flanagan, Nicola J. Gilmour, David A. Basketter, and Ian Kimber, (2003):"Chemical Allergy: Considerations for the Practical Application of Cytokine Profiling". **Toxicol. Science,** 71.pp. 137 - 145.

- Reja, U., Lozar Manfreda, K., Hlebec, V., Vehovar V, (2003):" Open-ended vs. Close-ended Questions in Web Questionnaires". Developments in Applied Statistics (Metodološki zvezki) 19: 159-177. Available in 17.08.2008. **(http://www.websm.org/index.php?fl=2&lact=1&bid=821&avtor=10&parent=12)**

- Schlesselman, JJ. (1982): **Case-Control Studies: Design, Conduct, Analysis.** New York : Oxford University Press, p.354.

- Scobbie E, Dabble DW, Groves JA. (1996): "Chemical pollutants in X-ray film processing departments". **Annals of Occupational Hygiene,** 40.pp.423–35.

- Scobbie E, David W, John A. Groves. (1998): "Chemical pollutants in X-ray film processing departments". **Oxford Journal, 40.pp.423**-435.

- Smedley M, Inskip H, and Wield G, (1996):"Work related respiratory symptoms in radiographers". **Occupational and Environmental Medicine, 53**.pp.450–454.

- Smedley J, Cullinan P, Frew A,(1999): "Work-related respiratory symptoms in radiographers". **Occupational and Environmental Medicine,**56**.**pp.648.

- Sood A, Redlich CA, (2001):"Pulmonary function tests at work". **Clin Chest Med**, 22.Pp.783-93.

- Spicer J, Hay DM, Gordon M, (1986):"Workplace exposure and reported health in diagnostic radiographers in New Zealand". **Australasian Radiology**,11.pp. 281-286.

- Susan M, Tarlo M, Gary M, Liss GM, Justina M, Jim P, Lisa M, Howard K, Mickey K.(2004): "Work-Attributed Symptom Clusters (Darkroom Disease) Among Radiographers Versus Physiotherapists". **American Journal of Industrial Medicine,** 45.pp.513–521.

- Sutton D, Young J.(1995): **A Concise Textbook of Clinical Imaging,** Second Edition. Mosbey, USA.

- Tarazi Issa, Sirdah Mahmoud, El Jeadi Hesham, Al Haddad Rami, (2008):" Does cigarette smoking affect the diagnostic reliability of hemoglobin $\alpha 2\delta 2$ (HbA_2)?". **Journal of Clinical Laboratory Analysis,** 22(2).pp.119-122.

- Tarlo SM, Liss GM, Green JM, Purdham J, McCaskell L, Kipen H and Ker M (2004) :" Work-attributed symptom clusters (darkroom diseases) among radiographers versus physiotherapists: associations between self reported exposures and psychosocial stressors. AM J Ind Med 45, 513-521.

- Teschke K, Chow Y, Beauer M. (2002): "Exposures and their determinants in radiographic film processing". **American Industrial Hygiene,** 63.pp.11–21.

- Teschke K, Chow Y, Brauer M, Wield G, (2000):"Exposures and their control in radiographic film processing in British Columbia". Report to the Workers' Compensation Board of British Columbia, Vancouver.

- Tomoko Takigawa, Yoko Endo, (2006):"Effects of Glutaraldehyde Exposure on Human Health". Occupational Health Journal, 48.pp.75-87.

- Trigg CJ, Heap DC, Herdman MJ, Davies RJ. (1992):" A radiographer's asthma". **Respir Med**, 86:2.pp.167–169.

- Venables KM, Farrer N, Sharp L.(1993): "Respiratory symptoms questionnaire for asthma epidemiology: Validity and reproducibility". **Thorax,** 48.pp.214-19.

- Vyas A, Pickering CA, Oldham LA, Francis HC, Fletcher AM, Merrett T and Niven RM, (2000):"Survey of Symptoms, Respiratory Function, and Immunology and their Relation to Gluteraldehyde and other Occupational Exposures Among Endoscopy Nursing Staff". **Occup Environ Med**, 57. Pp.752-759.

