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WORKPLACE EXPOSURES AND MALE INFERTILITY — A CASE-CONTROL STUDY

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Abstract
Objectives: This study examined the association between male infertility and certain occupational exposures. **Material and Methods:** A case-control study was carried out from January 2008 to February 2009; on 255 infertile men and 267 fertile men controls. Occupational exposure to certain chemical, physical and psychological workplace hazards was assessed by self-report questionnaire. General and andrological examination was conducted for all participants, however, semen analysis was done only for the infertile men cases, because the fertile men controls refused to give semen samples. **Results:** After adjustment of confounders, the results revealed that the following workplace exposure factors significantly increased the risk of male infertility: solvents and painting materials (OR: 3.88, 95% CI: 1.50–10.03), lead (OR: 5.43, 95% CI: 1.28–23.13), VDTs and computers (OR: 8.01, 95% CI: 4.03–15.87), shift work (OR: 3.60, 95% CI: 1.12–11.57) and work-related stress (fairly present: OR: 3.11, 95% CI: 1.85–5.24; often present: OR: 3.76, 95% CI: 1.96–7.52). **Conclusion:** In spite of the limitations of this study, it supports other studies that raise the attention to minimize the exposure to the workplace hazards that may affect the fertility of male workers.

Key words:
Occupational exposure, Male infertility, Semen quality, Risk

INTRODUCTION

Health researchers pay little attention to men's health in comparison to women's health. Recently, male reproductive function in the general population has attracted increasing attention due to reports suggesting that the occurrence of several biological problems affecting the male genital tract has risen during the last 50 years [1,2]. An obvious undesirable consequence of reproductive toxicants is infertility. Infertility, defined as the inability to conceive after 12 months of unprotected intercourse, affects 10–15 percent of all couples [3]. In roughly half of the cases, a male factor is identified, while an occult male factor may be involved in 15–24% of cases in which no etiology is uncovered [4].

Semen quality analysis, the standard clinical approach to assess male reproductive capacity, can be considered a sensitive biological marker of exposure to toxicants at the workplace [5]. Based on semen quality analysis, it has been stressed that the percentage of men whose sperm count has fallen below the level associated with optimal fertility has increased [6–8]. This may be related to the consequences of environmental or occupational exposure to chemicals, radiation, toxicants and heat [9]. However, the knowledge existing today regarding the influence of chemical, physical and emotional factors on male fertility is limited. Moreover, in recent decades, the industrial world has become inundated with an ever-increasing number of chemical and physical agents whose toxicity in general, and toxicity on the male reproductive system, is very little known [10–12]. Therefore, the objective of this study was to examine the association between male infertility and certain occupational exposures.

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MATERIAL AND METHODS

A case-control study was carried out from January 2008 to February 2009. The study was granted the ethical approval by Mansoura Faculty of Medicine Ethical Committee. The cases were males having their first appointment for infertility evaluation at the Andrology Clinic of the Mansoura University Hospital, Mansoura, Egypt. Only 601 men agreed to participate in the study by giving a formal consent. Out of the total of 601 men, random sample of 255 were selected that fulfilled the following criteria:

1. No female factors of infertility (such as: pelvic inflammatory diseases, tubal occlusion, endometriosis, or endocrine and ovulation defects).
2. Absence of medical and surgical causes of infertility such as DM, febrile illnesses, urinary tract infection, sexually transmitted diseases, a history of chemotherapy or radiotherapy, varicocele, undescended testes, small testes or testicular injury. Those health conditions were diagnosed by past medical history, andrological examination by andrology specialists, fasting blood glucose, urine analysis, and other investigations including a Doppler examination of both testes. Moreover, cases with family history of any genetic disease were excluded.
3. Cases having their complete data including questionnaires and semen analysis.

