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THE LEVEL OF VISUAL AND MUSCULOSKELETAL DISORDERS AMONG OFFICE WORKERS IN PALESTINE

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Abstract Visual and Musculoskeletal Disorders (VMSD) are one of the occupational diseases prevalent among office workers in the globe. Many studies have been devoted to examine such disorders in developed countries. However, few studies have recently been initiated in developing countries. Among them is this study which aims to assess the prevalence of VMSDs among office workers in Palestine. To this end, a self-reporting questionnaire was designed and distributed to 501 respondents from office workers working in public and private organizations in West Bank, Palestine. The collected data were statistically analyzed performing, ANOVA and Multiple Linear Regression. The results showed that about 62.5% of the sampled workers suffered from the development of at least one VMSD symptom, and about 17% indicated they have one permanent symptom. Besides, gender and age of office workers showed significant statistical differences in the prevalence of VMSD's symptoms. The results of the MLR showed significance in modeling the VMSD's symptoms prevalence. The findings of this study could help the relevant stakeholders in taking engineering and administrative interventions to alleviate the adverse effects of VMSD on office workers' occupational health, safety and job performance.

Keywords: Office workers; musculoskeletal disorders; visual disorders; ergonomics; multiple linear regression.

1. INTRODUCTION

Musculoskeletal disorders (MSDs) or interchangeably, cumulative trauma disorders (CTDs), overuse syndrome or repetitive strain injuries (RSIs), are occupational diseases associated with tasks involving repetitive, forceful movements and long-period sustained postures, causing damages to tendons, bones, nerves and other soft tissues [1]. Without loss of generality, MSDs is used in the presentation of the material in this study. MSDs have been considered as one of the most prevalent and costly occupational diseases in many manufacturing and services industries in the world. Specifically, MSDs contribute to more than 30% of diseases treatment compensations in the developed countries including USA, Japan and Great Britain [2,3]. In the USA alone, the estimated cost of MSDs is estimated to be $ 2.1 billion [4]. Furthermore, according to [5], the reason for these high costs is that a person with a severe MSD can be disabled for months or even years. For employers and insurers, disability and treatment payments can amount to $25,000 per case, besides the loss of a productive and experienced employee. A recent study by Bevan [6] argues that MSDs are highly-contributing to work disabilities, high rates of sickness absenteeism from work as well as loss of productivity across all the European Union (EU) member states. In the sequel, the total cost of lost productivity caused by various types of MSDs prevalent among people working age in EU is roughly 2% of gross domestic product (GDP).

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On the other hand, many studies have been devoted to address MSDs in different industries and different settings in developing countries, to name but a few, Maakip et al. [7] conducted a study on the prevalence of MSDs among Malaysian public office workers and examined the associated MSD discomfort predictors. Also, Veselinovic et al developed a computer-based expert system to determine the ergonomic risks for work-related MSDs in a wide spectrum of jobs among them jobs including administrative tasks [8]. Moom et al.[9] studied the prevalence of MSDs among computer bank office employees in India. Likewise, Darvishi et al. [10] examined the correlation of subjective mental workload with MSDs in bank staff members in Kurdistan in western Iran. Sadeghi et al. [11] examined the prevalence of CTDs among amateur music students playing one of the two traditional Iranian instruments, Daf and Setar.

MSDs and their associated complaints, particularly in the upper extremities of persons working in many occupations including administrative and office works are becoming more challenging in organizations [12]. The literature is very rich with studies devoted to identification of MSDs risk factors. The most common risk factors were reported to be repetitive motions, awkward prolonged postures, forceful movements, vibration, mechanical pressure [13-15], cold and muscle fatigue [16-17]. On the other hand, individual demographic factors including, but not limited to, color (white versus black), gender, pregnancy, age and obesity were also reported to be additional risk factors of MSDs [18, 19]. Some specific occupational diseases which belong to MSDs include, tendinitis, carpal tunnel syndrome (CTS), epicondylitis, tenosynovitis, De Quervain's syndrome, trigger finger syndrome, white (dead) finger syndrome, Guyon tunnel syndrome, cubital tunnel syndrome, neck tension syndrome, pronator teres syndrome, rapid tunnel syndrome, shoulder tendinitis, rotator cuff syndrome, nerve entrapment and low back pain [20]. Many MSDs share some common symptoms that appear on the affected parts of the human body. Kroemer [20] summarized these symptoms to include persistent nocturnal pain, tumescence, tingling, numbness, itching, burning, clumsiness, prickling, cracking of joints, weakness, redness, decreased joint motion and heat around the affected area both while working and resting. Mackinnon and Novak [21] discussed the pathogenesis of cumulative trauma disorders (CTDs) clinically. The diagnosis and treatment of various types of MSDs were thoroughly discussed by Armstrong [5].

During their work shifts, office workers spend long times sitting, using computer keyboard and mouse for typing, experience some of these risk factors of MSDs. In particular, maintaining a constrained posture for doing day-long static jobs with high repetition of hands and fingers to achieve the desired accuracy using computer keyboard and mouse are considered generic risk factors for the initiation of MSDs among office workers [12]. This results in pains and aches due to damage developed in the soft tissues, bones, joints and ligaments of office workers' neck, low back and upper extremities. A great deal of research in the literature has been devoted to address the various types of MSDs among office workers doing their office jobs. More specifically, Franzblau et al. [22] conducted a study to identify the types of CTDs suffered by office workers employed in medical illustration and medical graphics department. CTS was found to be the most prevalent CTD among those office workers.