- Waters A, Beach J, Abramson M, (2003):"Symptoms and lung function in health care personnel exposed to glutaraldehyde**". Am J Ind Med.,** 43.pp.196–203.

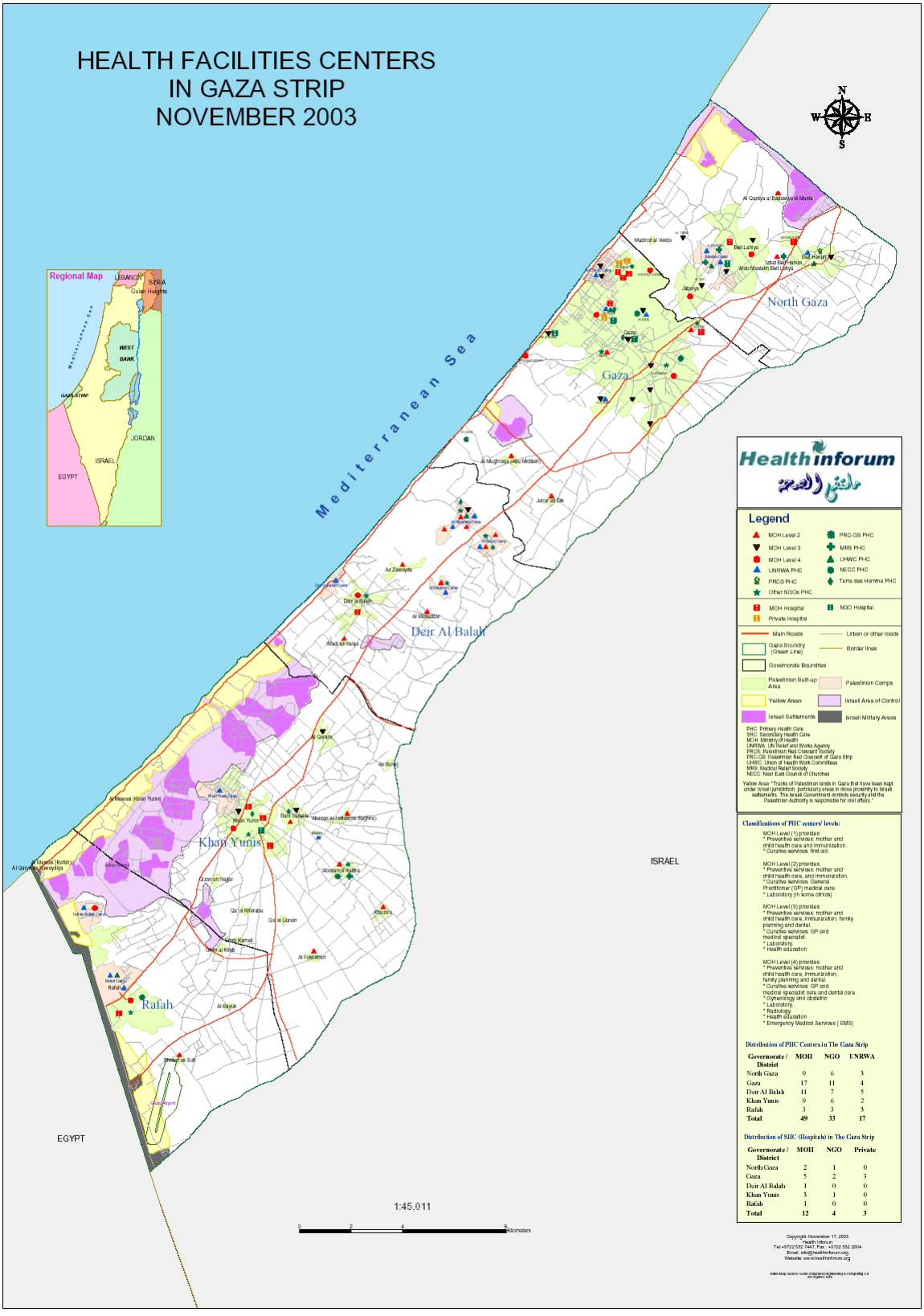
- Wilt TJ, Niewoehner D, Kim C, (2005):"Use of spirometry for case finding, diagnosis, and management of chronic obstructive pulmonary disease (COPD)". **Evid Rep Technol Assess,** 121.pp.1-7.

