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Occupational stress and the role of allostatic load index in its prediction

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Abstract
Work stress is a problem facing human power everywhere with extensive impact on increased health risks in developing countries. Prolonged exposure to stress, results in debilitating chronic diseases that affect the wellbeing of the human power and reduce their productivity. Allostatic Load Index (ALI) is a measure that detects stress at its early stages and predicts individuals at high risk. The present perspective gives a brief account on types and consequences of stress in the working environment. It also describes the concept of allostasis, how ALI is calculated and the importance of Allostatic load assessment as a protective measure for the workforce general state of health.

Keywords: occupational stress, allostatic load, health risk assessment, biomarkers of stress

1. Introduction

Workplace stress is one of the most common types of distress. Scientific terms like 'occupational stress', 'work stress', 'job stress' and 'work-related stress' are known to be interchangeable on describing workplace stress. They refer to how persons go through mental and physical pressures to the extent that threatens their ability to achieve their career goals [1]. Job stress attributes to reduced job satisfaction [2] and plays an obvious role in increasing the rate of employees' turnover [3].

As shown in table (1) stressors in the work environment include factors unique to job itself, factors related to the individual role in the organization, career development requirements, interpersonal relationships between coworkers and the general climate in the work environment. Despite the great efforts exerted to reduce and eliminate work stress, Colligan and Higgins (2005) [4] claim that occupational stress is still a '*complicated scientific construct that requires an initial understanding of the parent construct; stress in the beginning*'.

Table 1: Categories of workplace stressors and examples of each [5].

Categories of Job Stressors	Examples
Factors unique to the job	▪ Workload (overload and under load) ▪ Pace/ variety / meaningfulness of work ▪ Autonomy (e.g., the ability to make ▪ your own decisions about your own ▪ job or about specific tasks) ▪ Shift work/ hours of work ▪ Physical environment (noise, air ▪ Quality, etc.) ▪ Isolation at the workplace (emotional ▪ or working alone)
Role in the organization	▪ Role conflict (conflicting job demands, multiple supervisors / managers) ▪ Role ambiguity (lack of clarity about ▪ Responsibilities, expectations, etc.) ▪ Level of responsibility
Career development	▪ Under / over promotion ▪ Job security (fear of redundancy either from economy, or a lack of tasks or work to do) ▪ Career development opportunities ▪ Overall job satisfaction
Relationships at work (interpersonal)	▪ Supervisors ▪ Coworkers ▪ Subordinates ▪ Threat of violence, harassment, etc.

	▪ (threats to personal safety)
Organizational structure / climate	▪ Participation (or nonparticipation) in ▪ Decision making ▪ Management style ▪ Communication patterns

2. What is Stress?

Stress is '*a normal, adaptive response to stressors in our environment*'. It has many definitions in literature. According to Erkutlu and Chafra, (2006) [6], stress is '*the reaction of individuals to demands (stressors) imposed upon them*' that refers to situations themselves where the well-being of individuals is detrimentally affected by their failure to cope with the demands of their environment.

As reported by Colligan and Higgins (2005) [4], Selye has defined two types of stress; eustress and distress. "Eu" as a Greek word means 'good' and is meant to represent responding positively with external stressors, while distress is the negative response to stressors that affects well-being. Yet, in both cases, Selye emphasizes that stress disrupt normal homeostatic regulatory physiological functioning of the individual under pressure.

On biological bases, our bodies have automatic responses to deal with stress. Prolonged exposure to stress even at lower but constant levels without a "turn off" is called "Generalized Stress Response". "Generalized Stress Response" consists of a number of physiological manifestations like: increased blood pressure and metabolism (e.g., faster respiration and faster heartbeat), decrease in protein synthesis, different immune responses, increased cholesterol and fatty acids in blood, faster clotting of blood, localized inflammation, increased blood sugar, acidity in stomach and others [7].

In this context, continuous exposure to stress without manipulation, individuals begin to display physical, psychosocial, and behavioral signs and symptoms that indicate the presence of difficulty in coping with stressors in their lives. Physical symptoms may include: headaches, clenched jaws, chest pain, grinding teeth, shortness of breath, pounding heart, muscle aches, indigestion, high blood pressure, constipation or diarrhea, increased perspiration, insomnia, fatigue and frequent illness. For the psychosocial signs of stress the most prominent are anxiety, irritability, defensiveness, sadness, anger, mood swings, apathy, depression, hypersensitivity, slowed thinking known as racing thoughts, feelings of helplessness, hopelessness and fear of being trapped. Behavioral signs of stress on the other hand include: over eating or loss of appetite, quickness to argue, impatience, procrastination, increased use of drugs and alcohol, increased smoking, withdrawal from others, neglect of responsibility, poor personal hygiene, poor job performance, change in religious practices and changes in close family relationships [8].