Marcoux et al. [23] conducted a pilot study on assessing the effectiveness of an educational and awareness intervention program on reducing the risk of developing various types of CTDs of office workers in a health maintenance organization in Michigan, USA. Participating office workers have

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shown a significant improvement in preventing the emergence of MSDs symptoms in their hands/wrists, necks and shoulders after completing such an educational and awareness intervention program. Amell and Kumar [4] examined the relation between the use of computer keyboards and the development of MSDs. Based on biomechanical evaluation, alternative keyboard designs were considered. The repetition of keyboarding, prolonged sitting posture and forceful movements were found to be the apparent risk factors of developing MSDs among keyboarders. Another relevant study was conducted by Hernandez et al. [24] to investigate the prevalence of MSDs among office workers in a newspaper publishing office in Mexico City using a questionnaire for data collection. The results of the study revealed that office workers who used computers, those working on editing and those working in unconformable environment had greater tendency for being affected by MSDs.

Cirla et al. [25] worked on preventing the development of MSDs among office workers aged 40 to 60 years through conducting a training of ergomotricity. Data on MSDs complaints were reported by a group of participants before and after training of ergomotricity. The results showed that complaints have been reduced in more than 35% of participants. One more study by Ripat et al. [26] investigated the effectiveness of long-term training using an ergonomic keyboard in reducing the development of MSDs symptoms in the upper extremities of office workers. The results of this follow-up study showed that after six month of use, a significant improvement in reducing the development of MSDs symptoms could be achieved by office workers while maintaining their keyboarding speed and accuracy.

Andersen et al. [27] investigated the effect of physical exercises and reference intervention on alleviating the symptoms of MSDs in different parts of the bodies of office workers. Based on the analysis of the data obtained by questionnaires reported by participants, the physical exercises program for office workers outperformed reference intervention programs in reducing the pains of MSDs of office workers. Apart from physical risk factors of MSDs, a study by Choobineh et al. [28] examined the effects of psychosocial risk factors on the development of MSDs of office workers working in Iranian oil refinery and the effects of applying an ergonomic intervention on them. Questionnaires were employed for obtaining the needed data on subjects before and after ergonomic interventions. Low back pains were found to be common in office workers, whereas significant statistical differences were found before and after interventions, specifically in upper and lower back and foot/ankle regions of subjects. In fact, there are many other studies which have been conducted to investigate the prevalence of MSDs among office workers including but not limited to, Ered et al. [29] who conducted a comparison of occupational exposure methods related to MSDs in office workers in a local newspaper in Canada, Sherrod et al. [30] reported the case of managing the CTDs among employees in a college work environment in Canada using both chiropractic care and applied ergonomics. Cruz et al. [31] conducted a cross-sectional MSD study to establish the level of musculoskeletal fitness and health-related quality of life in sedentary office workers in Spain, Herr et al. [32] also studied three job stress models and their relationship with musculoskeletal pain in blue- and white-collar workers in Germany, and Hadgraft et al. [33] assessed the effect of total and prolonged sitting time on the prevalence of MSDs in Australian office workers.

Other similar previous studies thoroughly addressed the issue of ergonomic interventions and their effects on alleviating MSDs attributed to computer use, to name by a few, Goodman et al. [34], who examined the effective interventions for CTDs of the upper extremities in computer users in USA.

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Cho et al. [1] investigated the prevalence of MSDs symptoms among high-load computer users in Taiwan, while Robertson et al. [35] examined the prevalence of VMSD among intensive users of computers in USA. On the other hand, Collins and O'Sullivan [36] investigated the prevalence of MSDs among office workers who intensively use computers in their daily tasks in a university in Ireland, while Penheiro et al. [37] evaluated the flexion-relaxation phenomenon and ratios of computer workers with and without chronic neck pain on subjects in Brazil. In addition to MSDs among office workers who use computer in their offices, visual disorders including dry eyes could develop among them as well. Many previous studies have addressed this problem among computer and visual display terminal users, for instance, Uchino et al. [38] examined the prevalence of dry eye disease and risk factors among young and middle-aged Japanese office workers using visual display terminals, while Blehm et al. [39] conducted a review study on the computer vision syndrome. On the other hand, Tsubota and Nakamori [40] studied the dry eyes and video terminal displays in Japan and Mocci et al. [41] examined the psychological factors and visual fatigue in working with video display terminals. Another study by Yan et al. [42] was devoted to study the computer vision syndrome among computer users. Other studies covering visual disorders among workers can be found in [12, 35, 43, and 44].

As presented previously, the prevalence of VMSD among office workers has been addressed by researchers in both developed and developing countries. To the best of our knowledge, this research is the first of its kind that examines the prevalence of VMSD disorders among office workers in Palestine which is a developing country. Palestine is a third-world state with an approximate population of 4,816,503 capita divided into 2,935,368 capita in West Bank and 1,881, 135 capita in Gaza Strip [45]. Due to extreme difficulty in accessing Gaza Strip and collecting the needed information, this study is restricted to office workers working in West Bank. According to PCBS, 2016's published statistics, around 78% of employees and workers aging over 18 years (who count for 25% of the entire population) work in both private (50%) and public (i.e. governmental with 28%) organizations. About 33% of those are office workers handling administrative eight-hour one shift-long tasks [45]. Consequently, in regard to the West Bank's population, approximately the population size of the study is calculated as [0.25 (workers aging over 18 years)×0.33 (office workers handling administrative tasks)×0.78 (50% of workers in private and 28% in governmental organizations)×2,935,368 (West Bank's population size)= 188,890] office workers are working in public and private sectors in West Bank. This study gains its significance from the unique particularity of Palestine. As the most valuable asset for Palestinians is the human resource working in private and public organizations in Palestine. In order to maintain high levels of performance of people handling administrative tasks as office workers in those organizations, the working environment they are working in should be healthy, safe and ergonomically-designed. To this end, we were motivated to conduct this study which mainly aims at examining the prevalence of VMSD among office workers (both genders) working in public and private organizations in Palestine. Office workers in both private and public sectors basically implement tasks involving working on computers, keyboarding, using computer mouse, editing, record keeping and archiving and other similar tasks that are sedentary in nature.

