Medical Profession Strain and Cardiovascular Disorders: A Longitudinal Study on a Cohort of Egyptian Physicians

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Abstract: In spite of being economically and socially rewarding, medical professions are medically and socially debilitating. Therefore; this study aimed to evaluate the impact of medical profession strain on cardiovascular diseases risk factors in an Egyptian cohort of medical graduates in ten years period. A total of 92 medical graduates were subjected to interview questionnaire and medical examination and investigations of CVDs risk factors in 2001 as a baseline and ten years later in the evaluation phase. By the end of the evaluation phase of the study the results showed that the mean values of body mass index, systolic and diastolic blood pressure, fasting blood sugar, total cholesterol and stress hormones e.g., cortisol, adrenaline and nor-adrenaline were significantly increased in 2011 than the baseline values in 2001. There were significant moderate correlations between the values of 2001 and 2011. We concluded through that medical profession strain has a significant impact on increasing the CVDs risk factors, as all of blood pressure, blood glucose levels, cholesterol, weight and stress hormones showed significantly evident increase in the studied cohort in 2011 than 2001. Re-evaluation after 5 years will be confirming of the current results. We recommend stress-coping procedures to mitigate the adverse effects of medical profession strain while keeping observation of the CVD risk factors by regular medical check-ups.

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1. Introduction

According to the World Health Organization (WHO), cardiovascular diseases (CVDs) accounts for 16.7 million deaths per year. The projection of the prevalence of CVDs for 2020, estimates that CVD will be the main cause of death and disability. Developing countries contribute more to the burden of these diseases than developed ones **(Ramires and Chagas, 2005)**.

On the other hand, there is a cumulating body of evidence on the association between psychosocial hazards at work and the physical health of workers, namely CVDs. The job stress model most frequently used is that of job strain **(Schnall et al., 1994)**. This model postulates that psychological strain and increased cardiovascular risk result not from a single factor, but from the joint effects of the psychological demands of the work situation and the range of decision-making freedom with respect to task organization and skill usage (decision latitude or job control) available to the workers facing those demands. Thus, psychological strain results when individuals have insufficient control over their work situation to be able satisfactorily to deal with the level of demands being placed on them **(North et al., 1996)**.

As early as 1968, **Mechanic** stated that "the average doctor responds to his growing practice and increasing demands on his time, by practicing at a different pace and style. Such a pattern of work requires doctors to practice on an assembly line basis, which diminishes the unique satisfaction possible in general practice" **(Mechanic, 1968)**. Since that time there has been a growing amount of published work on job dissatisfaction and stress among health care givers.

Actually, chronic stressors, doctors usually experience during their working day, are not the only association with cardiovascular illnesses incidence or progression **(Greenwood et al., 1996 ; Cohen et al., 1997; Everson et al., 1997)**, but they may experience prolonged anticipatory bereavement over lost aspects of relationships with their care recipients. Such bereavement is positively associated with cardiovascular morbidities **(Kaprio et al., 1987)**, and mortality **(Goldman et al., 1995)**.

Further, behavioral changes occurring as adaptations or coping responses to stressors such as increased smoking, decreased exercise and sleep, and poorer adherence to medical regimens provide an important pathway through which stressors can influence disease risk **(Cohen et al., 1995)**.

Besides, doctors are often perfectionists, self-sacrificing people with high levels of personal drive and altruism. This predisposes them to put others' needs before their own, thus increasing stress but their personality also makes it hard for doctors to self-reflect or to seek help. For most doctors, stress or illness is what happens to other people, and doctors are there to help them get better. It is sometimes very difficult for doctors to acknowledge their own stress and distress, and even more difficult to acknowledge that their work performance is affected as a result **(Wong, 2008)**.

Worldwide, tens of studies discussed the relationship between job strain and cardiovascular disorders among workers from different professions, and most of these studies reached a conclusion that stressful working life is a determinant factor to many cardiovascular abnormalities as elevated systolic and diastolic pressure, high rates of heart beats, elevated fasting blood sugar, increased total plasma lipids in addition to increasing mortality from cardiac ischemia and chronic heart failure **(Baumgarten et al., 1992; Jardim, 2010)**, whereas some others did not observe differences **(George and Gwyther, 1986 ; Haley et al., 1987)**.

The current study aimed to assess the effect of a ten-year medical profession strain on cardiovascular illnesses and its risk factors in a cohort of medical practitioners'.

To our knowledge, this is the first Egyptian longitudinal study that followed a cohort of medical graduates to evaluate the impact of job stress on their development of CVDs or its risk factors after ten years of medical practice.

