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Original Article

Occupational Exposure to Some Environmental Physical Factors as Related to Productivity in the Garment Industry of Egypt

Kamal H. Noweir [1], Fadia A. El- Marakby [1 ¥], Hend A Yousef [2], Gehan R. Zaki [1]

[1] Department of Occupational Health and Air Pollution, Occupational Hygiene and Air Pollution Specialty, High Institute of Public Health, Alexandria University, Egypt

[2] Occupational Health and Safety Inspector, Ministry of Manpower and Immigration, Gharbia Governorate, Egypt

Abstract

Background: Garment industry in Egypt has been estimated in 2008 to be about 458 enterprises (employing 103,000 workers) representing 42.0% of the overall textile and garments industries, and 4.8% of the total private sector enterprises. Al-Mahalla Al-Kubra, which is the greatest city of El-Gharbia Governorate houses 263 (57.4%) of these enterprises (employing 12,209 workers). The occupational exposure to physical hazards may adversely affect workers' comfort, health, performance and productivity.

Objective(s): This study was designed to assess the relation between work stresses imposed by exposure to physical hazards and productivity in Garment industry in that city.

Methods: This was a cross-sectional study that was conducted in five garment enterprises in Al-Mahalla Al-Kobra city. The five enterprises included two public and three private sector units, representing 12% of the total number of garments' workers within the city. The collected data included data from records, workers' and employers' or managers' interview, and the results of the physical hazards' assessments. Since it was difficult to calculate the workers' productivities directly from enterprises' records, the productivities of the workers were computed as follows: % of productivity = Standard workers' productivity (100%) - % deficiency in his or her productivity from the standard.

Results: The higher percent productivity reported in the Private sector enterprises (86.5%, 86.5% and 100% in C, D, and E enterprises respectively) than in the Public (71.5% and 54.7% in A and B enterprises respectively) may be attributed to the production payment regimen common in the former than in the latter. The workers in the Private-sector enterprises were keen to achieve the greatest production to get maximum payment. This may also interpret the considerably higher workers' attendance (less absenteeism) among Private-sector workers than in the Public-sector ones.

Conclusions: The deleterious effects of workers' exposure to physical hazards; heat, noise and vibration, and improper illumination on their productivity are clearly demonstrated in the present study. Attention should be directed towards the control of these hazards and improving the work environment of the garment industry in Egypt, particularly in the Public sector enterprises.

Key Words: Ready Made Garment Industry, Productivity, Physical Hazards, Al-Mahalla Al-Kubra, Egypt

Available on line at:

www.jhiph.alexu.edu.eg

¥*Correspondence*:

Email: felmarakby@yahoo.com

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INTRODUCTION

The ready-made garment industry is a total production process constitutes several discrete stages of activities, which are linked in a progressive manner forming a chain of labor intensive production process.[(1)] Within each department, there are a number of steps through which raw materials are passed to make a finished and packed garment. These steps or sub-processes may vary according to the model of the end product. Most common steps in each department of the apparel industry include: cutting, sewing, and finishing.[(2)] The garment industry is at the forefront of the globalization process, where multinational investors continuously shift production from one part of the world to another searching for low wages and even more “competitive” locations. This has led to an increase in working hours and a substantial reduction in safety standards, especially in the newly industrialized countries. The economic

viability of this sector largely depends on the performance of the workers.[3] Consequently, it has been necessary to maintain an excellent work environment for maximizing productivity.[1] However, many work stresses are facing most workers in the garment industry due to poor working environment.[4]

The garment industry comprises a large number of small units, spread all over Egypt. Each industrial unit has as few as five sewing machines to as many as 1,000 to 1,200 machines. It is estimated that about 458 units are operating in the country, representing 42.0% of whole textile and garments units and 4.8% of the total private sector unit, in 2008. The overall workforce employed within the garment industry is about103 thousands workers, representing 56.6% of total textile and garments' workforce, and 12.7% of total private sector workforce; women represent the major work-force. The annual industrial production of was estimated to be around 330.1 million pieces in 2009/2010 versus 269.2 million pieces in 2007/2008 by an increase of 22.6%. These figures, however, do not include machine operators of the countless number of small tailoring shops at every hook and corner of the country.[5]

Al-Mahalla Al-Kubra is a large industrial and agricultural city in Egypt, representing the greatest city of El- Gharbia Governorate and the second-largest city in the Nile Delta. It has been known for its dominant textile industry as it homes the largest public sector Egyptian Textile Company "Misr Spinning and Weaving Company," which employs 27,000 workers.[3] Meanwhile, Al-Mahalla Al-Kubra garment industries represent 17.4 % of the total garment industry in Egypt (n=1510), and employing 11.9% of the workers in this industry in the country (n= 103000).[6]

The physical hazards such as noise, heat, vibration and deficient lighting adversely affect workers' comfort, health, performance and productivity.[7] A comfortable working environment reduces accidents and associated costs. Meanwhile, it increases the productivity through enhancing workplace safety awareness, improving work satisfaction and workers' performance. In addition, workers understand that the employer cares about their safety; and then, they become more motivated.[8]

Productivity is a measure of how well a manufacturing unit uses its resources measured as units of output per unit of input. Output includes all the goods, and services produced and sold. Input includes all the materials, services, machinery usage, and efforts expended in the production of the outputs. A production unit can be defined at any level of aggregation desired: a single facility within a multi-facility organization, an entire firm, a whole industry, a sector of the economy, a country, or a region. In practice, there are many different ways to measure productivity. Each measure has its benefits and drawbacks.[9]

The European Union Community strategy (2007-2012), points that guaranteeing quality and productivity at work can play a role in promoting economic growth and employment. This is because of the lack of effective protection can result in absenteeism and increase of workplace accidents and illnesses that can lead to permanent occupational disability. This does not only have a considerable human dimension, but also has a major negative impact on the economy. This statement is derived from the European Union strategy that confirms the interaction between health and safety at work on the one hand, and on the other hand, reduction of productivity.[10] Besides, European Association for National Productivity Centers issued a memorandum in 2005, looking upon productivity from the perspective of value creation, stressing that several factors contribute to this value creation. Health and safety at work are some of these factors. This is why companies increasingly need qualified, motivated and efficient workers who are able and willing to contribute actively. Healthy workers working in healthy working conditions are thus an important precondition for the enterprise to work smoothly and productively.[11]

This study was designed to investigate the relation between work stress introduced by physical hazards, viz; heat, noise, vibration and deficient illumination in the work environment, and productivity, in the garment industry in Al-Mahalla Al-Kobra, as an example of the garment industry of Egypt.