Within the Palestinian context, this study aims at identifying the main types of VMSDs among Palestinian office workers working in Palestinian private and public (governmental) organizations and the effect of such disorders on their health, safety and job performance. The study is conducted on

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a randomly-selected representative sample of office workers in Palestine, where the data on VMSDs was collected via self-reporting questionnaires. The findings of this study would be of the great value for many stakeholders in Palestine, including employers, office workers (employees), the government and the Palestinian society in general. In particular, the findings of the study would help office workers in conducting their office administrative tasks without endangering themselves to risks of developing many occupational diseases like VMSDs while maintaining a high level of performance. In addition, the employers themselves, would benefit from the outcomes of this study by securing an ergonomically-designed offices for their employees such that the previously-mentioned adverse effects of VMSDs could be prevented. The health care, medication, insurance and VMSDs' complaints, direct and indirect costs (compensations bill), for the government is expected to be lower, in case both office workers and their employers comply with the ergomotricity of their offices and tasks. Such compliance in turn guarantees the realization of the greatest benefit for both Palestinian government and society of having healthy Palestinian office workers capable to survive and perform successfully in their jobs.

The rest of the paper is organized as follows. Section two discusses the methodology adopted in designing the survey, data collection and statistical analysis. Section three presents the results of the statistical analyses. In section four, discussion of the results and their implications are presented. Section five summarizes the limitations of the study. The last section; Section six, concludes the work.

2. METHODOLOGY

2.1. Study Population and Sample Size

The current study is a cross-sectional population-based study with the Palestinian office workers. More specifically, the study population consists of all sedentary (sitting most of the time) office workers working in private and public local organizations doing administrative tasks using computers. The sample size was calculated using Minitab 17.0 with a population of 188,890 office workers with a margin of error of 5% and a significance level of 5% and was found to be 384. Self-reported data were collected via paper-based and web-based questionnaires. The questionnaire was designed after a thorough examination of some office work places in Palestine along with careful review of similar related literature, namely [7, 9, 35, 36, 46]. The questionnaire was distributed in a uniformly manner across Palestine, namely in three main cities, namely (Tulkarem, Nablus and Ramallah) in the West Bank. The researchers distributed about 1000 questionnaires to randomly-selected office workers working in local organizations all in the three cities in West Bank, 50.6% of the questionnaires were filled and returned.

2.2. Questionnaire Design

Different previous studies in the literature included the methods used to gather information considered to form the survey related to chronic occupational diseases or VMSDs. Office workers in general or any computer-involved tasks users in the West Bank area of Palestine were the intended population of this study. The self-reporting questionnaire was designed to determine the VMSDs that affect the targeted office workers, in order to identify the potential mechanism for dealing with these

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occupational diseases and design an effective system to prevent them. The questionnaire was reviewed and validated by a consultant Orthopedics Medical Doctor, and by Industrial Engineering researchers in the field of ergonomics and product design.

The questionnaire consisted of three sections. The first section includes demographic data about the respondents (office workers). The second section is related to issues that might aggravate/relief the symptoms VMSDs. While, the third section asks about different types and symptoms of VMSDs in office workers.

2.3 Symptoms of Musculoskeletal and Visual Disorders

The last section of the questionnaire presented a drawing of the human body alongside a table. The respondent was asked to indicate the level of discomfort/pain in that particular area corresponding to a certain limb depicted on the figure. The table had the following body parts in the rows (eyes, neck, shoulders, upper back, upper hands, arms, wrists, fingers, low back, hips, thighs knees, legs and feet) that the respondent needed to assess his/her level of (numbness, itching, tumescence, redness, prickle, tingling and/or heat) which are also included in the columns of the table. The respondent should report this level using a score from 1 (low level) to 9 (high level). Each limb had two rows one to indicate the side (right/left side body parts) and some had central areas such as the neck, upper and low back.

Each respondent was asked to use the values 1,2,3 to represent rare symptoms of VMSDs where 1 indicates light pain, 2 indicates moderate pain and 3 indicates severe pain. Values 4,5,6 represent temporary symptoms with 4 indicates light pain, 5 indicates moderate pain and 6 indicates severe pain. Finally values 7, 8 and 9 represent permanent pain with 7 indicates light pain, 8 indicates moderate pain and 9 indicates severe pain. To illustrate that, for instance, if a respondent has redness in his/her right eye with moderate discomfort, and this issue happens temporarily s/he would fill under the redness column and right eye row by writing down the number 5 to indicate this symptom of a visual disorder. If the respondent did not report any problem at any given limb the value 0 would be assigned. These values will be used later on to evaluate the level of VMSDs disorders the respondent is suffering.

2.4 Demographic Variables

Demographic factors were collected from the questionnaires to describe the study group including gender, number of children, living place, age, weight, marital status, working sector, and monthly salary. Once the respondent filled the last set of questions, s/he is asked to answer if s/he has been an office worker for at least 5 years in administrative roles as most symptoms of VMSDs are chronic and need some time to develop. Section two, starts with a question on the mental status of the respondent at office work also via answering questions related to work stress, his/her general health, doing relaxing exercises, going to vacations, resting break during a work day, spending some time using social media and smoking.