- Wymer ML, Chan-Yeung M, Kennedy SM, (2000): "A comparison of respiratory symptoms between physiotherapists and radiographers". **American Thoracic Society International Conference,** 161.pp.167.

- Ying-Chu Lin, Huey-Jen Su, Tzuen-Ren Hsiue, Cheng-Hung Lee, Chang-Wen Chen and Yueliang Leon Guo, (2002):" Levels of House Dust Mite-Specific IgE and Cockroach-Specific IgE and Their Association With Lower Pulmonary Function in Taiwanese Children". **Chest** , 121.pp.347-353.

- Yun SH, Choi YH, Moon YS, Ahn SH, and Kim TG, (2002):"Difference in hemoglobin between smokers and non-smokers". **Journal Korean Acad Fam Med.**,23.pp.80–86.

Annex 1


HEALTH FACILITIES CENTERS
IN GAZA STRIP
NOVEMBER 2003
Regional Map
LEBANON
SYRIA
Golan Heights
WEST BANK
GAZA STRIP
JORDAN
ISRAEL
EGYPT
Mediterranean Sea
North Gaza
Gaza
Deir Al Balah
Khan Yunis
Rafah
ISRAEL
EGYPT
1:45,011
Kilometers
Healthinforum
Legend
MOH Level 2
MOH Level 3
MOH Level 4
UNRWA PHC
PRCS PHC
PRC-GS PHC
MRS PHC
UHWC PHC
NECC PHC
Terre des Hommes PHC
Other NGOs PHC
MOH Hospital
Private Hospital
NGO Hospital
Main Roads
Urban or other roads
Gaza Boundry (Green Line)
Border lines
Governorate Boundries
Palestinian Built-up Area
Palestinian Camps
Yellow Areas
Israeli Area of Control
Israeli Settlements
Israeli Military Areas
PHC: Primary Health Care
SHC: Secondary Health Care
MOH: Ministry of Health
UNRWA: UN Relief and Works Agency
PRCS: Palestinian Red Crescent Society
PRC-GS: Palestinian Red Crescent of Gaza Strip
UHWC: Union of Health Work Committees
MRS: Medical Relief Society
NECC: Near East Council of Churches
Yellow Area: "Tracks of Palestinian lands in Gaza that have been kept under Israeli jurisdiction, particularly areas in close proximity to Israeli settlements. The Israeli Government controls security and the Palestinian Authority is responsible for civil affairs."
Classifications of PHC centers' levels:
MOH Level (1) provides:
* Preventive services: mother and child health care and immunization.
* Curative services: first aid.
MOH Level (2) provides:
* Preventive services: mother and child health care, and immunization.
* Curative services: General Practitioner (GP) medical care.
* Laboratory (in some clinics)
MOH Level (3) provides:
* Preventive services: mother and child health care, immunization, family planning and dental.
* Curative services: GP and medical specialist.
* Laboratory.
* Health education
MOH Level (4) provides:
* Preventive services: mother and child health care, immunization, family planning and dental.
* Curative services: GP and medical specialist care and dental care.
* Gynaecology and obstetric
* Laboratory.
* Radiology.
* Health education.
* Emergency Medical Services (EMS)
Distribution of PHC Centers in The Gaza Strip
Governorate / District | MOH | NGO | UNRWA
North Gaza | 9 | 6 | 3
Gaza | 17 | 11 | 4
Deir Al Balah | 11 | 7 | 5
Khan Yunis | 9 | 6 | 2
Rafah | 3 | 3 | 3
Total | 49 | 33 | 17
Distribution of SHC (Hospitals) in The Gaza Strip
Governorate / District | MOH | NGO | Private
North Gaza | 2 | 1 | 0
Gaza | 5 | 2 | 3
Deir Al Balah | 1 | 0 | 0
Khan Yunis | 3 | 1 | 0
Rafah | 1 | 0 | 0
Total | 12 | 4 | 3
Copyright November 17, 2003
Health Inforum
Tel: +9722 532 7441, Fax: +9722 532 2804
Email: info@healthinforum.org
Website: www.healthinforum.org

Annex 2

Palestinian National Authority
Ministry of Health
Helsinki Committee

السلطة الوطنية الفلسطينية
وزارة الصحة
لجنة هلسنكي

Date: 15/8/2008
Name: Yasser Alajrami

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

Possible Effects of X-Ray Film Processing on Respiratory Functions of Medical Radiographers in Gaza Governorates: Case-Control Study

In its meeting on August 2008
and decided the Following:-
To approve the above mention research study.