The mean age of the cases was: 30.10±6.20 years and all of them had primary infertility. Controls were recruited from husbands accompanying their pregnant women attending an obstetric clinic of the Mansoura University Hospital, for antenatal care of their first pregnancies. We approached 422 husbands from January 2008 to February 2009, to whom we explained the purpose of the study. However, only 317 husbands agreed to participate, so the participation rate was 64.69%. Out of the 317 husbands willing to take part in the study, 273 were randomly selected. Finally, from the randomly selected 273 husbands, 267 men whose wives had a time-to-pregnancy (TTP) of ≤ 12 months (of unprotected intercourse) composed the control group and the remaining 6 men were excluded as their wives had a TTP of > 12 months [13].

All participants signed a formal consent including information on the purpose and procedures of the study, information about the researchers and the confidentiality of the data. Nevertheless, all the controls refused to give a semen sample, as they considered themselves as fertile men with no need for semen analysis. The mean age of the controls was 29.92±6.11 years.

Assessment of occupational and environmental exposure

All participants completed extensive self-report questionnaire on socioeconomic, medical, occupational and environmental factors. The questionnaire included questions about the presence and duration of occupational exposures occurring within the past month, including exposures to pesticides; solvents (such as: glues, adhesives, polishes, thinner or turpentine); painting materials; gasoline; welding or soldering fumes; mineral oils or wax; printing materials; anesthetic gases; lead; VDTs; radiation; excess heat and whole-body vibration. In addition to this, the questionnaire contained questions about the presence of work-related stress (no stress, fairly present, often present) and shift work.

Semen analysis

All cases agreed to give semen samples, however all the controls refused to give a semen sample, as they considered themselves as fertile men with no need for semen analysis. All cases were asked to collect their semen at the Andrology Clinic lab by masturbation into a sterile plastic specimen cup. They were instructed to abstain from ejaculation for at least 3 days prior to sampling. All semen samples were processed and analyzed by computer aided semen analyzer (CASA, version 10 HTM-IVOS; Hamilton Thorne Research, Beverly, Mass). Each semen sample was liquefied for at least 20 minutes, but no longer than 1 hour prior to semen analysis. Volume, pH, sperm concentration per ml, sperm motility, sperm morphology (Morphological Index) and sperm viability were examined according to the World Health Organization (WHO) guidelines for the examination of human semen [14].

To measure both the sperm concentration and motility a minimum of 200 sperm cells from at least four different fields as analyzed from each specimen. Motile sperm was defined according to the WHO grade as ‘a’ grade sperm (rapidly progressive with a velocity ≥ 25 mm/s at 37°C) and ‘b’ grade sperm (slow/sluggish progressive with a velocity ≥ 5 mm/s, but < 25 mm/s). Progressive motile sperm was defined as grade 'a' sperm [14].

In respect of the sperm morphology, at least two slides were made for each fresh semen sample. The resulting thin smear was allowed to air dry for 1 hour before staining it with the Diff-Quik staining kit (Dade Behring AG, Dudingen, Switzerland). Morphological assessment was performed with a Nikon microscope using an oil immersion 1006 objective (Nikon Company, Tokyo, Japan). A minimum of 200 sperm cells was counted from the 2 slides for each specimen. Strict scoring criteria were used to classify men as having normal or subnormal morphology, according to Kruger et al. [15].

Statistical analysis

Baseline demographic information for cases and controls was compared. Next, bivariate analyses were performed to determine the association between the fertility status and exposure factors based on a priori hypotheses. Bivariate analyses were performed using student-t test for continuous variables and the Pearson Chi-Squared (χ^2) and Fisher's exact tests for categorical and dichotomous variables. Next, a multivariable logistic regression model was employed using forward Wald strategy. Candidate variables had a bivariate association with fertility of p ≤ 0.05. Odds ratio (OR) and 95% confidence intervals (CI) were calculated for case-control associations with factors suspected to affect male fertility with adjustment of the confounders. Statistical analysis was performed using SPSS, version 16.0, on a personal computer. A two-tailed p value lower than 0.05 was considered statistically significant and a p value lower than 0.01 was considered to have high statistical significance.