After inputting the data from the collected questionnaires and before the analysis of the questionnaire, outlier detection was applied using Minitab 17.0, namely using the Grubber's test. The test identified

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21 observations as outliers. Based on the collected data, respondents reporting more than 55 symptoms were considered outliers using the test. The researchers think that these respondents did not answer the questionnaire correctly and their removal would give more meaningful results to the study. The VMSD score was calculated for each respondent. The VMSD score is the summation of the all the different symptoms the respondent is suffering for each limb. The higher the score is the more VMSD problems are prevalent among office workers. This score is equal to zero for respondents having no symptoms of VMSDs. An interesting question would be investigating the effect of demographic variables on the computer VMSD score. One-Way-ANOVA was used to answer this question, the corresponding hypothesis is presented in the following section (denoted by H1). Furthermore, multiple-linear regression (MLR) was used to build a representative model to study the different interactions between the demographic variables and their connection to the VMSD score. The corresponding hypothesis for this is stated in H2 below.

2.5 Research Hypotheses

The research test the following two main hypotheses:

H1: *There are no significant differences in VMSD scores (at significance level of 5%) between the Palestinian office workers having the following demographic variables (gender, age, living place, marital status, administrative work duration, monthly income, working sector, level of stress at work, health status, exercising , vacation days per year, break time per day, smoking, and the use of social media platforms)*

H2: *The VMSD score for office workers is not affected (at a significance level of 5%) by any of the demographic variables or the second level interactions.*

3. RESULTS

3.1 Descriptive Statistics

The filtered input data were statistically analyzed using Minitab 17.0. Table 1 summarizes the descriptive statistics of the sampled data based on the respondent's gender. Concerning the descriptive statistics on the prevalence of symptoms of VMSDs among sampled office workers, the analysis of sampled office workers indicated that 42.8% of them complain from at least one symptom of VMSDs. Table 2 shows the number (count) of symptoms that were reported from the sampled office workers.

Table 1. Gender-based descriptive statistics of the sampled office workers.

#	Item [Variable Name]	Men (n=220)	% *	Women (n=265)	%*
		Count		Count	
1	**Number of Children** [CHD]				
	No children	106	48.2%	141	53.2%
	1-2	44	20.0%	52	19.6%
	3-4	49	22.3%	60	22.6%
	More than 4	21	9.5%	12	4.5%
2	**Place of living** [POL]				
	City	152	69.09%	225	84.90%

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#	Item [Variable Name]	Men (n=220) Count	% *	Women (n=265) Count	%*
	Village	61	27.72%	31	11.69%
	Refugee Camp	7	3.18%	7	11.69%
3	**Age (years)** [AGE]				
	20-30	100	45.45%	101	38.11%
	31-40	55	25%	94	35.47%
	41-50	40	18.18%	44	16.60%
	More than 50	25	11.36%	25	9.43%
4	**Weight (Kg)**[WT]				
	50-60	5	2.2727	103	38.87%
	61-70	47	21.3636	100	37.74%
	71-80	72	32.7273	42	15.85%
	More than 80	95	43.1818	17	6.41%
5	**Marital Status** [MS]				
	Single	146	66.36%	162	61.13%
	Married	72	32.72%	84	31.70%
	Divorced/ Widowed	2	0.9%	14	5.28%
6	**Working Sector**[SECT]				
	Private Sector	156	70.9%	174	65.6%
	Governmental Sector	63	28.6%	86	32.45%
7	**Monthly Income**[INC]				
	Less than $570	18	8.18%	48	18.11%
	From $570 - $715	37	16.81%	63	12.83%
	More than $715	164	75.54%	146	23.77%
8	**Administrative Work Duration**[AWD]				
	Less than or equal 5 years	88	40.00%	89	33.58%
	More than 5 years	113	51.36%	150	56.60%
9	**Do you think the work you are doing is stressful?**[STRS]				
	Yes	125	56.81%	179	67.55%
	No	89	40.45%	84	31.69%
10	**How do you evaluate your health situation?**[HEA]				
	Excellent	84	38.15%	46	17.36%
	Good	115	52.27%	167	63.02%
	Acceptable	14	6.36%	42	15.85%
	Bad	4	1.82%	6	2.26%
11	**Do you exercise regularly?**[EXER]				
	Yes	90	40.91%	75	28.30%
	No	125	56.81%	184	69.43%
12	**Numbers of vacation days/year**[VACT]				
	Less or equal to 10	40	18.18%	51	19.25%
	From 11 to 20	59	26.82%	73	27.55%
	More than 20	10	4.55%	19	7.16%
13	**Break time per day**[BRK]				
	10-20 minutes	89	40.45%	128	46.79%
	21-30 minutes	51	23.18%	58	21.88%
	31-40 minutes	27	12.27%	27	10.18%
	More than 40 minutes	38	17.27%	24	9.06%
14	**Do you Smoke?**[SMK]				
	Yes	78	35.45%	26	9.8%
	No	139	63.18%	237	89.43%
15	**Do you spend your free time on the computer on social media platforms (such as Facebook/Twitter…)?** [SMA]				
	Yes	173	78.63%	195	73.59%
	No	43	19.55%	68	25.66%

* If the summation of percentages do not add up to 100%, this means there are some missing values.

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Table 2. Descriptive statistics of VMSDs symptoms among sampled office workers.

