Effects of x-Ray Film Processing on Health Status of Medical Radiographers at Gaza Strip, Palestine

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Abstract: *The present study aimed to understand the association between health status of medical radiographers and the exposure to chemical fumes in an x-ray film processing room of radiographic departments as compared to control group of physiotherapists. Study tools included a closed ended questionnaire, spirometric measurements, complete blood counts, and serum total IgE quantitation. Results showed a significant and worse deviations in health status of medical radiographers (health complains, spirometric measurements, platelets count, serum IgE) as compared to control group. Significant correlations were reported between the evaluation variables of health status and years of experience of medical radiographers and number of weekly processing hours at darkrooms. Unawareness of MRs, poor structural designs together with operational deficiencies were major features of radiology departments. In conclusion, the present study revealed an exaggerated health status of medical radiographers. The responsibility could be attributed on one hand to the irresponsible practices and less awareness of the medical radiographers, while on the other hand to poor design of radiographic departments and darkrooms operational and ventilation deficiencies.*

Keywords*: Medical radiographers, darkroom, spirometry, health complains, x-ray film, IgE*

Introduction

Medical radiographers (MRs) have potential exposure to the processing chemicals (developer and fixer) involved in developing and fixing x-ray films at the darkrooms. There have been reports of 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. Therefore, much

efforts and safety measures have been introduced and adopted aiming at the minimization of the adverse effects of the chemical hazards. These safety measures included the using of automated processors, safer radiological designs, powerful and effective local exhaust ventilation systems, increasing awareness of MRs for the safer use and handling of such chemicals, and the introduction of legislative directives into working practices. 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. Unfortunately and despite of the previous preventive and safety measures, darkroom disease remains a well-reported health status among MRs [1-3]. This study is aimed to investigate any association between health status of MRs and the exposure to chemical fumes, in an x-ray film processing room of radiographic departments. Meanwhile evaluation of the structural and operative issues in radiographic departments.

Methodology

Study Design

The present work was designed as cross sectional study that investigated the possible health effects of x-ray film processing on respiratory functions and some hematological and biochemical parameters of MRs as compared to a control group of physiotherapists (PTs) who are working at the same hospitals and health centers of MRs, which minimizes or diminishes any interrupting factors that may affect the reliability of the results. PTs were preferred over other health professionals like nurses due to the fact that nurses may convoy patients with special needs to the radiology departments.

Study Tools

Close ended questionnaire together with spirometric analysis, complete blood count, and determination of serum IgE levels were the main tools of the study.

Questionnaire

Important part of data was collected by using close-ended questionnaire which was designed to include socio-demographic and health characteristics and complains (12 complains) of the subjects.

Also the questionnaire included evaluation items about the radiology departments and about the knowledge and practices of the MRs.

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. 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 health complains were summarized and categorized so that 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. 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 % complain, while who mentioned no complains was scored as 0 % complain. The remaining categories were percentages of the number of complain to 12.

Spirometric Measurements

Spirolab II spirometer (Medical international research, Rome, Italy) was used to provide spirometric measurements for the subjects. Spirolab II makes breathing pattern tests, 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].

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 K_3-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, hemoglobin (Hb) concentration, hematocrit (Hct) percentage, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RDW), platelets (PLT) count, mean platelets volume, and platelets distribution width.

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.

Sample Size

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 statistical cell our provisional sample size has been increased. Eighty five questionnaires were distributed to the MRs at their working radiology departments.

Sampling

The questionnaire was distributed to the MRs and PTs through meeting interviews, and they kindly and freely asked 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. After filling and signing the questionnaire, subjects who agreed were subjected to spirometry test to assess pulmonary functions and venous blood sampling for CBC and IgE determination.

Ethical Considerations

The approval for the topic and methodology of the present study was obtained from the Helsinki committee at the Palestinian ministry of health (MOH). The authors explained the purpose and objectives, and methodology of the study to all subjects included in the present study. They 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.

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 measurements and tests (Chi square test, Z-test, Spearman rank correlation coefficient r_s, and Kruskal –Wallis test) were performed aiming at the description, identification of significant relationship, correlations and differences between the MRs and PTs of the present variables and parameters [5,6] .

Results

Respondent Rates

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 (1). According to the free acceptance to be involved, 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 (1): Distribution of the Subjects According to Governorate

Governorate	MRs		PTs	
	N	%	N	%
Northern	14	18.4	18	19.7
Gaza	24	31.6	31	34.1
Mid Zone	18	23.7	19	20.9
Khanyounis	14	18.4	15	16.5
Rafah	6	7.9	8	8.8
Total	**76**	**100 %**	**91**	**100 %**

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 MRs and PTs are mentioned in Table (2). The mean age of the overall subjects was 39.1± 6.6 years, while for the case and control groups it was 40.7± 6.9 and 37.7± 6.0 years respectively. The majority (68.3 %)of the subjects were in the age group 30-40 years.