3. Allostatic Load: Theory and Practice

Allostatic load (AL) represents a multi-component assessment of long-term physiological changes occurring secondary to somatic responses to stress [9]. The conceptualization of AL was first introduced by Sterling and Eyer during the 1980s. AL was later modeled in the 1990's to assess the process of wear and tear or fight and flight in response to multiple stressors [10].

Conceptually, AL is divided into three stages; Primary stage, secondary stage and tertiary stage. Primary mediators of AL are hormones produced by the sympathetic nervous system (SNS), hypothalamic-pituitary-Adrenal (HPA) and other organs. They include catecholamines (epinephrine, norepinephrine), cortisol, dehydroepiandrosterone sulfate (DHEA-s) and others. Primary stress mediators are known to control a cascade of biochemical and physiological reactions promoting secondary physiological outcomes. Secondary outcomes include elevating systolic and diastolic blood pressure, total serum cholesterol, high density lipoprotein cholesterol, triglycerides, fasting glucose, and glycosylated hemoglobin. Increasing aspects of skin folds, body mass index (BMI) and waist-to-hip ratio (WHR) are also characteristic to secondary stage. Tertiary or disease outcomes of elevated AL are chronic degenerative diseases: atherosclerosis, cardiovascular diseases, and diabetes mellitus [10].

4. Allostatic load index

Allostatic load Index (ALI) is a score that represent the interplay of different systems (inflammatory, neuro-endocrine and metabolic) where the composite markers range from acute (primary mediators) to more long-term effects (secondary outcomes). ALI is widely applied in occupational health research [11]. There is a wide range of biomarkers (table 2) that vary between studies. As mentioned by Edes *et al*., (2017) [9] there is no specific marker that could be viewed as "gold standard". Choice of individual biomarkers to be included in ALI depends on the matter of availability of measures in most cases. ALI is calculated according to the number of biomarkers where the individual lies in the highest risk quartile. Risk quartiles could either be the upper or lower 25th percentile. The cutoff point can be also set to the highest and lowest 10% according to literature. It is also possible to use clinical cut-offs, but until now there are no universally agreed values for cut-offs.

Workplace stress has proved -according to literature- to be a serious cause of deteriorated state of health among employees around the world. However, not much is known about the degree and nature of the contribution of work stress in the prevalence of chronic diseases and reduced health and wellbeing in developing countries and particularly Egypt. Using ALI for early detection of stress in working adults in Egypt seems promising. A pilot sample was collected from two different working environments; faculty of pharmacy (Girls) at Al-Azhar University and National Cancer Institute pediatric outpatient clinic and ALI was calculated with different methodologies [12]. Upon statistical analysis of the obtained results it was found that employees and workers of Al-Azhar University suffered from worse health state and recorded higher values of ALI regardless of the method used for its calculation. Population working at Al-Azhar University was also found to be significantly different from those working at the National Cancer Institute in being older in age, most of them females and non-married, have been working for more than 10 years and work for less than 5 hours daily. On the other hand no significant difference was found upon comparing ALI between workers and employees.

In conclusion, the theory of allostasis and using ALI for early detection of stress, especially in developing country, could save

many people at risk of chronic diseases. It can also represent a reliable alarm for healthcare professional to take the appropriate measures for saving people at risk from expected health deterioration. The diversity of applicable biomedical markers used for construction of ALI could also allow us in developing countries to use economic and informative markers for early prediction of bad health. Applying preventive measures -like ALI calculation- on large scale among the population and specially the workforce could save a lot of wasted money and effort exerted on the different health services. So it is highly recommended for both public, governmental and private sectors to apply ALI determination to their workforce to save them from bad consequences of stress and debilitating diseases for better wellbeing and improved performance and productivity.

Table 2: Stress mediation, systems and biomarkers used to measure Allostatic load.

Stress mediation	System	Biomarker
Primary mediators	Neuroendocrine	Epinepherine, norepinephrerine, dopamine, cortisol, dehydroepiandrosteronesulphate, aldosterone
Secondary outcomes	Immune	Interleukin-6, tumor necrosis factor alpha, c-reactive protein (CRP),insulin-like growth factor-1
	Metabolic	HDL and LDL cholesterole, triglycerides, glucosylated hemoglobin, glucose insulin, albumin, creatinine, homocysteine
	Cardiovascular and Respiratory	Systolic blood pressure, diastolic blood pressure, peak expiratory flow, heart rate/pulse
	Anthropometric	Waist-to-hip ratio, body mass index
Tertiary outcomes	Poor subjective health, disability, cognitive decline, cellular aging, diseases, death	

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