Symptoms	Count	Percentage
No symptoms	182	37.5%
1 – 5 symptoms	93	19.2%
6 -10 symptoms	75	15.5%
11-15 symptoms	41	8.4%
16-20 symptoms	27	5.6%
21-25 symptoms	16	3.3%
26-30 symptoms	21	4.3%
31-35 symptoms	27	5.6%
More than 35 symptoms	3	0.6%
Total	**485**	**100%**

Table 2 also shows that although 37.5% of office workers show no symptoms of VMSDs, the majority have suffered from at least one symptom. The results indicate an alarming 27.9% who suffer from more than 10 different symptoms of VMSDs. It should be emphasized, that these symptoms do not have to happen all at the same time, but at any point of time during a year of work. In addition, VMSD is a wide group of different problems that could take some time to develop and could affect multiple body parts and each limb with different kinds of pain or discomfort. Table 3 summarizes the prevalence of VMSDs symptoms per affected limb among the sampled office workers. It should be clear that any person affected by a VMSD could report more than one symptom, and s/he also could report more than one affected body part. To identify the statistics of specific relevant symptoms among the sampled office workers, the analysis revealed that the most reported prevalent symptoms are numbness, prickling and tingling, as shown in Table 3. On the other hand, the reported body parts with most occurrences of these symptoms are eyes, neck, low back and upper back. Such symptoms are expected to be found in office workers in the administrative work sector, as most of the office workers sit for long periods of time on desks using computers.

Table 3. Number of VMSDs' symptoms among office workers' affected body parts.

Affected body part	Symptoms of VMSD								
	Heat	Itching	Numbness	Prickling	Redness	Tingling	Tumescence	Total #.	Total %
Arm	1	5	110	32	4	13	11	**177**	**4.6%**
Eyes	29	105	50	53	161	33	25	**456**	**12%**
Fingers	4	16	127	23	1	40	11	**222**	**5.8%**
Foot	10	9	135	59	10	41	16	**280**	**7.4%**
Hips	1	3	106	35	4	14	4	**167**	**4.4%**
Knee	4	14	109	65	9	12	8	**221**	**5.8%**
Leg	2	11	108	46	4	24	15	**210**	**5.5%**
Low back	6	8	191	124	7	40	7	**383**	**10%**
Neck	11	31	218	125	10	32	11	**438**	**11.5%**
Shoulder	0	5	187	89	3	28	10	**322**	**8.4%**
Thigh	2	10	95	33	5	8	5	**158**	**4.1%**
Upper back	2	23	171	112	9	29	3	**349**	**9.2%**
Hand	2	8	134	49	4	18	10	**225**	**5.9%**

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Affected body part	Symptoms of VMSD								
	Heat	Itching	Numbness	Prickling	Redness	Tingling	Tumescence	Total #.	Total %
Wrist	2	10	110	45	6	21	9	**203**	**5.4%**
Total #.	**77**	**258**	**1851**	**890**	**237**	**353**	**145**	**3811**	**100%**
Total %	**2%**	**6.8%**	**48.6%**	**23.3%**	**6.2%**	**9.3%**	**3.8%**	**100%**	

The research also investigated the duration/level of pain of each symptom. Table (4) shows that the affected body part with number of cases reported to have (rare, temporary, or permanent occurrence) and the level of pain. More specifically, Table 4 indicates that most of the pain levels are of light/moderate with rare occurrences. This result is basically attribute to the fact that about 70% of the sampled office workers were young people who are supposed to pathologically have recently started to develop the symptoms of VMSDs. Concerning the continuous duration of the symptoms, it can be seen from Table 4 that about 17.1% of the symptoms are permanent distributed among 130 respondents of the sampled office workers. Collectively, this means that about 26.8% of the sample have currently at least one permanent symptom of VMSDs.

Table 4. Affected body parts of the sampled office workers, associated with their pain levels and pain durations.

Affected body part	Rare Occurrence			Temporary Occurrence			Permanent Occurrence			Total #.	Total %
	Light Pain	Moderate Pain	Severe Pain	Light Pain	Moderate Pain	Severe Pain	Light Pain	Moderate Pain	Severe Pain		
Arm	54	31	11	18	29	9	9	13	3	**177**	**4.6%**
Eye	110	70	27	78	77	33	36	19	6	**456**	**12%**
Fingers	55	46	7	39	36	14	14	8	3	**222**	**5.8%**
Foot	76	55	8	35	37	22	17	16	14	**280**	**7.4%**
Hips	56	30	2	21	15	8	11	18	6	**167**	**4.4%**
Knee	58	47	5	20	25	19	23	13	11	**221**	**5.8%**
Leg	52	39	8	24	33	19	11	16	8	**210**	**5.5%**
Low Back	54	67	12	42	47	54	36	36	35	**383**	**10%**
Neck	96	89	16	46	69	50	24	36	12	**438**	**11.5%**
Shoulder	46	77	22	31	50	39	19	27	11	**322**	**8.4%**
Thigh	61	25	9	13	17	9	15	6	3	**158**	**4.1%**
Upper Back	55	72	8	40	45	57	21	28	23	**349**	**9.2%**
Hand	47	62	16	32	33	11	9	12	3	**225**	**5.9%**
Wrist	52	55	4	19	30	20	8	10	5	**203**	**5.4%**
Total #.	**872**	**765**	**155**	**458**	**543**	**364**	**253**	**258**	**143**	**3811**	**100%**
Total %	**22.9%**	**20 %**	**4.1%**	**12%**	**14.2%**	**9.6%**	**6.6%**	**6.8%**	**3.8%**	**100%**	

3.2 Hypothesis Testing

The set of hypotheses in (H1) related to the prevalence of VMSDs among office workers in Palestine were tested. Table 5 reports the results obtained from Minitab 17.0 for performing the corresponding set of hypothesis testing, (Minitab Inc,2010). Table 5 summarizes the results of hypothesis testing stated in H1. It is shown that most of the considered demographic variables were not found to have significant differences among their levels. More specifically, the results showed that there are no differences between males and females with regard to developing VMSDs symptoms. This is also true when considering other demographic variables, namely, number of children, place of living, weight, marital status, working sector and doing exercises.