METHODS

The present study is a cross-sectional study. It was conducted in five garment enterprises in Al-Mahalla Al-Kobra city. The five enterprises are denoted by the symbols A to E, where the A and B enterprises belong to the public sector, while the C, D and E enterprises belong to the private sector. The selected sample represents 12% of the total number of garments' workers in Al-Mahalla Al-Kobra city. The enterprises employ less than 10 workers were excluded. [12]

The collected data comprised:

- Measurement of the physical environmental factors, mainly heat, noise, vibration and illumination in different locations in the work environments of the studied enterprises.
- Workers' interview for their demographic data and for their job and industrial relation' satisfaction.
- Interview of the employers / managers for their satisfaction with the workers.
- Examining the enterprises' records for workers' production, and absenteeism.

Heat exposure was assessed in the garment departments according to the Heat Stress Standard ISO 7243 [13] as wet bulb globe temperature index (WBGT) using the WBGT-Heat stress monitor (QUESTempo 34; Canada). [14] Noise was assessed according to the OSHA standard specification for testing: 29 CFR 1910.95 [15] in the selected garment enterprises as A-weighted equivalent noise level in decibel using (Extech 407735 dual range sound level meter) calibrated at 114 dB. [16] Vibration was measured according to the standard specification for testing: ISO 10816-4:[17] using vibration meter (GA2003; UK). [18] Illumination was measured according to the standard specification for testing British Standard [19] using Lux meter (YF-1065; Taiwan).[20]

The workers and the employers / managers were interviewed using pre-designed and pretested forms developed according to the US labor Department of OSHA guidelines.[21] Due to the difficulty in calculating productivity of the workers directly from enterprises' records, data of the percentage deficiency from the required standard productivity for each worker during a certain period of the year (viz; week, or month) were collected, and then the percent of productivity was calculated as follows: % productivity = 100% - % Deficiency.[22]

Ethical Considerations

The study was approved by the institutional review board and the ethics committee. The study conformed to the principles of Helsinki declaration and the international ethics guidelines. A verbal consent was taken from all participants after explanation of the purpose and benefits of the study. Confidentiality of the data was assured.

RESULTS

1-Levels of Occupational Exposure to Physical Factors in the Studied Enterprises

Table (1) presents the measurements of environmental physical factors in the studied enterprises. The levels of exposure to heat and noise were lower than the Threshold Limit Values (TLVs). [23] Meanwhile, the heat exposure is relatively high in the B and C enterprises (24.2°C and 23.2°C respectively). The noise exposure was greater in the Public sector enterprise B (83.5 dBA) than in the private. Worthy, noting that the environmental measurements were conducted in fall, winter and spring climatic seasons. However, exposure to vibration exceeded the TLVs in A and D enterprises (4.1 and 4.6 m/sec^2 respectively), and unfavorable levels of illumination were predominant in all the enterprises; meanwhile, the levels of illumination in the Private sector were better than those in the Public sector enterprises.

2-Demographic and Occupational Data of the Workers

According to the enterprises' records, the total number of the workers is 1510 (table 2), out of which 1180 work by production regimen. The five enterprises apply one shift system; the shift in the public sector enterprises (A and B) consists of 8 hours, while that in the private sector ones (C, D and E) are 10 hours. Over-time hours are normally applied whenever it is needed. The starts of practicing production activities in the public sector enterprises (A and B) were in the years 1979 and 1989 respectively, which were relatively older than that in the Private sector enterprises (C, D and E) in the year 1985, 2003, and 2000 respectively). Enterprises of the Public sector consist of one floor; while the work force in the Private sector' enterprises perform their activities at different floors. The countries of manufacture of the tools and equipment as scissors, sewing machine …etc. in the Public sector enterprises are USA Germany, Italy and France, produced through the years of 1980s until 2000. While that in the Private sector are USA, European countries, in addition to South - East Asian countries such as Japan, Taiwan and Korea, which have been more recently produced and range from the years 2000s until 2011.

The workers' demographic data in the studied enterprises are presented in table (2) demonstrating that male children labor (< 20 years aged) was dominant in the Private rather than Public sector enterprises. At the same time, the females were the most common in the Public sector enterprises A, and B (89.3 and 77.4 respectively) and in the two Private D, and E (63.3% and 62.0% respectively). The highest prevalent age group was (31-40) years old, existing in the Public sector (34.6% and 47.0% in enterprises A and B respectively). The workers aged more than 30 years, represent 87.0% and 77.0% in A, and B Public enterprises, while this age category of workers expresses just 5.0% in the enterprise C, 41.0% and 28.0% in enterprises D and E respectively of the Private sector. Mostly, one-third of the workers were illiterate in the studied enterprises, except for enterprise B, in which the illiterate workers represent 24.2%. Most of the married workers were in the Public sector representing 53.0%, while most of the single workers were in the Private sector representing 66.0% of the workers there. The majority of workers have a family size of (1-5) representing 49.5%; however, still large families (6- 12 persons) represent more than one-half of the population (50.5%). The occupational data of the studied workers are illustrated in table (3). More than 60% (61.9%) of the workers are involved in sewing and finishing, particularly in the private sector enterprises (72.7%, 63.3% and 62.2% in D, E, and C enterprises respectively.