2. Subjects and Methods

After excluding those with any existing (congenital or rheumatic) heart disease, or known to have type 1 diabetes mellitus, a total of 108 fresh medical graduates representing all graduates who finished their training year "house-officers" on February 2001in El-Minia University hospitals, were recruited for this study. Precisely, 92 medical graduates accepted to take part in the study giving a response rate of 85.2%. Subjects had been informed of every single detail of the study and its steps before they signed the consent forms.

A well-designed questionnaire was introduced to the subjects on February 2001. This questionnaire included some information about age, sex, special habits in addition to some socio-demographic details, previous medical history and family history. Further, the subjects were asked about their smoking habits, hours of physical activity per week and type of sports practiced, if present.

Then, height and weight of all subjects were measured for calculation of their body mass index (BMI).

For measuring the weight, individuals were wearing light clothing and without shoes; an electronic scale, with a maximum capacity of 150 kg and precision of 100gm was used.

Afterwards subjects were asked to quit smoking, coffee, tea and alcoholics, if any, for 24 hours and blood pressure measurements were taken in the right upper limb after 10 minutes of rest using electronic digital sphygmomanometer and revised by a manual mercury one. These measurements were taken again under the same conditions two more times, one and two weeks after the day of first reading.

Subjects were asked to fast for 12 hours, and then fasting blood glucose and total cholesterol were checked using (Accurtend GC portable device by Roche) by finger prick method. The subjects who had cholesterol $\geq$200 mg/dl were considered dyslipidemic.

Blood samples were collected from all subjects using in dwelling catheter in order to detect the levels of adrenaline and nor-adrenaline in plasma. The blood samples were collected into chilled lithium - heparin tube then the specimens were frozen by dry ice and centrifuged at 4°C within 20 minutes of sampling. On the other hand, plasma cortisol was determined directly using radioimmunoassay.

Ten years later, the same subjects were asked to fill out the same questionnaires and repeat the same medical measurements and laboratory investigations to evaluate the same parameters under the same conditions. Out of the 92 subjects who participated in 2001 baseline phase of the study, only 85 completed 2011 evaluation phase of the study.

Of the 7 who missed the evaluation phase, 4 died in traffic accidents and 3 travelled abroad before the evaluation phase due time.

Ethical considerations:

The study was approved by the ethical committee of the Faculty of Medicine, El-Minia University. Prior to data collection, official permissions were obtained from the authorities of El-Minia University hospitals. All participants were asked to sign informed consents before giving the blood samples and filling out the questionnaires.

The questionnaires included explanations about the purpose of the study with confirming confidentiality of data and assuring that it will never be used for purposes other than scientific research.

Statistical analysis:

Data were analyzed using the software, Statistical Package for Social Science, (SPSS) version 17. Frequency distribution with its percentage and descriptive statistics with mean and standard deviation were calculated. Comparisons between data of the baseline and evaluation phases were performed using, t-test, test of proportions and correlation, whenever needed. Prevalence of cardiovascular risk factors among the studied physicians between February 2001 and 2011calculated by z- test. P-values of less than 0.05 were considered significant.

3. Results

A total of 92 medical graduates of El-Minia University, Faculty of Medicine, took part in this study. The subjects were 54 males (58.7%) and 38 females (41.3%), with a mean age of 24.8±2.9 for males and 24.5±3.4 for females. Our subjects were interviewed and examined to determine the incidence and prevalence rates of cardiovascular disorders and risk factors such as overweight, hypertension, hypercholesterolemia, smoking habits and physical inactivity, as a baseline on 2001 and ten years later in the evaluation phase.

Table 1: Prevalence of cardiovascular risk factors among the studied physicians between February 2001 and 2011

CVDs risk factors	2001(n= 92)	2011(n=85)	P-value
Overweight	7 (7.6%)	17(20.0%)	0.029*
Hypertension	2 (2.2%)	9 (10.6%)	0.045*
Hypercholesterolemia	3(3.3%)	11(12.9%)	0.035*
Physical inactivity	4 (4.3%)	7(8.2%)	0.561
Smoking	3 (3.3%)	6(7.1%)	0.423

*= Significant by test of proportion (z -test)

Table 1 shows the frequency CVDs' risk factors amongst the studied physicians in the year 2001 and after 10 years in 2011. Throughout the mentioned period, the prevalence rate of overweight was more than doubled, while that of hypertension and hypercholesterolemia increased to more than triple ($P<0.05$). Despite the noticed increase in the figures for physical inactivity and smoking habit between 2001 and 2011, this increase was statistically non-significant.