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It is also interesting to see that the chance to develop a VMSD is not affected by doing exercises. This might be due to the fact that not all exercises are useful for reducing the chance of developing a VMSD; the office worker might do exercises which are not effective in preventing the development of VMSDs, for example, some people consider walking very slowly for half an hour a week sufficient for prevention. The same conclusion applies for the period of breaks per day. The tests showed having a long break, a medium break or a short break has no effect of developing a VMSD. The reason for having no differences could be due to the fact that most resting time is also taken seated, probably chatting with colleagues. Thus it will give enough time for the affected body part to recover. Likewise, this is true for number of vacation days taken per year, specifically, where having a long vacation or a short one does not differ in terms of having the chance of developing a VMSD among an office worker. The questionnaire included a follow-up question asking the respondent if the vacation time was spent (travelling, in the house or with friends); not surprisingly about 76% of the sample responded that they spend their vacation at the house. This might be due to the economic and political conditions in Palestine, where people rarely spend their vacations outdoor, or travel abroad. In fact, most of the vacation time is devoted for local social visits and/or on watching TV at home. Thus the vacation time is not actually helping the office worker in reducing the effect of the VMSDs on his/her body.

Table 5. Summarized results of the hypothesis testing of H1 at 5% significance level.

#	Demographic Variable	P-value	Result	Fisher's Test
1	Gender	0.073	Fail to reject the null hypothesis	Not applicable
2	Number of children	0.764	Fail to reject the null hypothesis	Not applicable
3	Place of living	0.796	Fail to reject the null hypothesis	Not applicable
4	Age	0.033	Reject the null hypothesis	Level 1 VMSD Score is significantly higher than levels 3 and 4
5	Weight	0.289	Fail to reject the null hypothesis	Not applicable
6	Marital status	0.240	Fail to reject the null hypothesis	Not applicable
7	Working sector	0.255	Fail to reject the null hypothesis	Not applicable
8	Monthly Income	0.034	Reject null hypothesis	Level 3 VMSD score is significantly lower than levels 1 and 2
9	Administrative work duration	0.004	Reject null hypothesis	Level 2 VMSD score is significantly lower than level 1
10	Do you think the work you are doing is stressful?	0.025	Reject Null Hypothesis	Level 2 VMSD score is significantly higher than level 1
11	How do you evaluate your health situation?	0.133	Fail to reject the null hypothesis	Not applicable
12	Do you exercise regularly?	0.447	Fail to reject the null hypothesis	Not applicable
13	Numbers of vacation days/year	0.98	Fail to reject the null hypothesis	Not applicable
14	Break time per day	0.661	Fail to reject the null hypothesis	Not applicable
15	Do you smoke?	0.085	Fail to reject the null hypothesis	Not applicable
16	Do you spend your free time on the computer on social media platforms (such as Facebook/Twitter…)?	0.007	Reject null hypothesis	Level 2 VMSD score is significantly lower than level 1

Also, working sector was among the variables that were not significant with regard to the VMSD. This is expected as there are no apparent differences in the administrative/office work tasks done by office workers working in the private or public sectors. In the next section, the effects of other demographic variables on the development of VMSDs are investigated.

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3.3 Multiple Linear Regression

In order to test the second hypothesis H2, a Multiple Linear Regression model was built, where an indicator of the VMSD is modeled as a response variable (called VMSD score) depending on a set of independent demographic variables. Since the number of demographic variables is large, applied stepwise method was adopted to keep the most significant variables and their interactions in the model. The model considered only the data reported by office workers who suffered or currently are suffering from at least one symptom of VMSDs. Due to having some missing values some outliers in the sampled data, the model was built based on data-complete sample of 125 respondents. Upon testing the adequacy of the built regression model, the residuals analysis failed in the normality test. To overcome this problem, Box-Cox transformation on data was applied and hence an adequate regression model could be obtained. The new transformed variable was found to be a natural logarithm of the VMSD score (i.e. ln(VMSD Score)).

Table 6 shows the ANOVA results for the transformed built MLR as obtained from Minitab 17.0. The regression model was significant, p-value = 0.000, R^2 and R^2-adjusted were found to be equal to 85.81% and 83.34%, respectively, indicating that the modelled demographic variables were able to explain 85.81% of the variability among office workers in developing their VMSD symptoms in the workplace. Based on residual analysis, the model is statistically adequate and hence, the second null hypothesis, H2, could be rejected, indicating that the selected demographic variables and some of their interactions were significant (at significance level 0.05) in the development of VMSD symptoms in office workers in Palestine. It is worth noting here that the MLR model was not built to predict the development of VMSD in office worker; the model indeed was built to investigate if the demographic variables have an effect in the development of VMSD symptoms among office workers in Palestine.

Table 6. ANOVA for the multiple linear regression (MLR) model.