Table 1: Results of Environmental Physical Factors Measurements in the Studied Enterprises

Physical Factor	The Studied Enterprises										TLV#
	Public sector group				Private sector group						
	A		B		C		D		E		
	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median	
Heat	20.2-22.0	21.1	24.0-24.9	24.2	23.0-24.1	23.2	19.0-21.4	20.1	19.1-20.0	19.5	28.0°C*
WBGT :°C	($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=12)		
Noise : dBA	68.0- 86.3	79.4	67.0-88.0	83.5	57.0-83.0	76.5	61.0-84.0	79.0	60.0-84.0	75.0	85.0 dBA
	($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=12)		
Vibration	2.2-5.0	4.1	0.2-5.0	4.0	0.0-7.0	2.5	0.0-8.0	4.6	0.0-10.0	3.0	4.0 ms^{-2**}
$m / sec.^2$	($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=12)		
Illumination	80-340	221	66-380	169	265-465	436	115-470	255	319-552	445	325 lux***
Lux	($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=6)		($n^{§}$=8)		($n^{§}$=12)		

$n^{§}$: number of measurements through study period

#ACGIH: American Conference of Governmental Industrial Hygienists Threshold Limit Values

*For moderate physical activity dominant in garment industry (75 – 100%) work.

**For 4 up to < 8hrs / shift.

***For precise type of work dominant in garment industry

Table (2): Demographic Data of the Workers in the Studied Enterprises

Property		Public sector group				Private sector group						Total	
Enterprises		**A**		**B**		**C**		**D**		**E**			
No. of workers		279		356		280		275		320		1510	
Demographic Data		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Gender	Male	63	22.6	38	10.7	207	73.9	101	36.7	122	38.1	531	35.1
	Female	216	77.4	318	89.3	73	26.1	174	63.3	198	61.9	979	64.8
Age (years)	10-20	0	0	0	0	145	51.8	106	38.6	86	26.9	337	22.3
	21-30	38	13.6	81	22.8	120	42.9	55	20	143	44.7	437	28.9
	31-40	95	34.1	167	46.9	6	2.1	85	30.9	73	22.8	426	28.2
	41-50	77	27.6	67	18.8	5	1.8	20	7.3	14	4.4	183	12.1
	51-60	69	24.7	41	11.5	4	1.4	9	3.3	4	1.3	127	8.4
Level of Education	Illiterate	81	29	86	24.2	94	33.6	85	30.9	107	33.4	453	30
	Read Write	56	20.1	53	14.9	64	22.9	122	44.4	41	12.8	336	22.3
	Primary	39	14	58	16.3	33	11.8	20	7.3	34	10.6	184	12.2
	Preparatory	29	10.4	73	20.5	8	2.9	0	0	27	8.4	137	9.1
	Secondary	74	26.5	86	24.2	69	24.6	43	15.6	102	31.9	374	24.8
	University	0	0	0	0	12	4.3	5	1.8	9	2.8	26	1.7
Marital Status	Single	77	27.6	85	23.9	242	86.4	161	58.6	165	51.6	730	48.3
	Married	136	48.8	203	57	37	13.2	111	40.4	150	46.9	637	42.2
	Divorced	16	5.7	22	6.2	1	0.4	0	0	3	0.9	42	2.8
	Widow	50	17.9	46	12.9	0	0	3	1.1	2	0.6	101	6.7
Family Size	1-5	106	38	224	62.9	100	35. 1	115	41.8	202	63.1	747	49.4
	6-10	137	49.1	113	31.7	155	55.4	136	49.5	84	26.3	625	41.4
	11-15	36	12.9	19	5.3	25	8.9	24	8.7	34	10.6	138	9.1

This was followed with the great differences, by "ironing" (13.8), "supervision" (8.4%), and "testing and packing" (8.8%). More than one-half of the workers in the Private sector (53.4%) have limited experience (0-5 years) particularly in enterprise C (75.0%), while this sector represents only 6.2% of the workers in the Public sector. The workers employed for over 10 years are 71.7% in the Public sector and just 17.1% in the Private sector. Furthermore, none of the workers in the Private sector were employed over 30 years. The average monthly payment for the Public sector's workers in the enterprises is 1741.3 LE, while that of the worker in the Private sector was 758.6 LE. Meanwhile, mostly 80% (79.1%) of the Private-sector workers' monthly payments range from 500 to 1000 LE. This workers' sector in the Public enterprises was just 4.7%; 62.5% of the workers, there get monthly payments ranging from 1500 to 3000 LE, while none of the workers in the Private sector get such payment. Mostly, 80% (79.1%) of the Private-sector workers' monthly payments range from 500 to 1000 LE. This workers' sector in the Public enterprises was just 4.7%; and 62.5% of the workers there get monthly payments ranging from 1500 to 3000 LE, while none of the workers in the Private sector get such payment.

3- Productivity, Absenteeism and Satisfaction of the Workers

The lowest number of workers resulted in deficient productivity of the Public sector in enterprises A and B (3.2% and 0.7% respectively); while, the highest number exist in the Private sector, especially in enterprise E (76.0%), as illustrated in (Figure 1). However, the magnitude of the product deficiency in the Public sector enterprises was considerably higher than in the Private sector as shown in table. [(4)] The percent productivities in the private sector enterprises are 86.5%, 86.4% and 100.0% in C, D, and E enterprises respectively, in comparison to 71.5% and 54.3% in the public sectors' enterprises A and B. Meanwhile; the lowest productivity ranges in the Public sector enterprises (54.3% in enterprise A, and 14.3% in enterprise B) were considerably lower than those in the Private sector enterprises (75.5%, 76.8% and 76.1% in enterprises A, B and C respectively). Besides, there is a statistically significant difference between the percent productivity of the selected enterprises ($p<0.001$, 95% C.I). The workers' status of absenteeism in the studied enterprises is presented in table 5. All types of absenteeism were considerably higher in the enterprises of the Public sector than in those of the Private sector. For example, the authorized, the non- authorized and the occupational injuries' absences among the workers of the Public sector enterprises were 95.9%, 12.0% and 1.5%, while in the Private sector enterprises, there were 62.7%, 2.2% and 0.6% respectively. Furthermore, the mean days of sickness absence among the workers at the Public sector enterprises were two days, while in the Private-sector enterprises, was just 0.1 day. Meanwhile, the maximum percentage of sick leaves (30-90 days group) was only in Public sector enterprises A and B (5.1% and 4.8% respectively).