التاريخ:١٥/٨/٢٠٠٨
الاسم: ياسر العجرمي
نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم حول:-

و ذلك في جلستها المنعقدة لشهر أغسطس ٢٠٠٨
و قد قررت ما يلي:-
الموافقة على البحث المذكور عاليه.

Signature
توقيع

Member
عضو

Member
عضو

Chairperson

Ministry of Health
Helsinki Committee

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.

Gaza Etwam – Telefax 972-7-2878166

Annex 3

Al-Quds University

Jerusalem

School of Public Health

جامعة القدس

القدس

كلية الصحة العامة

2008/7/6

حضرة السيد مدير عام المستشفيات – بوزارة الصحة المحترم

تحية طيبة وبعد،،،

الموضوع: مساعدة الطالب ياسر العجرمي

يقوم الطالب المذكور أعلاه بإجراء بحث بعنوان:

"Possible Effects of X-Ray Films Processing on Respiratory Functions of Medical Radiographers in Gaza Governorates: Case-Control Study"

كمتطلب للحصول على درجة الماجستير في الصحة العامة-مسار صحة البيئة و عليه نرجو التكرم للإيعاز لمن ترونه مناسب لتسهيل مهمة الطالب في جمع البيانات اللازمة من المستشفيات التابعة لوزارتكم في محافظات غزة.

علماً بأن المعلومات ستكون متوفرة لدى الباحث و الجامعة فقط.

و اقبلوا فائق التحية و الاحترام،،،

د. بسام أبو حمد

منسق عام برامج الصحة العامة

نسخة:

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Annex 4

Al-Quds University
Jerusalem
School of Public Health

جامعة القدس
القدس
كلية الصحة العامة

2008/7/6

الأخ/د. فؤاد العيسوي المحترم
مدير عام الرعاية الأولية – وزارة الصحة
تحية طيبة وبعد،،،

الموضوع: مساعدة الطالب ياسر العجرمي

يقوم الطالب المذكور أعلاه بإجراء بحث بعنوان:

"Possible Effects of X-Ray Films Processing on Respiratory Functions of Medical Radiographers in Gaza Governorates: Case-Control Study"

كمتطلب للحصول على درجة الماجستير في الصحة العامة–مسار صحة البيئة و عليه نرجو التكرم بالموافقة و الإيعاز لمن ترونه مناسب للسماح للطالب ب:

1- استعارة جهاز قياس كفاءة الجهاز التنفسي التابع لدائرة الصحة المهنية.

2- تسهيل مهمة الطالب في جمع البيانات اللازمة من مراكز الرعاية الأولية التابعة لدائرتكم.

علماً بأن المعلومات ستكون متوفرة لدى الباحث و الجامعة فقط.

و اقبلوا فائق التحية و الاحترام،،،

د. بسام أبو حماد
منسق عام برامج الصحة العامة

وزارة الصحة
الإدارة العامة للرعاية الأولية
الرقم: ٩٨٥٧
التاريخ: ٢٠٠٨/٧/١٠

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Annex 5

Al-Quds University
Jerusalem
School of Public Health

جامعة القدس
القدس
كلية الصحة العامة

2008/7/6

الأخت / د. رندة الخضري المحترمة
مدير المختبرات المركزية – وزارة الصحة
تحية طيبة وبعد،،،

الموضوع: مساعدة الطالب ياسر العجرمي

يقوم الطالب المذكور أعلاه بإجراء بحث بعنوان:

"Possible Effects of X-Ray Films Processing on Respiratory Functions of Medical Radiographers in Gaza Governorates: Case-Control Study"

كمتطلب للحصول على درجة الماجستير في الصحة العامة-مسار صحة البيئة و عليه نرجو التكرم بالموافقة و الإيعاز لمن ترونه مناسب للسماح للطالب باستخدام أجهزة المختبر المركزي (عيادة الرمال)، مع تحمل الطالب لجميع تكاليف المواد المستخدمة.