Source		DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
Regression		19	621.149	85.81%	621.149	32.6921	34.7	0**
	GNDR	1	428.964	59.26%	16.87	16.8701	17.91	0**
	AGE	3	62.576	8.64%	9.091	3.0305	3.22	0.026**
	AWD	1	1.674	0.23%	17.352	17.3525	18.42	0**
	VACT	2	42.646	5.89%	37.529	18.7646	19.92	0**
	HLTH	3	23.657	3.27%	8.493	2.8309	3	0.034**
	STRS	1	1.509	0.21%	0.385	0.3847	0.41	0.524
	SMA	1	1.177	0.16%	1.371	1.3706	1.45	0.23
	INC	2	11.405	1.58%	3.74	1.8701	1.99	0.142
	GNDR*AGE	3	5.557	0.77%	5.029	1.6762	1.78	0.155
	AWD*VACT	2	41.985	5.80%	41.985	20.9925	22.28	0**
Error		109	102.687	14.19%	102.687	0.9421	---	---
	Lack-of-Fit	80	90.384	12.49%	90.384	1.1298	2.66	0.002

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Source		DF	Seq SS	Contribution	Adj SS	Adj MS	F-Value	P-Value
	Pure Error	29	12.303	1.70%	12.303	0.4243		
Total		**128**	**723.836**	**100.00%**				

Figure 1 shows the main effect of each demographic variable used in the MLR model. One can notice that there is a significant difference between males and females in their mean VMSD scores. Females have more symptoms of VMSD compared to males. The same can be applied to variables AGE, VACT, HLTH, AWD, SMA, and INC. However, the variable STRS is not significant, indicating that if an office worker works in a stressful work environment, s/he has more tendency to develop VMSD symptoms compared to office works in non-stressful working environments.

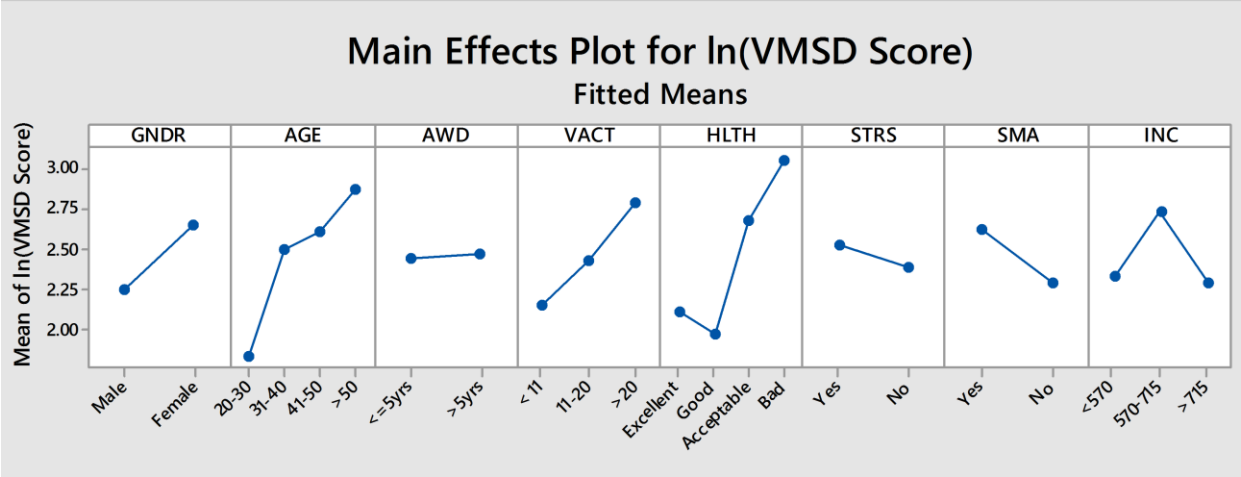

Figure 1. The main factor plot for (fitted means) for the MLR variables.

On the other hand, Figure 2 presents the interaction plot for the two-second level terms included in the MLR model. For example, Females with age between (20-30) have higher symptoms of VMSD compared to males. This does not apply to the age group from (31-40) as males and females have the same level of having VMSD symptoms. The same logic is also applied to AWD and VACT. This interaction is not as straight forward as the previous one. For low level of administrative works, vacations of less than 11 days are beneficial in reducing the symptoms of VMSD, however, switching to higher levels of administrative works, longer vacations (more than 11 days) are beneficial in mitigating the symptoms of VMSD. This interaction suggests having longer vacations helps recover from the symptoms of VMSD.

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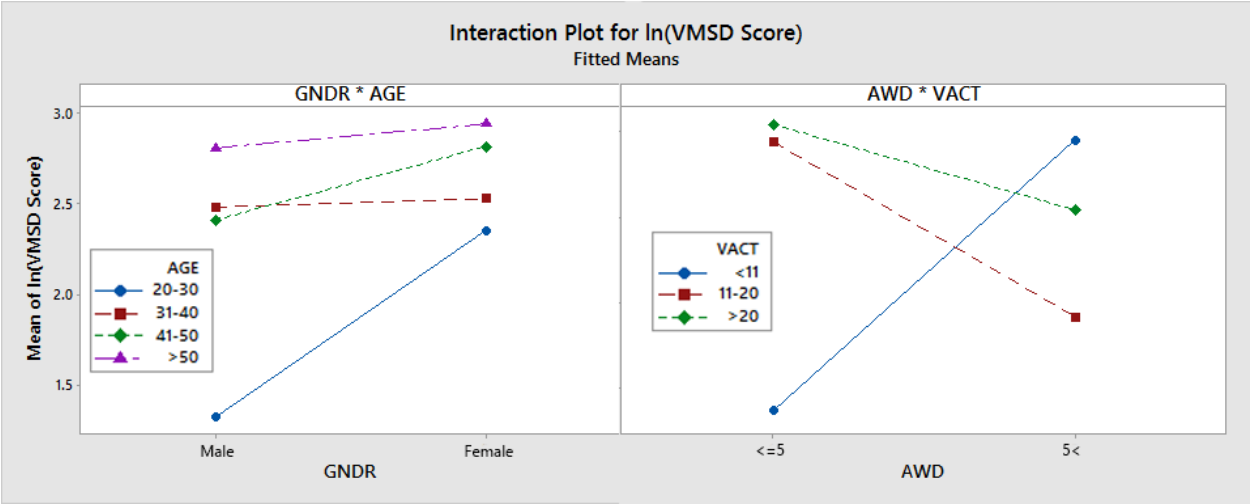

Figure 2. The interaction plot (fitted means) for the MLR model.