Furthermore, the highest percentage of workers, who didn't have any type of absenteeism at all, was found in the C, D and E Private sector enterprises (39.3%, 34.9% and 37.5% respectively). Worth noting that according to enterprises' records, the most frequent disciplinary actions for unauthorized absence were in the public sector in factories A and B (9.0% and 11.5% respectively). The workers' and employer / manager satisfactions are illustrated in figure (2). The highest percentage of workers who are unsatisfied in their job was found in the Public sector enterprises A and B (81.7% and 71.6% respectively). The maximum percent of workers, who were relatively satisfied about their job, was found in Private sector C, D and E enterprises (51.1%, 46.2% and 36. 6% respectively). The maximum percent of workers, who are highly satisfied about their employer / manager was found in the Private sector, C, D and E enterprises (80.0%, 70.6% and 63.1% respectively). Whereas, the highest percentage of workers, who are unsatisfied about their employers / managers was found in the Public sector enterprises A and B (71.0% and 79. 8% respectively). The maximum percent of highly satisfied employer / manager about his workers was found in factories A, B and C (74.9%, 60.4%, 60.0% respectively), while the lowest percentage was found in factories D and E (58.2% and 59.1% respectively).

Table (3): Occupational Data of Workers in the Studied Enterprises

Property		Public sector group				Private sector group							
Enterprises		**A**		**B**		**C**		**D**		**E**		**Total**	
No. of workers		279		356		280		275		320		1510	
Occupational Data		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Job	Cutting	7	2.5	4	1.1	4	1.4	3	1.1	5	1. 6	23	1.5
	Sewing and finishing	160	57.4	197	55.3	178	63.6	200	72.7	199	62.2	934	61.9
	Ironing	51	18.3	86	24.2	22	7.7	23	8.4	27	8.4	209	13.8
	Packing & Testing	28	10	20	5.6	20	7.1	21	7.6	35	10.9	124	8
	Supervision	20	7.2	30	8.4	31	11.1	16	5.8	30	9.4	127	8.4
	Assisting production & cleaning	13	4.7	19	5.3	25	8.9	12	4.4	11	7.5	93	6.2
Duration of Employment	0-5	22	7. 9	18	5.1	210	75	146	53.1	111	34.7	507	33.6
	6-10	22	7. 9	93	26.1	58	20.7	74	26.9	126	39.4	373	24.7`
	11-20	74	26.5	95	26.7	9	3.2	46	16.7	62	19.4	286	19
	21-30	68	24.4	76	21.4	3	1.07	9	3	21	6.6	177	11.7
	31-45	93	33.3	74	20.8	0	0	0	0	0	0	167	11.1
Average monthly payment	1-500	0	0	0	0	35	12.5	25	9.09	24	70	0.584	5.56
	501-1000	3	1.08	27	7.58	239	85.36	241	87.64	212	66.25	722	47.81
	1001-1500	50	17.92	158	44.38	6	2.14	9	3.27	84	26.25	307	20.33
	1501-2000	92	32.97	124	34.83	0	0	0	0	0	0	216	14.3
	2001-3000	134	48	47	14,2	0	0	0	0	0	0	181	12

4-Workers' Productivity and Their Occupational Exposure to Physical Factors

In order to test the effect of workers' exposure to the physical factors on their productivity, the data of all the studied workers were pooled and divided into eight groups according to their occupational exposures, viz; exposed to WBGT < 24°C and to 24+ °C, exposed to noise < 85 dBA and to 85+dBA, exposed to vibration < 5m-2 and to 5+ m-2 and working at levels of illumination < 400 lux and 400+ lux. The median and range of the percent productivity of both groups of each exposure are compared as illustrated in (Figure 3). Lower levels of productivity existed among the group of the workers who are exposed to the higher levels of heat and noise, as well as those working at lower levels of illumination (Figure 3A, 3B, 3D). However, although workers in all the enterprises are exposed to levels of vibration exceeding the threshold limit value (4m/sec^2), [23] levels of workers' productivity decreased as the levels of exposure to vibration increased particularly in the Private sector enterprises (Fig. 3C).

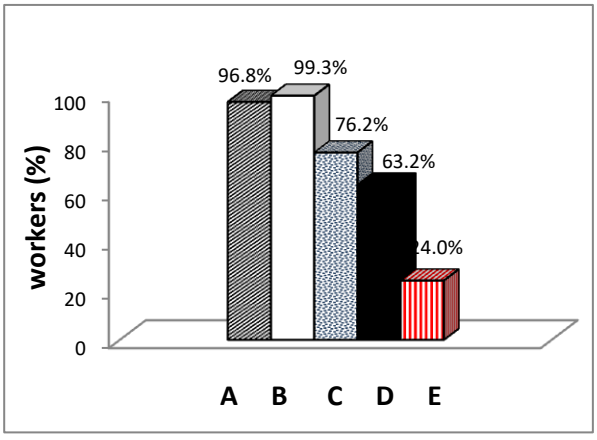


Figure 1: Distribution of Workers of the Selected Enterprises Whose Productivities are within Standard Productivity