RESULTS

There was statistically non-significant difference between the cases and controls regarding their age, residence, education levels and economic status. However, the cases

Table 1. Demographic characteristics of the study population

Variable	Cases (n = 255)	Controls (n = 267)	P
Age (years), mean ±SD	30.10±6.20	29.93±6.11	t = 0.33 P > 0.05
Body Mass Index (kg/m^2), mean ±SD	27.80±4.85	26.80±4.13	t = 2.15 P < 0.01
Smoking n(%)			
non-smoker	97(38.00)	171(69.01)	χ^2 = 35.09
current smoker	158(62.00)	96(36.00)	P < 0.01
Residence n(%)			
rural	64(25.09)	62(23.22)	χ^2 = 0.25
urban	191(74.90)	205(76.77)	P > 0.05
Education n(%)			
illiterate	26(10.19)	18(6.74)	χ^2 = 3.02
read and write / primary school	29(11.37)	34(12.73)	P > 0.05
preparatory / secondary school	107(41.96)	125(46.81)	–
university graduated or higher	93(36.47)	90(33.71)	–
Income n(%)			
not enough	156(58.41)	127(49.80)	χ^2 = 4.38 P > 0.05
enough	107(40.12)	121(47.51)	–
enough with savings	4(1.50)	7(2.72)	–

Table 2. Semen quality of the cases

Semen quality parameters	Mean ±SD median (min–max)	WHO (1999) accepted levels
Abstinence (day)	4.09±1.00 4.00 (3.00–9.00)	3.00
pH	7.231±0.08 7.33 (7.21–8.00)	7.2–8.0
WBCs (cell) HPF	2.29±1.37 2.00 (1.00–5.00)	< 5.00
RBCs (cell) HPF	2.11±1.35 2.12 (0.00–4.00)	< 5.00
Semen Volume (ml)	3.55±1.27 3.50 (0.70–7.00)	≥ 2.00
Sperm Density (10^6/ml)	39.97±39.13 23.90 (0.80–218.70)	≥ 20.00
Morphological Index (% normal sperms)	14.95±8.51 14.01 (0.12–49.00)	> 15.00
Sperm Motility (%)	45.81±26.82 40.02 (1.00–90.00)	≥ 50.00

HPF — high power field.

differed significantly from the controls concerning smoking and the body mass index (BMI) (Table 1).

As regards the semen quality of the cases, the mean values of the morphological index and the sperm motility were lower than the WHO standards [14] for normal individuals. However, the mean values of pH, semen volume, sperm density, WBCs and RBCs were within the norm, according to the WHO standards [14] (Table 2).

The infertile men were significantly more likely to be exposed to solvents and painting materials (OR: 3.88, 95% CI: 1.50–10.03); lead (OR: 5.43, 95% CI: 1.28–23.13) and VDTs (OR: 8.01, 95% CI: 4.03–15.87) than the fertile men. Apart from that, shift work (OR: 3.60, 95% CI: 1.12–11.57) and work-related stress (fairly present: OR: 3.11, 95% CI: 1.85–5.24; often present: OR: 3.76, 95% CI: 1.96–7.52) were significantly associated with infertility. Smoking and BMI were also considered to make significant risk factors of male infertility. On the other hand, no significant associations were found between infertility and exposure to pesticides, gasoline, welding fumes, anesthetic gases, printing materials, excess heat, whole-body vibration, and radiation (Table 3).