Table 2: Cardiovascular disorders risk factors in the studied physicians as measured at the baseline phase in 2001 and evaluation phase in 2011

Measurements	2001(n= 92)	2011 (n= 85)	P-value
Body mass index (BMI) (kg/m^2)	24.0±3.3	25.4±3.8	0.01*
Systolic blood pressure (mmHg)	123.7±7.3	127.5±7.6	0.006*
Diastolic blood pressure (mmHg)	71.3±5.1	78.0±5.6	0.001*
Fasting blood sugar (mg/dL)	82.6±15.1	85.4±16.9	0.023*
Total cholesterol (mg/dL)	177.2±30.1	190.6±36.4	0.001*

*= Significant by t-test

Table 2 shows the mean values of BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood sugar (FBS) and total plasma cholesterol among the studied medical graduates in the years 2001 and 2011. It is obvious that the mean values of all measurements increased significantly during the period of the study.

Table 3: Cardiovascular disorders risk factors in the studied male physicians as measured at the baseline phase in 2001 and evaluation phase in 2011

Measurements	2001 (n= 54)	2011 (n= 49)	P-value
Body mass index (BMI) (kg/m^2)	24.7±3.4	26.5±3.8	0.01*
Systolic blood pressure (mmHg)	124.3±7.4	128.4±7.9	0.021*
Diastolic blood pressure (mmHg)	71.7±4.8	75.1±5.3	0.033*
Fasting blood sugar (mg/dL)	84.2±15.4	86.8±15.6	0.01*
Total cholesterol (mg/dL)	180.1±31.1	196.6±33.4	0.001*

*= Significant by t-test

Table 3 demonstrates the mean values of BMI, SBP, DBP, FBS and total plasma cholesterol among the male medical graduates in the years 2001 and 2011. In consistence with the results shown in table 2, the mean values of the males measurements showed a significant rise (P<0.05). For instance, total cholesterol increased from 180.1 mg/dL in 2001 to 196.6 mg/dL ten years later. Alike, the mean value of BMI rose from 24.7 in 2001 to 26.5 in 2011, which means that the mean BMI of subjects moved from normal to overweight category.

Table 4: Cardiovascular disorders risk factors in the studied female physicians as measured at the baseline phase in 2001 and evaluation phase in 2011

Measurements	2001(n= 38)	2011 (n= 36)	P-value
Body mass index (BMI) (kg/m^2)	23.2±3.3	24.9±3.4	0.03*
Systolic blood pressure (mmHg)	123.2±7.1	125.2±7.7	0.25
Diastolic blood pressure (mmHg)	70.6±4.2	72.4±5.5	0.12
Fasting blood sugar (mg/dL)	82.1±16.2	84.9±16.4	0.02*
Total cholesterol (mg/dL)	171.2±31.2	188.6±34.6	0.008*

*= Significant by t-test

Table 4 shows the mean values of BMI, SBP, DBP, FBS and total plasma cholesterol among the female medical graduates in the years 2001 and 2011. It was clear that the mean values of measurements rose, albeit by varying degrees. For example, total cholesterol significantly, increased from 171.2 mg/dL in 2001 to 188.6 mg/dL in 2011. BMI and FBS showed similar significant rise (P<0.05), whereas the rise in SBP and DBP figures were statistically insignificant (P>0.05).

Table 5: Correlation between the BMI, SBD, DBP, FBS and total cholesterol measurements of 2001 and 2011

Correlation between parameters' values in 2001 and 2011	Males		Females		Total sample	
	r	P-value	r	P-value	r	P-value
Body mass index (BMI) (kg/m^2)	0.46	0.001*	0.54	0.001*	0.35	0.001*
Systolic blood pressure (mmHg)	0.50	0.001*	0.59	0.001*	0.42	0.001*
Diastolic blood pressure (mmHg)	0.42	0.003*	0.47	0.004*	0.30	0.005*
Fasting blood sugar (mg/dL)	0.40	0.004*	0.43	0.008*	0.29	0.005*
Total cholesterol (mg/dL)	0.19	0.190	0.19	0.260	0.13	0.210

*Significant r= correlation coefficient

Table 5 shows correlation analysis of the five parameters measured in 2001 and 2011; BMI, SBP, DBP, FBS and total cholesterol. Apart from total cholesterol which was not correlated with any risk factor (P>0.05), a positive correlation was noticed between BMI, SBP, DBP, FBS (P<0.05).