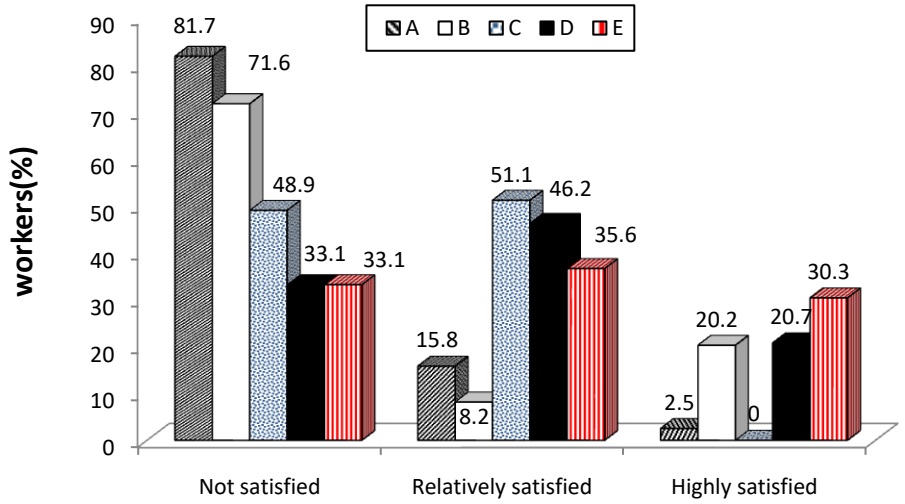


Figure (2-A) :Workers' Satisfaction about their job

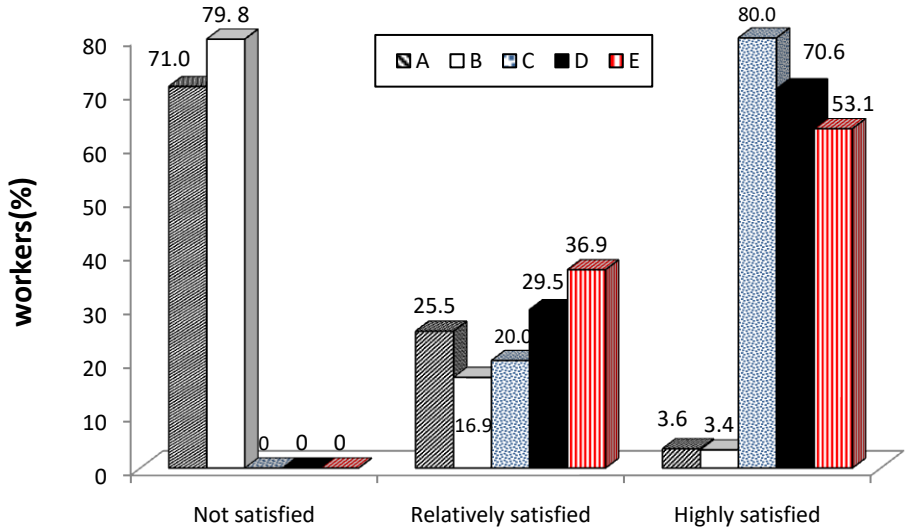
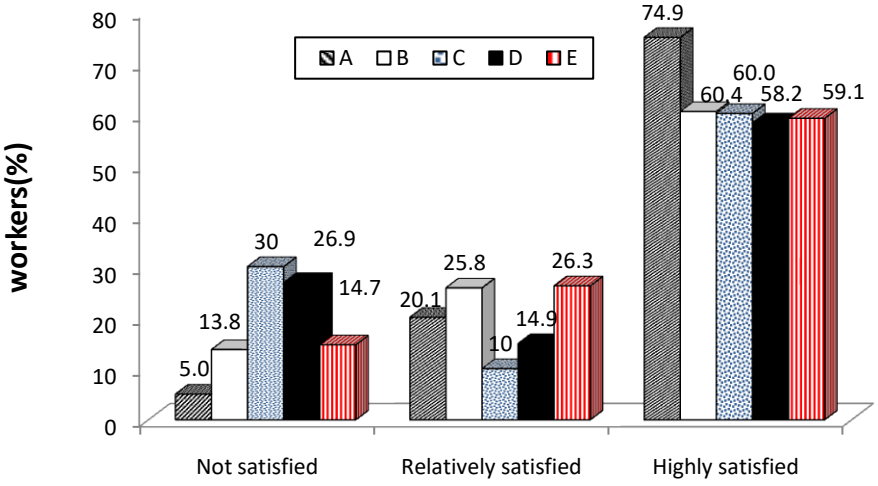


Figure 2-B:Workers' Satisfaction about their employer\manager



Figur 2-C: Employers ˙\managers ' satisfaction about workers

Figure 2: Percent Distribution of Workers and Employers/ Managers in the Studied Enterprises According to

