THE ROLE OF WORK STRESS IN THE DEVLOPMENT OF METABOLIC SYNDROME AMONG JORDANIANS

Tawfiq Almadi

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This is to certify that the thesis entitled "The role of work stress in the development of Metabolic Syndrome among Jordanians" submitted by **Tawfiq Almadi** in fulfilment of the requirements for the degree of Doctor of Philosophy is in a form ready for examination.

Signed [redacted]

Date 21/10/2013

Dr Chin Moi Chow

Senior Lecturer

Discipline of Exercise and Sport Science

Faculty of Health Sciences

The University of Sydney

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LIST OF ABBREVIATIONS

ACE/AACE	American college of endocrinology / American association of clinical endocrinologists
ACTH	Adrenocorticotropin hormone
AHA/NHLBI	American heart association/National heart, lung, and blood institute
APSS-14	Arabic perceived stress scale -14
AUC	Area under the curve
BMI	Body mass index
BP	Blood pressure
CHD	Coronary heart diseases
CRH	Corticotrophin-releasing hormone
CRP	C-reactive protein
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
DC	Demand-control
EGIR	Group for the Study of insulin resistance
ER ratio	Effort-Reward ratio
ERI	Effort Reward imbalance
F	Female
FA	Factorial analysis

FBG	Fasting blood glucose
ICC	Intra-class correlation coefficients
HDL-C	High-density lipoprotein cholesterol
HIV	Human immunodeficiency virus
HPA	Hypothalamic-pituitary-adrenal axis
IDF	International diabetes federation
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
IPAQ	International physical activity questionnaire
KMO	Kaiser–Meyer– Oklin
LDL-C	low-density lipoprotein cholesterol
M	Male
MtS	Metabolic syndrome
NAATI	The national accreditation authority for translators and Interpreters
NCEP ATP III	National cholesterol education program adult treatment panel III.
NSAIDs	Non-steroidal anti-inflammatory drugs
OC	Over Commitment
OR	Odd ratio
PCA	Principal components analysis
PCSO	Polycystic ovarian syndrome
PSS-14	Perceived stress scale

PSQ	Perceived stress questionnaire
PSQI	Pittsburgher sleep quality index
PVN	Paraventricular nucleus
RR	Risk ratio
SAM	Sympathetic-adrenal-medullary axis
SBP	Systolic blood pressure
SD	Standard deviation
TA	The study coordinator
TG	Triglyceride
T2DM	Type 2 diabetes mellitus
WHO	World health organization

I, **Tawfiq Almadi**, hereby declare that the work contained within this thesis is my own and has not been submitted to any other university or institution as a part or a whole requirement for any higher degree.

I, **Tawfiq Almadi**, hereby declare that I was the principal researcher of all work included in this thesis, including work published with multiple authors.

In addition, ethical approval from the University of Sydney Human Ethics Committee and Jordan University was granted for the studies presented in this thesis. All participants had read the Participant Information Statement and the informed consent document was signed prior to data collection.

Name: Tawfiq Almadi

Signed [redacted]

Date 20/10/2013

Parts of the work presented in this thesis have been published in journals or presented at conference meetings:

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3. Almadi, T., Cathers, I., Hmadan Mansour, A. M., & Chow, C.M. (2012). An Arabic version of the perceived stress scale: translation and validation study. *International Journal of Nursing Studies*, 49: 84–89, 2012.

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ABSTRACT

This thesis reports on a novel, cross-sectional field study of middle-aged Jordanian workers recruited from industrial and the school teaching community. It examines the relationship between work-related stress, cortisol, and C-reactive protein (CRP) in predicting metabolic syndrome (MtS). Self-reported work stress measured by the Effort-Reward imbalance ratio (ERI), anthropometric data, serum CRP level, and saliva cortisol were collected from male workers. In addition, the thesis describes the translation and validation studies of an Arabic version of the Perceived Stress Scale (PSS-14), Effort-Reward Imbalance questionnaire (ERI), and the Pittsburgh Sleep Quality Index (PSQI) questionnaire.

Chapter one provides background pertinent to the rationale of the study; metabolic syndrome (MtS), its components and health consequences; the concept of stress; the neural and hormonal stress responses; and the association between work-related stress and MtS. The chapter also gives a description for each of the questionnaires, the ERI, PSS-14 and the PSQI.

Chapter two, published in *International Journal of Nursing Studies*, describes the development of an Arabic version of the Perceived Stress Scale (PSS-14). The PSS-14 has been designed to measure the degree to which situations in a person's life are perceived as stressful.

Chapter three, published in *Psychological Reports*, describes the development of an Arabic version of the Effort-Reward Imbalance questionnaire (ERI). The questionnaire assesses three aspects of work stress: “Effort”, “Reward” and “Over commitment”. The Effort-Reward imbalance model claims that a lack of reciprocity between effort and reward at work with high effort and low Reward, elicits sustained stress reactions (distress). In addition, the model assumes that distress will be higher in more highly over-committed employees than in less over-committed employees.

Chapter four, submitted for journal publication, describes the translation and validation of the PSQI questionnaire. The PSQI is a standardized, self-administered questionnaire to assess subjective sleep quality over the last month.

The translation process of the three questionnaires (PSS-14, ERI and PSQI) employed an iterative forward-backward translation process involving a wide range of translators to balance issues between linguistic and cross-cultural concerns. The participants were asked to complete the three questionnaires twice in their homes. The translated questionnaires were evaluated for reliability and validity.

Prior to Factorial Analysis (FA), the suitability of data for factor analysis was assessed. The FA using a Principal Components Analysis (PCA) was performed to

inspect the factorial structure of the questionnaire items, in which the factors with eigenvalues more than one were extracted and rotated by the varimax method. The internal consistency was examined by Cronbach's alpha coefficient and the test-retest reliability was examined by the intra-class correlation coefficient.

The internal consistency, test-retest reliability and factor structure of the Arabic versions of the three questionnaires were satisfactory. Therefore, the Arabic PSS-14, ERI and PSQI are considered suitable psychological instrument for Arabic people.

Chapter five, published in *Psychophysiology*, aimed to establish the association between work stress, expressed as Effort-Reward imbalance (ERI), and the inflammatory marker, C-reactive protein (CRP) in Jordanian male employees. Self-reported work stress, anthropometric data, and blood for CRP analysis were collected. A significant correlation between ERI and CRP ($r = 0.29$, $p < .01$), and between waist circumference with CRP ($r = 0.44$, $p < .01$) was found. After controlling for the covariates of age, hypertension, waist circumference, fasting blood glucose, cholesterol, HDL- C and triglycerides, ERI was not a significant predictor of CRP (p=0.052). However, when only the centrally obese group (waist circumference ≥ 94 cm; $n = 78$) was considered, ERI accounted significantly for 5.0% of the variability in the CRP ($p = .034$). On the other hand, when only subjects without central obesity (waist circumference < 94 cm, $n = 74$) were analyzed, waist circumference and not ERI or any other variable was

significantly positively associated with CRP ($p < 0.01$). The results of this study confirmed previous findings that obesity was significantly associated with CRP, and supported the notion that higher ERI amongst obese workers was one small but significant predictor of increased levels of CRP.

Chapter six, a published cross-sectional study in *Psychophysiology*, examined the relationship between work-related stress, cortisol, and CRP in predicting MtS. Self-reported work stress measured by the ERI, anthropometric data, serum CRP, and saliva cortisol were collected from Jordanian male workers. ERI and cortisol were significantly associated with the presence of MtS. The odds of MtS in men with high ERI and high cortisol were significantly higher than that of men with low ERI and low cortisol (OR=11.50, 95% CI: 2.16-59.14). CRP was significantly associated with MtS (OR=2.51, 95% CI: 1.50-4.20, p≤0.001). The odds of MtS were significantly higher in centrally obese men with both high ERI and CRP level (OR=5.23, 95% CI: 1.41-19.45, p<0.05).Thus, high ERI along with high cortisol or high CRP increases the risk for MtS, especially among centrally obese men.

In conclusion, the Arabic versions of the questionnaires have demonstrated good internal consistency and reliability. We consider the Arabic versions of the PSS-14, ERI and PSQI suitable instrument to assess perceived stress, work related stress and sleep quality, respectively, for Arabic speakers. The key findings of this thesis suggest that work-related stress predicts a small

inflammatory response in a sample of overweight or centrally obese Jordanian workers. Work-related stress and its resultant hypercortisolemia and augmented CRP synergistically contribute to the development of MtS in middle-aged Jordanian workers. High work-related stress in the presence of central obesity predisposes Jordanian workers to increased risk of MtS.

CHAPTER 1

INTRODUCTION

The relationship between work-related stress, cortisol, and C-reactive protein (CRP) in predicting metabolic syndrome (MtS) is explored in this thesis. In line with this objective, this chapter will review pertinent topics of the research thesis: MtS and its components and health consequences; the concept of stress, and work- related stress, stress response (involving the activation of the sympathetic-adrenal-medullary axis and the hypothalamic–pituitary–adrenal axis) and its relationship to the development of MtS. The chapter will also provide a review of the questionnaires: ERI, PSS-14 and the PSQI.

METABOLIC SYNDROME

The MtS is a cluster of metabolic risk factors: elevated abdominal obesity, fasting plasma glucose, insulin resistance, high cholesterol and high blood pressure (International Diabetes Federation, 2005). The best available evidence suggests that people with MtS are at increased risk of cardiovascular events (Gami et al., 2007; Lorenzo, Okoloise, Williams, Stern, & Haffner, 2003) and diabetes mellitus (Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005). Although genetics (Teran-Garcia & Bouchard, 2007) and poor life style (Lakka et al., 2003) play major role in the development of MtS, stress has a role in the development of MtS (Bjorntorp & Rosmond, 1999; Brunner et al., 2002). Stress evokes neural and hormone responses, in addition to initiating an inflammatory process; these responses may lead to the development of MtS (Black, 2003; Brunner et al., 2002; Vogelzangs et al., 2007).

Historic Background to Metabolic Syndrome

The group of metabolic risk factors that characterize the MtS was first named by Reaven (1988) as “syndrome X” or “insulin resistance syndrome”. After Reaven’s initial description, many refinements of MtS were suggested. In 1998, the World Health Organization (WHO) (Alberti & Zimmet, 1998) and later, the third Adult Treatment Panel of the National Cholesterol Education Program NCEP (NCEP, 2002), the International Diabetes Federation (IDF) (2005) and other

organizations issued different definitions of MtS criteria (Grundy, 2007; Huang, 2009). IDF, WHO and NCEP are currently the most widely used criteria to identify the MtS cases (Table1.1).

Although MtS definitions are similar in their values for triglycerides, high-density lipoprotein cholesterol (HDL-C), and blood pressure, they vary in how they define obesity and insulin resistance. The European Group for the Study of insulin resistance (EGIR) uses fasting insulin levels to estimate insulin resistance, and impaired fasting glucose (IFG) as a substitute for impaired glucose tolerance (IGT) (Balkau & Charles, 1999).

Several other metabolic abnormalities have been associated with this syndrome, including elevation in inflammatory markers (Esposito & Giugliano, 2004; Ridker, Buring, Cook, & Rifai, 2003) and abnormalities in plasma lipid, fibrinolysis, and coagulation (Genuth et al., 2003; Sakkinen, Wahl, Cushman, Lewis, & Tracy, 2000). Other risk factors recognized by the American College of Endocrinology / American Association of Clinical Endocrinologist (ACE/AACE) include polycystic ovarian syndrome (PCOS), prior gestational diabetes, sedentary lifestyle, age, ethnicity, family history of type 2 diabetes mellitus (T2DM) , hypertension, and cardiovascular disease (CVD) (Einhorn et al., 2003) .

Table 1.1: MtS definitions

Criteria / MtS definition	Insulin resistance	Fasting glucose	Waist circumference	Body Mass Index (BMI)	Triglycerides	HDL-C	Blood pressure	other
NCEP ATP III[1]		> 100 mg/dL	>102 cm M >88 cm F		≥150 mg/dL	<40 mg/dL M <50mg/dL F	>130/85 mmHg	
AHA/NHLBI[2]		≥100 mg/dL	>102 cm M >88 cm F		≥150 mg/dL	< 40 mg/dL M <50mg/dL F	≥ 130/85 mmHg	
IDF[3]		≥100 mg/dL	≥94 cm M * ≥80 cm F **(E)**		≥150 mg/dL	< 40 mg/dL M <50mg/dL F	≥ 130/85 mmHg	
WHO[4]	Insulin resistance **(E)**		Waist-hip ratio >0.9 M >0.85 F	BMI>30 kg/m^2	≥150 mg/dL	< 35 mg/dL M <39mg/dL F	≥ 149/90 mmHg	Urinary albumin excretion rate >20 µg/min
ACE/AACE[5]		110-125 mg/dL or 2-h post 75g glucose challenge >140 mg/dL	≥94 cm M ≥80 cm F	BMI≥25 kg/m^2	≥150 mg/dL	< 40 mg/dL M <50mg/dL F	≥ 130/85 mmHg	Family history of T2DM, PCOS, Sedentary lifestyle, Advancing age, Non-Caucasian ethnicity
EGIR[6]	Hyperinsulinaemia (plasma insulin>75th percentile)≠ **(E)**	≥110 mg/dL	≥94 cm M ≥80 cm F		≥177 mg/dL	< 39 mg/dL	≥140/90 mmHg	

1-NCEP ATPIII = National Cholesterol Education Program Adult Treatment Panel III.

2-AHA/NHLBI = American Heart Association/National Heart, Lung, and Blood Institute.

3-IDF = International Diabetes Federation.

4-WHO = World Health Organization.

5-ACE/AACE= American College of Endocrinology / American Association of Clinical Endocrinologist.

6-EGIR= European Group for the Study of Insulin Resistance.

*Europeans: men ≥94 cm, women ≥80 cm; South Asians: men ≥90 cm, women ≥80 cm; Chinese: men ≥90 cm, women≥80 cm; Japanese: men ≥85 cm, women ≥90 cm; South and Central Americans: men ≥90 cm, women ≥80 cm; Sub-Saharan Africans: men ≥94 cm, women ≥80 cm; Eastern Mediterranean and Middle East (Arab) populations use European data until more specific data are available.

≠; only non diabetic subjects.

E; Main criteria of metabolic syndrome definition.

M; Male

F; Female

Prevalence of Metabolic Syndrome

It is estimated that up to 25% of the world's adults have metabolic syndrome (International Diabetes Federation, 2005). In Australian adults the prevalence of the MtS using the ATPIII definition was 22.1% (Cameron, Magliano, Zimmet, Welborn, & Shaw, 2007). In the United States of America, and based on the ATPIII definition, the prevalence among men of the MtS was 34.0 % (Ervin, 2009), while it was 39.0% based on the IDF definition (Ford, Giles, & Dietz, 2002). In European countries and based on ATPIII the prevalence in Ireland was >20 % (Villegas, Perry, Creagh, Hinchion, & O'Halloran, 2003) Scotland >26% (Sattar et al., 2003), and in Finland > 13% (Lakka et al., 2002). In India, the prevalence is 19.1 % using ATPIII (Sawant et al., 2011).

The prevalence of MtS among the Arab population was high. For example, the prevalence in Oman was > 20% (Al-Lawati & Jousilahti, 2008); in Tunisia it was 45.5% (Bouguerra et al., 2007); and among the northern Jordanian population it was 36.3% (28.7% among men and 40.9% among women) (Khader, Bateiha, El-Khateeb, Al-Shaikh, & Ajlouni, 2007). Unfortunately, this study did not extend to the whole of Jordan, and hence the results cannot be generalized to the entire Jordan population.

It is clear that the reported prevalence of MtS is dependent on the MtS definition used and countries where the data are collected. The age-adjusted prevalence for males using the four definitions (WHO, EGIR, ATPIII, and IDF) ranged from 21.9% to 42.2 % (Australia), 3.4% to 8.1% (Japan), 7.3% to 19.6%

(Korea), and 16.6% to 45.3% (Samoa). For females, the prevalence ranged from 15.8% to 33.3% (Australia), 2.5% to 11.3% (Japan), 13.8% to 28.9% (Korea), and 21.7% to 59.5% (Samoa). With the exception of Japanese males, the IDF definition yielded the highest prevalence of MtS (Lee et al., 2008).

Previous studies have reported ethnic differences in the prevalence of MtS (Ford et al., 2002; Tan, Ma, Wai, Chew, & Tai, 2004). In 2005, the International Diabetes Federation strongly recommended that for case detection, ethnic group-specific cut-off points for waist circumference should be used, regardless of place and country of residence. As an example relevant to the current study, their recommendation for the male population from Middle Eastern (Arab), the cut off value of waist circumference ≥ 94 cm would be used in expatriate Middle East communities regardless of place and country of residence (International Diabetes Federation, 2005).

Metabolic Syndrome health consequences

There are many consequences of MtS, some with particularly serious health implications such CVD and T2DM (Wilson et al., 2005; Hoffmann et al., 2007). Longitudinal studies that followed up non-diabetic persons with MtS showed that they had a 3 to 34 fold increased risk of developing T2DM, and the degree of risk correlated positively with the number of metabolic abnormalities (Hanson, Imperatore, Bennett, & Knowler, 2002; Klein, Klein, & Lee, 2002).

Cardiovascular disease (CVD) and all-cause mortality are increased in men with the MtS, who were initially free of diagnosed CVD and T2DM. The 11-year follow-up study of 1200 middle-aged Finnish men showed that men with MtS were 2.9 to 4.2 times more likely to die of coronary heart diseases (CHD) after adjustment for conventional cardiovascular risk factors (Lakka et al., 2002).In a study that followed a cohort of 3323 middle-aged adults for the development of new CVD, and T2DM over an 8-year period, the risk ratio (RR) of incident T2DM was greatly increased in persons with MtS at baseline. The overall RRs exceeded 4 in both genders (Wilson et al., 2005). In conclusion, MtS is strongly associated with CHD and T2DM.

STRESS

There is no agreement among scientists regarding a definition of stress (Pacak & Palkovits, 2001; Rozanski, Blumenthal, Davidson, Saab, & Kubzansky, 2005), and this is exacerbated by the fact that stress has been examined from different perspectives by several disciplines including sociology, anthropology, psychology, physiology, and medicine (Lazarus & Folkman, 1984). The following section examines the more influential approaches to a definition of stress in order to determine the most applicable stress definition for the current study.

Stress definition

In the past, scientists adopted three main approaches to a definition of stress. The first approach considered stress as a stimulus to the organism - an external event that makes a demand on the organism (Pacak & Palkovits, 2001). The second approach considered stress as a response. Cannon (1929) suggested that the body possesses an internal mechanism to maintain stable bodily functions or equilibrium. As the environment presents the organism with various stressors, the body must respond to each new situation by adjusting various physiological responses to compensate for the resources being taxed (Cannon, 1929; 1939). For example when organism ingests large quantity of water, the kidney releases more water as waste, to maintain body fluid equilibrium (Larkin, 2005). The third approach considered stress as a process of a series of interactions or a relationship between the organism and the environment. According to Lazarus and Folkman (1984) in this transactional model, it is not the initial stressor that is significant in linking stress to disease, but rather the person's response to the stressor that determines whether a cyclic stress reaction develops.

Literature analysis has demonstrated that studies of stress have been characterised by complex debates (Pacak & Palkovits, 2001). Selye (1936) defined stress as a non-specific response of the body to any demand upon it. Thus, in this scheme, different type of stress always elicits a similar physiological

response. Later biochemical analysis used to measure the level of hormonal response to stress, revealed that the physiological response is much more variable than Selye assumed (Mason, 1971). However, stress may be classified as a stimulus, a response or a dynamic relationship between the organism and his environment (Brantley& Thomason, 1995). It is proposed that stress refers to a dynamic process in terms of relationship between the organism and his external environment, where stress is neither an environmental stimulus nor a physiological, behavioural or psychological response, but rather a relationship between environmental demands and the ability to deal with them. Thus, stress is seen as a transaction between individual and environment. In other words, the environment provides the initial stimulus, but the key determinants of stress are the way the individual perceives the environment and his ability to cope with the stress (Lazarus & Folkman, 1984).

The complexity revolving around the concept of stress makes it difficult to find a unique stress definition. By the 1980s, a new era of stress understanding has emerged; this new understanding explains stress as neural and hormonal responses. Hence, it is more useful and applicable to examine the new understanding of stress and adopt it in this study.

Current stress definition

After the discovery of corticotrophin-releasing hormone (CRH) that is secreted by the paraventricular nucleus (PVN) of the hypothalamus (Vale, Spiess, Rivier, & Rivier, 1981), the neurohormonal response patterns to stress have been intensely investigated in both animals and humans (Chrousos & Gold, 1992; Gold, Goodwin, & Chrousos, 1988 a & b; Lazarus & Folkman, 1984). These studies suggested that two principal components in the hypothalamus and the brainstem mediate the stress response: 1) the CRH-neurons, and 2) the locus coeruleus-norepinephrine/sympathetic system.

An increased or decreased activity in this 'stress system' produces abnormal levels of mainly cortisol, norepinephrine and epinephrine, and contributes to stress-related health disorders (Epel et al., 2000; Kosten, Mason, Giller, Ostroff, & Harkness, 1987; Rosmond, 2005; Vogelzangs et al., 2007). The neurohormonal response will be examined in more detail later in this thesis. Following a similar paradigm, Sterling and Eyer (1988) applied the term "allostasis", which means "achieving stability" or homeostasis through change, i.e., the body has the ability to increase or decrease vital functions to changing demands. McEwen (1998) introduced the term "allostatic load" to indicate the long-term effects of repeated disruptions to homeostasis due to repeated or chronic stress, resulting in a drift of the equilibrium towards levels that can predispose disease. Based on the above work of Chrousos and Gold (1992), McEwen, (1998) and Rosmond

(2005) suggested the following stress definition: “Stress is a state of threatened homeostasis, and chronic stress is the long-term repeated disruption of a homeostatic system”, a definition most fitting for use in this study. This definition is most fitting for use in the current study, as its goal to link the chronic stress and the hormonal disruption to MtS. which we will explain later in this thesis.

Stress and Stressors

The term “stress” has often been used in a confused manner to mean “stressor” in the medical and scientific literature. It has been wrongly used to indicate the causative agent of stress (Selye, 1956). In what follows, “stressor” will be used when referring to the cause of stress, while the word “stress” will be used to indicate the response to stressor (Holmes, 1994).

Stressors can be categorised according to the stressor nature or duration. Physical stressors include cold, heat, infection, physical deprivation and pain. Which may have positive or negative consequences on people’ physical or psychological wellbeing (Pacak & Palkovits, 2001). Whereas psychological stressors reflect a learned response to previously experienced adverse condition, and may affect person’s emotional processes, which may lead to anxiety and fears. Social stressors reflecting disturbed interactions among individuals, include unemployment, and divorce (Pacak & Palkovits, 2001). Such

stressors may threaten cardiovascular and metabolic homeostasis (Van de Kar & Blair, 1999; Pacak & Palkovits, 2001).