Table 3. Odds Ratios (OR) of factors associated with male infertility

Factors[a]	Cases (n = 255) n(%)	Controls (n = 267) n(%)	OR[b] (95% CI)	P
Occupational exposures				
solvents and painting materials	31(12.2)	9(3.4)	3.88 (1.50–10.03)	< 0.05
gasoline	19(7.5)	10(3.7)	1.03 (0.30–3.50)	> 0.05
lead	18(7.1)	3(1.1)	5.43 (1.28–23.13)	< 0.05
welding fumes	23(9.0)	3(1.1)	3.95 (0.58–26.97)	> 0.05
VDTs and computers	81(31.8)	14(5.2)	8.01 (4.03–15.87)	< 0.01
excess heat	25(9.8)	13(4.9)	1.47 (0.59–3.61)	> 0.05
stress — fairly present	118(46.3)	46(17.2)	3.11 (1.85–5.24)	< 0.01
stress — often present	57 (22.4)	27(10.1)	3.76 (1.96–7.52)	< 0.01
shift work	21(8.2)	7(2.6)	3.60 (1.12–11.57)	< 0.05
Smoking	158(62.0)	96(36.0)	2.622 (1.66–4.14)	< 0.01
BMI (kg/m^2) Mean ±SD	27.80±4.85	26.80±4.13	1.07 (1.06–1.13)	< 0.01

[a] Exposure categories were not mutually exclusive.

[b] There was a non-statistically significant difference between the cases and controls concerning the following exposure factors that were not entered into the logistic model: pesticides, vibration, anesthetic gases, printing materials and radiation.

DISCCUSION

In the present study, different types of occupational exposures were evaluated based on a self-report detailed questionnaire. Doubtless, a questionnaire as a tool of qualitative measurement of exposure has disadvantages such as recall bias and exposure misclassification; and is inferior to the biological assessment of exposure which is more precise. Despite these limitations, questionnaires have provided good estimates of exposures [2,16]. In this study, the biological assessment could not be used because of the cost and the diversity of chemicals that the subjects were exposed to. Therefore, in the present study questionnaire, the answer "yes" for the studied exposures was limited to the intense and frequent workplace exposures.

Concerning adjustment of confounders, there was a non-significant difference between cases and controls regarding other confounders such as age, residence, education levels or economic levels. On the other hand, as expected, infertility was significantly associated with smoking [17] (OR: 2.622, 95% CI: 1.66–4.14) and the body mass index, (OR: 1.07, 95% CI: 1.06–1.13).

As for the studied occupational chemical exposures, the present study found that infertile men were significantly more likely to be exposed to solvents and painting materials and lead. However, no significant associations were found between infertility and exposure to pesticides, gasoline, welding fumes, anesthetic gases and printing materials.

Organic solvents are widely used in various industrial settings, such as electronics, shoemaking, furniture manufacturing, painting, dry cleaning, metal industries, reinforced plastic industries, and the production of paints, glues, and other chemicals [18]. In animal experiments, 2-bromopropane, ethylene glycol ethers, n-hexane, and thinners, particularly ethyl acetate and xylene, can cause testicular damage and degeneration [19–21].

Many epidemiological studies were carried out to investigate the association between occupational exposure to solvents and the risk of male infertility. Our results support these of other studies which found that occupational exposure to solvents significantly increased the risk of male infertility [2,22–24]. On the other hand, other studies have been negative [25–27]. Tielemans et al. concluded that it seems that there is a clear association between solvent exposure and impaired semen parameters [28].

Our results, concerning significantly increased risk of infertility in relation to occupational exposure to lead, confirm several other occupational surveys that linked exposure to inorganic lead with reduced sperm count and other signs of male reproductive toxicity [2,29–31]. Nevertheless, our study found non-significant risk of infertility for exposure to welding fumes. This was in agreement with De Fleurian et al. and against Gracia et al. [2,16].

Surprisingly, the present study found no significant association between infertility and exposure to pesticides. This was in agreement with Gracia et al. and Clementia et al. [16,32], but they reported that their studies had several limitations. On the other hand, Roeleveld and Bretveld [33] reported that several studies from the 1970s and 1980s showed that occupational exposure to specific pesticides such as dibromochloropropane, ethylene dibromide, and chlordecone had detrimental effects on semen quality, affecting sperm count, sperm motility and morphology. However, the majority of studies published since 2000 have reported some effects of pesticide exposure on semen quality or time-to-pregnancy, but the results have not been consistent [33].