Table 6: The mean values of stress hormones among the studied medical graduates at the baseline phase in 2001 and evaluation phase in 2011

Measurements	2001 (n=92)	2011 (n=85)	P-value
Cortisol µg/dL	30±4.2	37±5.9	0.01*
Adrenaline nmol/l	0.4±0.13	1.2±0.34	0.001*
Nor-adrenaline nmol/l	0.5±0.08	2.2±0.26	0.001*

*Significant by t-test

Table 6 compares the mean values of cortisol, adrenaline and nor-adrenaline among the studied medical graduates between 2001 and 2011. After adjustment of time of sampling in both occasions, it was clear that the mean values of the measured hormones, especially adrenaline and nor-adrenaline significantly increased in the evaluation phase in 2011 than the baseline phase of 2001, (P<0.05).

4. Discussion

It is well-known that being a doctor is stressful. Previous studies have shown a higher level of stress amongst medical doctors when compared to the general population **(Baumgarten et al., 1992; Jardim, 2010)**. Firth-Cozens noted that the proportion of doctors showing above threshold levels of stress is around 28%, in cross-sectional and longitudinal studies, compared to around 18% in the general working population. There is also evidence to show an increased rate of psychological morbidity, for example, depression, anxiety and substance abuse among doctors **(Firth-Cozens, 2003)**.

In spite of being economically and socially rewarding, care-giving professions are medically and socially debilitating. A cohort study revealed that during 4 years of follow-up of documented 321 incident cases of coronary heart diseases among health care givers, and after multivariate analyses controlling for age, smoking, exercise, alcohol intake, body mass index, history of hypertension, diabetes mellitus, and other covariates, care-giving for 9 hours per week was associated with increased risk of CHD (RR, 1.82; 95% confidence interval, 1.08 –3.05), **(Lee et al., 2003)**.

Overall, the main and disturbing findings of the present study are that, throughout the 10 years period of the study, the rates and mean values of all cardiovascular diseases risk factors and stress hormones witnessed a significant increase among the studied subjects, rendering them more prone to CVD complications even after adjustment for age, sex and family history.

While the negative health outcomes associated with obesity defined as BMI of 30 or more; are accepted within the medical community, the health implications of the overweight category are more controversial. The generally accepted view is that being overweight, defined as BMI of 25 or more **(WHO, 1999)**, causes health problems similar to that of obesity, but to a lesser degree. **Adams et al., (2006)** estimated that the risk of death increases by 20 to 40 percent among overweight people, and a study from the Netherlands found that being overweight at the age of 40 reduced life expectancy by three years **(Peeters et al., 2003)**.

In consistent with this study results which showed a rise in the mean value of BMI of the subjects after 10 years of working, many previous studies had connected the medical profession and overweight **(Lurie et al., 1991; Backer, 2000; Kassirer, 2001)**.

Further, the subjects in current study stated that they suffered social isolation because of the need for working long hours in addition to working during national holidays. We also found that commitment to unique standards lead doctors to get bored. Previous studies have suggested that eating in response to boredom is associated with excess weight **Abramson and Stinson (1977)** and loneliness **Schumaker (1985)**.

A substantial body of data indicates that exposure to job strain in cross-sectional and longitudinal studies associated with significant elevations in ambulatory blood pressure of a clinically important magnitude, greatest at work, but also evident at home and during sleep **(Laflamme et al., 1998 ; Schnall et al., 1992 ; Schnall et al., 1998)**. Moreover, exposure to job strain has been directly associated with increased left ventricular mass **(Schnall et al., 1990)**. It is therefore plausible that long-term exposure to job strain leads to a sustained elevation in blood pressure, which in turn causes structural changes in the left ventricle. Considering the strong, independent relation between increased left ventricular mass and cardiac events, this pathophysiological process may account for a substantial part of the reported association between job strain and CVD-related morbidity and mortality.

Sustained elevations in blood pressure contribute to atherogenesis by creating shear stress at branching points on the arterial tree, and they also have a direct pro-inflammatory effect **(Steptoe and Marmot, 2000)**. Nitric oxide production, upon which endothelial function depends, is impaired among patients with hypertension **(Cardillo et al., 1998)**. Moreover, a study by **Rosvall** et al., had revealed a significant cross-sectional association between exposure to job strain and plaque prevalence in the carotid artery and intimae-medial thickness at carotid bifurcations, after adjustment for standard cardiac risk factors in a population-based sample of working women in Sweden **(Rosvall et al., 2002)**.