Stressors from complex life events are those such as adversity in relationships, health, work, finances, and social structure (Rosmond, 2005). Specifically, work-related stress may adversely affect physical health (Leka & Jain, 2010). Work Effort-Reward imbalance is a serious form of psychological work-related stress, since workers may feel under-compensated for their efforts, and this psychological stress may compromise workers health and wellbeing over the long term (Siegrist, 1996; 2005). In terms of duration, stressors can be divided into two main categories: 1) acute , being of single, intermittent, and time-limited exposure, and 2) chronic which is prolonged and continuous exposure to stressors (Pacak & Palkovits, 2001).

Stress response

Life exists by maintaining homeostasis that is constantly challenged by the intrinsic or extrinsic stressors (Chrousos & Gold, 1992). The human body and mind react to stress by activating physiologic adaptive responses in order to maintain homeostasis. If the response is inadequate and/or prolonged, health problems may result (Charmandari, Tsigos, & Chrousos, 2005). Regulation of the adaptive physiological stress response involves two pathways: the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis

(Gold et al., 1988 a & b). Stress responses of both (HPA and SAM) axes are outlined in the following sections.

The sympathetic-adrenal-medullary (SAM) axis

The acute response to stress, which usually lasts a few minutes, consists of SAM activation (Henry, 1992). This response is commonly referred to as the "fight or flight" response described by Walter B. Cannon (1929). Through the hypothalamus and the sympathetic nervous system, stress stimulates the adrenal medulla to secrete the two catecholamines, epinephrine and norepinephrine, into the blood stream (Mason, 1968) . These hormones regulate rapid and short, acute responses (Esler et al., 1990). The SAM system activates the cardiovascular and neuroendocrine functions through increases in blood glucose level, heart rate, respiration rate and metabolism, and dilation of the pupils (Krantz & Manuck, 1984). These changes allow energy to be used rapidly - more energy is taken up by muscles, which is what the organism needs to face an alarming situation triggering a "fight or flight response".

The hypothalamic–pituitary–adrenal (HPA) axis

The HPA axis is mainly involved in the long-term stress response. When the brain detects a stressor, the hypothalamus releases CRH (Miller & O'Callaghan, 2002). CRH stimulates the secretion of adrenocorticotropin hormone (ACTH) from the

anterior pituitary gland. ACTH then circulates to the adrenal glands and stimulates the release of glucocorticoid steroid hormones including cortisol.

Cortisol has many crucial roles and its secretion is affected by many factors. Cortisol is involved in learning, memory, and emotions. In the metabolic system, cortisol regulates glucose storage and utilization. In non-stressful situations, cortisol secretion has an ACTH-dependent circadian rhythm with a peak in the early morning and a nadir at night (Krieger, 1975). These diurnal variations are moderated by changes in lighting, feeding schedules, activities and stress (Tsigos & Chrousos, 2002). Increased levels of cortisol in the circulation act as a negative feedback (inhibitory mechanism) on the hypothalamus. Consequently, the hypothalamus decreases cortisol secretion through inhibiting the secretion of ACTH (Miller & O'Callaghan, 2002) .

A balance, regular response pattern of the HPA system is a prerequisite for body successful response to stressor (O'Connor, O'Halloran, & Shanahan, 2000). General findings from many studies suggest that chronic stress is accompanied by a dysregulated pattern of HPA hormone secretion (Bjorntorp & Rosmond, 1999; Rozanski et al, 2005).

Repeated activation of the HPA axis in response to frequent or chronic stress has been noted to have serious pathological complications; CVD ,T2DM and central obesity (Rosmond & Björntorp, 2000 ;Tsigos & Chrousos, 2002), which will be discussed later.

Stress coping

Coping refers to cognitive and behaviours activities that individual use to deal with the demands of a situation appraised as stressful, and that protect the individual from psychological harm (Lazarus & Folkman, 1984; Folkman & Moskowitz, 2004). Cognitive coping efforts are mental processes of how a person appraises the situation in terms of the level of stress and the coping strategies that the person should adopt (Lazarus & Folkman, 1984). The behavioural coping strategy, however, refers to the physical activities that deal with stressors. Both of these efforts may either heighten or lessen the psychological distress.

Strategies and style of coping

There are two main approaches to the concept coping; one examines the coping strategies, and the other the coping foci or styles. There are two main groups of coping strategies: problem-focused and emotion-focused. The first aims to modify the stressful situation. The second, however, aims to emotionally

accommodate the stressful situation (Parker & Endler, 1996). As the stress responses are directed at managing or reducing the feeling of distress, a person may use both strategies when facing a stressor. Both strategies are not opposed to each other, on the contrary, they are often used together (Aldwin, 1999).

There are a number of types of coping styles: the approach-type and the avoidance-type. The approach-type deals with the problem directly and the avoidance-type avoids dealing with the problem (Moos, Brennan, Fondacaro, & Moos, 1990). Though their focus is different, both approach-type and avoidance-type coping use cognitive and behavioural methods to address the stressful situation (Gentry & Kobasa, 1984). The approach-type has been associated with positive health outcomes whilst the avoidance-type has been associated with negative health outcomes (Penley, Tomaka, & Wiebe, 2002).

The approach-type has been associated with positive health outcomes in chronically ill patients and has alleviated depression and pain (Smith, Lumley, & Longo, 2002. The avoidance-type has been associated with negative health outcomes with worsened depression and pain (Patterson et al., 1993; Penley, Tomaka, & Wiebe, 2002; Rowland & Massie, 1998). Selye (1974) described the stress response as an “eustress” and “distress” that is based on how a person perceives the stressor; a 'eustress' is a positive psychological response to a stressor, whereas ‘distress’ is a negative psychological response (Simmons & Nelson, 2001).

The impact of coping on the psychological and physiological responses

Coping strategies can shape psychological responses in different ways. The psychological coping responses can be reflected in the form of anger, anxiety, guilt, sadness, happiness, threat and challenge. According to Lazarus and Folkman (1984), in the presence of a stressor, a person undertakes a primary appraisal of the potential threat. This primary appraisal is a judgment about the significance of an event as stressful, positive, controllable, challenging or irrelevant. A secondary appraisal follows, which is an assessment of person's coping resources and options (Cohen, 1984) from which the person chooses accordingly.

Personal differences can affect coping responses. There is a general recognition that person-variations exist in responses to stressful situations (Lazarus & Folkman, 1984; McEwen, 1998). Some of the personal variations that have been examined in the literature in relation to stress responses were genetic variations (Mickey et al., 2011; Zhou et al., 2008), sex and ethnicity (Myers, 2009).

Persons differ regarding the stress coping skills, attitudes and behaviour they have learned through life. These differences influence the level and pattern of the stress response. A person with excellent coping skills is likely to experience less severe acute stress reactions, and by so doing will experience lesser risk of

stress-related disease outcomes (Lazarus & Folkman, 1984). Persons with Type A behaviour (impatience, aggressiveness) pattern have been shown to exhibit significantly greater psychological and physiological stress reactions and risk for stress-related illnesses than their Type B counterparts (apathetic, patient, relaxed) (Friedman & Rosenman, 1974). Furthermore, a person's socioeconomic status and the social support system are factors influence his responses to stress. Persons with a low socioeconomic status have been shown to exhibit greater stress responses than those having a higher socioeconomic status (Steptoe et al., 2003).

The person who is socially supported exhibits less acute stress response and has better long-term health outcomes (Kamarck, Manuck, & Jennings, 1990; Von Dawans, Fischbacher, Kirschbaum, Fehr, & Heinrichs, 2012). The frequency of annual leisure time activities and vacations has been found to be associated with a reduced risk of all-cause mortality (Gump & Matthews, 2000). Persons who are physically active have been found to have no increase in the incidence of illness during times of high stress (Brown & Siegel, 1988).

Coping is a multifaceted process, where physiological responses overlap psychological reactions. Any threat a person perceives in the environment triggers a chain of neuroendocrine responses, which are the SAM and the HPA response explained above. The final effectors of the SAM response are the catecholamines and the final effecter of HPA is cortisol. A lack of coping

recourses to chronic stress leads to prolonged secretion of cortisol, and in turn results in many health complications. The complications of excessive secretion of cortisol include dysregulation of glucose metabolism, insulin-resistance (Amatruda, Livingston, & Lockwood, 1985), and central obesity development (Rosmond, Dallman, & Bjorntorp, 1998). In addition, the final products of SAM (catecholamine) and HPA (cortisol) induce an inflammation reaction such as C-reactive protein production (Black, 2002, 2003; Gabay & Kushner, 1999; Rosmond et al., 1998).

In summary, coping is a complex process, which comprises a response to a stimulus. This response is highly dependent and variable in that it depends on the context of the stress. Coping has alternative pathways and in which take the form of psychological and physiological responses.

Stress assessment

Evaluation of stress can be achieved by various methods. Self reported questionnaires are by far the most common method of stress assessment tool (Beck, 2012). In this thesis, three self-reported stress questionnaires have been translated into Arabic and validated: the Perceived Stress Scale (PSS-14), Effort-Reward Imbalance questionnaire (ERI), and the Pittsburgh Sleep Quality Index (PSQI). The three questionnaires have been used in two of the thesis studies investigating the association of stress with health disorders.

Work-related stress assessment (Effort-Reward Imbalance Questionnaire)

The adverse physical health effects of psychosocial stress in the workplace has mainly been investigated through two theoretical models: the demand-control model (Karasek, 1979; Karasek & Theorell, 1990) and the Effort-Reward imbalance model (Siegrist, 1996). The demand-control model emphasises psychological demands of work and job control by the individual, where a high demand job with little control produces job strain. The Effort-Reward imbalance model, on the other hand, assesses three aspects of work stress: "Effort", "Reward" and "Over commitment." It is based on the notion of social reciprocity whereby effort is reciprocated by socially defined reward. Effort represents the job demands and/or obligations that are imposed on the employee, while reward includes such things as salary, bonuses, esteem, job security and career opportunities. The Effort-Reward imbalance model claims that a lack of reciprocity between effort and reward at work, with high effort and low reward, elicits sustained stress reactions. In addition, the model assumes that such distress will be higher in more over-committed employees than in less over-committed employees.

Whilst the demand-control model emphasizes task-level control, the Effort-Reward imbalance model emphasizes employees' rewards (Tsutsumi & Kawakami, 2004). Thus the Effort-Reward imbalance has advantages over the

demand-control model, since it focuses attention on stressors such as payment adequacy, job insecurity, job changes and job promotion prospects (Griep et al., 2009).

The Effort-Reward Imbalance Questionnaire consists of 23 items measuring work Effort, Reward and Over commitment, and many studies have supported its validity for evaluating stress in the working environment (Tsutsumi & Kawakami, 2004; Unterbrink et al., 2007). Employees who scored high on the questionnaire were at higher risk of health disorders (Bosma, Peter, Siegrist, & Marmot, 1998; Dragano, Knesebeck, Rödel, & Siegrist, 2003; Wada et al., 2007).

At time of conducting the current study there was no evaluated Arabic version of ERI, and therefore the ERI English version questionnaire (Siegrist et al., 2004) was translated into the Arabic language and validated (see
for the Arabic ERI). Later in this dissertation there is a published report on the development of a translated Arabic version of the ERI, together with testing for reliability and validity.

Global perceived stress assessment (Perceived Stress Scale)

The Perceived Stress Scale (PSS-14) of Cohen, Kamarck, & Mermelstein (1983) has been chosen for this project because it is a global measure of stress, and the most widely used psychological instrument for measuring the perception of stress (Cohen, 1986). It is a measure of the degree to which situations in one's life are appraised as stressful. The PSS-14 items were designed to gauge how unpredictable, uncontrollable, and overloaded respondents find their lives. The scale also includes a number of direct queries about current levels of experienced stress. The PSS was designed for use in community samples with at least a junior high school education. The items are easy to understand, and the response alternatives are simple to grasp. Moreover, the questions are of a general nature and hence are relatively free of content specific to any subpopulation group. The questions in the PSS ask about feelings and thoughts during the last month.

At time of conducting the current study there was no evaluated Arabic version of PSS-14, and in the current study, the PSS-14 English version questionnaire (Cohen et al., 1983) was translated into the Arabic language and validated (see Appendix C for the Arabic PSS). Later in this dissertation there is a published report about the development of a translated Arabic version of the PSS-14, together with testing for reliability and validity.

Sleep quality assessment (Pittsburgh Sleep Quality Index questionnaire)

Work stress has been associated with sleep-related problems (Knudsen, Ducharme, & Roman, 2007). Sleep quality is significantly related to the metabolic syndrome and several of its core components (Jennings, Muldoon, Hall, Buysse, & Manuck, 2007) , and it is also reported that disturbed sleep is associated with increased inflammation reactions (Okun, Coussons-Read, & Hall, 2009). In the current study we have assessed sleep quality using a self-reported global sleep quality index - the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI is a 19-item questionnaire about sleep quality in the previous month. The total scores of all items are computed to generate 7 component scores with subscale scores of 0 to 3 for the 7 components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The sum of responses of all 7 components yields a global score of sleep quality. A subject with a global PSQI score greater than 5 is considered to be a poor sleeper, and a subject with a value of ≤ 5 is considered to be a good sleeper (Buysse et al., 1989).

At the time of conducting this study there was no evaluated Arabic version of PSQI, and therefore in this study, the PSQI English version questionnaire (Buysse et al., 1989) was translated into the Arabic language and validated (see

Appendix C for the Arabic PSQI). Later in this dissertation there is a published report about the development of a translated Arabic version of the PSQI, together with testing for reliability and validity.

WORK-RELATED STRESS AND MtS

Work-related stress may adversely affect physical health (Leka & Jain, 2010). Evidence from the Whitehall II study (n=1038, follow-up 14 years) found that employees with chronic work stress were more than twice as likely to have the MtS than those without work stress (Chandola, Brunner, & Marmot, 2006). Further evidence from the Whitehall II study (n=5,895) has also indicated that psychosocial work stress was an independent predictor of T2MD after a 15-year follow-up (Heraclides, Chandola, Witte, & Brunner, 2009)

Effort-Reward imbalance (ERI) (Siegrist, 1996) is a serious form of work stress, where the worker feels under-compensated for their effort. There is growing evidence that stress associated with ERI may cause major life-threatening and disabling diseases, such as cardiovascular disease (Kivimaki et al., 2002; Kuper, Singh-Manoux, Siegrist, & Marmot, 2002) and T2DM (Kumari, Head, & Marmot, 2004). A high level of ERI has also been found to be associated with components of the MtS, namely hypertension (Peter et al., 1998), high BMI (Kivimaki et al., 2002), increased triglyceride level (Fan et al., 2009), and high fasting glucose

(Kumari et al., 2004). The underlying basis for these observations is that stress activates both the HPA and the SMA (Rosmond, 2005).Altered activity of both these axes predisposes to increased risk of developing MtS with its main component being abdominal central obesity (Bjorntorp & Rosmond, 2000). The two axes, however, act through separate pathways, one through hypercortisolemia, the other through cytokines and inflammatory reactions (Bellingrath, Weigl, & Kudielka, 2009; Black, 2003; Gold et al., 1988 a & b; Sternberg, Chrousos, Wilder, & Gold, 1992; Yudkin, Stehouwer, Emeis, & Coppack, 1999).

The first pathway involves cytokines that induce acute phase proteins, such as C-reactive protein (CRP) (Gabay & Kushner, 1999). CRP, one of the best-characterized systemic inflammatory biomarkers, may interfere with insulin signalling and down-regulate corticosteroid-binding globulin, resulting in increased free cortisol levels and consequentially insulin resistance as well as other manifestations of MtS (Hotamisligil et al., 1996). Furthermore, proinflammatory cytokines inhibit lipoprotein lipase activity and increase the concentration of non-esterified fatty acids, contributing to dyslipidemia and insulin resistance (Perry, Sattar, & Petrie, 2001).

The second pathway through hypercortisolemia involves increases in cortisol levels. Elevated cortisol levels increase glucose production within liver cells resulting in hyperglycemia. In addition, increased cortisol levels inhibit insulin secretion from pancreatic β-cells, as well as inhibit muscle glucose uptake. These

effects lead to impaired glucose tolerance and insulin resistance(Lambillotte, Gilon, & Henquin, 1997). Cortisol also stimulates the breakdown of stored triglycerides in the adipose tissue, resulting in an increase in free fatty acids in the plasma. A higher level of free fatty acids prevents the release of insulin, further worsening glucose intolerance and insulin resistance (Rosmond, 2005). Density of cortisol receptors is higher in intra-abdominal (visceral) fat than in other fat deposits, and the activity of cortisol in fat accumulation is accentuated in visceral adipose tissue (Bjorntorp& Rosmond, 2000 ; Salehi, Ferenczi, & Zumoff, 2005), suggesting a mechanism by which excessive cortisol accelerates abdominal obesity (Qi & Rodrigues, 2007).

The relationship between stress and inflammation markers such as CRP, is observed mostly among subjects with central obesity (Shen, Farrell, Penedo, Schneiderman, & Orth-Gomer, 2010). Central obesity amplifies the release of proinflammatory cytokines (Kern et al., 2001), In humans, high stress in the form of ERI (Bellingrath et al., 2009), life stresses and mood disturbance (Lutgendorf et al., 1999), activate both HPA and SMA with increased production of proinflammatory cytokines (Black, 2002). In turn, cytokine-induced acute phase proteins such as C-reactive protein (CRP) (Gabay & Kushner, 1999), which imposes an inflammatory response that contributes to the pathogenesis of MtS (Laaksonen et al., 2004). Previous reports showed that the association between

stress and inflammation was observed mostly in subjects with central obesity (Shen et al., 2010).

Little attention has been given to the effect of chronic work stress in a normal work environment on the inflammatory process in men (Hamer et al., 2006). There have been only a few studies that investigated the association between ERI and CRP. A cross-sectional study of German school teachers with high ERI showed significantly higher CRP compared to teachers with low ERI (Bellingrath et al., 2009). Furthermore, individuals with a high ERI had an increased plasma level of CRP following a mental stress task compared to those with a low ERI (Hamer et al., 2006). Following the commencement of this thesis work, a few studies conducted in Jordan that investigated work-related stress and its impact on the quality of life of Jordanians have emerged. A strong association between work stress and general physical health (using self-report questionnaires) has been found in these studies (AbuAlRub & Al-Zaru, 2008; Hamaideh, 2012). There was no published study investigating work-related stress and its impact on a particular physical health problem such as the metabolic syndrome and its core components within Jordanian cohorts. On the other hand, recent studies have shown a high prevalence of metabolic syndrome (>37%) within Jordanian cohorts (Khader et al., 2007; Yasein & Masa'd, 2011)

SUMMARY

This thesis explores the relationship between work-related stress and MtS. The MtS is a cluster of metabolic risk factors of abdominal obesity, elevated fasting plasma glucose, insulin resistance, high cholesterol and high blood pressure (Alberti & Zimmet, 1998; IDF, 2005). Work stress may be associated with ill health when the stress response is inadequate (Charmandari, Tsigos, & Chrousos, 2005). Prolonged work-related stress activates both HPA and SAM axes (Gold et al., 1988 a & b). These two axes act through separate pathways, one through hypercortisolemia, the other through cytokines and inflammatory reactions (Bellingrath, Weigl, & Kudielka, 2009; Black, 2003; Gold et al., 1988 a & b; Sternberg, Chrousos, Wilder, & Gold, 1992; Yudkin, Stehouwer, Emeis, & Coppack, 1999). Stress-related hypercortisolemia has been associated with MtS components such as abdominal obesity and glucose intolerance (Bjorntorp & Rosmond, 1999). High work-related stress levels induce low grade inflammatory responses with increased production of proinflammatory cytokines (Bellingrath et al., 2009, Black, 2002). Subsequently, these cytokines induce an increase in CRP production (Gabay & Kushner, 1999). This increase in CRP is thought to contribute to the pathogenesis of MtS (Laaksonen et al., 2004).

Until now, there has been no study that has simultaneously investigated the association of both the hypercortisolemia and the inflammatory response measured by CRP in the development of MtS. Thus, we propose that: (1) work stress increases the inflammatory response involving CRP, and (2) stress increases the stress hormone cortisol and initiates an inflammatory reaction involving CRP, which in turn increases the risk of MtS.

This research project will provide an original approach to understanding the pathways of how both the cortisol and inflammation changes may contribute to MtS under conditions of high work stress.

We translated into Arabic, and validated questionnaires of the ERI (Siegrist, 1996) and PSS-14 (Cohen et al., 1983) to determine work-related stress, and the PSQI (Buysse et al., 1989) to evaluate sleep disturbance. These questionnaires were used to conduct these studies in a sample of Jordanian worker population.

THESIS AIMS AND HYPOTHESES

Aim 1: To translate and validate the ERI, PSS-14 and PSQI questionnaires.

Aim 2: To examine the association of work stress and CRP in Jordanian male workers.

Hypothesis: Work-related stress is positively associated with CRP.

Aim 3: To examine the associations between work-related stress, cortisol, CRP and MtS.

Hypotheses: 1) Work-related stress is positively associated with hypercortisolemia, high CRP, and MtS. 2) Work-related stress and its resulting hypercortisolemia and augmented CRP, synergistically contribute to the development of MtS in middle-aged Jordanian workers.

CHAPTER 2

STUDY ONE

AN ARABIC VERSION OF THE PERCEIVED STRESS SCALE: TRANSLATION AND VALIDATION STUDY

A B S T R A C T

Background: The Perceived Stress Scale has been designed to measure the degree to which situations in a person's life are perceived as stressful.

Objective: The paper describes the development of an Arabic version of the Perceived Stress Scale.

Design: A translation process with cross-cultural considerations, and statistical evaluation of scale reliability and validity were employed to produce an Arabic version of the Perceived Stress Scale.

Settings: Participants were asked to complete the Arabic version Perceived Stress Scale twice in their homes.

Participants: The Jordanian study population for the Arabic version Perceived Stress Scale validation consisted of 126 volunteers (74 male, 52 female). Ninety participants completed the scale twice (55 male, 35 female), of whom 58 were high schools teachers and 32 technical workers. Arabic was the first language of all participants and all gave informed consent.

Results: The Arabic version Perceived Stress Scale reliability and validity were evaluated. The suitability of data for factor analysis was assessed with

acceptable results. The factorial factor analysis showed two factors with eigenvalues greater than 1.0 (45.0% of variance). The Cronbach's alpha coefficients were 0.74 (Factor 1), 0.77 (Factor 2) and 0.80 for the Arabic version Perceived Stress Scale overall. The test–retest reliability had an intra-correlation coefficient of 0.90.