و اقبلوا فائق التحية و الاحترام،،،

د. بسام أبو حمد
منسق عام برامج الصحة العامة

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Annex 6

إقرار بالشهادة

استبيان حول إمكانية تأثير عملية تحميض الأفلام السينية على وظائف الجهاز التنفسي لفنيي الأشعة في محافظات قطاع غزة: (دراسة مقارنة)

يهدف هذا الاستبيان إلى معرفة تأثير الأحماض المستخدمة في غرفة تحميض الأفلام الإشعاعية الخاصة بمستشفيات ومراكز الرعاية الأولية بقطاع غزة, من خلال المقابلة المباشرة مع نحو 100فني أشعة. ستستخدم هذه المعلومات لأهداف البحث العلمي فقط. لذا نرجو الإجابة بصراحة ولا تترك أي إجابة فارغة. تذكر أن المعلومات التي تقدمها لنا سرية ومجهولة.

أنا الموقع أدناه أوافق على إجراء الفحوصات التالية :

☐ تعبئة الاستبانة ☐ كفاءة الجهاز التنفسي ☐ سحب عينة دم من الوريد

ملاحظة: جميع الفحوصات (Spirometry and Venous Blood Sample) ستتم عن طريق مختصين لهم خبرة ودراية كافية لإجراء هذه الفحوصات.

التوقيع / اخوكم الباحث /

ياسر صالح العجرمي

0599-711648

رقم الاستبيان.....

أسئلة عامة:

1-الجنس: O ذكر O أنثى

2-العمر: O 30-40 سنة O 41- 50 سنة O 51- 60 سنة

3-المهنة: O فني أشعة O فني علاج طبيعي

4-مكان العمل : O مستشفى حكومي O مركز رعاية أولية

5-عدد سنوات الخبرة:

6-الحالة الاجتماعية : O أعزب O متزوج

7- المحافظة : O الشمال Oغزة O الوسطى O خان يونس O رفح

8 – مكان السكن : O قرية O مدينة Oمخيم

9- نوع السكن: O باطون Oاسبست

10--التدخين : O مدخن: O غير مدخن

أسئلة صحية:

11-هل عانيت من أي مشكلة صحية سابقا : O نعم O لا

إذا كانت الإجابة نعم, وضح في أي جهاز؟

Oالجهاز الهيكلي العضلي Oالجهاز التنفسي Oالجهاز العصبي Oالجهاز الهضمي O أخرى

12 –هل تعاني من أي مشكلة صحية حاليا: O نعم O لا

إذا كانت الإجابة نعم, وضح في أي جهاز؟

Oالجهاز الهيكلي العضلي Oالجهاز التنفسي Oالجهاز العصبي Oالجهاز الهضمي O أخرى

13– هل مشكلتك الصحية لها علاقة بطبيعة عملك : O نعم O لا

14–هل مشكلتك الصحية لها علاقة بمكان سكنك: O نعم O لا

15– هل مشكلتك الصحية تختفي في العطل و الإجازات: O نعم O لا

16–هل تعاني من احدي أو أكثر من الأعراض التالية في الجلد (احمرار، طفح، حكة)خلال ساعات العمل؟ O نعم O لا

17– هل تعاني من احدي أو أكثر من الأعراض التالية في العين (حكة، احمرار، دعم، الم، ضبابية الرؤية) خلال ساعات العمل؟ ؟ O نعم O لا

18– هل تعاني من صداع متكرر خلال ساعات العمل؟ O نعم O لا

19– هل تعاني من تعب أو ألم عند صعودك درج بسرعة ؟ O نعم O لا

20- هل تعاني من نوم متقطع؟ O نعم O لا

21- هل تعاني من خروشة بالصدر؟ O نعم O لا

22- عند استيقاظك صباحا هل تشكو من ضيق نفس/ بلغم / كحة ؟ O نعم O لا

23- هل تشكو من حالة عدم الارتياح او ضيق عندما تكون في غرفة مغلقة/في غرفة تدخين/في غرفة مغبرة؟ O نعم O لا .