Concerning the studied occupational physical exposures, the results of our study revealed that infertile men were significantly more likely to work with video display terminals (VDTs) and computers (OR: 8.01, 95% CI: 4.03–15.87) than the fertile men. Nonetheless, no significant associations were found between infertility and exposure to excess heat, whole-body vibration or radiation.

Many jobs that require extensive daily computer use have been found to be stressful [34,35] and stress is a risk factor of infertility [11]. Also, prolonged sitting in front of VDTs may affect semen quality through increasing the temperature of the testes [2]. Moreover, the computer-released radiation causes changes in enzymatic antioxidant defense system and leads to oxidant stress [36]. Other studies reported that electromagnetic field exposure from electronic equipment and VDTs may decrease the melatonin level, leading to oxidative stress [37,38] which may result in impairment of the semen quality. On the other hand, other studies found no significant association between exposure to VDTs and male infertility [2,16].

Many studies reported increased risk of infertility among workers exposed to high temperature [2,39,40]; however, the present study did not find significant increased risk of infertility in relation to exposure to excess heat, which is in accordance with Oliva et al. [10]. This may be due to low exposure times or intensities among the studied population that did not include workers in industries associated with high temperature exposure as iron and steel industry or glass industry.

The present study found that shift work (OR: 3.60, 95% CI: 1.12–11.57) significantly increased the risk of male infertility. This is in accordance with Irgens et al. [41] who reported a tendency toward reduced semen quality among shift workers (OR: 1.46, 95% CI: 0.89–2.40) which may be explained by stress and specific lifestyle factors. Moreover, Tuntiseranee et al. estimated the effect of long working hours and shift work on time-to-pregnancy and they found that long working hours constitute a risk factor for subfecundity, but, shift work was not associated with subfecundity in their study [42]. However, Zhu et al. examined whether shift work is associated with reduced fecundity as estimated by time-to-pregnancy (TTP). They found no evidence of a causal association between shift work and subfecundity [43].

In our study, work-related stress significantly increased the risk of male infertility with a dose-response effect (OR: 3.11, 95% CI: 1.85–5.24 for fairly stressed and OR: 3.76, 95% CI: 1.96–7.52 for often stressed). These results support other studies [11,44] that found significant increased risk of infertility in relation to work-related stress. Psychological stress has been demonstrated to depress testosterone levels in humans and rodents [45] and it has a negative impact on the semen quality [16,46]. In addition, stress may affect libido and sexual performance that could indirectly influence fertility [47].

The present study had several limitations: no biological monitoring done, occupational exposures were assessed by a questionnaire not by actual exposure monitoring, and the fertile male controls refused to give semen samples for semen analysis. However, the sample size of the present study was considerably large and the participation rate was good. Based on the results of this study we will arrange for another study focusing on special work categories considered to be at more risk for male infertility (such as painters), with more sophisticated biological monitoring and exposure assessment.

CONCLUSION

This case-control study found that workplace exposure to solvents and painting materials, lead, VDTs and computers, shift work and work-related stress significantly increased the risk of male infertility. In spite of the limitations of this study, it supports other studies that raise the attention to minimize the exposure to the workplace hazards that may affect the fertility of male workers.

REFERENCES

1. Telisman S, Cvitkovic P, Jurasovic J, Pizent A, Gavella M, Roc B. *Semen Quality and Reproductive Endocrine Function in Relation to Biomarkers of Lead, Cadmium, Zinc, and Copper in Men.* EnvironHealth Perspect 2000;108:45–53.
2. De Fleurian G, Perrin J, Ecochard R, Dantony E, Lanteaume A, Achard V, et al. *Occupational exposures obtained by questionnaire in clinical practice and their association with semen quality.* J Androl 2009;30:566.
3. Mosher WD, Pratt WF. *Fecundity and infertility in the United States: incidence and trends* [editorial]. Fertil Steril 1991;56:192–3.
4. Skakkebaek NE, Giwercman A, De Kretser D. *Pathogenesis and management of male infertility.* Lancet 1994;343:1473–8.
5. Bigelow PL, Jarrell J, Young MR, Keefe TJ, Love EJ. *Association of semen quality and occupational factors: comparison of case–control analysis and analysis of continuous variables.* Fertil Steril 1998;69:11–8.
6. Carlsen E, Giwercman A, Keiding N, Skakkebaek N. *Evidence for decreasing quality of semen during the past 50 years.* Br Med J 1992;305:609–13.
7. Jouannet P, Auger J. *Declining sperm counts? More research is needed.* Andrologia 1996;28:302–3.