Conclusions: The Arabic version Perceived Stress Scale showed an adequate reliability and validity. Therefore, the Arabic Perceived Stress Scale is considered a suitable instrument to assess perceived stress in Arabic people

INTRODUCTION

Stress may be considered a stimulus, a response or an interaction process between the individual and his environment (Brantley& Thomason, 1995). Lazarus (1999) and Lazarus and Folkman (1984) take the latter view that psychological stress is a dynamic interaction between the individual and his environment, and they proposed that stress is neither an environmental stimulus nor a psychological response, but rather a relationship between environmental demands and the ability to deal with them. Thus, stress is seen as a transaction between individual and environment. In other words, the environment provides the initial stimulus, but the key determinants of stress are the way the individual perceives the environment and his ability to cope with the stress. Based on this transactional definition of stress, Cohen et al. (1983)

designed the Perceived Stress Scale (PSS) and later Levenstein et al. (1993) published the Perceived Stress Questionnaire (PSQ), which are self-reported measures of the degree to which situations in an individual's life are perceived as stressful. Both the PSS and PSQ have been translated into many languages and applied in different settings. We chose the PSS (14 items) to be translated and validated rather than the PSQ (30 items), since the PSS -14 is a validated questionnaire used more frequently in stress health studies (Lee, 2012). In addition, it has been translated into several other languages

PSS items were designed to assess the degree to which individuals found their life unpredictable, uncontrollable, and overloaded. These issues have been repeatedly found to be central components of the experience of stress (Cohen et al., 1983). The PSS has been applied in a variety of studies including those linking stress to psychological or physiological disorders and depression symptoms (Chang, 1998); detecting the stress level of schizophrenia caregivers (Dyck , Short, & Vitaliano, 1999); assessing the stress level of HIV infected patients (Cruess et al., 1999); correlation between stress and increased susceptibility to respiratory diseases (Cohen et al., 1993); and also to the anti-inflammatory response (Song et al., 1999).

The PSS assesses the level of perceived stress experienced over the previous month, and has three versions: the PSS-14 (Appendix C), PSS-10, PSS-4 with 14, 10 and 4 items respectively (Cohen et al., 1983). The PSS-4 and 10 are the

shorter versions of PSS-14. The 14-item version is more commonly used in health studies (see, for example, references on Macarthur Research Network on SES and Health (2008). Furthermore, since there is a tendency for the internal consistency to increase with increases in scale items (Pedhazur& Schmelkin, 1991), we chose the PSS-14 to be translated into Arabic and validated.

The PSS-14 has seven positive and seven negative items. The tool has demonstrated good reliability coefficients with Cronbach's alpha ranging from 0.75 to 0.91 (Cohen et al., 1983; Cohen & Williamson, 1988; Cole, 1999). The PSS has been translated into several languages including Spanish (Remor, 2006), Swedish (Eskin & Parr, 1996), Chinese (Lee & Crockett, 1994), and Japanese (Mimura & Griffiths, 2008). Thus, its application has particular value in cross-cultural studies, since it has been used in a wide range of cultures. While there has been one validation study of an Arabic version of the PSS-10 (Chaaya , Osman, Naassan, & Mahfoud, 2010), there is no evaluated Arabic version of the PSS-14. This paper reports the development of a translated Arabic version of the PSS-14 together with testing for reliability and validity.

METHODS

Perceived Stress Scale

The Perceived Stress Scale has 14 items related to the level of perceived stress experienced over the previous month and measures the degree to which situations in a person's life are perceived as stressful. Each item is answered on a

5-point response giving a scale range of 0–56, with a high score representing a high perceived stress level. Theoretically the scale has two components; a positive perception component, which includes items (1, 2, 3, 8, 11, 12, and 14), and a negative perception component, which includes items (4, 5, 6, 7, 9, 10, and 13) (Cohen et al., 1983).

Translators

Professional translators were recruited through The National Accreditation Authority for Translators and Interpreters Ltd (NAATI) web site (www.naati.com.au). The translators were selected in accordance with the following criteria: (1) accredited by NAATI and (2) hold a postgraduate degree in translation. Non-professional translators, which included bilingual academic and health professionals, were recruited through collegial contacts of the study coordinator and all worked within the Australian university system. Non professional, married couple translators were recruited through Arabic community centers in Australia. Each married couple had one native English speaker and one Arabic native speaker, who were educated in an English speaking country (Australia). Married couples were specifically chosen in an attempt to use simple language rather than classical Arabic language (Arabic Fus-ha), which is used less frequently by the general public.

Translation

The repeated forward–backward translation procedure was adopted (Meadows, Bentzen, & Touw-Otten, 1997) for the translation of the PSS into Arabic. The process of producing the Arabic PSS version involved seven stages (Fig. 2.1).

Stage 1: English to Arabic translations

Twelve people (three professional translators, three academics, and three married couples) were involved in Stage 1 of the Arabic PSS version. All translators were asked to avoid a literal translation and to ensure that the translation used simple language providing equivalence in the meaning of questions and rating scales. Each married couple had one native English speaker and one Arabic native speaker, who were educated in an English speaking country (Australia). The married couples worked as a team in translating the English version into Arabic.

Stage 2: Arabic version (1)

One of the authors (TA) and one health academic, both bilingual in Arabic and English, unified the nine Arabic translations produced from Stage 1 into a single translated version (Arabic version (1)).

Stage 3: Arabic version (2)

Another couple, both bilingual health professionals one of them experienced in the use of psychological research studies within the Arabic community, and familiar in psychological terminology in both Arabic and English and not employed for Stages 1 or 2 compared Arabic version (1) to the English original. They evaluated the clarity of writing and equivalence in the meaning of questions and answers. Unclear or ambiguous Arabic expressions were modified to produce Arabic version (2).

Stage 4: 1st back translation of Arabic to English

A further two independent translators, one professional translator and one a bilingual health academic, both blind to the original English version, back-translated Arabic version (2) into English.

Stage 5: Identification of discrepancies in back translation

Two health academics (native English speakers) compared the original English version and the two back translated versions, and checked for equivalence in the meaning of scales, questions and the answer options. They identified discrepancies between the original and the back-translated versions.

Stage 6: Arabic version (3)

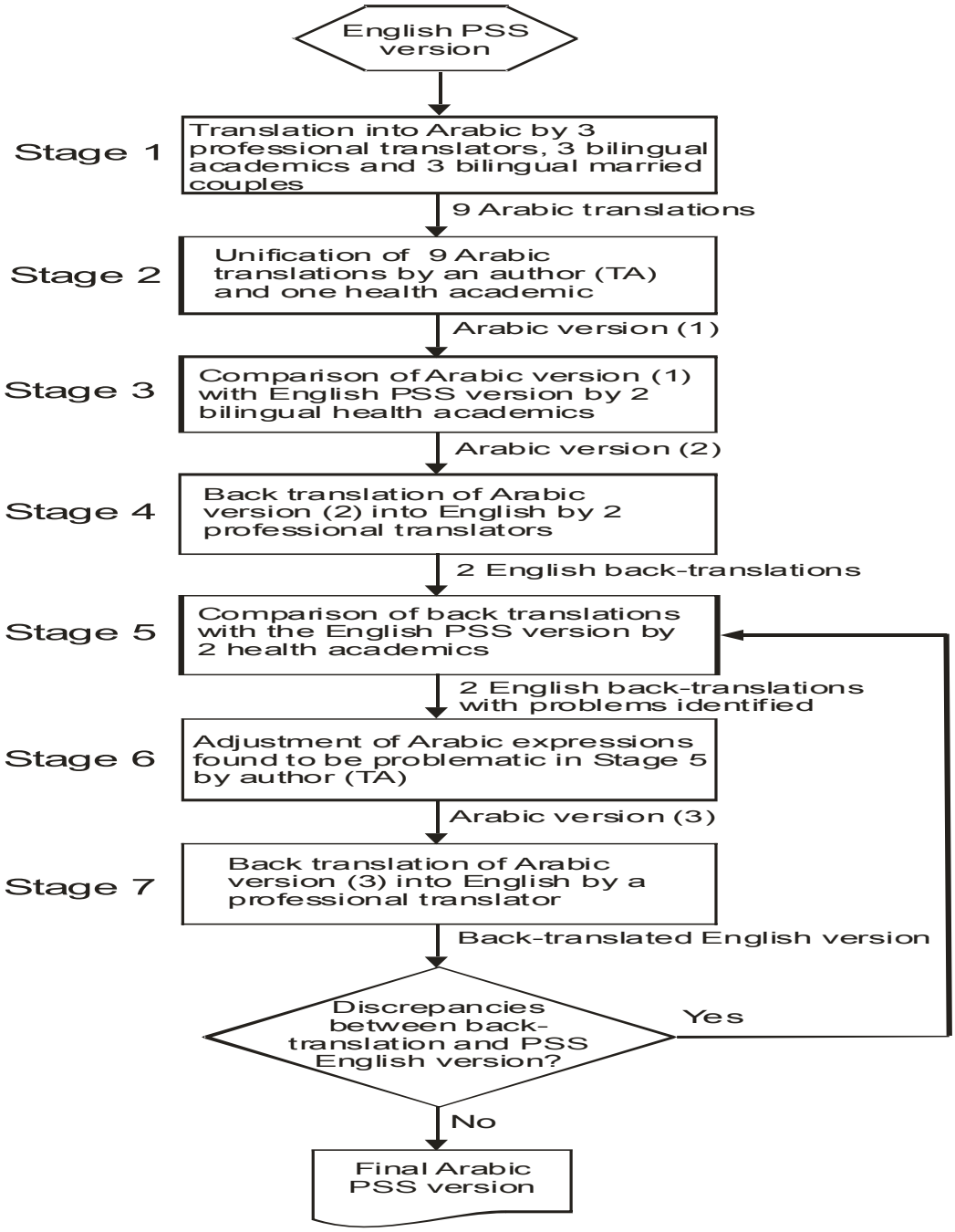
To resolve the discrepancies identified in Stage 5, the author (TA) adjusted the Arabic expressions that were found to be ambiguous or unclear, using

alternative Arabic expressions from the nine translations produced in Stage 1, and resulting in Arabic version (3).

Stage 7: 2nd back translation of Arabic to English

One of the professional translators from Stage 4 was asked to do a back-translation into English a second time. Stages 5, 6, and 7 were repeated until all ambiguous and unclear statements were resolved and a final consensus version was obtained. See Appendix C for the final Arabic PSS.

Figure 2.1: Translation process



Participants

The study population for the Arabic PSS validation consisted of 126 volunteers (74 male, 52 female), of whom 101 were teachers and 25 were technical staff from three high schools located in the city of Zarka, Jordan. All subjects had at least a high school education certificate. Thirty-six subjects were excluded because they did not answer all the Arabic PSS questions. Ninety participants completed the Arabic PSS twice (55 male, 35 female; mean age of 35.2 ±10.1 years), of whom 58 were teachers and 32 were technical staff. Arabic was the first language of all participants and all gave informed consent. The study was approved by the Human Research Ethics Committees of The University of Sydney and Jordan University.

Procedure

We had sought permission only from the large schools in Zarka City, in terms of teacher and staff numbers. Three schools agreed to conduct our study in their schools. Flyers about the study and contact details of the study coordinator had been given to school staff, and where available, in tea rooms in the three schools. Study coordinator (TA) had attended the three schools and handed the questionnaires to subjects, who agreed to participate and who then signed a

consent form. Selection criteria included subjects who were school staff, more than 18 years old, with a minimum education of high school certificate level, willing to complete the questionnaires twice, as well as to answer some additional questions regarding the participant's sex, age, education level and current job. Participants returned the questionnaire by mail or in person to the study coordinator during a subsequent weekly visit to the school (4 visits for each school). After an average of 14 days from the completion of the first testing, a second Arabic PSS questionnaire was given to each participant for completion. Confidentiality of participants was assured by the use of identification codes which were known only by one of the authors.

Statistical analysis

Internal consistency reliability was assessed by Cronbach's alpha coefficient (Cronbach, 1951) and the item-total correlation coefficient. Test-retest reliability was assessed by the intra-class correlation coefficient. The suitability of data for factor analysis was assessed by the (1) correlation between the scale items (Tabachnick & Fidall, 1996), (2) Kaiser–Meyer– Oklin (KMO) sample normality and adequacy measure (Kaiser, 1970, 1974), and (3) Bartlett's test (Bartlett, 1954). The principal component analysis (PCA) was conducted to examine the component structure of the 14 items of the Arabic PSS-14. Three criteria were used for deciding the number of components to be retained for extraction and rotation. Components with high eigenvalues (>1.0) according to Kaiser's criterion were extracted (Kiaser, 1974). The Cattell's Scree plot (Cattell, 1966)

was used to produce a plot of each component's eigenvalues, followed by graph inspection for a break point in the data, where the curve began to level. Data points above the break, having eigenvalue >1 were taken to be the components retained for extraction and rotation. Based on these two criteria, the potential number of components to be rotated was identified. These components were then rotated by the varimax rotation (Fabrigar, MacCallum,Wegener, & Strahan, 1999). In addition, the contents of items essentially matched the previous loadings of items within the two components (positive perception items and negative perception) (Cohen et al., 1983). Items with loadings above 0.32 were assumed to load on a given component (Tabachnick & Fidell, 2001). The above methods of factor analysis using PCA, extraction method, rotation methods, and loading criterion were the same as those employed in a previous study that validated the PSS in Japanese (Mimura & Griffiths, 2008), and as described by and Pallant (2001). Data were analyzed using the Statistical Package for Social Science (SPSS) Version 17.0 (SPSS, IBM).

RESULTS

Table 2.1 shows the internal consistency and test–retest reliability of the Arabic PSS. Inspection of the strength of correlation between the 14 items revealed the presence of many correlation coefficients of 0.3 and above, which is considered adequate (Tabachnick & Fidall, 1996). The Kaiser–Meyer–Oklin value was 0.71, which exceeded the minimum recommended value of 0.60, and the Barlett's test of sphericity reached statistical significance, $p < 0.001$ (Pallant, 2001).

Therefore, all assessment results supported the suitability of the study data for factorial analysis.

Principal Components Analysis (PCA) revealed the presence of four components with eigenvalues exceeding 1, explaining 64% of the variance. An inspection of the Scree plot (Fig.2. 2) (Catell, 1966) revealed a break after the second component. Varimax rotation was performed and the rotated solution (Table 2.2) revealed the presence of a simple structure (Thurstone, 1947). The rotated major two components explained 45% of the variance. Seven items of the scale represents positive perception (1, 2, 3, 8, 11, 12, and 14) loaded highly on the first component and explained 23% of the variance, while the other seven items (4, 5, 6, 7, 9, 10, and 13) represents negative perception loaded strongly on the second component and explained 22% of the variance.

Table 2.1: Mean scores (SD), range, Cronbach's alpha coefficient, and intra-class correlation coefficients (ICC) for the Arabic PSS-14.

Mean (SD)	Range	Cronbach's Alpha	ICC (95%CI)
26.3 (8.2)	8-47	0.80	0.90 (0.87-0.93)

Figure 2.2: Scree test for the Arabic PSS-14

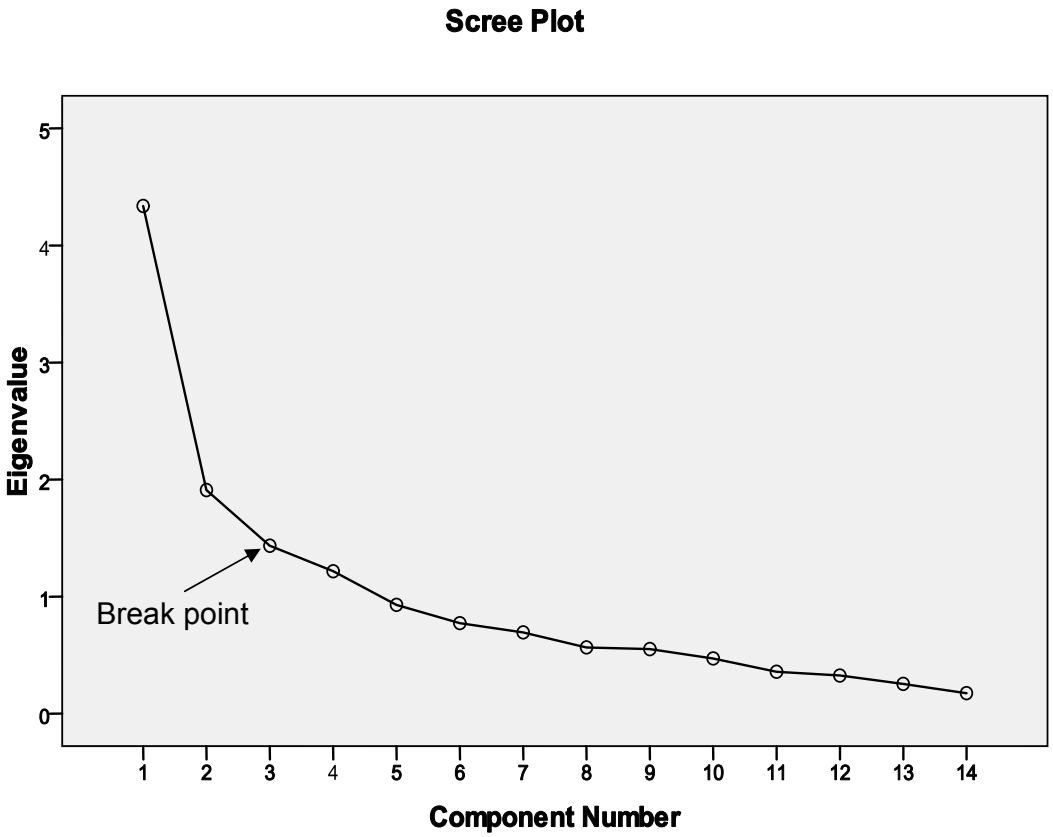


Table 2.2: Comparison of the varimax rotation of the two factor solutions for Arabic PSS-14 and English PSS-14

	Varimax rotation of the Two Factor Solution for Arabic PSS-14, n=90		Varimax rotation of the Two Factor Solution for English PSS-14, n=96 (adapted from Hewitt et al, 1992)	
Item	Component one (positive perception items)	Component two (negative perception items)	Component one (positive perception items)	Component two (negative perception items)
1	0.63	0.02	0.74	0.03
2	0.59	0.17	0.79	0.01
3	0.68	0.11	0.80	0.14
4	0.20	0.55	-0.27	0.68
5	0.19	0.73	0.16	0.83
6	0.05	0.65	0.34	0.65
7	0.25	0.52	0.49	0.38
8	0.60	0.18	0.66	-0.02
9	-0.09	0.47	0.12	0.63
10	-0.01	0.64	Not reported	
11	0.66	0.16	0.55	-0.024
12	0.54	0.21	Not reported	
13	0.21	0.72	Not reported	
14	0.55	-0.24	0.66	0.33
Cronbach's Alpha	0.74	0.77	0.81	0.72

DISCUSSION

The PCA results indicated that the Arabic PSS items can be loaded on four components (factors). The Scree plot (Fig. 2.2) revealed a break after the second component. Based on PCA and Scree plot result, the first and second (the largest two) components were retained for extraction and rotation by the Varimax rotation method.

The two component solution of the PSS were also adopted in other PSS versions: Japanese, Spanish, and English, and similar items loading on the two components have been reported as the Arabic PSS in the current study (Hewitt et al., 1992; Mimura & Griffiths, 2008; Ramirez & Hernandez, 2007). The varimax rotation showed that the Arabic PSS and the English PSS have almost the same loading except for item 7 (Table 2.2).

In the present study, the Arabic PSS showed that the loading of positive and negative items is consistent with the original English PSS, except for the loading of item 7 (Table 2.2). However, the loading of Arabic PSS-14 items, including item 7, is consistent with the versions in Japanese, Spanish and Hungarian (Mimura & Griffiths, 2008; Remor, 2006; Stauder & Konkoly¨ , 2006). Internal consistency of the Arabic PSS, assessed by the Cronbach's alpha coefficient of both components, was acceptable (0.74 and 0.77) and for the Arabic PSS-14 scale overall (0.80). These values are close to those for the widely used original English version which was from 0.80 to 0.86 (Cohen et al., 1983, Hewitt et al.,

1992). These values show that the Arabic PSS-14 and its components have good internal consistency. Additional test–retest reliability/ stability assessment was performed using intra-correlation coefficient, which was high, reflecting high reliability of the scale (Table 2.1) (Gronblad et al, 1993).

While there has been one validated Arabic version of the PSS-10 (Chaaya et al., 2010), up to now, there is no Arabic version of the PSS-14. The current validated Arabic PSS-14 provides an important tool for comparison with other ethnic/language groups, since the longer 14 item version is more commonly used in health studies (see, for example, references on Macarthur Research Network on SES and Health (2008)), Furthermore, the Arabic PSS-14 has higher internal consistency, reliability and stability values than the Arabic PSS-10, while having similar factorial analysis results. A concerted effort was made to produce an Arabic translation of the PSS with a wide range of translators involved in the process (married couples, professional translators, and academics with experience in psychological scales). The translation process had a balanced treatment of both linguistic and cross-cultural considerations (Hambleton, 1994; Van de Vivjer & Hambleton, 1996). This was achieved by using three married couples with a native English speaker and an Arabic native speaker to discuss word meanings in the PSS and identify equivalent Arabic words. In addition, professional translators were used to further improve the translation from a linguistic point of view. Despite these steps having been taken, the influence of

cultural differences on both the experience of stress, and responses to it, cannot be eliminated.

The 14-day interval between test and retest has been used in the validation studies of Spanish and Chinese PSS versions (Remor, 2006; Yu& Ho, 2010). The wash-out period is long enough that the participants do not remember their previous response to the scale items, yet not too long that their responses might change due to external factors (Flanagan, 2013). It is worth mentioning that there was a relatively high failure rate of returning the second questionaries (28% of the sample of whom 27 were teachers and 9 were technical staff). However, no obvious reasons for this were reported or found. However, a self-selective bias among the participants not completing the questionnaires twice cannot be ruled out.

A further study using a larger sample size is needed to assess the cross-cultural validity of this scale using confirmatory factorial analysis as described by Beckstead et al. (2008). Future studies could also examine convergent validity by assessing correlations between Arabic PSS scores and other scales measuring perceived stress. In summary, this Arabic version of the PSS-14 has good internal consistency and reliability. The factorial structure was similar to the PSS translated into other languages, and further establishes its value in cross cultural studies. We consider this Arabic version of the PSS a suitable instrument to assess perceived stress for Arabic people.