4. DISCUSSION OF RESULTS

The research tried to evaluate to what extent VMSD symptoms are prevalent among office workers in Palestine. The analysis done on the sampled office workers working in public and private sectors in Palestine, shows a serious alarm for the prevalence of this set of occupational diseases among those workers. Specifically, the study show that about 62.5% of the participating office workers complain from at least one symptom of VMSD. More critically, about 26% of the sampled office workers proved suffering from one permanent VMSD symptom. These numbers indicate that the level of awareness towards VMSD from the employers, employees themselves and even the Palestinian community is very low. Makkip et al. [7] reported that about 92.8% of the sampled office workers in Malaysian public service sector develop MSDs during a period of 6-months. This proves that MSDs among Malaysian public service office workers are more prevalent compared to those prevalent among Palestinian office workers. Aslo, Darvishi et al. [10], Robertson et al. [35], Cho et al. [1], and Collins and O'Sullivan [36] came up with similar finding which highly agree with this finding as well.

Moom et al. [9] found that bank workers usually are suffering from MSDs in their low backs, upper back, neck, hand/wrist and shoulder. Their findings agree with the current study's findings shown in Tables 3 and 4 in addition to suffering in eyes (visual disorders). Also, Marcoux et al. [23] reported infection of similar body parts with MSDs.

Hadgraft et al. [33] developed a mixed linear regression model to study the effect of sitting time on the prevalence of MSDs among Australian office workers. The MLR model in this study, on the other hand, correlates the VMSDs score with some significant demographic variables, however, the sitting time was set to be constant (8-hours) in this study and, hence, it was excluded. Herr et al. [32] modeled three job stress models and their relation with MSD pains in administrative and technical workers in Germany. Using linear regression, they built a model to correlate the job stressors and their two-way interactions with the development of MSDs symptoms among workers

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The findings of this results opens the door for stakeholders and decision makers to implement a set of measures and programs to prevent and stop the prevalence of VMSDs among office workers in both public and private organizations in Palestine. Namely, such programs should be adopted by the Ministry of Work, Higher Education Institutes and other various labor unions. These bodies, should impose new regulations of mandatory ergonomics training for office workers, and yearly medical checks to diagnose VMSD problems at their early stages (as some of them could be treated in such time). On the other hand, keeping ignoring this problem would force some office workers to either resign due to injury and suffering, or to be fired due to their deteriorating performance; putting much pressure on their families, the government and the health/insurance companies. Such measures and programs for preventing the prevalence of MSDs among office workers have been suggested in previous works including, but not limited to, Cruz et al. [31], Ered et al. [29], Veselinovic et al. [8] and Pinheiro et al. [37].

5. CONCLUSION

This research studied the prevalence of visual and musculoskeletal disorders (VMSD) among the Palestinian office workers. The analysis revealed that about 62.5% of the sampled workers suffered from at least one symptom of VMSD, whereas 17% indicated that they suffered from at least one permanent symptom of VMSD. Furthermore, most reported complaints were from the eyes, neck, low back and upper back. ANOVA analysis indicated that demographic variables including (age, monthly income, administrative work duration, stress level at work and the use of social media platforms) are statistically significant at a significance level of 5%. More specifically, a cluster has emerged for office workers who are young, with low income and are new in the area of administrative office work. The analysis done supports the idea that these workers perform most of their tasks seated probably typing or editing. They also tend to spend most of their free time on social media platforms. This behavior tends to increase their chances of developing some VMSD symptoms. The multiple linear regression (MLR) builds on this result, indicating once a worker is suffering from a symptom of VMSD, as she/he gets older, the number of symptoms aggravates. The results of the ANOVA analysis shows that there are no significant differences between males and female administrative office workers in Palestine in their VMSD scores. A closer look, shows that among those who currently are suffering from VMSD, females suffer more. This might be due to the house hold work they should do after they go home after work, besides that their physical and physiological structures increase their vulnerability of developing VMSD. The study also presented a multiple linear regression (MLR) model to understand if there is a relationship between the VMSD score (the weighted score of symptoms) and the study demographic variables. The model was significant at a significance level of 5% indicating that a strong linear relationship exists.

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Based on the findings of the study, VMSD are found to be widely-prevalent among office workers in Palestine. However, unfortunately, neither serious engineering nor administrative intervention are being done to prevent the prevalence of VMSD among office workers in Palestine. The findings of the study recommend that awareness programs and adequate training should be provided for the administrative office workers continuously. Such programs are supposed to be developed via encouraging the main stakeholders (governmental bodies) to apply to donating partners in Europe and the USA to fund projects in this regard. More specifically, for the sake of sustainability, capacity building programs for multi-disciplinary teams of Palestinian experts from medicine and engineering should be conducted by other European and American partners on awareness, prevention, diagnosis and treatments of VMSD among office workers in Palestine. The study also touched one side which is neglected but was significant in both the ANOVA and the MLR model, which is the impact of social media use on increasing the symptoms of VMSD. More work should be done in this area, and on different age groups as the use of social media is very common among young age users.

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