Table (2): General Characteristics of the Subjects

	MRs N (%)	PTs N (%)
Gender		
Males	62 (81.6)	50 (54.9)
Females	14 (18.4)	41 (45.1)
Marital Status		
Single	5 (6.6)	13 (14.3)
Married	71 (93.4)	78 (85.7)
Smoking Habit		
Smoker	18 (23.7)	13 (14.3)
Non smoker	58 (76.3)	78 (85.7)

Data are expressed as number of subjects and percentage in parentheses
MRs = medical radiographers, PTs= physiotherapists

Health Characteristics of the Subjects

The responses to questionnaire items about health characteristics of the subjects are mentioned in Table (3). The majority of the MRs (81.6 %) and PTs (75.8%) did not report any previous health problems However, a significant ($p<0.0001$) proportion (73.7 %) of the MRs reported current health problems compared to PTs (31.9 %).

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.

Table (3): Health characteristics of the subjects

	MRs			**PTs**			**Z-test**
	N	(%)	***P value***	N	(%)	***P value***	***P value***
Previous health problems							
Yes	14	18.4	***0.000***	22	24.2	***0.000***	***0.181***
Current health problems							
Yes	56	73.7	***0.000***	29	31.9	***0.001***	***0.000***
Respiratory	51	91.1		6	20.7		***0.000***
Skeletal	0	0.0		7	24.1		***0.000***
Others	5	8.9		16	55.2		***0.000***
Current health problems related to work							
Yes	43	76.8	***0.000***	12	41.4	***0.075***	***0.001***
Current health problems related to house?							
Yes	7	12.5	***0.000***	2	6.9	***0.000***	***0.305***
Are health problems disappear or reduce in holidays							
Yes	52	89.7	***0.000***	10	58.8	***0.467***	***0.002***

MRs = medical radiographers, PTs= physiotherapists

Specific Health Complains of the Subjects

The specific health complains of the MRs and PTs are mentioned in Table (4). Except 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 as compared to PTs. The mean health complains score percentage (MHCSP) of MRs (53.9 ± 27.6 %) was significantly higher as compared to PTs (21.1 ±19.5 %) with mean ranks of 113.7 and 59.2 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%).

Significant differences (p=0.040) were reported in MHCSP with respect to working experience, where 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 MHCSP and years of experience of MRs (r_s = 0.244, p=0.034) and between MHCSP and number of weekly processing hours at darkroom (r_s = 0.430, $p < 0.0001$). Non significant difference was reported in MHCSP between smokers and non smokers MRs (55.2 ± 25.6 % vs 50.0± 33.8 % with mean ranks of 39.3 and 35.8 respectively, $p = 0.547$). Also non significant difference was reported in MHCSP between males and females MRs (54.8 ± 28.2 % vs 50.0± 25.5 % with mean ranks of 39.2 and 35.5 respectively, $p = 0.576$).

Table (4): Health complains of the subjects

Questionnaire item	MRs			PTs			*Z test*
	N	%	*P value*	N	%	*P value*	*P value*
Do you have skin complains (Reddish Rash Itching Mixture)							
Yes	31	40.8	***0.11***	6	6.6	***0.000***	***0.000***
Do you have eye symptoms/complains during working hours							
Yes	50	65.8	***0.006***	11	12.1	***0.000***	***0.000***
Do you complain recurrent headache during working hours							
Yes	60	78.9	***0.000***	25	27.5	***0.000***	***0.000***
Do you feel tired when step the stairs quickly							
Yes	17	22.4	***0.000***	13	14.3	***0.000***	***0.087***
Are you suffering from intermittent sleep?							
Yes	50	65.8	***0.006***	29	31.9	***0.001***	***0.000***
are you suffering from wheezy chest							
Yes	28	36.8	***0.022***	6	6.6	***0.000***	***0.000***
Are you suffering from wakeup symptoms or complains							
Yes	52	68.4	***0.001***	27	29.7	***0.000***	***0.000***
Do you feel discomfort in closed/smoky/or dusty rooms							
Yes	75	98.7	***0.000***	75	82.4	***0.000***	***0.000***
Are you suffering from winter dyspnea							
Yes	16	21.1	***0.000***	8	8.8	***0.000***	***0.012***
Are you suffering difficulties in nose breathing							
Yes	56	73.7	***0.000***	33	36.3	***0.009***	***0.000***
Are you sneezing during working hours							
Yes	48	63.2	***0.022***	24	26.4	***0.000***	***0.000***
Do you suffer from heart disruption during working hours							
Yes	34	44.7	***0.359***	35	38.5	***0.028***	***0.21***

MRs = medical radiographers, PTs= physiotherapists

Complete blood count and IgE

For CBC results, statistically significant differences were reported only in platelets count and platelets related indices (Table 5). Platelets count (PLT) and platelets distribution width (PDW) in 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.

Table (5): Mean ± SD of CBC parameters and IgE of MRs & PTs.

Parameters	**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 IU/ml	145.17 ± 109.67	69.94 ± 61.71	*0.001*

MRs = medical radiographers, PTs= physiotherapists

MRs showed a significantly ($p = 0.001$) higher serum concentration of IgE (145.17 ± 109.67 IU/ml) as compared to PTs control group (69.94 ± 61.71 IU/ml). Significantly higher IgE concentrations were reported in MRs who have additional working schedule with other sectors; 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 MRs IgE serum concentration and weekly hours she/he spent at darkroom, with Persons correlation coefficient r= 0.671 and $p < 0.0001$.