CHAPTER 3

STUDY TWO

AN ARABIC VERSION OF THE EFFORT-REWARD IMBALANCE QUESTIONNAIRE: TRANSLATION AND VALIDATION STUDY

ABSTRACT

An Arabic version of the Effort-Reward Imbalance Questionnaire was developed and validated through a translation process with cross-cultural considerations. The translated questionnaire was evaluated for reliability and validity. A Principal Components Analysis was conducted following assessment of the suitability of data for factor analysis. Components with high eigenvalues were extracted, followed by varimax rotation. Three components with eigenvalues greater than 1.0 (50% of variance) were indicated. The analysis showed Cronbach's alpha coefficients of .82 for the Effort scale, .88 for the Reward Scale and .74 for the Over commitment scale. The test-retest reliability was high with intra-correlation coefficients of ≥.86. The Arabic version of the Effort-Reward Imbalance Questionnaire showed adequate reliability and validity and is a suitable instrument to assess work stress in Arabic-speaking people.

INTRODUCTION

The adverse physical health effects of psychosocial stress in the workplace have mainly been investigated through two theoretical models: the demand-control model (Karasek, 1979; Karasek & Theorell, 1990) and the Effort-Reward imbalance model (Siegrist, 1996). The demand-control model emphasises psychological demands of work and job control by the individual, where high job demand with little control over work produces job strain. The Effort-Reward imbalance model, on the other hand, assesses three aspects of work stress: "Effort", "Reward" and "Over commitment." It is based on the notion of social reciprocity whereby effort is reciprocated by socially defined reward. Effort represents the job demands and/or obligations that are imposed on the employee, while reward includes such things as salary, bonus money, esteem, job security and career opportunities. The Effort-Reward imbalance model claims that a lack of reciprocity between effort and reward at work with high effort and low reward, elicits sustained stress reactions (distress). In addition, the model assumes that distress will be higher in more highly over-committed employees than in less over-committed employees (Siegrist, 1996).

Whilst the demand-control model emphasizes task-level control, the Effort-Reward imbalance model emphasizes employees' rewards (Siegrist, 2001;

Tsutsumi & Kawakami, 2004). Thus the Effort-Reward imbalance has advantages over the demand-control model, since it has focused attention on stressors such as payment adequacy, job insecurity, job changes and job promotion prospects (Griep et al., 2009).

The Effort-Reward Imbalance Questionnaire consists of 23 items measuring work effort, reward and over commitment; many studies have supported its validity for evaluating stress in the work environment (Tsutsumi & Kawakami, 2004; Unterbrink et al., 2007). Employees who scored high on the questionnaire were at higher risk of health disorders; CHD (Bosma et al., 1998), musculoskeletal discords (Dragano et al., 2003), and chronic fatigue syndrome (Wada, Sakata et al., 2007).

In this study, the Effort-Reward Imbalance Questionnaire, English version (Siegrist et al., 2004), was translated into the Arabic language and validated. The questionnaire has been translated into several languages including French (Niedhammer, Siegrist, Landre, Goldberg, & Leclerc, 2000), Japanese (Tsutsumi et al., 2001), Dutch (Hanson, Schaufeli, Vrijkotte, Plomp, & Godaert, 2000), Chinese (Li, Yang, Cheng, Siegrist, & Cho, 2005), Brazilian (Chor , Werneck, Faerstein, Alves, & Rotenberg, 2008), Thai (Buapetch, Lagampan, Faucett, & Kalampakorn, 2008) and Korean (Eum et al., 2007). ERI has particular value in cross- cultural studies due to its frequent usage in a wide range of cultures as compared to other measures. Nevertheless, there are an increasing number of studies that assess work stress within Arabic countries using the English version

of the questionnaire. Therefore, only those who understand written English could take part in those studies (Devreux, Jacquerye, Kittel, Almazrooa, & Al-Awa, 2012; Hamdan-Mansour, Al-Gamal, Puskar, Yacoub, & Marini, 2011). Such findings may not be generalized to the whole population, since those who understand English may be among higher socio-economic groups with more education. Unfortunately, the research is limited by the fact that there is as yet no Arabic version of the Effort-Reward Imbalance Questionnaire. This paper reports the development of a translated Arabic version of the Effort-Reward Imbalance Questionnaire, together with testing for internal consistency reliability and validity.

METHODS

Effort-Reward Imbalance Questionnaire

The questionnaire consists of 23 items with three scales; 6 items measure Effort, 11 measures Reward and 6 measure Over commitment (Appendix C). The items of the Effort and Reward scales are rated in two steps. In Effort and Reward scales, in a first step, the respondents are asked whether the item content describes a typical experience in their workplace. If the participants “disagree” with the content of the question then the item is scored 1. If the participants “agree”, then in a second rating step, they are asked to rate the distress associated with this experience by choosing one of four options: 2: I am not at

all distressed, 3: I am somewhat distressed, 4: I am distressed or 5: I am very distressed. For the Over commitment scale, ratings are 1: Strongly disagree, 2: Disagree, 3: Agree, 4: Strongly agree. (Siegrist et al., 2004)

A summary score is computed for each scale, which ranges between 6 and 30 for Effort, 11 and 55 for Reward, and 6 to 24 for Over commitment (reverse scoring Item 3; Strongly disagree=4, Disagree = 3, Agree = 2, Strongly agree=1). The Effort-Reward ratio (ER ratio) is calculated by dividing the total Effort score by the Reward score with a correction factor for the different number of items in each scale: ER ratio = (Effort score/Reward score x 1.834) (Siegrist et al., 2004).

Translation

For the translation into Arabic, a repeated forward-backward translation technique was used (Meadows et al., 1997). The translation process involved seven stages. It included professional translators, bilingual academics, bilingual married couples, and bilingual health professionals, which had been used in the validation of Arabic PSS-14 (Almadi et al., 2012a), as described below in detail.

Stage 1: English to Arabic translations.

Translators were from different sectors: professional translators, academics, and married couples. All translators were instructed to use simple language in translating items and avoid the use of classical Arabic language (Arabic Fus-ha), which is used less frequently by the general public. Each bilingual (English-

Arabic) married couple worked together on the translation as one team. The couples consisted of one Arabic native speaker and one English native speaker, and both were educated in an English-speaking country (Australia). Each couple was instructed to discuss the item expressions and their meaning. Then the Arabic spouse was instructed to write down the Arabic translation resulting from this discussion.

Stage 2: First Arabic version.

The study coordinator (TA) and one university academic, both bilingual in Arabic and English, integrated the nine Arabic translations from Stage 1 into a single translated Version 1.

Stage 3: Second Arabic version.

Another two translators, both bilingual health professionals, not employed in previous translation stages, evaluated the Arabic Version 1 against the English original. Of these two translators, one was an experienced psychology researcher within the Arabic community and was familiar with Arabic and English psychology terminology. Both assessed the simplicity of writing and similarity in the meaning of questionnaire items and response options. Any problematic Arabic expressions were modified to produce the Arabic Version 2.

Stage 4: First back translation of Arabic to English.

Two independent translators, one professional translator and the other a health academic, who had not been employed in previous translation stages but who had not seen the original English version, were asked to back-translate the Arabic Version 2 into English.

Stage 5: Identification of discrepancies in back translation.

Two native English speakers, both health academicians, compared the two back-translated versions against the original English version, and checked for similarity in the meanings of the questionnaire items and the response options. They identified differences between the original and the back-translated versions.

Stage 6: Arabic version 3.

To resolve the differences found in Stage 5, the first author (TA) changed the Arabic terms that were identified as problematic, using alternative Arabic terms from the nine translations formed in Stage 1, to produce Arabic Version 3.

Stage 7: Second back translation.

The same professional translator involved in Stage 4 was requested to carry out a back-translation into English a second time. Previous Stages 5, 6 and 7 were repeated until all problems were resolved and a final agreed-upon version was obtained (Appendix C).

Participants

We had sought permission only from the large schools in Zarka City, in terms of teacher and staff numbers. Three schools agreed to conduct our study in their schools. Flyers about the study and contact details of the study coordinator had

been given to school staff, and where available, in tea rooms in the three schools.

Study coordinator (TA) had attended the three schools and handed the questionnaires to subjects, who agreed to participate and who then signed a consent form. Selection criteria included subjects who were school staff, more than 18 years old, with a minimum education of high school certificate level, willing to complete the questionaries twice, as well as answer some additional questions regarding the participant's sex, age, education level and current job. Participants (N=126) agreed to be involved in the study (74 men, 52 women), with 96 participants (61 men, 35 women) completing the questionnaires twice. The participants (Males, mean age =35.1± 10 years) were teachers (81%) with a minimum qualification of diploma in teaching and technical staff (19%). The Human Research Ethics Committees of both The University of Sydney and Jordan University approved the study protocol. Written consent was obtained from all participants and school administrations.

Procedure

The participants completed the Arabic Effort-Reward Imbalance Questionnaire and demographic questionnaires at home and returned them by mail or in person to the first author (TA). After a two-week period, the participants repeated the process by responding to the same questionnaire for the purpose

of reliability testing. Confidentiality of participants was assured by the use of identification codes which were known only by study First Author (TA)

Statistical Analysis

Internal consistency reliability was assessed by Cronbach's alpha coefficient (Cronbach, 1951) and the item-total correlation coefficient. Test-retest reliability was assessed by the intra-class correlation coefficient. Prior to the factor analysis, the data were evaluated by performing correlations between the scale items (Tabachnick & Fidell, 1996). The Kaiser-Meyer-Oklin (KMO) sample normality and adequacy index was >0.6 (Kaiser, 1970, 1974) and Bartlett's sphericity test (Bartlett, 1954).

The Principal Component Analysis (PCA) was conducted to examine the component structure of the 23 items of the Arabic Effort-Reward Imbalance Questionnaire. Three criteria were used for deciding the number of components to be retained for extraction and rotation. Components with high eigenvalues (>1.0) according to Kaiser's criterion were extracted (Kiaser, 1974). The Cattell's Scree plot (Cattell, 1966) was used to produce a plot of each component's eigenvalues, followed by graph inspection for a break point in the data, where the curve began to level. The number of data points above the break represented the components retained for extraction and rotation. Based on these two criteria, the potential number of components to be rotated was identified. These components were then rotated by the varimax rotation

(Fabrigar et al., 1999). In addition, the contents of items essentially matched the previous loadings of items within the three components (Effort, Reward, and Over commitment) (Siegrist, 1996). Items with loadings above 0.32 were assumed to load on a given component (Tabachnick & Fidell, 2001). The above methods of factor analysis using PCA, extraction method, rotation methods, and loading criterion were the same as those employed in previous studies that validated the Effort-Reward Imbalance Questionnaire in Japanese (Tsutsumi, Ishitake, Peter, Siegrist, & Matoba 2001), Brazilian (Chor et al., 2008), and Korean (Emu et al., 2007). Data were analyzed using the Statistical Package for Social Science (SPSS) Version 17.0 (SPSS, IBM).

RESULTS

Table 3.1 shows the mean values, standard deviations and range for each scale of the Effort-Reward Imbalance Questionnaire for the sample. The Effort mean =15.3 (maximum = 30); Reward mean =21.3 (maximum =55), and the Over commitment mean =13.7 (maximum=24). The sample had low work-related Reward scores, and the mean Effort-Reward ratio was high (Mean = 1.48, SD = 0.61).

Table 3.1: Mean scores, standard deviations and range of scores for the three scales (N=96)

Scale	M	SD	Range
Effort	15.3	4.4	8.0-27.0
Reward	21.3	8.7	10.0-46.0
Over commitment	13.7	3.5	8.0-22.0

Inter-correlations between the Effort-Reward Imbalance Questionnaire items indicated many correlation coefficients above the threshold of .30, which is considered adequate. The Kaiser-Meyer-Oklin value of 0.76 exceeds the minimum suggested value of 0.60. Barlett's test of sphericity was significant (p<.001) (Pallant, 2001).

Internal consistency of ERI scales was assessed by item-total correlations and Cronbach's alpha coefficient. The results are given in Table 3.2. All item-total correlations were above 0.3 and all the Cronbach's alpha coefficients were higher than 0.7, suggesting considerable consistency of items contributing to their respective scales. It is worth to mention that multi-co linearity has been inspected for items correlation, and there was no high items correlation(r>.8) (Hensher, 2005) or determinant greater than .00001, which indicated there was no multi-co linearity (Field, Miles, & Filed, 2012). The test-retest reliability/stability assessment as measured by the intra-correlation coefficient (ICC) was high, reflecting good reliability (Table3.2).

Table 3.2: Item-total correlations and Cronbach's alpha coefficients for the Arabic Effort-Reward Imbalance Questionnaire (*N*=96), with summary item content.

Scale	Item	Item–total correlations
Effort		
	Cronbach's alpha= .82, test-retest ICC=.86 (95%CI=.80- .90)	
	ERI 1: constant time pressure	.65
	ERI 2: interruptions and disturbances	.68
	ERI 3 : a lot of responsibility	.59
	ERI 4: pressured to work overtime	.51
	ERI 5: physically demanding	.53
	ERI 6: increasingly demanding	.67
Reward		
	Cronbach's alpha= .88, test-retest ICC=.87 (95%CI=.81- .91)	
	ERI 7: receive respect from superiors	.56
	ERI 8 : receive respect from colleagues	.42
	ERI 9: supported in difficult situations	.67
	ERI 10: treated unfairly	.61
	ERI 11: poor job promotion prospects	.76
	ERI 12: expecting undesirable change	.64
	ERI 13: poor employment security	.57
	ERI 14: position adequately reflects education and training	.50
	ERI 15: receive deserved respect and prestige	.71
	ERI 16: considering effort, adequate promotion prospects	.57
	ERI 17: considering effort, adequate salary/income	.48
Over commitment		
	Cronbach's alpha= .74, test-retest ICC=.92 (95%CI=.88- .95)	
	OC 1: overwhelmed by time pressure at work	.32
	OC 2: think about work as soon as get up in morning	.64
	OC 3: at home, able to relax and "switch off" work	.44
	OC 4: people say I sacrifice too much for job	.33
	OC 5: work on my mind at bedtime	.48
	OC 6: deferred work task leads to trouble sleeping	.65

The principal component analysis identified six components with Eigenvalues >1, which explained 26.3%, 14.2%, 10.3%, 6.1%, 5.1% and 4.4% of the variance, respectively. The scree plot showed a break after the fourth component (Figure 3.1). In addition, the content of items matched the loadings of items within three components as reported in the original theoretical model of Siegrist (1996), so only the first three components were retained for the Arabic Effort-Reward imbalance questionnaire for rotation by the varimax method.

Figure 3.1: Scree test for the Arabic ERI

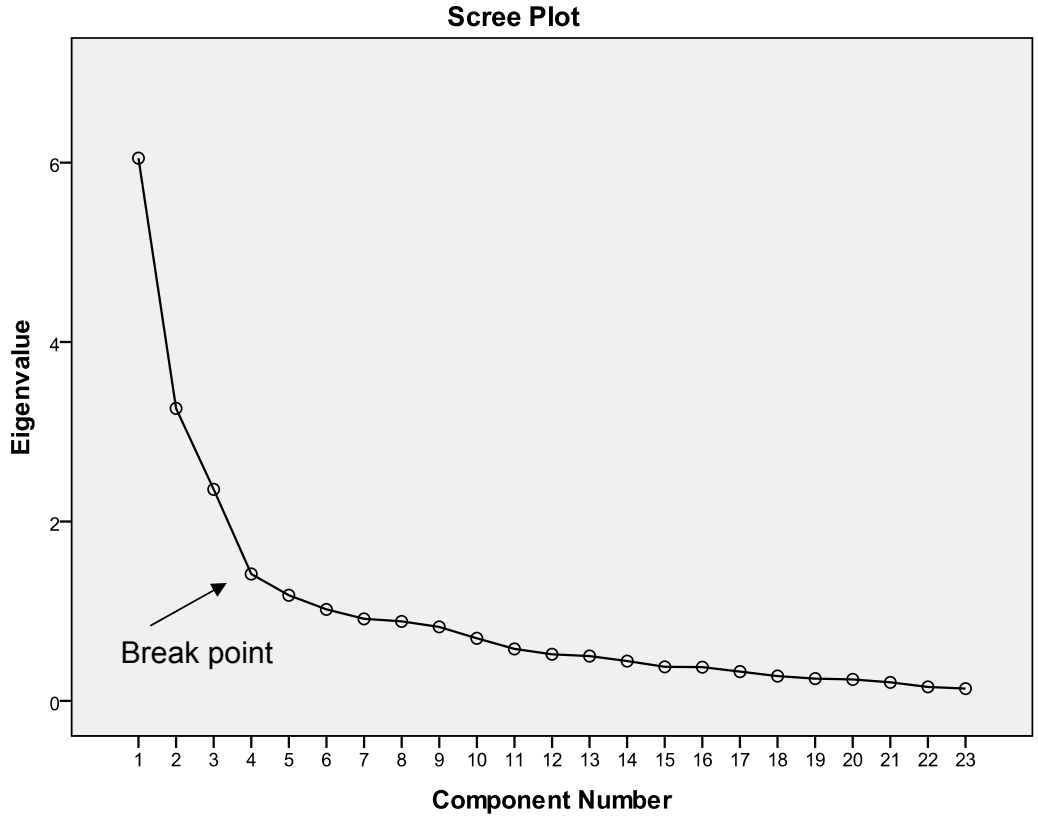


Table 3.3: Varimax rotation of three-component solution for the Arabic version of Effort-Reward Imbalance Questionnaire

Item	Component one	Component two	Component three	Communalities h^2
ERI 1	.15	**.79**	.14	.66
ERI 2	.17	**.79**	.14	.67
ERI 3	.09	**.74**	-.19	.59
ERI 4	-.20	**.67**	.22	.54
ERI 5	.04	**.64**	.11	.42
ERI 6	.09	**.73**	.04	.54
ERI 7	**.64**	.02	.12	.43
ERI 8	**.54**	.05	-.17	.32
ERI 9	**.69**	.31	.09	.59
ERI 10	**.65**	.25	.11	.49
ERI 11	**.79**	.20	.08	.67
ERI 12	**.70**	.12	.16	.53
ERI 13	**.69**	-.11	.01	.49
ERI 14	**.54**	.08	.29	.38
ERI 15	**.81**	-.04	.05	.65
ERI 16	**.69**	-.11	.02	.49
ERI 17	**.54**	.16	.19	.35
OC 1	.23	***.37***	***.40***	.35
OC 2	.10	.06	**.79**	.64
OC 3	.15	.20	**.57**	.39
OC 4	.09	.16	**.45**	.24
OC 5	.03	.16	**.73**	.56
OC 6	.02	.08	**.82**	.68
Total communality	6.05	3.26	2.36	11.67
% of Variance	26.3	14.2	10.3	50.8

Note.—Loadings with an absolute value >.32 are in boldface. Item OC1 has a notable cross-loading (italics).

According to the varimax rotation (Table 3.3), 50% of the variance was explained by the three major rotated components. Effort items (ERI1 – ERI6) loaded on the second component and accounted for 16% of variance. Reward items (ERI7 – ERI14) loaded on the first component and accounted for 22% of variance. Over commitment items (OC1-OC6) loaded strongly on the third component and explained 13% of the variance. Items ERI9 and OC1 had additional loadings on a second component (Table 3.3).

DISCUSSION

The results of this preliminary psychometric study indicated that the internal consistency and test- test reliability of the Arabic version of the ERI were satisfactory. Its factor structure was consistent and reflected the theoretical components of the Effort-Reward imbalance model well

It was noted that the mean ER ratio was high (1.48) when compared to the large-scale Whitehall study using the English version of the ERI (ER ratio = 0.44) (Siegrist et al., 2004), and the study of teachers (ER ratio = 0.70) (Bellingrath, Weigl, & Kudielka, 2008).

However, the ER ratio obtained for this study was comparable to that reported for Saudi Arabic hospital workers (ER ratio = 1.21) (Devreux et al., 2012). The results of this study suggest that Jordanian workers have higher work stress and lower job satisfaction than workers in other nations. Additional research is

recommended to explore the moderators (baseline variables of age, gender, and occupational type) of the work-stress relationship (high Effort-Reward ratio) and its long-term health effects on workers in Jordan.

Internal consistency reliability of the Arabic Effort-Reward Imbalance Questionnaire scales was satisfactory and reliability/stability assessment was high. The PCA indicated that the Arabic ERI items load on six components with eigenvalues above 1.0. The first three of the six components explained most of the variance. The first three components were extracted, and the varimax rotation indicated that the Reward, Effort and Over commitment items loaded strongly on components 1, 2, and 3, respectively. This factor solution of the Arabic Effort-Reward Imbalance Questionnaire was consistent with the Effort-Reward imbalance model as well as with validations of Chinese, Korean and Thai language versions (Li et al., 2005; Eum et al., 2007; Buapetch et al., 2008). While the factorial pattern of the scales (Effort, Reward and Over commitment) was clearly reflected in PCA, an interesting exception was observed concerning Reward Item OC 1 (overwhelmed by pressure), which loaded equally on the Effort and Over commitment components. Interestingly, OC1 loaded in the same way in both the Chinese and Korean validation studies (Li et al., 2005; Eum et al., 2007), suggesting the possibility that the item may not transfer well to other languages. However, a re-run of the factor analysis of the questionnaire, after removal of item OC1, did not affect the questionnaire in terms of number of components, structure, or other items' loadings, which may indicate that OC1

could be evenly construed as an Effort or Over commitment item. The problem with OC1was not reported in the English version of Effort-Reward Imbalance Questionnaire; Over commitment items were consistently found to load highly on one component in many studies using the English version as reported by Siegrist (2004). Similarly, the Effort and Reward items of the English version loaded strongly on separate components. In the communalities analysis, some items did not reach the cut-off point of 0.40 (Tabachnick & Fidell, 2001), although there was not a need to eliminate those items or repeat the component analysis, since all of those items loaded in their proposed latent component. According to Child (2006, p. 47), it was not recommended to eliminate the item from the analysis unless the item's communality was less than 0.2. None of the Arabic Effort-Reward Imbalance Questionnaire items' communalities were less than 0.24.

A strength of this study was the translation process, which involved a broad range of translators with different backgrounds (academic, health) to provide a balanced treatment of linguistic and cross-cultural considerations (Hambleton, 1994; Van de Vivjer & Hambleton, 1996). In addition, the use of informal language was encouraged in the translation process. Married couples were engaged to translate, who in general tended to use the informal, relaxed conversational language in their own home. Notably, in a translation process, it is difficult to eliminate the influence of cultural differences on both the experience of stress and responses to it: in Item OC1, the translation of the term

"time pressure" in the original English version became "work pressure" in the back-translation from Arabic to English; the term "overwhelmed" is used only to express an emotion in the Arabic culture. To overcome this difficulty, an explanation was added to indicate that the item was about the subject's feeling of not being able to carry out the required work in a set time. For another example, the Arabic translation of Item ERI13 "My job security is poor" has two different meanings in Arabic: as both "job security" or "physical protection of the work place provided for the employees," and the latter meaning is more prevalent in Arabic culture. Thus, a short explanation was added to indicate that the item was about continuation of the position. Although the back-translation of Item ERI9 agrees with the original English version, it is not clear why Item ERI9 loaded equally on both the Effort and Reward components.