Herd (1991), Lovallo (1997) and **Lovallo and Thomas (2000)** found that health care givers had significantly higher SBP and DBP than any other profession; and they also recorded higher rates of mortality from coronary heart diseases among physicians. The study by **Shneiderman** and **Skyler (1996)** revealed that physicians had higher levels of total plasma cholesterol than any other group. Alike, the current results showed a significant increase in SBP, DBP and total plasma cholesterol by the end of ten years of study, (P=0.001).

Stress may sometimes unmask diabetes, by causing blood glucose levels to rise. Making things worse, many sources of stress are not short-term threats. For example, it can take many months to recover from surgery. Stress hormones that are designed to deal with short-term danger stay turned on for a long time. As a result, long-term stress can cause long-term high blood sugar levels.

Stress can alter blood sugar levels. It does this in two ways **(Wellen and Hotamisligil, 2005)**. First, people under stress may not take good care of themselves. People who are anxious are under pressures and may lose appetite and skimp on eating, or reach for not-so healthy quick fixes like candy or chips and sometimes seek refuge in food and drink. This can take the form of chocolates, sweets and crisps, often in between meals. Many people who are under stress turn to food as a source of 'comfort'. This pattern of 'comfort eating' can often play havoc with blood sugar level. Further anxiety leads to less exercise. The results can be disastrous for people with diabetes. They may forget, or not have time, to check their sugar levels or plan good meals. Second, stress hormones may also alter blood sugar levels directly as it antagonizes the action of insulin **(Mitra, 2008)**.

Shneiderman and Skyler (1996) detected hyperinsulinemia and high fasting glucose (FBS) levels amongst health care givers. In agreement with this finding, in this study medical graduates FBS significantly increased from 82.6±15.1mg/dL in 2001to 85.4±16.9 mg/dL in 2011, (P=0.001).

Behavioral changes occurring as adaptations or coping responses to stressors such as increased smoking, decreased exercise and sleep, and poorer adherence to medical regimens provide an important pathway through which stressors influence disease risk. Stressor-elicited endocrine response provides another key pathway. Two endocrine response systems are particularly reactive to psychological stress: the hypothalamic-pituitary-adrenocortical axis (HPA) and the sympathetic-adrenal-medullary (SAM) system. Cortisol, the primary effector of HPA activation in humans, regulates a broad range of physiological processes, including anti-inflammatory responses; metabolism of carbohydrates, fats, and proteins; and gluconeogenesis. Similarly; catecholamine's, which are released in response to SAM activation, work in concert with the autonomic nervous system to exert regulatory effects on the cardiovascular, pulmonary, hepatic, skeletal muscle, and immune systems. Prolonged or repeated activation of the HPA and SAM systems can interfere with their control of other physiological systems, resulting in increased risk for physical and psychiatric disorders **(Cohen et al., 1995** and **McEwen, 1998)**. That HPA and SAM systems mediate the effects of stress on disease is supported by experimental evidence from animal as well as human studies that show a wide variety of stressful stimuli provoke activation of these systems. However, stress also may influence disease risk through its effects on other systems. For example, psychological stress has been found to impair vagal tone, **(Porges, 1995)** which also can increase disease risk, particularly for CVDs.

Supporting the previous literature, the present study showed a statistically significant increase in the mean levels of stress hormones; cortisol, adrenaline and nor-adrenaline, ($P<0.05$).

On studying the correlation between values (SBP, DBP, blood glucose, and BMI) in 2001 and 2011; significant positive correlations between 2001 and 2011 values were found, i.e. the same individuals who had higher levels at the baseline phase of 2001 also had higher levels in the evaluation phase in 2011. However, cholesterol values were not correlated between the two phases of the study. **Jardim, (2010)** reached a similar conclusion during a 15 years follow up study on medical professionals.

Conclusions

By following up the levels of blood pressure, cholesterol, glucose, and BMI of medical professionals, we found a significant elevation in all these parameters over the 10-years period. Analyzing these parameters by gender, a significant increase in BMI, blood glucose, and cholesterol in both genders were detected, whereas the increase in blood pressure (systolic and diastolic) was significant in males; only. Additionally, there were significant increase in the mean levels of stress hormones; cortisol, adrenaline and nor-adrenaline.

In order to cope with job stress, we recommend some stress-coping procedures which can help mitigate the adverse effects of medical profession strain. To begin with, physicians should identify the most important sources of stress in their working day and keep a distance from people who drain them of emotional energy, manage their schedule. Further, physicians should make sure they get enough rest, take a break from time to time, engage in a leisure activity, exercise regularly, have a healthy diet and finally seek social support in case of need. It's also recommended to do routine regular medical check-ups to all medical professionals for early detection of CVDs or its risk factors.

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