24-هل تشكو من ضيق نفس في فصل الشتاء أثناء تواجدك بمكان العمل؟ O نعم Oلا .

25- هل تعاني من صعوبة تنفس من الأنف خلال ساعات العمل؟

O نعم O لا

26- هل تعاني من تكرار العطس أثناء ساعات العمل؟

O نعم O لا.

27- هل تلاحظ اضطراب في ضربات القلب عند بذل جهد أثناء ساعات العمل؟

O نعم Oلا .

-أسئلة خاصة بفنيي الأشعة فقط :

28- هل معايير السلامة والأمان مطبقة بغرفة التحميض (الغرفة المظلمة)؟

O نعم O لا.

29- هل هناك إجراءات و مراقبة إدارية لمعايير ضبط الجودة في غرف التحميض؟

O نعم O لا.

30- هل قسم الأشعة ككل مزود بنظام تهوية مناسب وفعال؟ O نعم O لا .

31- هل غرفة التحميض مزودة بنظام تهوية خاص؟ O نعم O لا.

32- هل تشعر بوجود رائحة حادة أو كريهة بقسم الأشعة؟

O نعم O أحيانا O لا.

33- هل تشعر بوجود رائحة حادة أو كريهة بغرفة التحميض؟

O نعم O أحيانا O لا.

34- هل غرفة التحميض/جهاز التحميض مزود بمدخنة أو أنابيب خاصة للتخلص من عادم الجهاز الهوائي (شكمان)؟ O نعم O لا O لا اعرف .

35- هل يوجد صيانة دورية للجهاز؟ O نعم O أحيانا O لا .

36- هل غرفة التحميض ملاصقة لغرفة استراحة أو جلوس الفنيين؟

O نعم O لا .

37- مدى تقييمك لكفاءة جهاز التحميض؟

O جيدة O مقبولة O رديئة .

38- هل يتم مراقبة عملية تحضير الأحماض من قبل إدارة قسم الأشعة ؟

O نعم O أحيانا O لا .

39- هل يتم استخدام الشفط خلال تحضير الأحماض ؟

O نعم O أحيانا O لا .

40- هل تعمل كفني أشعة في غير القطاع الحكومي:

O نعم O لا.

41- عدد ساعات العمل الأسبوعية بقسم الأشعة:

O 30-40 O 41-50 O أكثر من 50 .

42- عدد ساعات العمل الأسبوعية في غرفة التحميض:

O 1 -10 O 11-20 O أكثر من 20 .

43- هل يوجد فحوصات دورية لفنيي الأشعة؟ O نعم O أحيانا O لا

44- هل تعرف تركيبة الأحماض المستخدمة و مخاطرها على صحتك؟

O نعم بالتفصيل O نوعا ما O لا .

45- هل تعتقد بوجود مشكلة أو مشاكل صحية ناتجة من غرفة التحميض؟

O نعم O لا O لا أعرف

46 – هل تعرف مقاييس السلامة اللازم تواجدها بغرفة التحميض؟

O نعم بالتفصيل O لا O نوعا ما

47– هل يتم تنظيف جهاز التحميض جيدا من قيل الفنيين بعد الاستعمال؟

O نعم O أحيانا O لا

48– هل تستخدم أدوات و سبل الوقاية الشخصية في عملية التحميض؟

O نعم O أحيانا O لا

49– خلال تحضير الأحماض هل تشعر بأحد أو أكثر من الأعراض التالية (حكة في العين/كحة/عطس/ضيق نفس): O نعم O لا

Annex 7

Panel of Expert

The questionnaire was examined by group of experts, some items were added, modified or excluded as a results of their comments.

1-Dr. Mahmoud Sirdah

2-Dr. Yunis Al-Astal

3-Dr. Yousef Abu-Safia

4-Dr, Yehia Abed

5-Dr. Jamal Safi

6-Mr. Kazem Al-Habash

7-Mr. Basel Khamis

8-Mr. Khalil Mater