Although the sample was relatively small, it was comparable to that of the Japanese validation study (Tsutsumi et al., 2001), and larger than that of the Brazilian study (Chor et al., 2008). Future studies should use larger samples to enable confirmatory factorial analysis of the questionnaire, in addition to examining discriminate validity. This sample consisted mostly of school teachers, who have a middle class socioeconomic status within the Jordanian community. It is not clear to what extent the Arabic Effort-Reward Imbalance Questionnaire results can be generalized to lower or higher socioeconomic groups or other types of work.

The 14-day interval between test and retest has been used in the validation studies of Spanish and Chinese PSS versions (Remor, 2006; Yu& Ho, 2010). The wash-out period is long enough that the participants do not remember their previous response to the scale items, and not too long that their responses would change (Flanagan, 2013).

It is worth mentioning that there was a relatively high failure rate of returning the second questionaries (32%) from female participants. However, no obvious reasons or major changes or sudden accidents were recorded that may have affected the work environment during the two study weeks beginning September 2009. The demographics (job type and mean age) were similar for the women who completed the evaluations and those who dropped out in the second evaluation. Any self-selective bias among the women completing the questionnaires twice cannot be ruled out.

CONCLUSION

The Arabic Effort-Reward Imbalance Questionnaire has satisfactory psychometric properties as the results are in line with those available from studies testing translations into other languages. The Arabic version of the questionnaire is appropriate for evaluation of work stress among Arabic-speaking employees.

CHAPTER 4

STUDY THREE

AN ARABIC VERSION OF THE PITTSBURGH SLEEP QUALITY INDEX;

TRANSLATION AND VALIDATION STUDY

ABSTRACT

The Pittsburgh Sleep Quality Index (PSQI) is a standardized self-administered questionnaire composed of 19 items to assess subjective sleep quality over the past month. It has been translated into many languages and is widely used in clinical and non-clinical base research studies. This article presents the Arabic translation and validation of the Pittsburgh Sleep Quality Index (PSQI) questionnaire. The translation process employed an iterative forward-backward translation process involving a wide range of translators to balance issues between linguistic and cross-cultural concerns. The Arabic PSQI questionnaire demonstrated satisfactory reliability and validity, and is considered an appropriate scale for sleep quality evaluation in Arabic people.

INTRODUCTION

The Pittsburgh Sleep Quality Index (PSQI) is a standardized self-administered questionnaire to assess subjective sleep quality over the past month (Buysse et al., 1989). The PSQI questionnaire has been used in clinical and non-clinical populations (Byles, Mishra, & Harris, 2005; Lai & Good, 2005). PSQI has been used for patients with medical conditions that associated with sleep disruption; depression (Norra et al., 2012), inflammation & CVD (Miller & Cappuccio, 2007), T2DM (Knutson, Ryden, Mander, & Van, 2006), and MtS (Hung et al., 2013).

The PSQI has demonstrated good internal consistency and high test-retest reliability (Buysse et al., 1989). It has been translated into several languages including Japanese, French, German, Spanish, Chinese and Greek (Backhaus, Junghanns, Broocks, Riemann, & Hohagen, 2002; Blais, Gendron, Mimeault, & Morin, 1997; Doi et al., 2000; Escobar & Eslava, 2005; Kotronoulas, Papadopoulou, Papapetrou, & Patiraki, 2011; Tsai et al., 2005). During the period of this study (2007-9), an Arabic version of the PSQI was not available. The need for the translation of the PSQI questionnaire arose as part of a larger study on stress and health issues (Almadi, Cathers, Hamdan Mansour, & Chow, 2012b; Almadi, Cathers, & Chow, 2013b). Meanwhile, an Arabic PSQI was published by Suleiman and colleagues (2010).

METHODS

The PSQI Questionnaire

The questionnaire comprises 19 self-rated questions grouped into 7 clinical component scores of sleep difficulty: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, daytime dysfunction and sedative medication use; each weighted equally on a 0–3 point scale. The seven-component scores are then summed to provide a global PSQI score, which ranges from 0-21. A cut-off score of 5 has been recommended, with scores > 5 indicating poor sleep (Buysse et al., 1989).

The Translation Process

The repetitive forward-backward translation practice was adopted (Meadows et al., 1997) for the translation of the English version of PSQI into Arabic.
Briefly, the development of the Arabic PSQI version consisted of seven phases of translation employing a wide range of translators; expert translators, bilingual academic colleagues, bilingual health professionals, and bilingual married couples. The process of translation has been fully described on page 34-39 of this thesis report. The process of translation has been fully described on page 37-39 of this thesis.

The translation process involved several steps: translation into Arabic followed by back translation to English; comparison of the accuracy in the meanings of the back translated one against the original English one; and any differences identified resolved by repeating the Arabic translation process

Participants

We had sought permission only from large schools in Zarka City, in terms of teacher and staff numbers. Three schools agreed to conduct our study in their schools. Flyers about the study and contact details of the study coordinator had been given to school staff, and where available, were placed in the tea rooms in the three schools.

Study coordinator (TA) had attended the three schools and handed the questionnaires to subjects, who agreed to participate and then signed a consent form. Selection criteria were; subject was a member of school staff, more than 18 years old, with minimum education level of a high school certificate, and willing to complete to the questionaries twice, as well as answer some additional questions regarding the participant's sex, age, education level and current job. All subjects gave informed consent for this study, which was approved by the Human Research Ethics Committee of The University of Sydney and Jordan University. Written consent to complete the Arabic PSQI was given by 101 teachers and 25 technical staff (N = 126, 74 males and 52 females), all of whom had a minimum education level of a high school certificate. Of these, 104

participants (60 males, 44 females; 72 school teachers, 32 technical staff) with a mean age 35.5 ± 9.7 years answered the questionnaire twice

Procedure

All volunteers completed both the Arabic PSQI questionnaire and a short demographic questionnaire. The completed questionnaires were returned by post or in person to the study coordinator (TA). For test-retest reliability, the Arabic PSQI questionnaire was repeated two weeks after its initial completion. The collected data were de-identified by replacing the participants' names with numeric identification codes.

Statistical Analysis

The Factorial Analysis (FA) using the Principal Component Analysis (PCA) method was performed once the data satisfied the three statistical tests: 1) a reasonable correlation (correlation coefficients >0.3) between the scale items (Tabachnick & Fidall, 1996), 2) a sample normality adequacy measure using the Kaiser-Meyer-Oklin test with a score > 0.60 (Kaiser, 1970, 1974), and 3) the Bartlett's test that showed statistical significance with $p< 0.05$ (Bartlett, 1954). The PCA was performed to inspect the factorial (component) structure of the 19

PSQI items. A PCA was conducted in which the components with eigenvalues greater than 1 were extracted and rotated by the varimax method (Fabrigar et al., 1999) . Items with loadings of 0.32 or more were considered to load on a given component (Tabachnick & Fidell, 2001).

The internal consistency was examined by Cronbach's alpha coefficient and the test-retest reliability was examined by the intra-class correlation coefficient. Statistical analysis was conducted using SPSS (version 17, IBM).

RESULTS

The mean PSQI global score for the sample was 6.3 (SD ±3.5) (Table 4.1). An examination of the correlation matrix of PSQI items showed 22 of 42 had correlation coefficients above the threshold of 0.30, which was considered adequate. The Kaiser-Meyer-Oklin value was 0.69, which was greater than the threshold value of 0.60, and the Barlett's test was statistically significant with $p<0.001$ (Pallant, 2001). Therefore, the data were suitable for PCA. The internal consistency for the PSQI was evaluated by Cronbach's alpha coefficient, which was 0.71, suggestive of reasonable consistency of PSQI components contributing to their respective scales. The intra-correlation coefficients (ICC) were high (Table 4.1) indicating a good test-retest reliability of the PSQI scale.

According to the PCA, there were two components with eigenvalues > 1. These components explained 39.8% and 20.7% of the variance. The Scree plot (Figure 4.1) shows a break after the second component, resulting in two components being retained for the varimax rotation (Catell, 1966). The rotated solution (Table 4.2) showed the existence of a simple structure with the two rotated components explaining 61.4% of the variance. Component one, "perceived sleep quality", explained 36.5% of the variance. The items which loaded highly on this component were subjective sleep quality, sleep latency, sleep disturbances, daytime dysfunction and sedative medication use. Component two, "sleep efficiency", explained 24.9% of the variance. The items which loaded highly on component two were sleep duration and habitual sleep efficiency.

Table 4.1: Mean scores (SD), range, Cronbach's alpha coefficient, and intra-class correlation coefficient (ICC) for the Arabic PSQI (N=104).

Mean (SD)	Range	Cronbach's Alpha	ICC (95%CI)
6.3 (3.5)	1-15	0.71	81.3 (0.74-0.87)

Figure 4.1: Scree test plot for the Arabic PSQI

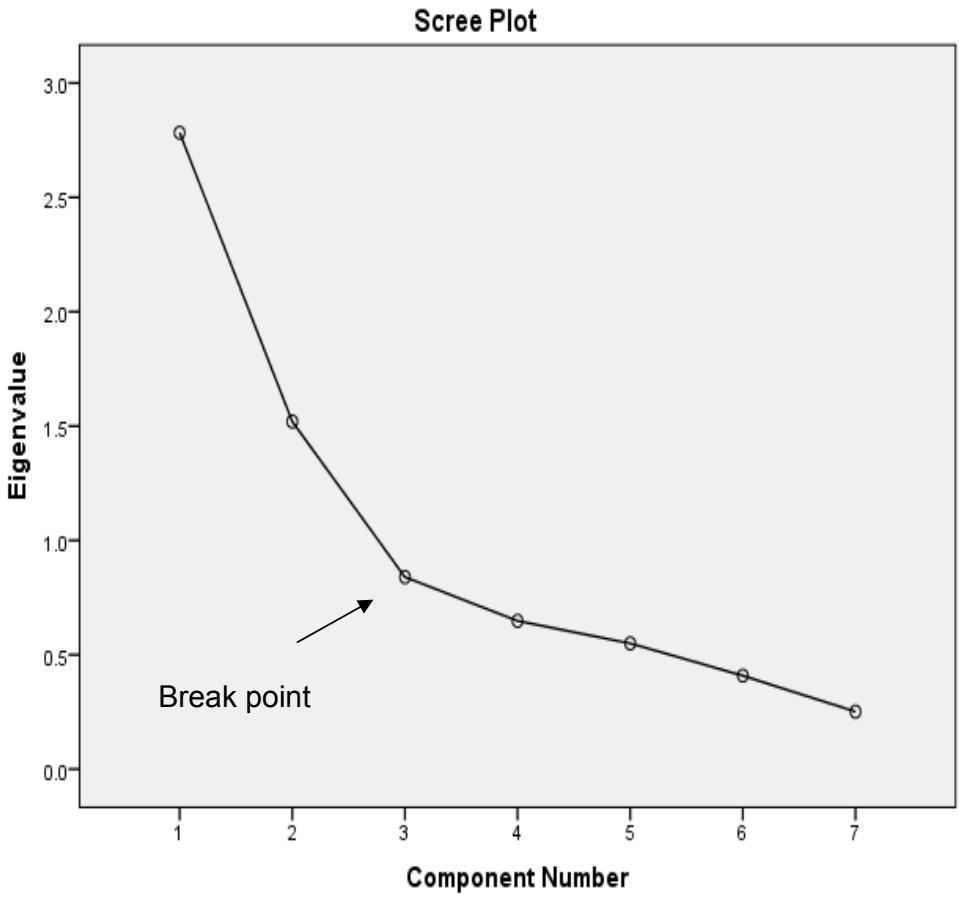


Table 4.2: The varimax rotation of the two- component solution for the Arabic PSQI (N=104)

Item	**Component one (Perceived Sleep Quality)**	**Component two (Sleep Efficiency)**
Subjective sleep quality	0.69	0.16
Sleep latency	0.73	0.05
Sleep duration	0.02	0.93
Habitual sleep efficiency	0.17	0.91
Sleep disturbances	0.62	0.02
Sleep medications	0.66	0.05
Day time dysfunction	0.82	0.18
Cronbach's Alpha	0.73	0.83

DISCUSSION

The data of this psychometric study showed high internal consistency and test-retest stability for the Arabic version of the PSQI questionnaire. The PCA indicated that the Arabic PSQI items can be loaded on two components: perceived sleep quality and sleep efficiency. This two-component solution of the Arabic PSQI concurred with the findings of several recent studies. These include

a second evaluation of the PSQI by Buysse et al (2008) and other studies (Cole et al., 2006; Kotronoulas, Papadopoulou, Papapetrou, & Patiraki, 2011). The two-component solution could be more suitable to improve the sensitivity of the PSQI, even though the PSQI was originally introduced as a single-factor model with a single global score of sleep quality (Buysse et al., 1989). The mean global score of the PSQI for this study sample was higher than the cut-off score for poor sleep. However, it was consistent with the mean PSQI of healthy subjects reported by Buysse et al (2008), as well as with two studies of healthy Arabic subjects (Devreux et al., 2012; Voss & Tuin, 2008).

This study was planned and conducted during 2007-9 as part of a bigger study on stress and health issues (Almadi et al. , 2012 b, Almadi et al. , 2013b). At the time of the study, an Arabic version of the PSQI was not available. Meanwhile, in 2009 Suleiman et al published their Arabic PSQI. Their sample size was relatively small (n=35) compared with the larger sample size of 104 in the current study. The internal consistency was lower with Cronbach's alpha of 0.65 compared to the current study of 0.71. None of the later studies that employed the Suleiman's Arabic PSQI had reported the Cronbach's alpha. Furthermore, their sample was derived from participants of Arabic origin but who lived in USA, whereas the current sample was Arabic subjects whose usual language was Arabic living in an Arabic country (Jordan).

The present results supported the Arabic PSQI as a valid self-report measure in Arabic adults with important implications for evaluating the subjective sleep quality; it is a tool that is inexpensive and easy to use. However, approximately 55% the study sample were well-educated subjects, but 45% were at the High School Certificate level. Hence, it is not confirmed as to what degree the PSQI results can be generalized to groups with different educational levels. Further study using a sample from varied educational backgrounds, socio-economic statuses, and clinical conditions will be needed to assess the confirmatory factorial analysis of the Arabic PSQI. Future studies could also examine the discriminatory and convergent validity by assessing the correlations of Arabic PSQI with other Arabic translated questionnaires in assessing sleep quality. In addition, it is suggested that future research examines the factorial structure of the PSQI across a wider range of ages in both the clinical and non-clinical setting. Future study using a larger sample size is needed to confirm the structural constrain of the Arabic PSQI using confirmatory factorial analysis (Beckstead et al., 2008). Notably, a thorough process employing a wide and varied range of translators was made in the course of developing an Arabic translation of the PSQI in order to balance issues of linguistic and cross-cultural concern (Hambleton, 1994; Van de Vivjer & Hambleton, 1996).

The 14-day interval between test and retest has been used in the validation of the Spanish version of PSQI (Hita-Contreras, et al., 2014). This interval is long enough that the participants do not remember their previous responses to the scale items yet not too long that their responses would change (Flanagan, 2013).

In summary, this Arabic version of the PSQI has demonstrated good internal consistency and reliability. We consider this Arabic version of the PSQI a suitable instrument to assess perceived sleep quality for Arabic speakers.

CHAPTER FIVE

STUDY FOUR

THE ASSOCIATION BETWEEN WORK STRESS AND INFLAMMATORY BIOMARKERS IN JORDANIAN MALE WORKERS

ABSRTACT

The study aimed to examine the association of work stress, assessed by effort-reward imbalance (ERI), and inflammatory markers; C-reactive protein (CRP) in 152 Jordanian male employees. Self-report work stress, anthropometric data, and blood for CRP analysis were collected. A significant correlation between ERI and CRP (r = 0.29, p < .01), and between waist circumference with CRP (r = 0.44, p < .01) was found. Central obesity explained most of the variance in CRP after controlling for various covariates, and ERI was not a significant predictor of CRP (Δ $R2$ = 0.02; β= 0.15, p = .052). However, when only the centrally obese group was considered, ERI accounted for 5.0% of the variability in the CRP (β = 0.24, p < .05). Results of this study confirm previous findings that obesity is significantly associated with CRP, and support the notion that higher ERI amongst obese workers is one small but significant predictor of increased levels of CRP.

INTRODUCTION

Physiological factors (obesity, low physical activity, or smoking) and psychological stress may contribute to inflammation with increased levels of inflammatory markers such as C-reactive protein (CRP) (Bellingrath et al., 2009; Geffken et al., 2001; Ohsawa et al., 2005; Visser, Bouter, McQuillan, Wener, & Harris, 1999). Notably, chronic stress was significantly associated with higher CRP among subjects with central obesity, suggesting that obese subjects may have an increased vulnerability to manifesting a higher degree of inflammation (Dixon et al., 2008; Shen et al., 2010). Chronic inflammation contributes to the pathogenesis of CVD (Ridker, Cushman, Stampfer, Tracy, & Hennekens, 1997), CHD (Koenig et al., 1999), T2DM (Han et al., 2002), and MtS (Laaksonen et al., 2004). CRP has showed a strong association with CVD, and a longitudinal study showed that CRP predicts future CVD in people free of traditional risks factors of hypertension, dyslipidaemia, diabetes and smoking (Ridker et al., 1997). Additional studies showed that CRP plays a role in atherothrombosis which is a primary cause of CVD, by inducing the expression of cellular molecules of proinflammatory cytokines by endothelial cells (Pasceri, Willerson, and Yeh, 2000). The association of CRP and CVD independent of traditional risks factors know to predict CVD has raised the question whether the psychological stress is associated with CRP (Suarez, 2004).

Considerable theoretical attention has been paid in recent years to the role of psychosocial stress in the development of chronic inflammation. Black (2002) hypothesized that repeated episodes of acute or chronic stress can lead to a chronic inflammatory process that in turn is implicated in cardiovascular metabolic disorders. According to Black's hypothesis, stress can induce an inflammatory process called the acute phase response that prepares the body to deal with injury, infection, and psychological stress. The acute phase response is characterized by the production of proinflammatory cytokines, which are the inducers of acute phase proteins such as CRP (Gabay & Kushner, 1999).

The work stress Effort-Reward-imbalance (ERI) model was introduced by Siegrist (1996) to provide a framework for examining work stress and its contribution to the development of disease. In the ERI model, effort is reciprocated by socially defined rewards. Efforts represent job demands and/or obligations that are imposed on the employee, while rewards include money, esteem, job security, and career opportunities. A lack of reciprocity between effort and reward at work (i.e., high effort and low reward) leads to a state of emotional stress (distress) and ill health. In addition, the model assumes that distress will be higher in highly overcommitted employees than less overcommitted employees.

Little attention has been given to the effect of chronic work stress in a normal work environment on the inflammatory process in healthy men. There have been only a few studies that investigated the association between ERI and CRP.

A cross-sectional study of German school teachers with high ERI showed significantly higher CRP compared to teachers with low ERI (Bellingrath et al., 2009). Furthermore, individuals with a high ERI had an increased plasma level of CRP following a mental stress task compared to those with a low ERI (Hamer et al., 2006). In this current field study of a Jordanian cohort, we collected data on work stress (ERI and over commitment), as well as data with a possible impact on work stress and CRP association including age (Wener, Daum, & McQuillan, 2000), smoking, perceived stress (McDade, Hawkley, & Cacioppo, 2006), physical activity (Kasapis &Thompson, 2005), sleep (Okun et al., 2009), blood pressure (Blake, Rifai, Buring, & Ridker, 2003), and biochemical indices of glucose and lipids (Fröhlich et al., 2000).

This study sought to answer the following questions: (a) Does chronic work stress measured by ERI predict an increase in the inflammatory marker, CRP; and (b) Does accompanying central obesity predict a greater degree of inflammation? The study specific hypotheses are: ERI is positively associated with CRP, and centrally obese workers show a stronger association between ERI and CRP than non obese workers

METHODS

Participants

Jordanian male workers (*n* = 264) were recruited from the veterinary, agricultural, textile, and poultry industries. Self reported questionnaires (Appendix B) were used to exclude all cases with physical or psychological conditions known to influence CRP plasma levels (Gabay & Kushner, 1999; Maes et al., 1997). Subjects were encouraged to seek information from their family physician or the study physician if they were in doubt about these conditions., which included inflammatory diseases, CVD, previous stroke, rheumatic disease, liver disease, viral or recent infection, connective tissue disease, peripheral blood disease, tumor, neurological and endocrine disease, recent injury or surgical operation, and mental or psychological problems. The study excluded all subjects taking medications including those with effects on the inflammatory response, cholesterol-lowering agents, steroids, reductase inhibitors (statins), nonsteroidal anti-inflammatory drugs (NSAIDs) or analgesic medications, antidepressants, sedatives, antipsychotic medications, and hormone and hormone-related therapy (Elgharib, Chi, Younis, Wehbe, & Krishnaswamy, 2003; Ridker et al., 1997; Ridker, Rifai, Pfeffer, Sacks, & Braunwald, 1999). All subjects gave informed consent for this study, which was approved by the Human Research Ethics Committee of The University of Sydney and Jordan University.

Demographic Data

Data on age, race, work characteristics (full-time/part-time, night/ day shift), smoking status, and alcohol intake were collected using self-reported questionnaires (Appendix B)

Study Questionnaires

Four Arabic translated questionnaires were administered to subjects: (1) work stress related to ERI and work over commitment (Almadi et al., 2013a); (2) Perceived Stress Scale (PSS) (Almadi et al., 2012a); (3) the short version International Physical Activity Questionnaire (IPAQ) (Al-Hazza, 2006); and (4) the Pittsburg Sleep Quality Index (PSQI) (Almadi et al., unpublished). The official Arabic version of IPAQ and its scoring system are available at the IPAQ web site (www.ipaq.ki.se). The Arabic PSS, ERI, and PSQI (see Appendix C) have undergone a translation process that was examined for factorial structure, and tested for reliability. The translation and validation process for these questionnaires are described in separate reports (Almadi et al., 2012 a, 2013 a)

Work stress was measured by the Arabic translated version of the ERI questionnaire (Almadi et al., 2013a) (see Appendix C for the Arabic ERI), with an internal reliability as measured by Cronbach's alpha coefficient of 0.85. The ERI contains 17 items: "Effort" with 6 items and "Reward" with 11 items. Items on

the effort scale were answered in two steps. First, participants agreed or disagreed whether the item content reflected their typical work situation. Those who agreed that it was typical were also asked to evaluate the extent to which these conditions produced distress using a 4-point rating scale, with higher scores indicating higher distress. The 11 items measuring reward are framed similarly, but the coding is reversed, so that a lower summary score for reward indicates a higher subjective rating of distress due to low reward. The overall ERI score was calculated as effort divided by reward; a score of one represents a balance of effort and reward, whereas higher scores reflect a perceived disproportionate effort. In addition, participants were asked to respond to six additional questions on work over commitment scored on a 4-point scale and with a total score range of 0–24. A higher over commitment score indicates high-risk conditions for physical or mental disorders (Van Vegchel, de Jonge, Bosma, & Schaufeli, 2005).