8. Bonde JP, Hjollund NH, Kolstad KA. *Environmental semen studies: is infertility increased by a decline in sperm count?* Scand J Work Environ Health 1999;25:76–8.
9. Friedler G. *Paternal exposures: impact on reproductive and developmental outcome: an overview.* Pharmacol Biochem Behav 1996;55:691–700.
10. Oliva A, Spira A, Multigner L. *Contribution of environmental factors to the risk of male infertility*. Hum Reprod 2001;16:1768–76.
11. Sheiner EK, Sheiner E, Hammel RD, Potashnik G, Carel R. *Effect of Occupational Exposures on Male Fertility: Literature Review.* Industrial Health 2003;41:55–62.
12. Kumar S. *Occupational Exposure Associated with Reproductive Dysfunction.* J Occup Health 2004;46:1–19.
13. Gnoth C, Godehardt E, Frank-Herrmann P, Friol K, Tigges J, Freund G. *Definition and prevalence of subfertility and infertility.* Hum Reprod 2005;20(5):1144–7.
14. World Health Organization (WHO). *WHO Laboratory Manual for the Examination of Human Semen and Semen-Cervical Mucus Interaction.* New York: Cambridge University Press; 1999.
15. Kruger TF, Acosta AA, Simmons KF, Swanson RJ, Matta JF, Oehninger S. *Predictive value of abnormal sperm morphology in in-vitro fertilization.* Fertil Steril 1988;49:112–7.
16. Gracia CR, Mary D, Coutifaris SC, Guzick DS, Barnhart KT. *Occupational exposures and male infertility.* Am J Epidemiol 2005;162:729–33.
17. Vine MF, Margolin BH, Morrison HI, Hulka BS. *Cigarette smoking and sperm density: a meta-analysis.* Fertil Steril 1994;61:35–43.
18. Hooiveld M, Haveman W, Roskes K, Bretveld R, Burstyn I, Roeleveld N. *Adverse reproductive outcomes among male painters with occupational exposure to organic solvents.* Occup Environ Med 2006;63:538–44.
19. Nylen P, Ebendal T, Eriksdotter-Nilsson M. *Testicular atrophy and loss of nerve growth factor-immunoreactive germ cell line in rats exposed to n-hexane and a protective effect of simultaneous exposure to toluene or xylene.* Arch Toxicol 1989;63:296–307.
20. Yamada K. *Influence of lacquer thinner and some organic solvents on reproductive and accessory reproductive organs in the male rat.* Biol Pharm Bull 1993;16:425–7.
21. Ichihara G, Asaeda N, Kumazawa T, Tagawa Y, Kamijima M, Yu X, et al. *Testicular toxicity of 2-bromopropane.* J Occup Health 1996;38:205–6.
22. De Celis R, Feria-Velasco A, Gonzalez-Unzaga M, Torres-Calleja J, Pedron-Nuevo N. *Semen quality of workers occupationally exposed to hydrocarbons.* Fertil Steril 2000;73:221–8.
23. Cherry N, Labreche F, Collins J, Tulandi T. *Occupational exposure to solvents and male infertility.* Occup Environ Med 2001;58:635–40.
24. Kurinczuk JJ, Clarke M. *Case-control study of leatherwork and male infertility.* Occup Environ Med 2001;58:217–24.
25. Spinelli A, Figa TI, Osborn J. *Time to pregnancy and occupation in a group of Italian women.* Int J Epidemiol 1997;26:601–9.
26. Kolstad HA, Bisanti L, Roeleveld N, Baldi R, Bonde JP, Joffe M. *Time to pregnancy for men occupationally exposed to styrene in several European reinforced plastics companies.* Scand J Work Environ Health 1999;25:66–9.
27. Plenge BA, Karmaus W. *Exposure to toluene in the printing industry is associated with subfecundity in women but not in men.* Occup Environ Med 1999;56:443–8.
28. Tielemans E, Burdorf A, Velde ER, Weber RF, Van-Kooij RJ, Veulemans H, et al. *Occupational related exposures and reduced semen quality: a case-control study.* Fertil Steril 1999;4:690–96.
29. Lancranjan I, Popescu HI, Gavanescu O. *Reproductive ability of workmen occupationally exposed to lead.* Arch Environ Health 1975;30:396–401.
30. Apostoli P, Bellini A, Porru S, Bisanti L. *The effect of lead on male fertility: a time to pregnancy (TTP) study.* Am J Ind Med 2000;38:310–5.
31. Shiau CY, Wang JD, Chen PC. *Decreased fecundity among male lead workers.* Occup Environ Med 2004;61:915–23.
32. Clementia M, Tibonib GM, Causinc R, Roccad C, Maranghid F. *Pesticides and fertility: An epidemiological study in Northeast Italy and review of the literature.* Reprod Toxicol 2008;26:113–8.
33. Roeleveld N, Bretveld R. *The impact of pesticides on male fertility.* Curr Opin Obstet Gynecol 2008;20:229–33.
34. Carajon P. *Job design and job stress in office workers.* Ergonomics 1993;5:463–77.