Spirometric Measurements

Tables (6&7) respectively present the spirometric respiratory function tests and diagnosis of MRs and PTs.

Table (6): Mean ± SD of the spirometric parameters of MRs & PTs

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

MRs = medical radiographers, PTs= physiotherapists
** significantly different*

Table (7): Diagnosis of MRs & PTs according to spirometry

Spirometric diagnostic results	MRs (N= 57)		PTs (N= 62)		*P value*
	N	%	N	%	
Normal	11	19.3	44	71.0	***0.000***
Mild restriction	23	40.4	15	24.2	***0.022***
Moderate restriction	9	15.8	3	4.8	***0.023***
Moderate–severe restriction	2	3.5	0	0	
Sever restriction	1	1.8	0	0	
Mild obstruction	2	3.5	0	0	
Moderate obstruction	1	1.8	0	0	
Moderate-severe obstruction	2	3.5	0	0	
Moderate Restriction with Moderate-severe obstruction	6	10.6	0	0	

MRs = medical radiographers, PTs= physiotherapists

Except for FEV1% and FEF_{75}, all other spirometric parameters and respiratory function tests revealed better value for control group of PTs as compared to MRs group. 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 8), mild spirometric results were reported in 43.9 %, while 17.5 % for moderate, 7.0 % for moderate –severe, and 12.3 % for severe spirometry.

Significant differences were reported in spirometric results of MRs with experience group (25-32 years), where 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, FEF_{25}, FEF_{50}) and the number of weekly hours at the processing darkroom, the r_s 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.

Table (8): Spirometric classification of MRs and PTs

Spirometric classification	MRs		PTs		*P value*
	N	%	N	%	
Normal spirometry	11	19.3	44	71.0	***0.000***
Mild spirometry	25	43.9	15	24.2	***0.012***
Moderate spirometry	10	17.5	3	4.8	***0.013***
Moderate–severe spirometry	4	7.0	0	0	***0.017***
Sever spirometry	7	12.3	0	0	***0.002***

General and Technical Evaluation of the Radiology Departments

The majority (82.9%) of MRs mentioned the inapplicability of safety measures in darkrooms; 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%). Concomitantly, 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%). Moreover, the regular administrative monitoring on chemical preparations was reported by only 9.2 % of the MRs.

General and Technical Evaluation of the MRs Knowledge and Practice

About three quarters 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. Moreover, only one-fourth of the MRs are familiar with the safety standards of the darkroom, while, 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.

Discussion

Medical radiographers 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 darkrooms 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. Among these

hazardous chemical are glutaraldehyde, formaldehyde, hydroquinone, sulphur dioxide, and acetic acid which separately or collectively have been considered as sensitizing agents and associated with health complains and problems that are mainly related to the respiratory system and airways [7-9]. In our study we aimed at the evaluation of the health status of the MRs in relation to the structural and operative issues at their radiographic departments.

The relatively high response rates of the MRs in the present study questionnaire and spirometry tests could 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 [10-12].

Fortunately, smoking was reported only in 18.6 % of the overall subjects, which minimizes or diminish interference and confliction of smoking on respiratory function results and parameters of the case and control group. Because of the possible interruption of smoking on spirometry [13,14] and CBC parameters [15-17], and to secure as much as possible controlled results and outcomes, the smokers' data were excluded from the spirometry and CBC statistical analysis.

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 work and ameliorated on off days [18]. Moreover, a similar study which was conducted by Prabhakara and Lakshman, 2002, showed that respiratory symptoms among MRs were several times higher than PTs, with intensified respiratory complains during working hours [19].

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 [9,18-21]. 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 [8,20,21]. 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 [3,9].

For CBC results, 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 attributed this reduction to the effect of x-ray ionizing radiation only [22]. 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, it has been shown that reduction in platelets count together with increased MPV and PDW are a reliable and predictive results for the diagnosis of idiopathic thrombocytopenic purpura [23]. Whatever the diagnosis, it is so important for future sties to find the contributing factor behind the abnormalities in the haemostatic pathway of MRs.

The IgE immunologic response and the higher IgE levels in MRs and workers in radiographic and photographic film processing could be 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 that triggers IgE production [24-26]. Glutaraldehyde may resemble 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, 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 also reflect the level of ventilation and safety measures that available at the radiographic departments [3,27,28].

Up to our knowledge and after full searching the electronic literature, only one scientific study partially dealt with spirometric

measurements of MRs, and the results 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 [21]. Our present 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 provide the spirometric tests to evaluate and assess the functionality of the respiratory system of MRs and workers who continuously subjected to chemical fumes.

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 [20]. 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 [9].

The most serious and crucial point is the number of 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 [9]. In our study and as mentioned about 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. The reported health complains and the abnormal spirometric and laboratory results of the MRs of the present study could be attributed 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 [9,20,29].

In conclusion, the present assessment study revealed an exaggerated health status of the of Palestinian MRs in 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.

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