Perceived stress was assessed by the Arabic translated version of PSS-14 (Almadi et al., 2012a) (see Appendix C for the Arabic PSS-14), with Cronbach's alpha coefficient = 0.68. The scale has 14 items related to the level of perceived stress experienced over the previous month and measures the degree to which situations in a person's life are perceived as stressful. Each item is answered on a 5-point response giving a scale range of 0–56, with a high score representing a high perceived stress level (Cohen et al., 1983).

Participants were asked to answer questions regarding their physical activity level using the validated Arabic version of the IPAQ (Al-Hazza, 2006) (see

Appendix C for the Arabic IPAQ). The questionnaire contains items about physical activity patterns over the previous week in four domains: work, home, leisure, and travel. IPAQ provides a score of energy expenditure expressed as MET-min/week, computed by multiplying the metabolic equivalent (MET) intensity of the activity X the number of minutes per week the activity was performed. A MET is defined as the number of calories consumed by an individual per minute in an activity relative to the basal metabolic rate. Therefore, one MET is the energy consumption of that individual while at complete rest. Based on this MET-min/week calculation (Ainsworth et al.,1993), the IPAQ allows classification of subjects' physical activity level into three categories: low (less than 600 accumulated over a week), moderate (between 600 and 1500 accumulated over a week), and high (more than 1500 accumulated on 3 days, or more than 3000 accumulated over a week) (Craig et al., 2003)

Sleep quality was measured by an Arabic translated version of the PSQI (Almadi et al., unpublished) (see Appendix C for the Arabic PSQI), with Cronbach's alpha coefficient = 0.66. The scale is a 19-item questionnaire about sleep quality in the previous month. Subscale scores of 0 to 3 were generated for seven components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The sum of responses of all seven components yields a global score of sleep quality. A subject with a global PSQI score greater than 5 is considered to be a poor sleeper, while a subject with a value less than 5 is considered to be

a good sleeper (Buysse et al., 1989). In the analyses of this study, the global PSQI score was used as a continuous variable.

Physiological and Biochemical Measurements

Following an overnight fast, subjects attended a private room at their worksites between 6.30 am to 8.30 am. Subjects were seated for at least 5 min before blood pressure was measured with a standard mercury sphygmomanometer. Weight and height were measured with a calibrated balance beam scale and stadiometer, respectively. The waist circumference was obtained by measuring at the narrowest point of the abdomen, between the lower costal (tenth rib) and the iliac crest, using a flexible non elastic measuring tape. Body mass index (BMI) was calculated as mass (kg) divided by height squared (m2). Fasting venous blood samples were then collected in plain tubes and centrifuged at 1500 g for 10 min at room temperature, and the serum samples were frozen at -20°C until assayed. High-sensitivity CRP was determined with an automated Roche Diagnostics modular analyzer (Roche, Switzerland), using a particle-enhanced immunoturbidimetry method with a measuring range of 0.085–1600 mg/L. Blood glucose and blood lipid profile (total cholesterol, high-density lipoprotein-cholesterol, triglycerides, and low-density lipoprotein-cholesterol) were determined with an Accent 200 automated chemistry analyzer (PZ Cormay S.A., Poland) using an enzymatic kit (Randox, UK). Data collection and blood analysis were performed during the period of September to October 2007

Statistical Analyses

Any subjects with serum level of CRP > 10 mg/L have had been excluded from the study. The 25 subjects that were excluded from the study were composed of 19 subjects with CRP > 10 due to known medical conditions that elevate the CRP, and 6 subjects with CRP > 10 due unknown medical conditions factors. Also, there we were 87 subjects with missing data for one or more study parameters used in regression model have been excluded. Forty one of these participants were excluded due to insufficient or missing samples; 27 were excluded for missing work stress questionnaires; and 19 were excluded for missing physiological measurements or age. Thus, data from 152 subjects were used in the final analysis. The distributions of CRP and triglycerides were skewed and therefore log-transformed before analysis.

All of the analyses were conducted with SPSS (IBM, SPSS version 17). Descriptive statistics were determined and *t* tests were used to compare the means of the main variables for the high ERI group (ERI > 1) and the low ERI group (ERI ≤1), and the inter correlations between CRP and all study variables were examined. Hierarchical linear regressions were used to examine the relationship between ERI and CRP for the whole study population and were repeated separately for the obese and non obese subgroups. The following covariates were used in the regression analyses as they showed an association with the inflammatory factor,

CRP: waist circumference, age, glucose, cholesterol, triglycerides, high density lipoprotein-cholesterol (HDL-C), low-density lipoprotein-cholesterol (LDL-C), and blood pressure. Statistical significance was accepted at $p < .05$, and descriptive results are expressed as mean ± SD.

RESULTS

The mean age of the 152 male Jordanian workers was 35.3 ± 8.9 years with a high proportion (71.9%) aged between 26 and 45. In this cohort, 75.2% were blue-collar workers (factory manual workers), 87.6% worked for private companies, and 98.7% were full-time workers. Table 5.1 shows the psychological, physical, physiological, and biochemical characteristics among this study population of Jordanian male workers. The mean BMI was 26.8 ± 3.8 kg/m^2. According to the World Health Organization's definition of obesity (30 ≤ BMI < 40 kg.m-2) (WHO, 2004), 22.2% of the sample were obese. According to the International Diabetes Federation (2005), 51% of the sample satisfied the criteria of high waist circumference of ≥ 94 cm, and 11.1% satisfied the criteria of raised blood pressure (systolic BP > 130 or diastolic BP > 85 mmHg or currently taking medication for previously diagnosed hypertension). According to IPAQ, 58.7% had a low physical activity level. The PSQI indicated that 47.4% were classified as poor sleepers (PSQI > 5). The data revealed 49.7% were active smokers, and none took alcohol. In addition, the median for triglycerides was

120 mg/dL, and the interquartile range was 87–198 mg/dL, while the median for CRP was 2.04 mg/L, and interquartile range was 1.13–4.66 mg/L.

Table 5.1: Psychological, physical, physiological and biochemical characteristics of Jordanian male workers (N=152).

	Mean (SD)
Effort / Rewards ratio	1.24 (0.41)
Over commitment	14.5 (3.5)
Perceived stress	25.8 (6.3)
Age (year)	35.4(9.0)
Body mass index ($kg.m^{-2}$)	26.8 (3.8)
Waist circumference (cm)	93.0 (11.4)
Physical activity (MET -min/ week)	1136 (1741)
Sleep Quality	5.10 (2.53)
Fasting blood glucose (mg /dL)	89.6 (12.0)
Cholesterol (mg/dL)	187.3 (37.3)
HDL-C (mg/dL)	43.2 (9.4)
LDL-C (mg/dL)	112.7 (30.9)
Triglycerides (mg/dL)	146.9 (82.4)
CRP(mg/L)	3.14 (2.58)
SBP	123 (8)
DBP	81 (5)

Work Stress and CRP

The log-transformed CRP (CRP log) showed a significant correlation with ERI (Table 5.2). When the workers were divided into high stress (ERI > 1, *n* = 108) and low stress (ERI ≤ 1, *n* = 44), the values for CRP were 3.38 (±2.26) mg/L and

2.54 (± 2.22) mg/L, respectively, and were significantly different for the two groups ($p < .05$). CRP log was positively correlated with age, BMI, waist circumference, hypertension, glucose, cholesterol, and triglycerides, but negatively correlated with HDL-C (Table 5.2).

Table 5.3 shows the hierarchical linear regression of CRP. In Step1, all covariates of CRP were entered including age, hypertension, waist circumference, fasting blood glucose, cholesterol, HDL-C, and triglycerides. These variables explained a significant proportion of variance in CRP with $R2 = 0.245$ (standard error of the estimate, SEE = 0.78; F (1,151) = 6.74, $p < .01$). In Step 2, ERI ratio was forced in the regression analysis in addition to all covariates of CRP and, as a result, the whole model was not a significant predictor of CRP ($R2 = 0.265$; SEE = 0.77; $F(1,151) = 3.85$, $p = .052$). ERI alone did not significantly predict CRP (**Δ** $R2 = 0.020$, β= 0.15; t (151) = 1.96, $p = .052$). However, this analysis demonstrated that the strongest predictor of CRP was waist circumference. For the measures of obesity, BMI, and waist circumference, we applied waist circumference in the linear regression analysis but not BMI to avoid co linearity, since both measures were highly correlated ($r = 0.83$) and related.

In a separate analysis, the above hierarchical linear regression was repeated using data only from subjects with central obesity (waist circumference ≥ 94 cm; $n = 78$). The data showed that only ERI, and not other variables, were significantly associated with CRP. ERI accounted for 5.0% of the variability in the CRP (β = 0.241; t (78) = 2.161, p = .034). On the other hand, when only subjects

without central obesity (waist circumference < 94 cm, *n* = 74) were analyzed, waist circumference and not ERI or any other variable was significantly positively associated with CRP (β = 0.369; *t* (74) = 2.733, *p* < 0.01).

Further analysis of data from overweight subjects (BMI ≥25 kg/m2, n=106) showed that, after adjustment for other factors, work stress was not significantly associated with CRP.

Table 5.2: Correlations between CRP log with Physical, Physiological and Biochemical variables.

	CRP log	P value
Effort/Reward ratio	0.294	< 0.01
Perceived stress	-0.049	ns
Over commitment	-0.060	ns
Age (year)	0.264	< 0.01
BMI ($kg.m^{-2}$)	0.430	< 0.01
Waist circumference (cm)	0.441	< 0.01
Hypertension(yes/no)	0.231	< 0.01
Smoking (yes/no)	-0.096	ns
Physical activity (MET -min/week)	-0.017	ns
Sleep Quality	-0.041	ns
Fasting blood glucose (mg/dL)	0.248	< 0.01
Total Cholesterol (mg/dL)	0.193	< 0.01
Triglycerides-log (mg/dL)	0.249	< 0.01
HDL-C (mg/dL)	-0.161	< 0.01

Note. ns; not significant

Table 5.3 Hierarchical linear regression of (CRP log)

	Step1		Step2	
	B±SEE	ß	B±SEE	ß
Age	0.005±0.008	0.05 ns	0.005±0.008	0.06 ns
Waist circumference (cm)	0.024±0.007	0.04 **	0.021±0.007	0.28*
Hypertension (yes/no)	0.347±0.212	0.13 ns	0.258±0.215	0.09 ns
Fasting blood glucose(mg/dL)	0.008±0.006	0.11ns	0.006±0.006	0.09 ns
Total Cholesterol (mg/dL)	0.003±0.003	0.14 ns	0.003±0.003	0.12 ns
Triglycerides (mg/dL)	-0.021±0.155	-0.02 ns	-0.004±0.154	-0.01 ns
HDL-C (mg/dL)	-0.011±0.009	-0.12ns	-0.011±0.009	-0.11 ns
Effort/Reward ratio			0.324±0.166	0.1 5 *
R^2	0.245**		0.265 ns	

Notes. β = standardized coefficients; B = unstandardized coefficients; SEE = standard error of the estimate; ns = not significant; **Δ** R^2 = 0.020 for Step 2. *$p \leq .05$. **$p \leq .001$.

DISCUSSION

The key finding of this study is that work stress as measured by ERI as well as obesity measures (BMI and waist circumference), biochemical indices (cholesterol, triglycerides), and hypertension were significantly correlated with CRP. Central obesity explained most of the variance in CRP after controlling for other covariates. To our knowledge, this is the first study that has reported the CRP values for Jordanians. The median value of CRP agreed with that reported for a large American cohort, the Framingham Heart Study (Wilson et al., 2008). The strong association between waist circumference and CRP found in this study

confirms previous such findings (Huffman, Whisner, Zarini, & Nath, 2010), and suggests that at least half of the current Jordanian cohort may be at risk of MtS, since visceral obesity also predicts the MtS (Han et al., 2002).

The physiological basis for the association of ERI and CRP hinges upon the relationship between proinflammatory cytokines, CRP, and stress that is attended by the hypothalamic-pituitary-adrenal (HPA) and sympathetic axes. This system stimulates an increased production of proinflammatory cytokines (Black, 2002), which have been associated with a number of psychosocial stressors including symptoms of depression, posttraumatic stress disorder, and caregiving for a spouse with dementia (Kiecolt-Glaser et al., 2003; Lutgendorf et al., 1999).

The current results are compatible with the hypothesis that, at least in part, the association of ERI with CRP is due to the mediating role of risk factors, in particular, visceral obesity. We found that when considering only subjects with central obesity, ERI was significantly associated with CRP and accounted for 5.0% of its variability. When considering subjects without central obesity, ERI was not significantly associated with CRP. Our findings implicate work stress as an added stressor in obese individuals that may augment the degree of inflammation and future risk of MtS. Further, it is noted that central fat secretes proinflammatory cytokines (Kern et al., 2001). These proinflammatory cytokines not only induce CRP production by the liver (Papanicolaou, Wilder, Manolagas, & Chrousos,

1998), but also stimulate the HPA axis and activate cortisol secretion (Mastorakos, Weber, Magiakou, Gunn, & Chrousos, 1994). Therefore, proinflammatory cytokines play a critical role in the development of risk factors of MtS such as glucose intolerance and dyslipidemia (Pickup, Mattock, Chusney, & Burt, 1997).

Generally, participants in the present study who displayed a high ERI showed an elevated CRP without any study provocation. These results have provided evidence that low-grade inflammation was predicated by work stress and lend support to previous findings, which found that men with higher ERI demonstrated greater CRP responses when subjected to mental stress tasks (Hamer et al., 2006). However, these authors did not find a relationship between ERI and CRP at baseline. Their study subjects were healthy, non smokers of younger age, with a healthier BMI than the current study. Most importantly, they experienced less work stress (ERI) when compared with the current study's subjects. Furthermore, the current study did not involve additionally imposed mental stress tasks. Since work occupies a large portion of our lives, chronic work-related stress could have a negative impact on our health, and is an added health risk in the presence of obesity. Evidence provided in this study for an association between CRP and work stress in individuals without known diseases supports the notion that work stress mediates an inflammatory process, which predisposes susceptible individuals to CVD and MtS. Additionally, the current findings highlight the importance of evaluating the role of psychological stress

especially in overweight and obese workers and those in the early stages of CVD, and for occupational health bodies to adopt CRP as a biochemical measure to determine the impact of work stress on the general worker.

One limitation of this study lies with its relatively small sample size, although it is larger than some other studies of psychosocial factors and CRP (McDade et al., 2006; Suarez, 2004). We did not use the imputation technique for missing data-replacement to avoid the possibility of biased estimates in the regression (Allison, 2001; Enders, 2010; Little & Donald, 2002; Schafer & John, 2002. We were also able to replicate many of the known associations with CRP (e.g., BMI, waist circumference, age, glucose, and lipids). A further limitation was that only one inflammatory marker (CRP) was examined, although other inflammatory markers are similarly predictive of diseases and play a role in CVD development (Pearson et al., 2003). However, CRP is considered to be the strongest predictor of future CVD and MtS when compared with other inflammatory markers. The strength of this study is that it is the first field study that demonstrates a positive relationship between work stress and the inflammatory marker CRP in a Jordanian cohort, and reports the CRP values for Jordanian working group. In summary, we found that work stress predicts a small inflammatory response in a sample of overweight or centrally obese Jordanian worker.

CHAPTER 6

STUDY 5

ASSOCIATIONS AMONG WORK-RELATED STRESS, CORTISOL, INFLAMMATION, AND METABOLIC SYNDROME

ABSTRACT

This cross-sectional study examined the relationship between work-related stress, cortisol, and C-reactive protein (CRP) in predicting metabolic syndrome (MtS). Self-reported work stress measured by the Effort Reward imbalance ratio (ERI), anthropometric data, CRP, and saliva cortisol were collected from 204 Jordanian male workers. ERI and cortisol were significantly associated with the presence of MtS (OR=4.74, 95% CI: 2.13-10.55; OR=3.03, 95% CI: 2.08-4.40; OR=11.50, 95% CI: 2.16-59.14, respectively). The odds of MtS in men with high ERI and high cortisol were significantly higher than that of men with low ERI and low cortisol (OR=11.50, 95% CI:2.16-59.14). CRP was significantly associated with MtS (OR=2.51, 95% CI:1.50-4.20). The odds of MtS were significantly higher in centrally obese men with both high ERI and CRP level. Thus, high ERI along with high cortisol or high CRP increases the risk for MtS, especially among centrally obese men.

INTORDUCTION

Work related stress

Work-related stress may adversely affect physical health (Leka & Jain, 2010). Psychological stress in the workplace has mainly been investigated through two theoretical models, the demand-control (DC) model (Karasek, 1979; Karasek & Theorell, 1990) and the Effort-Reward imbalance (ERI) model (Siegrist, 1996). The DC model emphasizes task-level control, whereas the ERI model emphasizes employee perception of effort-reward imbalance (Tsutsumi & Kawakami, 2004). Effort-Reward imbalance is a serious form of psychological work-related stress, since workers may feel under-compensated for their efforts. The ERI model has advantages over the DC model in that ERI focuses on stressors such as adequate payment, job security, job changes, and job promotion prospects (Griep et al., 2009). A high level of ERI is associated with components of metabolic syndrome (MtS), namely hypertension (Peter et al., 1998), high body mass index (BMI) (Kivimaki et al., 2002), increased triglyceride level (Fan et al., 2009), and high fasting glucose (Kumari et al., 2004).

Stress response

Stress activates two fundamental axes, the hypothalamus-pituitary-adrenal (HPA) axis and the sympatho- medullary -adrenal (SMA) axis (Figure 6.1). Altered activity of both the HPA and SMA axes predisposes an individual to increased risk of developing MtS (Bjorntorp & Rosmond, 2000). However, these two axes act through separate pathways, one through hypercortisolemia, and the other through cytokines and inflammatory reactions (Bellingrath et al., 2009; Black, 2003; Sternberg et al., 1992; Yudkin et al., 1999).

Stress, Cortisol, CRP and MtS.

The first pathway through hypercortisolemia involves increases in cortisol levels. Elevated cortisol levels increase glucose production within liver cells resulting in hyperglycemia. In addition, increased cortisol levels inhibit insulin secretion from pancreatic β-cells, as well as inhibit muscle glucose uptake. These effects lead to impaired glucose tolerance and insulin resistance (Amatruda et al., 1985). Cortisol also stimulates the breakdown of stored triglycerides in the adipose tissue, resulting in an increase in free fatty acids in the plasma. A higher level of free fatty acids prevents the release of insulin, further worsening glucose intolerance and insulin resistance. Density of cortisol receptors is higher in intra-abdominal (visceral) fat than in other fat deposits, and the activity of cortisol in fat accumulation is accentuated in visceral adipose tissue (Bjorntorp &

Rosmond, 2000; Salehi et al., 2005), suggesting a mechanism by which excessive cortisol causes further abdominal obesity (Qi & Rodrigues, 2007).

The second pathway involves cytokines that induce acute phase proteins, such as C-reactive protein (CRP) (Gabay & Kushner, 1999). CRP, one of the best-characterized systemic inflammatory biomarkers, may interfere with insulin signaling and down-regulate corticosteroid-binding globulin, resulting in increased free cortisol levels and consequentially insulin resistance as well as other manifestations of MtS (Hotamisligil et al., 1996).
Furthermore, proinflammatory cytokines inhibit lipoprotein lipase activity and increase the concentration of non-esterified fatty acid**s,** contributing to dyslipidemia and insulin resistance (Perry et al., 2001). Central obesity amplifies the release of proinflammatory cytokines (Kern et al., 2001). Notably, the relationship between stress and inflammation markers (such as CRP) is observed mostly among subjects with central obesity (Almadi, Cathers, Mansour, A. M, & Chow, 2012b; Shen et al., 2010).

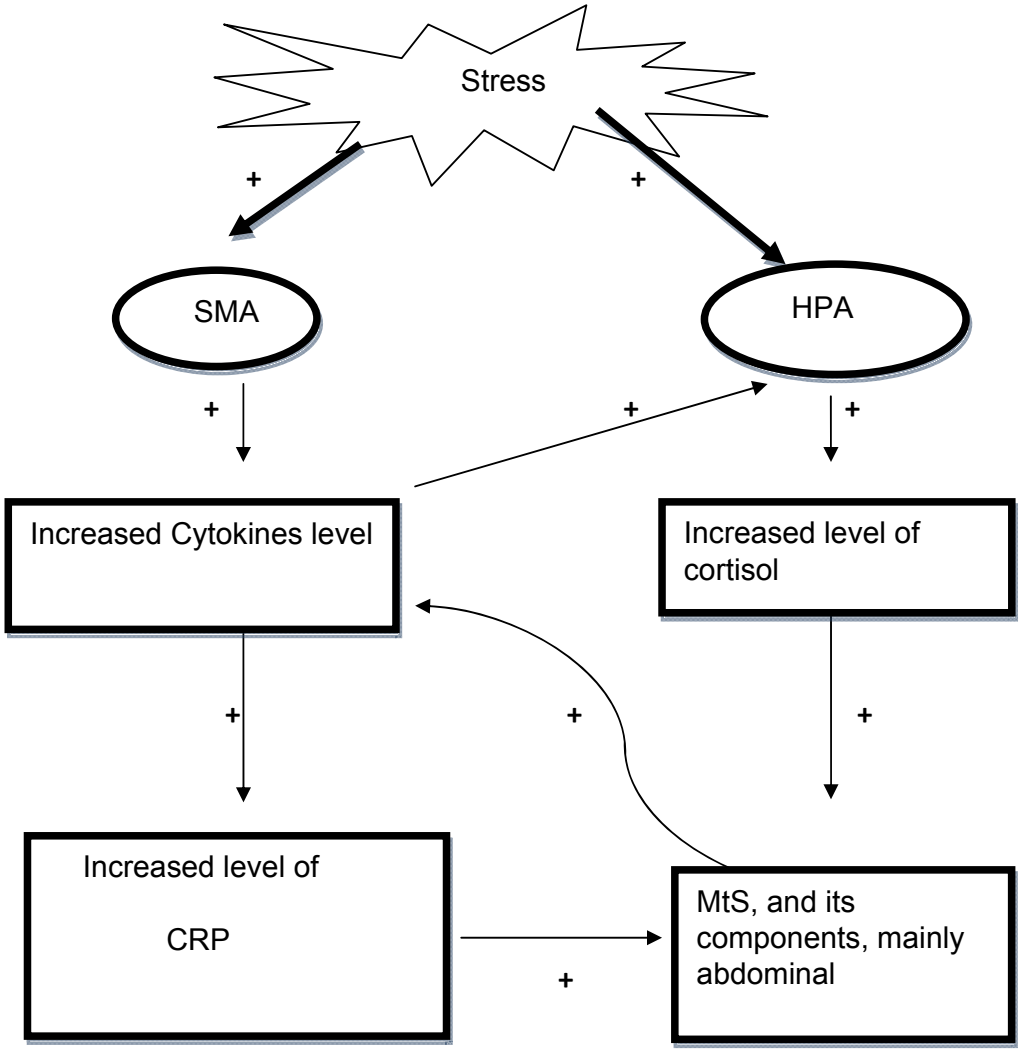
High stress levels as measured by the ERI (Bellingrath et al., 2009) and mood disturbance (Lutgendorf et al., 1999) induce low-grade inflammatory responses with increased production of proinflammatory cytokines (Black, 2002). Subsequently, these cytokines induce an increase in CRP production (Gabay & Kushner, 1999). This increase in CRP is thought to contribute to the pathogenesis of MtS (Laaksonen et al., 2004). Therefore, in this study, we sought to explore

the links between chronic work stress as measured by ERI and the MtS through the stress marker cortisol and the inflammatory marker CRP. These links are explored specifically in obese subjects.