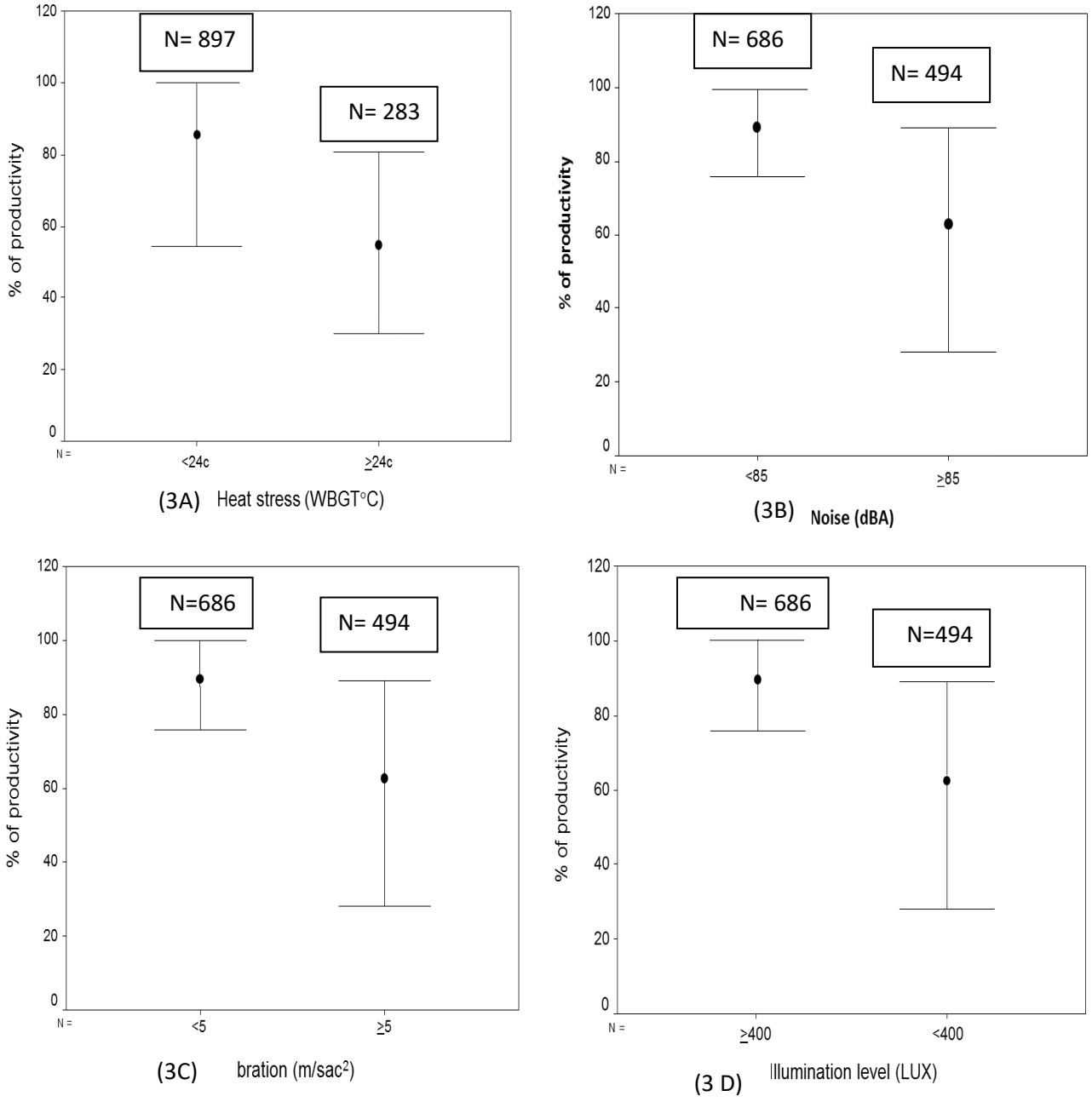


Figure 3: The medians and ranges of percent productivity of the workers in the studied enterprises as related to their exposures to different levels the tested physical factors

Table (4): Percent Productivity in the Studied Enterprises

Enterprises	Percent productivity				Kruskal-Wallis Test	
	Range	Median	Interquartile Range	Mean Rank	χ^2	P-value
A (N*= 279)	54.3 - 100	71.5	9.63	391.8	881.584	<0.001*
B (N= 356)	14.3 - 100	54.7	13.00	167.8		
C (N= 280)	75.5 - 100	86.5	8.96	763. 8		
D (N= 275)	76.8 - 100	86.4	16.65	787.0		
E (N= 320)	76.1 - 100	100.0	0.00	920.4		

*N is the number of workers in the enterprise

Table (5): Distribution of Workers of the Selected Enterprises According to Their Different Types of Absenteeism

Types of Absenteeism		Public sector				Private sector						Total (N= 1510)	
		A		B		C		D		E			
		(N=279)		(N=356)		(N=280)		(N=275)		(N=320)			
		N	%	N	%	N	%	N	%	N	%	N	%
Authorized absence		259	92.8	350	98.3	170	60.7	179	65.1	200	62.5	1158	76.7
Unauthorized Absence		25	9	42	11.8	6	2.1	7	2.6	6	1.9	86	5.7
Absence Due to Occupational Injuries		6	2.1	4	1.1	2	0.7	2	0.7	1	0.3	15	1
Number of Sick Leave Days	1-6	12	30.8	37	58.7	8	88.9	3	75	4	80	64	53.3
	7-14	16	41	6	9.5	1	11.1	1	25	1	20	25	20.8
	15-29	9	23	17	27	0	0	0	0	0	0	26	21. 7
	30-90	2	5.1	3	4.8	0	0	0	0	0	0	5	4.2

*p<0.0001

DISCUSSION

Although the levels of workers' exposure to heat in the studied enterprises were mostly lower than the TLV [23] for moderate activity type of work dominant in the garment industry. Since the measurements were conducted during fall, winter, and spring climatic season, yet much higher workers' exposure levels to heat are anticipated in summer months, climate presenting high stress on them. Meanwhile, the higher margins of the ranges of the exposure levels to noise are very close to the TLV [23] (85 dBA) in the Private sector enterprises, and higher than the TLV in the Public sector enterprises (86.3 dBA and 88.0 dBA in enterprises A and B, respectively). Moreover, unfavorable levels of illumination exist in all the studied enterprises, particularly in the Public sector enterprises. The relatively worse environmental exposure to the tested physical factors in the enterprises of Public sector than in these of the Private sector may be attributed to their older establishment with the rare (or even no) renovations.