35. Mocci F, Serra A, Corrias GA. *Psychological factors and visual fatigue in working with video display terminals* Occup Environ Med 2001;58:267–71.
36. Ergüder IB, Durak I. *Effects of computer use on human salivary oxidant/antioxidant status.* J Biol Sci 2006;6:14–17.
37. Buiatti E, Barchielli A, Geddes M, Nastasi L, Kriebel D, Franchini M, et al. *Risk factors in male infertility: a case--control study.* Arch Environ Health 1984;39:266–70.
38. Tan DX, Manchester LC, Reiter RJ, Qi WB, Karbownik M. *Significance of melatonin in antioxidant defense system: Reactions and products.* Biol Signals Recept 2000;9:137–59.
39. Thonneau P, Ducot B, Bugan L, Mieusset R, Spira A. *Heat exposure as a hazard to male fertility — letter.* Lancet 1996;347:204–5.
40. Thonneau P, Bujan L, Multigner L, Mieusset R. *Occupational heat exposure and male fertility: a review.* Hum Reprod 1998;13:2122–5.
41. Irgens A, Krüger K, Ulstein M. *The effect of male occupational exposure in infertile couples in Norway.* J Occup Environ Med 1999;41:1116–20.
42. Tuntiseranee P, Olsen J, GeaterA, Kor-anantakul O. *Are long working hours and shift work risk factors for subfecundity? A study among couples from southern Thailand.* Occup Environ Med 1998;55:99–105.
43. Zhu JL, Hjollund NH, Boggild H, Olsen J. *Shift work and subfecundity: a causal link or an artefact?* Occup Environ Med 2003;60:e12.
44. Sheiner EK, Sheiner E, CarelR, Potashnik G, Shoham-Vardi I. *Potential association between male infertility and occupational psychological stress.* J Occup Environ Med 2002;44:1093–9.
45. McGrady AV. *Effects of psychological stress on male reproduction: a review.* Arch Androl 1984;13:1–7.
46. Stoleru S, Teglas JP, Fermanian J, Spira A. *Psychological factors in the aetiology of infertility: a prospective cohort study.* Hum Reprod 1993;8:1039–46.
47. Chia SE, Tay SK. *Occupational risk for male infertility: A Case-Control Study of 218 Infertile and 227 Fertile Men.* J Occup Environ Med 2001;43:946–51.