Study Hypotheses and Questions

The current study sought to answer the following questions: (a) Does ERI predict an increased likelihood of MtS and its components? (b) Does ERI that is associated with high level of cortisol predict a greater likelihood of MtS and its components? c) Does ERI that is associated with a high level of CRP predict an increased likelihood of MtS and its components? (d) Does the high CRP in central obesity predict a greater likelihood of MtS compared to non-central obesity?

Figure 6.1: Stress and MtS pathways.



SMA; Sympathetic-adrenal-medullary (SAM) axis, **HPA;** Hypothalamic-pituitary-adrenal **, CRP;** C- reactive protein**,** + **;** Positive feed

METHODS

Participants

Jordanian male workers (N=264) were recruited from the veterinary, agricultural, textile, and poultry industries. Screening questionnaires were used to exclude all men with conditions known to influence cortisol secretion and increase CRP plasma levels. Excluded conditions included physical and endocrine abnormality, depression or other mental and psychiatric conditions, substance abuse, inflammatory diseases, CVD, previous stroke, rheumatic disease, diabetes mellitus, liver disease, viral or recent infection, connective tissue disease, peripheral blood disease, tumor, neurological and endocrine disease, and recent injury or surgical operation (Elgharib et al., 2003; Gaby & Kushner, 1999; Ridker et al., 1997; Ridker, et al., 1999). We excluded all male workers on steroid-based medications, hormone or hormone-related therapy, cholesterol lowering agents, antidepressants, psychotropic medications, or on any medications or drugs that can affect cortisol or lipid levels (Liu, Bravata, Cabaccan, Raff, & Ryzen, 2005; Ridker et al., 1997; Ridker et al., 1999). Finally, subjects were excluded if they were taking medications that affected inflammatory response, reductase inhibitors (statins), non-steroidal anti-inflammatory drugs (NSAIDs), analgesic medications, antidepressants, sedatives, antipsychotic medications, or if they had acute illness or were employed in night-shifts (Elgharib et al., 2003; Gabay & Kushner, 1999; Liu et al., 2005; Ridker et al., 1997; Ridker et al., 1999). All subjects gave informed consent for this study, which was approved by the

Human Research Ethics Committee of The University of Sydney and Jordan University.

Materials and procedures

Information was collected on age, race, work characteristics (full-time/part-time), smoking status (current smoker, non-smoker), and alcohol intake. Four self-reported questionnaires in Arabic were administered: the Effort-Reward Imbalance (ERI) questionnaire (Almadi et al., 2013a) ; the Perceived Stress Scale (PSS) (Almadi et al., 2012a); the International Physical Activity Questionnaire (IPAQ) (Al Hazza, 2006) ; and the Pittsburgh Sleep Quality Index (PSQI) (Almadi et al., unpublished).

The Arabic version of the ERI questionnaire (Almadi et al.,, 2013a) has a Cronbach's alpha coefficient of 0.82. It contains 17 items, 6 are related to "Effort" and 11 items are related to "Reward." The items of Effort and Reward include 5 responses and are answered in 2 steps. In the first step, the respondents are asked whether the item content describes a typical experience in their workplace. If the participants agree, they are asked about the level of distress by choosing 1 item of a 4-point Likert scale, ranging from 1 to 4 (1 = "I am not at all distressed" to 4 = "I am very distressed"). The ERI ratio was calculated as (Effort/Reward) × correction factor (correcting for the difference in the numbers of items of the 2 scales; Effort and Reward). A ratio of 1 represents a balance of Effort and Reward, whereas a ratio greater than 1 reflects disproportionate effort. Individuals with an ERI ratio ≥1 were classified as the

stressed group and the remainder with a ratio <1 were in the non-stressed group. Participants were also asked to respond to 6 additional questions on work "Over commitment," which was scored on a 4-point Likert scale, ranging from 1 to 4 (1 = "full disagreement with the statement" to 4 = "full agreement"). Higher Over commitment scores indicate high-risk conditions for physical or mental disorders (Van Vegchel et al., 2005).

Perceived stress was assessed by the Arabic version of the PSS (Almadi et al., 2012a) with a Cronbach's alpha coefficient of 0.68. The scale measures the level of perceived stress experienced over the previous month, and consists of 14 items with a 5-point Likert scale, ranging from 0 to 4 (0 = "never" to" 4 = "very often"). A high score represents a high level of perceived stress (Cohen et al., 1983).

Participants were asked to answer questions regarding their amount of physical activity using the Arabic version of the IPAQ (Al-Hazza, 2006). The IPAQ has undergone extensive validation and reliability assessment, and it contains items pertaining to physical activity patterns over the previous week in 4 areas: work, home, leisure, and travel (Craig et al., 2003).

Sleep quality was measured by the Arabic translated version of the PSQI (Almadi et al., unpublished), with Cronbach's alpha coefficient of 0.66. The PSQI is a 19-item questionnaire about sleep quality in the previous month. The total scores of all items are computed to generate 7 component scores with subscale scores of 0 to 3 for the 7 components: sleep quality, sleep latency, sleep duration,

habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The sum of responses of all 7 components yields a global score of sleep quality. A subject with a global PSQI score greater than 5 is considered to be a poor sleeper, and a subject with a value of ≤ 5 is considered to be a good sleeper (Buysse, et al., 1989).

In addition to the self-reported measures, male subjects also provided biologic and physiologic data. Subjects were seated for at least 5 minutes in a private room before blood pressure was measured with a standard commercial sphygmomanometer (Accson, UK). Subject height and weight were recorded, and the waist circumference was obtained by measuring at the narrowest point between the lower costal (tenth rib) and the iliac crest. BMI was calculated as weight (kg) divided by height squared (m^2). Venous fasting blood samples were collected in plain tubes and centrifuged at 1811 (X g) for 10 minutes at room temperature, and serum samples were frozen at −20°C until assayed. Fasting blood glucose (FBG) and blood lipid profile (total cholesterol, HDL-C, triglycerides, and LDL-C) were determined using enzymatic method kits; Glucose, Triglycerides, Cholesterol, HDL –C and LDL-C kits (Randox, UK) (Accent 200 automated chemistry analyser, Poland). High-sensitivity CRP was determined using a particle-enhanced immunoturbidimetry method; hs CRP kit with a measuring range of 0.085–1600 mg/L (Automated Roche Diagnostics modular analyzer, Roche, Switzerland).

Subjects also provided self-sampling of saliva for cortisol assessment. Cortisol assessment through saliva sampling has the advantage of easy and non-invasive sample collection (Kirschbaum et al, 1990), especially in an ambulatory setting. For example, subjects may collect saliva at any time at home or in the office. Therefore, subjects may collect saliva at any time at home or office. Subjects were given clear written instructions with graphic illustrations in addition to verbal instructions. Instructions provided the method of saliva collection, with emphasis on the importance of timing of saliva collection, and all necessary precautions associated with the collection (See Appendix D).

Samples were collected using cotton dental rolls that were chewed by subjects for 1 minute. Cotton rolls were then stored in Salivette tubes (Sarstedt Pty Ltd, Australia). Participants were instructed to give 3 saliva samples in a working day. The first sample was collected immediately after early morning awakening, while they were in bed (sitting up). Subsequent samples were taken at 10 and 20 minutes after awakening, but before brushing their teeth, eating, drinking, smoking, doing physical activity, having shower, or exposing their eyes to direct room artificial light or sunlight (Clow, Thorn, Evans, & Hucklebridge, 2004). Participants were asked to time their saliva collection accurately and write the time of awakening and the time of collection of each sample. Salivette tubes were bagged and stored in their home freezer until they came for their morning blood collection appointment.

Saliva samples were centrifuged for 15 minutes at 3,000 rpm, and salivary cortisol was measured immediately once the laboratory received the samples. Salivary cortisol levels were measured on an automated immunoassay analyzer (Elecsys, Roche, Germany). The study Coordinator (TA) performed all biochemical analyses for saliva cortisol and blood sample measurements using Sukina Medical Laboratory facility in Amman, Jordan

The area under the curve (AUC) was calculated using the measurements of cortisol concentration over the 3 time points of 0, 10, and 20 minutes (Pruessner, Hellhammer, Pruessner, & Lupien, 2003). The AUC for cortisol level after awakening was used as the index of HPA axis activity (Clow et al., 2004; Pruessner et al., 1997; Steptoe, Cropley, Griffith, & Kirschbaum, 2000). This index shows a high degree of intra-individual stability when measured over several days or weeks (Pruessner et al., 1997).

Data from 204 subjects were used for the cortisol analysis with data from 60 subjects being excluded due to either insufficient or missing cortisol samples, or missing data for one or more of the main parameters. Data from 146 subjects were used in the final CRP analysis with data from 79 subjects being excluded due to either CRP levels > 10 mg/L due to acute infections, or other inflammatory conditions (Ford et al., 2003; Jialal et al., 2004), or missing data for any of the study's main parameters.

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MtS was defined according to the International Diabetes Federation (International Diabetes Federation, 2005) criteria of central obesity (waist circumference of ≥94 cm for men), plus any 2 of the following 4 factors: triglyceride (TG) level of ≥150 mg/dL, HDL -Cl of <40 mg/dL, blood pressure (systolic blood pressure [SBP] level of ≥130 or diastolic blood pressure [DBP] level of ≥85 mm Hg), or fasting plasma glucose of ≥100 mg/dL.

Statistical analyses

Baseline characteristics were compared across stress groups (ERI ≥1 and ERI <1) and two-tailed p values were calculated using independent sample t-tests (Sheskin, 2003, page 398). We compared the of MtS across work stress and saliva cortisol (AUC) tertiles or CRP tertiles using chi-square and Fisher's exact tests. The chi-square or Fisher's test is a statistical test of independence, and is applied to the relationship between two categorical variables. In this case the variables are: MtS (have or not have MtS), and cortisol or CRP tertiles (high, medium, low) (David & Sutton, 2004). The distributions of CRP, physical activity score and triglycerides were skewed and were therefore log-transformed before analysis.

The independent associations of ERI ratio, cortisol (AUC), and CRP with MtS were calculated, adjusting for potential confounders, age (Hildrum, Mykletun, Hole, Midthjell, & Dahl, 2007; Wener et al., 2000), smoking (Oh et al., 2005; McDade et al., 2006; Kasapis & Thompson, 2005), physical activity (Lakka & Laaksonen, 2007), perceived stress (Yoo, Eisenmann & Franke, 2009), sleep

(Jennings et al., 2007; Okun et al., 2009), awakening time (Clow et al., 2004), work type (Sanchez-Chaparro et al., 2008), and work Over commitment (Steptoe, Siegrist, Kirschbaum, Marmot, 2004). Independent variables including the ERI ratio, cortisol (AUC), CRP, awakening time, age, type of work, physical activity, and Over commitment scores that were at 25% level of significance during univariate logistic regression were carried forward to multivariable binary logistic regression for adjustment (Hosmer & Lemeshow, 2000). PSS score, PSQI, smoking status and education level with a significance level >25% were excluded from further analysis. We used multivariable binary logistic regression analysis to adjust for the confounding factors. In addition, we included an interaction term in the multivariable logistic regression model to assess the possible interaction between the ERI ratio and cortisol or CRP (Hosmer, Lemeshow & Sturdivant 2013) . We also conducted separate analyses for the stress groups and for central obesity groups. Multivariable linear regression analysis was also carried out to evaluate the association between ERI ratio and cortisol (AUC), as well as between ERI ratio and CRP with each of the 5 components of MtS (Kleinbaum, Kupper, Nizam, & Rosenberg, 2013). For linear regression analysis, each component, as dependent variable, was taken on a continuous scale. A two-tailed p-value of ≤5% was considered significant during multivariable regression analysis. All statistical analyses were performed in SPSS (version 19, IBM).

RESULTS

Participant characteristics

The majority of Jordanian workers who participated in this study (74%) were aged 26–45 years. In terms of type of work, 74% were engaged in factory manual work (Labourer), 88% worked for private companies, and 99% were full time workers. Table 6.1 displays the means and standard deviations for all of the study variables.

Using the World Health Organization's definition of obesity (BMI ≥ 30 < 40 kg/m^2) (WHO, 2004), 25% of the sample was classified as obese. Based on the International Diabetes Federation criteria of MtS (International Diabetes Federation, 2005), 54% of the sample had a waist circumference of ≥94 cm, 42% had high triglycerides (≥150 mg/dL), 25% had high glucose levels (≥100 mg/dL), 48% had low HDL-C levels (<40 mg/dL), and 18% had high blood pressure. Therefore, 32% of the sample fit the meet the criteria of having MtS. A large proportion of the sample (62%) undertook little physical activity (<600 MET-min/week), 54% were active smokers, but none reported consuming alcohol. We found that 51% were poor sleepers (PSQI >5). High work-related stress, based on an ERI ratio ≥1, was prevalent in 65% of the subjects.

Comparison of the stressed and non-stressed groups

Table 6.1 shows the comparison of stressed (ERI ratio ≥1) and non-stressed subjects (ERI ratio <1). We found that stressed subjects had significantly higher

waist circumference, BMI, cortisol levels at 10 min, cortisol levels at 20 min, and cortisol (AUC). In addition, the stressed group had significantly more cases of MtS (n=51) than the non-stressed subjects (n=14, $p<0.05$). There were no significant differences between stressed and non-stressed subjects regarding other stress measures; perceived stress, over commitment, sleep quality. Furthermore, the fasting blood profile showed no significant differences.

Table 6.1: Psychological, physical, physiological, and biochemical characteristics of Jordanian male workers: comparison between stressed and non stressed group.

			Stressed (N=132)	Non stressed (N=72)	
	n	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**p***
Age (year)	198	35.3 (8.8)	35.6 (9.1)	34.7 (8.1)	ns
Waist (cm)	204	94.1 (12.6)	96.2 (12.3)	90.3 (12.1)	≤0.001
BMI ($kg.m^{-2}$)	203	26.9 (3.7)	27.4 (3.6)	26.0 (3.6)	<0.05
Perceived stress	204	25.6 (6.9)	25.3 (6.7)	26.1 (7.2)	ns
Over commitment	204	14.3 (3.9)	14.1 (3.7)	14.7 (4.1)	ns
Physical activity (MET)(m/w)	204	1210 (1948)	1138 (1946)	1341 (1958)	ns
Total sleep quality	204	5.4 (3.1)	5.3 (2.9)	5.7 (3.3)	ns
Fasting blood glucose(mg/dL)	204	91.1 (12.2)	91.9 (12.4)	89.6 (11.3)	ns
LDL-C (mg/dL)	204	111.2 (31.6)	111.9 (33.3)	109.9 (28.3)	ns
Total cholesterol (mg/dL)	204	187.1 (36.6)	188.3 (39.9)	184.8 (29.6)	ns
HDL-C (mg/dL)	204	42.1 (8.7)	42.2 (8.7)	41.9 (8.8)	ns
Triglycerides (mg/dL)	204	155.3 (85.4)	155.9 (84.9)	154.3 (86.9)	ns
Systolic blood pressure (mmHg)	200	122 (9)	120 (8)	123 (9)	<0.05
Diastolic blood pressure (mmHg)	200	80 (6)	81 (8)	81 (5)	ns
Saliva Cortisol 0 time (nmol/L)	202	11.3 (5.2)	11.8 (5.6)	10.4 (4.3)	ns
Saliva Cortisol 10 time (nmol/L)	202	14.7 (6.6)	15.5 (7.1)	13.2 (5.3)	<0.05
Saliva Cortisol 20 time (nmol/L)	202	18.2 (7.9)	19.1 (8.5)	16.6 (6.4)	<0.05
(Δ cortisol) (20min-0min) (nmol/L)	202	6.9 (4.9)	7.3 (5.1)	6.2 (4.1)	ns
Cortisol º (nmol/L)	202	305.9 (139.4)	326.9 (153.3)	267.3 (99.2)	<0.05

* Two-tailed p value based on independent sample t- test. ns; not significant. º Cortisol calculated from area under the curve (AUC)

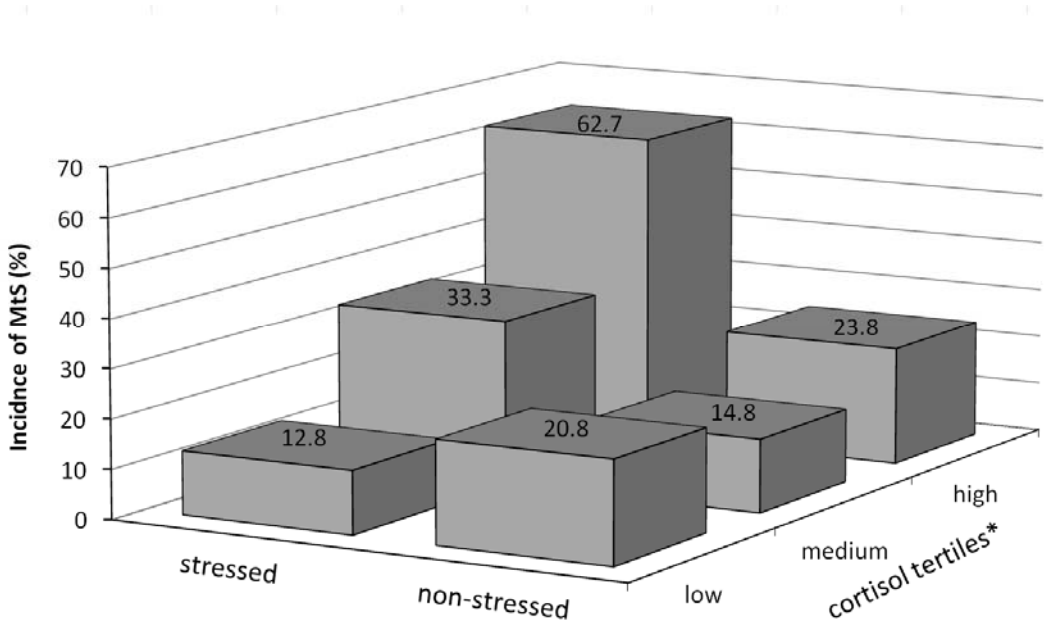
ERI and MtS

ERI and MtS through the cortisol pathway

Multiple regression analysis (Table 6.2) shows that the ERI ratio was significantly associated with MtS, even after adjustment for age, type of work, physical activity, awakening time, and work over commitment. However, adding cortisol expressed in AUC to the model considerably attenuated the association between the ERI ratio and MtS. In addition, the interaction between cortisol (AUC) and ERI was significantly associated with MtS.

The prevalence of MtS differed significantly across work stressed (ERI) groups and saliva cortisol (AUC) tertiles ($p \leq 0.001$; Figure 6.2). The majority of MtS cases was present in the highest cortisol (AUC) tertile and stressed group. After adjustment for age, type of work, physical activity, awakening time, and work Over commitment, the highest cortisol (AUC) tertile significantly predicted MtS (OR=11.50, 95% CI: 2.16-59.14) in subjects who had high stress. In contrast, there was no association between cortisol (AUC) and MtS in the non-stressed group. Stressed subjects with either middle or low cortisol (AUC) tertile did not differ from the non-stressed subjects for all tertiles of cortisol (AUC) (Figure 6.2).

Figure 6.2: Incidence of MtS across work stress status and tertiles of Cortisol.



*Cortisol calculated from Area under the curve (AUC). Low Cortisol tertile <230.5 nmol/L, middle tertile ≥230.5 < 340 nmol/L, high tertile ≥340 nmol/L

Table 6.2: Association between work stress, cortisol and Metabolic syndrome

	Unadjusted	Adjusted+	Adjusted++
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Effort Reward ratioª (n=192)	4.78 * (2.31-9.88)	4.74 * (2.13-10.55)	2.80 ** (1.15-6.78)
Cortisol º (n=192)	3.03 * (2.08-4.40)	2.86* (1.92-4.25)	
Effort Reward ratio and Cortisol interaction (n=192)	1.84* (1.50-2.26)	1.83* (1.47-2.28)	
Stressed group (n=126)			
Cortisol º	3.96* (2.39-6.56)	3.90* (2.23-6.81)	
Effort Reward ratio and Cortisol interaction	2.12* (1.60-2.81)	2.14* (1.53-2.98)	
Non stressed group (n=66)			
Cortisol	1.23ns (0.68-2.20)	1.15ns (0.52-2.55)	
Effort Reward ratio and Cortisol interaction	1.32ns (0.75-2.32)	1.15ns (0.55-2.39)	

ª per one unit increase in the Effort Reward ratio (0.1). º per SD increase in the area under the curve (AUC) of three timed cortisol measurements, * p ≤0.001, **p < 0.05, ns; not significant. +Adjusted for age, type of work, physical activity, awakening time and work over commitment. ++Adjusted for age, type of work, physical activity, awakening time, work over commitment and cortisol expressed in AUC.