Previous studies in the garment industries and others, particularly in developing countries have reported that workers' exposure to excessive climatic heat, and heat derived from improper lighting systems and lack of proper ventilation, to excessive noise and vibration, and to inappropriate illumination represent more hazards to them. [24-27] For example, both male and female workers have been reported to get injured with a machine needle due to the improper illumination. [24]

As related to workers' profiles, the data demonstrated that garment industry is a main employer of females (viz: in 84.1% of the studied Public sector and in 50.1% of the Private sector enterprises – table 2). Moreover, the child labors (< 20 year age) were mostly males, in the Private sector enterprises (38.5%), and illiteracy is high among them (30%), (Table 2). Previous studies in developing

countries, representing similar economic condition to the current conditions in Egypt, reported compliant findings. A study was conducted in the year 2000 Bangladesh used survey data from the years 1990, 1993 and 1997 to evaluate how the employment of women in export-oriented industries exploits the "comparative advantages of their disadvantages." According to the study, women constitute about 66 percent of the workforce in the export-oriented garment industry in Bangladesh. The assembly-line nature of garment manufacturing is one of the main reasons for higher employment of women in this industry. [28] Also, official estimates suggest more than 12 million child laborers in India (Census 2001). [29]

The age category of the workers at the Public sector enterprises (31 - 60 years old: 87.6%) was higher than at the Private sector. The workers aged 10 - 20 years old represented 74.9%, had its impact on the proportion of the married, divorced and widowed workers (viz: 46.1% in Public sector and 35% in Private sector), as well as their family size (Table 2).

The higher percent productivity reported in the Private sector enterprises (86.5%, 86.5% and 100% in C, D, and E respectively) than in the Public sector enterprises (71.5% and 54.7% in enterprises A and B, respectively) (Table 4) may be attributed to the production payment regimen common in the former than in the latter. The workers in the Private sector enterprises are keen to achieve the highest production to get maximum payment. This may also interpret the considerably higher workers' attendance (less absenteeism) among Private-sector workers than in the Public sector workers (Table 5). In addition, the job security feeling common among the Public sector may be a contributing factor to their lower productivity. However, the higher percentages of the workers practicing production deficiency in the Private sector enterprises than in the Public sector (Figure 1) may be attributed to their younger ages and shorter periods of experience (Tables 2 and 3).

Surprisingly, although the workers in the Public sector gained the higher payment, they were unsatisfied about their jobs and their employers/ managers, in spite of the satisfaction of the latter about their performance (Figure 2). This may be attributed to their older ages (workers aged 30+ years: 87.0% and 77.0% in A and B in comparison to 5.0%, 41.0%, and 28.0% in C, D and E, respectively) and to their marriage status (e.g. married, divorced, and widowed workers in the public enterprises are 75.0% in comparison to 35.1 % in the private sector) (Table 2). This was anticipated to put more economic and social burdens on them.

Regarding workers' Productivity as Related to Occupational Exposure to the Physical Factors, the data presented in this study (Figure 3) confirm the effect of occupational exposure to heat, noise, and vibration as well poor illumination, as stress factors, on the productivity of the workers in the garment industry.

The role of physical hazards in producing stress was studied previously in variety of research papers. These studies observed that the workers in industry are engaged at various jobs in the presence of multi-stresses like, heat, noise, vibration, and illumination, etc., which together is likely to cause health impairment and degrade performance capabilities and, consequently, reduce productivity quantitatively and qualitatively. [24, 28, 31-32] An epidemiological study (32) conducted to describe the effects of noise in the working environment on man concluded that the hearing ability among aged workers is evaluated (presbycusis) cannot be ignored. This may interpret the lesser productivity of some aged workers in Public sector enterprises than in the Private sector, where younger workers are dominant, in spite of the lower workers' noise exposure recorded in the former. Other studies and reports also concluded the inverse relationship between worker's noise exposure and the quantity and quality of work performed, absenteeism, accidents and disciplinary actions among them. [28-29,33] While the health impacts of noise and vibration are different, the controls are similar, particularly with respect to elimination and engineering [34] as well as diminishing their tolerance to other environmental hazards. [35] Worthy noting that the application of the international occupational safe levels for protecting workers in the tropics and in developing countries, since they have been developed for workers in western countries, most of which are in the temperate zone. There is a difference in heat tolerance and comfortable temperature zone for inhabitants of the tropics and those of other regions. Therefore, different standards must be established in considering the physical hazards and the social characteristics of workers in the developing countries.[36]

CONCLUSION AND RECOMMENDATIONS

The deleterious effects of workers' exposure to physical hazards; heat, noise and vibration, and improper illumination on their productivity are clearly demonstrated in the present study. Attention should be directed towards the control of these hazards and improving the work environment of the garment industry in Egypt, particularly in the Public sector enterprises.

Meanwhile, the enterprises' managements should not allow working hours exceeding eight hours daily as stated by law, increase workers' payment in the Private sector enterprises, and encourage them to take a one-day holiday off work weekly, and finally consider giving workers lunch hour and other rest-

pauses to reduce work stress and improve their efficiency.

Conflict of Interest: the authors declare that there is no conflict of interest.

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REFERENCES

1. Progressive Edge Consulting (PEC). Report on productivity and productivity improvement tools. New Denver: PEC; 2012 Feb. 46 p.
2. Debbie AG. Design for manufacturing and assembly in apparel handbook.1 ST ed. New York: The Educational Foundation for the Fashion Industries; 1991.
3. Selim T, Wissam Y. Oriental weavers, high financial profitability and low economic returns. Preliminary Draft. Cairo American University. Apr. 2012.
4. Grace IK, Ruth EG. Apparel manufacturing: sewn product analysis, 4th ed. New York: Pearson; 2004.
5. Central Agency for Public Mobilization and Statistics (CAPMAS). Reality of garment industry sector in Egypt. Cairo: CAPMAS; 2011. P. 32.
6. Ministry of Manpower and Immigration (MMI), Administration for Occupational Health and Safety. Occupational health and safety records. Tanta: MMI; 2016.
7. Nalini A C, Razia P. Occupational hazards among male and female sewing machine operators in a garment manufacturing units. International Journal of Multidisciplinary Research. 2011;1(3):96-100.
8. European Agency for Safety and Health at Work (EASHW).The business benefits of good safety and health. Facts 77 [Internet]. Bilbao: EASHW; 2007. [Cited in 2016 Dec 14]; Available from: http://osha.europa.eu
9. Hossain M, Ahmed S. Illumination condition and work efficiency in the tropics: study on production spaces of ready-made garments factories in Dhaka. Proceeding of the 28th Conference on Opportunities, limits &needs towards an environmentally responsible architecture, Lima. Peru; 2012 Nov 7-9.
10. Communication European Parliament (CEP). Improving quality and productivity at work: community strategy. 2007-2012 on health and safety at work. Brussels: CEP; 2007. p.15.
11. European Association of National Productivity Centers (EANPC). Productivity: The high road to wealth memorandum. Brussels: EANPC; 2005 Dec. 32 p.
12. Katz DL. Sample size, randomization, and probability theory. In: Katz DL, editor. Epidemiology, biostatistics and preventive medicine review. Philadelphia: W.B. Saunders Company; 1997.p.97-105.
13. Parsons K. Heat stress standard ISO 7243 and its global application. Journal of industrial health. 2006; 44:368-79.
14. 3M™ QUESTemp°™, Heat Stress Monitors: User Manual [Internet]. Sidney: 3M company2013. [Cited in 2016 Dec 23] Available from: http://www.3M.com/detection
15. United States Labor Department, Occupational Safety and Health Administration regulation (US/OSHA). Hearing conservation program (Standards -29 CFR), Standard part No.1910.95 (Occupational noise exposure). Washington DC: US/ OSHA; 2006 May. p.8.
16. Extech instruments, Digital sound level meters: Product datasheet [Internet]. Nashua: FLIR Commercial Systems, Inc.2007/ 2008 . [Cited in 2016 Dec 23] Available from: http://www.extech.com
17. Mechanical vibration-evaluation of machine vibration by measurements on non-rotatory parts. Part 4: Gas turbine sets with fluid-film bearings. International standard: ISO 10816-4:1998(E)[Internet]. Washington DC: ANSI 2009. [Cited in 2016 Dec 23] Available from: http://www.Iso.Org
18. Castle GA. vibration meter (0.01→100g), User manual [Internet]. RS Components Ltd. Northants: 2003. Cited in 2016 Dec 23. Available from: http://www.uk.rs-online.com/web/p/vibration-meters/3033722/
19. US Labor department. Occupational health and safety branch. Lighting assessment in the work place [Internet]. Washington DC: Labor, [Cited in 2016 Dec 23] Available from: http://www.labour.gov.hk /eng/public/oh/OHB50.pdf.
20. Light and display measurement. Measuring instruments Sensing Europe B.V[Internet]. London: Konica Minolta 2016. [Cited in 2016 Dec 14] Available from: http://www.konicaminolta.eu/en/measuring-instruments/home.html.
21. US Labor Department: Occupational health and safety branch. Guidelines for good occupational hygiene practice in a workplace [Internet]. Washington DC: Labor 2011 June. [Cited in 2016 Dec 14] Available from: https://www.legislation.gov.au/Details/F2011L02804/Download
22. Juan C H, editor. Improving working conditions and productivity in garment industry: An action manual. Geneva: ILO; 1998.
23. The American Conference of Governmental Industrial Hygienists (ACGIH). Threshold limit values (TLV®): Occupational exposure guidelines. Cincinnati: ACGIH; 2008. p.36.
24. Chotai NA. Occupational hazards among operators in a garment manufacturing Unit. The International Journal of Social Science &Management. 2012; 01(10): 110-111.
25. Hassan AK, Bhuiyan AM, Mojumdar MR. An endeavor to improve lighting efficiency in RMG (ready-made garments) industry: perspective Bangladesh. International Journal of Emerging Technology in Science and Technology. 2011;5(2):28-35.
26. Chowdhury S, Alam MR. Design approach of energy efficient readymade garments factory in view of thermal comfort. Proceeding of the Conference of the International Association for Automation and Robotics in Construction (IAARC), Seoul, Korea; 2011.p.27 – 32.
27. Gomes J, Llyod O, Norman N. The health of the workers in developing country: effects of occupational exposure to noise and heat. J. Occup. Med. 2002;52 (3):121-8.
28. Majumder PP, Begum A. The Gender imbalances in the export oriented garment industry in Bangladesh. Policy research report on gender and development. Working paper series No. 12, 2000 June [Internet].Dhaka: The World Bank Development Research Group/ Poverty Reduction and Economic Management Network. [Cited in 2016 Dec 14] Available from: http://www.worldbank.org/gender/prr.
29. Ribhu P, Agrawal S. Brief guide to garment manufacturing and child labour in garment sector in India [Internet]. New Delhi: Global March Org. [Cited in 2016 December 28] Available from: http://globalmarch.org/sites/default/files/pub/pdf
30. Noweir MH. Noise exposure as related to productivity, disciplinary action, absenteeism and accidents among textile workers. Journal of Safety Research.1984;15:163-74.
31. Muhammad JA, Muhammad AA, Amna B. Effect of noise pollution on hearing of public transport drivers in Lahore city. J Pak Med Sci 2008;24:142-6.
32. Nag A, Desai H, Nag PK. Work stress of women in sewing machine operation. Journal of Human Ergonomic. 1992;21:47-55.

33. Al-Akhtaby M Z. Design of workstation components in Egypt industry (ergonomic view) [Master thesis]. Arab academy for science, technology, and maritime transport. Alexandria. Egypt. 2004.
34. Ashraf HD, Younus MA, Kumar P, Siddiqui MT, Ali SS, Siddiqui MI. Frequency of hearing loss among textile industry workers of weaving unit in Karachi, Pakistan. J Pak Med Assoc. 2009;59(8):575-9.
35. Health and Safety Professionals Alliance. The core body of knowledge for generalist OHS professionals. Tullamarine: Safety Institute of Australia; 2012. p.12.
36. English B. Global women's work: historical perspectives on the textile and garment industries. Journal of International Affairs. 2013;67(1)4-7.