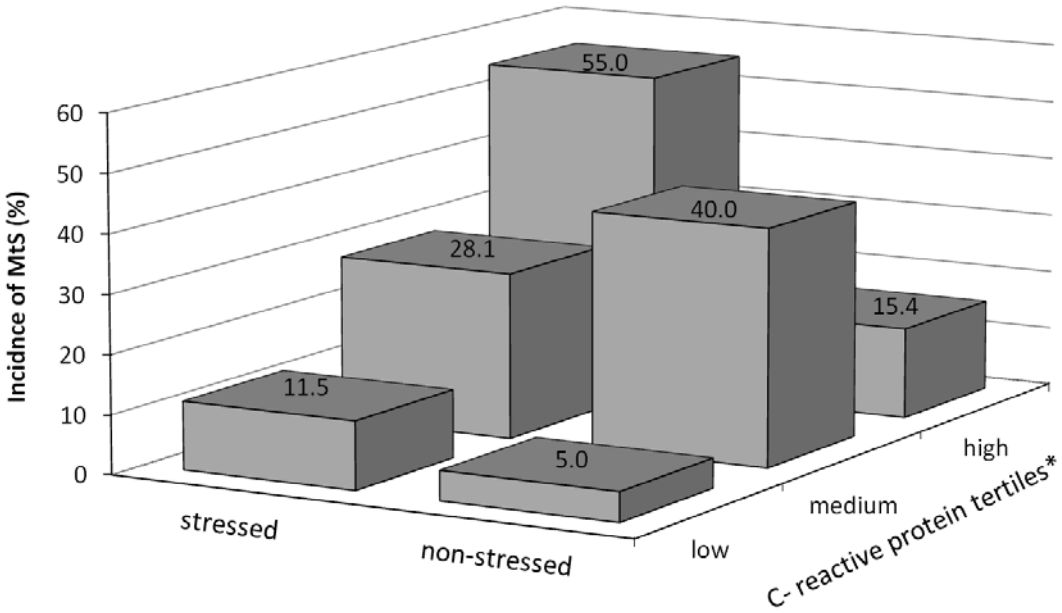
ERI and MtS through inflammatory pathway.

Overall, the mean CRP (n=146) was 2.04 ±0.82. There was a significant difference between the mean values of CRP for the stressed group (2.14±0.8, n=98) compared to the non-stressed group (1.85±0.82, n=48; $p \leq 0.05$). A significant difference in mean CRP was also observed between the MtS group (2.47±0.67, n=43) and the group without MtS (1.87±0.82, n=103; $p \leq 0.001$).

Table 6.3 shows the regression analysis of ERI adjusted for CRP. The ERI ratio after adjustment for other factors remained significantly associated with MtS. In addition, CRP was significantly associated with MtS. However, further adjusting by entering CRP into the model resulted in the association between ERI ratio and MtS being attenuated. The interaction between ERI ratio and CRP levels in predicting the chance of MtS was significant.

Accordingly, we stratified our logistic regression analyses to compare the stressed and non-stressed group. For the stressed group, the adjusted CRP remained associated with MtS, but there was no association in the non-stressed group (Table 6.3). Fisher's exact test showed that MtS was most prevalent among stressed subjects in the highest CRP tertile (Figure 6.3; $p \leq 0.001$).

Figure 6.3: Incidence of MtS across work stress status and tertiles of CRP.



*Low C-reactive protein tertile <1.44 mg/L, middle tertile ≥1.44 < 3.50 mg/L, high tertile ≥3.50 mg/L

Table 6.3 Association between work stress, C-reactive protein and Metabolic syndrome

	Unadjusted	Adjusted+	Adjusted++
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Effort Reward ratio[a] (n=146)			
	2.65** (1.13-6.25)	3.35** (1.32-8.53)	2.36ns(0.89-6.24)
CRP [1] (n=146)	2.49 * (1.55-4.01)	2.51* (1.50-4.20)	
Effort Reward ratio and CRP interaction (n=146)			
	1.80* (1.33-2.42)	1.85* (1.33-2.57)	
Stressed group (n=98)			
CRP	3.02* (1.67-5.47)	4.14* (1.99-8.62)	
Effort Reward ratio and CRP interaction			
	1.80* (1.34-2.42)	2.03* (1.39-2.98)	
Non stressed group (n=48)			
CRP	1.28 ns (0.53-3.06)	5.62 ns (0.67-47.40)	
Effort Reward ratio and CRP interaction			
	0.79 ns (0.35-1.78)	1.90 ns (0.46-7.87)	

[a] per one unit increase in the Effort Reward ratio (0.1). [1] per one unit increase in C-reactive protein (Log (1 mg/L)). *p≤ 0.001, ** p < 0.05, ns; not significant. +Adjusted for age, type of work, physical activity, awakening time and work over commitment. ++ Adjusted for age, type of work, physical activity, awakening time, work over commitment and Log value of C-reactive protein.

ERI and MtS components

ERI and MtS components through the cortisol pathway.

Table 6.4a shows that the ERI ratio was associated with the MtS components of waist circumference and SBP after adjusting for age, type of work, physical activity, awakening time, and work over commitment. The adjusted cortisol level AUC showed a significant positive association with waist circumference, SBP, and FBG, and a negative association with HDL-C. Moreover, there was a significant interaction between ERI ratio and cortisol AUC level in predicting the level of waist circumference, SBP, FBG, and HDL-C.

In the stressed group, high cortisol AUC level was significantly associated with large waist circumference, high triglyceride level, low HDL level, high SBP, and high DBP (Table 6.4b). In contrast, in the non-stress group, cortisol (AUC) was not associated with any of the MtS components (Table 6.4b).

ERI and MtS components through the inflammatory pathway.

Table 6.4a shows that CRP was associated with waist circumference, and triglycerides. There was a significant interaction between ERI ratio and CRP levels in predicting the levels of waist circumference, triglycerides, and SBP.

In the stressed group, the CRP levels were higher than in the non-stressed group. Within the stress group, CRP was significantly associated with waist circumference (Table 6.4b). In the non-stressed group, CRP was only associated with triglyceride level.

In a separate analysis, the binary regression was repeated only among subjects with upper tertile waist circumference of ≥98.5 cm (n=49). The data showed after adjustment, CRP was significantly associated with MtS (OR=4.26, 95% CI: 1.40-13.05; $p<0.05$), but was no longer significantly associated among subjects in the mid tertile waist circumference, 88.0 cm to 98.5cm group (n=45). The middle waist circumference tertile but not the lower tertile (waist circumference of <88cm, n=52) was used as the reference group, since none of the subjects on the lower tertile group had MtS.

ERI, MtS, and inflammation with central obesity

Further analysis of subjects with upper tertile waist circumference (≥98.5cm) and high stress (ERI ≥1, n=39) showed that, after adjustment for other factors, CRP was significantly associated with MtS (OR=5.23, 95% CI: 1.41-19.45, $p<0.05$). This association was not significant in the non-stressed group (ERI <1, n=9). The interaction between CRP and cortisol (AUC) was a significant predictor of MtS for the stressed group, even after adjustment for other factors ($p\leq0.001$), whereas the prediction was not significant for the non-stressed group.

Further analysis of data from overweight stressed group (ERI ≥1, BMI ≥25 kg/m2, n=86) showed that, after adjustment for other factors, CRP was significantly associated with MtS (OR=3.8, 95% CI: 1.75-8.04, $p< 0.05$). And the cortisol (AUC) was significantly associated with MtS (OR=3.9, 95% CI: 2.11-7.09, $p\leq0.001$). These associations were not significant for the overweight non-stressed group (n=35).

Table 6.4a: Associations between work stress, cortisol, C- reactive protein and components of metabolic syndrome, adjusted for age, type of work, physical activity, wakening time and work over commitment

	Waist Circumference		Triglycerides		*HDL-C*		*SBP*		*DBP*		*FBG*	
	ß	*t*	ß	*t*	ß	*t*	ß	*t*	ß	*t*	ß	*t*
Effort-Reward ratio ª(n=192)	.22*	3.61	.02 *ns*	0.28	−.01 *ns*	0.01	.18**	0.24	.02 *ns*	0.24	.12 tr	1.79
Cortisol º(n=192)	.17*	2.81	.08 *ns*	1.14	−.20**	−2.67	.26*	3.60	.12 *ns*	1.54	.14**	2.10
CRP[1](n=146)	.31*	4.22	.23**	2.66	−.16 tr	−1.84	.11 *ns*	1.26	.05 *ns*	0.54	.11 *ns*	1.30
Effort-Reward ratio and cortisol Interaction (n=192)	.25*	4.00	.11 *ns*	1.45	−.15**	−2.00	.28*	3.87	.11 *ns*	1.43	.17**	2.46
Effort-Reward ratio and CRP Interaction (n=146)	.32*	4.33	.18**	2.07	−.12 *ns*	−1.39	.19**	2.18	.54 ns	0.61	.13 *ns*	1.56

ª per one unit increase in the effort reward ratio (0.1). º per SD increase in the area under the curve (AUC) of three timed cortisol measurements .[1] per one unit increase in C-reactive protein (Log (1 mg/L)). ß = standardized coefficients, t= t value. * p≤0.001, **p<0.05, tr ; trend (p>0.05≤0.08), ns; not significant

Table 6.4b: Associations between work stress, cortisol, C- reactive protein and components of metabolic syndrome, adjusted for age, type of work, physical activity, wakening time and work over commitment: stressed vs.non stressed.

	Waist Circumference		Triglycerides		HDL-C		SBP		DBP		FBG	
	ß	*t*	ß	*t*	ß	*t*	ß	*t*	ß	*t*	ß	*t*
Stressed group												
Cortisol° (n=126)	.17**	2.18	.18**	2.06	−.25*	−2.70	.28**	3.14	.24**	2.75	.15 tr	1.87
Effort-Reward ratio and cortisol interaction (n=126)	.23**	2.86	.19**	2.09	−.20**	−2.19	.25**	2.70	.23**	2.46	.19**	2.28
CRP[1] (n=98)	.38*	4.20	.20 tr	1.91	−.20 tr	−1.96	.13 *ns*	1.23	.16 *ns*	1.58	.06 *ns*	0.67
Effort-Reward ratio and CRP interaction (n=98)	.34*	3.97	.16 *ns*	1.58	−.19 tr	−2.37	.09 *ns*	0.90	.16 *ns*	1.55	.14 tr	1.76
Non stressed group												
Cortisol°(n=66)	.14 *ns*	1.33	−.18 *ns*	−1.41	−.16 *ns*	−1.22	.07*ns*	0.52	−.08 *ns*	0.57	.04 *ns*	0.31
Effort-Reward ratio and cortisol interaction (n=66)	.19 tr	1.90	−.13 *ns*	−1.05	−.22 *ns*	−1.71	.06 *ns*	0.47	−.12 *ns*	0.39	−.01 *ns*	−0.10
CRP[1](n=48)	.15 *ns*	1.07	.48**	2.88	.24 *ns*	1.31	.09 *ns*	0.51	.15 *ns*	0.79	.23 *ns*	1.22
Effort-Reward ratio and CRP interaction (n=48)	.12 *ns*	0 .96	.41**	2.97	−.31**	−2.03	−.01 *ns*	−0.04	−.21 *ns*	−1.27	.19 *ns*	1.16

. º per SD increase in the area under the curve (AUC) of three timed cortisol measurements .[1] per one unit increase in C-reactive protein (Log (1 mg/L)). ß = standardized coefficients, t= t value. * p≤0.001, **p<0.05, tr ; trend (p>0.05≤0.08), ns; not significant

Cortisol measurement immediately on awakening and MtS

Adjustment for cortisol using cortisol measured at awakening (time=0) attenuated the association between ERI and MtS (OR=3.70, 95% CI: 1.60-8.60, $p<0.05$). Even after adjustment for the confounders, the cortisol at time=0 remained significantly associated with MtS (OR=1.93, 95% CI: 1.35-2.76, $p\leq0.001$). In addition, the interaction between ERI ratio and cortisol time=0 was significantly associated with MtS (OR=1.68, 95% CI: 1.35 -2.10, $p\leq0.001$). Among the stressed group, the adjusted cortisol at time=0 and the interaction between cortisol at time=0 and ERI was significantly associated with MtS (OR =2.39, 95% CI: 1.47-3.90, $p\leq0.001$; OR=1.89, 95% CI: 1.37-2.61, $p\leq0.001$, respectively). In contrast, there was no association between cortisol at time=0 or the interaction between cortisol at time=0 and ERI with MtS in non-stressed group.

Change in cortisol level and MtS

When change in cortisol level (Δ cortisol) (expressed as cortisol level at 20 min − cortisol level at time=0) was used in the regression analysis instead of the cortisol (AUC), the association between the ERI ratio and MtS was attenuated (OR=3.26, 95% CI: 1.41-7.50, $p<0.05$). Change in cortisol was significantly associated with MtS (OR=2.00, 95% CI: 1.37-2.93, $p\leq0.001$). Further, there was a

significant interaction between ERI ratio and change in cortisol and of MtS (OR=1.69, 95% CI: 1.33-2.14, p≤0.001). Among the stressed group, we found a significant association between change in cortisol level and MtS (OR=2.49, 95% CI: 1.48-4.17, p≤0.001). In addition, the interaction between change in cortisol and ERI was significantly associated with MtS (OR=1.67, 95% CI: 1.26-2.22, p≤ 0.001). In contrast, no such associations were found in the non-stressed group

DISCUSSION

A high proportion of Jordanian workers in this study had large waist circumference, undertook little physical activity, and were active smokers. When stratified by ERI ratio, there were clear differences in waist circumference, BMI, SBP, cortisol at awakening, and CRP. Stress activates the HPA and the SMA axes. This activation stimulates an increased production of cortisol and CRP, which are central to the development of MtS. In this study, we established a relationship between work-related stress, cortisol, and CRP in predicting MtS.

First, we showed that a high level of work-related stress (ERI ratio ≥1) was significantly associated with a large waist circumference, high DBP, and to some extent, with high FBG level, as well as with a greater number of cases of MtS. These results are consistent with studies examining the relationship between chronic stress and MtS (Chandola et al., 2006; Raikkonen, Matthews, & Kuller,

2007). In contrast, non-stressed subjects (ERI ratio <1), showed no association with the MtS or any of its components.

To our knowledge, this is the first study addressing this link through two pathways, the HPA and SMA pathways, through their effects on the endocrine system (cortisol) and inflammatory markers (CRP). Rosmond (2005) has hypothesized that stress-related high cortisol secretion is strongly associated with MtS. Few studies have investigated cortisol levels at awakening and ERI association, and some showed positive associations (Eller et al., 2012). However, other studies have shown inconsistent findings for cortisol levels on awakening that were associated with ERI (Bellingrath et al., 2008; Steptoe et al., 2004).

These inconsistent findings may be due to improper saliva cortisol collection, such as non-compliance with saliva sampling procedures or incorrect timing of sample collection. It can be difficult to guarantee true cortisol levels collected in ambulatory settings (Kudielka, Broderick, & Kirschbaum, 2003). Exposure to light following morning awakening may also affect the morning cortisol levels (Clow et al., 2004). In this study, the cortisol samples were collected with care, but while all precautions were taken, subjects' compliance could not be guaranteed. Although the awakening response of cortisol measured by AUC shows a high degree of intra-individual stability when measured over several days or weeks (Pruessner et al., 1997), this stability has not been tested in the current study, where only 1 set of samples was taken for the AUC analysis.

We further demonstrated the possible role of saliva cortisol and CRP in the development of MtS. Adjusting for saliva cortisol or CRP attenuated the association between stress and MtS. CRP elevation may also be a result of activation of the stress system (HPA and SMA) (Bruce, Rodman, & Newman, 2007; Rippe, 2012). Although hypercortisolemia-related stress appears to be a specific risk factor for MtS, the association for high CRP-related stress was only found in those with central obesity, consistent with many other studies (Hak et al., 1999; Lemieux et al., 2001; Saijo et al., 2004). A mechanism that explains the elevated CRP levels is that adipose tissues secrete proinflammatory cytokines (Kern et al., 2001), which in turn induce the synthesis and secretion of CRP by the liver (Papanicolaou et al., 1998). A synergistic effect of central obesity and work stress, acting together to intensify CRP production, is highly plausible (Dixon et al., 2008; Laaksonen et al., 2004; Visser et al., 1999).Indeed, weight loss was not only associated with a decrease in CRP level (Selvin, Paynter, & Erlinger, 2007), but also a reduction in psychological stress (Bruce et al., 2007; Rippe, 2012). This stress attenuates HPA and SMA activation, and in turn reduces cytokines and CRP production (Black, 2002; Gabay & Kushner, 1999). In addition, visceral fat loss may lead to decreased number of glucocorticoid receptors within visceral areas. Eventually, decreases in cortisol activity may lead to less abdominal fat deposition (McInnes et al., 2004; Tomlinson, Finney, Hughes, Hughes, & Stewart, 2008).

There are additional limitations to our study, such as the relatively small sample size of the study, particularly the small number of subjects with central obesity, which has an impact on the statistical power of this study. The strength of this study is the application of strict subject inclusion/ exclusion criteria that excluded all medical conditions that may impact cortisol or CRP levels. The ERI questionnaire is a commonly used scale that is designed to measure work stress, which has been linked to poor health outcomes (Siegrist, 2002). Thus, persons with psychiatric diagnoses of work-related stress would be expected to show a stronger positive association with MtS. In addition, this study indicated that Jordanian workers reported generally high level of work stress when assessed on the ERI questionnaire compared to other cohorts from European countries (Siegrist et al., 2004). This higher level of stress suggests Jordanian workers had higher perceived work effort and higher job demand, but job satisfaction was lower than workers in the samples from other nations (Siegrist et al., 2004). Additional research is recommended to explore the work-stress relationship (high ERI ratio) and its long-term health impact on workers in Jordan.

In conclusion, our results suggest that work-related stress and its resulting hypercortisolemia and augmented CRP, synergistically contribute to the development of MtS in middle-aged Jordanian workers. High work-related stress in the presence of central obesity predisposes Jordanian workers to increased risk of MtS, potentially working through inflammatory pathways. These

measures could also lead to an increased risk for developing cardiovascular disease or diabetes. These findings have important health implications for stress at work. Further research involving prospective studies should confirm our findings and investigate the causality and direction of the relationships among ERI, cortisol, inflammation (CRP), central obesity, overweight and MtS.

CHAPTER 7

CONCLUSIONS

This thesis reports on a novel field study of middle-aged Jordanian workers recruited from industrial and the school teaching community. It addressed work stress and its link to MtS, together with translation of several questionnaires into Arabic.

SUMMARY AND CONCLUSION

Work stress, inflammation (CRP), Cortisol and MtS

The research identified work-related stress as an important factor associated with the inflammatory marker, C-reactive protein, especially in centrally obese workers. Building on the initial findings of study four, we have examined the link between work stress and MtS through hypercortisolemia and CRP. Work-related stress, in this thesis, was identified based on the level of Effort-Reward imbalance. Other covariates examined included workers' perceived stress, sleep quality and physical activity levels.

To ensure methodological rigour of this study, we have applied strict subject criteria that excluded all medical conditions that could have potentially elevated cortisol or CRP level. Thus these applied criteria avoided ambiguity of results.

Our findings demonstrated a significant synergistic contribution of hypercortisolemia and augmented CRP in stressed subjects to the development of MtS. These findings have significant implications for occupational health bodies in using CRP and cortisol as biochemical measures to determine the impact of high work stress, and to consider the risks of such stress on the development of MtS in workers, particularly those that are overweight and central obese.

Translation and validation of questionnaires

At the time of conducting these studies, there were no validated Arabic version of Effort-Reward imbalance questionnaire (ERI), perceived stress scale (PSS-14), Pittsburgh sleep quality index (PSQI) questionnaire. Hence, one aspect of the thesis was to produce an Arabic version of the questionnaires: ERI, PSS-14 and PSQI. One strength of this thesis is the rigorous process used for the translation and validation of these questionnaires. The translation process employed a wide and varied range of translators to balance issues between linguistic and cross-cultural concerns (Hambleton, 1994; Van de Vivjer & Hambleton, 1996). The process included 7 separate steps of translation and back-translation, involving professional translators, married couples with an English speaking and Arabic speaking background, as well as translators with health and academic backgrounds. The Arabic versions of the questionnaires have demonstrated

good internal consistency and reliability. Therefore, these Arabic versions of the PSS-14, ERI and PSQI are suitable instruments to assess perceived stress, work related stress and sleep quality, respectively, for Arabic speakers.

LIMITATIONS OF THE PROJECTS

The cross-sectional design of this project did not allow us to investigate the causality and direction of the relationships among work-related stress, cortisol, CRP, central obesity and MtS. A longitudinal design would yield data that allowed explanations of cause and effect.

We have addressed the relatively small sample size, particularly the small number of centrally obese subjects, which limits the statistical power of the study. Our cross-sectional study was limited to male samples only, suggesting a need to include females in study trials. A further limitation due to financial considerations was that only one inflammatory marker (CRP) was examined, although other inflammatory markers such as interleukin-6 [IL-6] is similarly predictive of MtS (Pickup et al.,1997). However, CRP is considered to be the strongest predictor of MtS when compared to other inflammatory markers (Ridker et al, 2003).

Regarding the Arabic versions of the questionnaires, further studies using a larger sample size are needed to assess the cross-cultural validity of this scale using confirmatory factorial analysis. Future studies could also examine convergent validity of the Arabic version of PSS-14, by assessing correlations between the Arabic version of the PSS-14 scores and other scales measuring perceived stress, and similarly for ERI and PSQI.

FUTURE DIRECTIONS

A majority of people spend about two-thirds of their lifetime at work. The Australian Bureau of Statistics census (2002) showed that approximately 1.7 million Australia workers (one in six) worked 44 hours or more each week. These statistics suggest limited time left for family life, leisure, sleep and recovery. Added to the work scene are work place harassment, bullying, poor work ethics, and poor leadership that may result in psychological distress and subsequent physical ill health (EU-OSHA, 2007). It is the chronic nature of persistent stress and an inability to cope with stress that, in due course, leads to poor health. The current investigation provided a glimpse of how work-related stress may impinge on physical health, and that individuals with central obesity are particularly at greater risk. This area of research is worthy of further perusal because of the enormity of the implications for human health and longevity.

Further research involving prospective studies should confirm our findings and investigate the causality and direction of the relationships between work-related stress and MtS. Longitudinal studies including recruitment of female participants, with baseline measurements and follow-up at two time points 12 months apart, will elucidate the cause-and-effect of the impact of work stress on the development of MtS. Another important direction for investigations is to address the source of work stress. Apart from Effort-Reward imbalance, other stressors include workplace bullying and work under-recovery due to inadequate sleep. Importantly, the psychological aspect of work stress and its contributions to MtS will be worthy of investigation in future studies.

REFERENCES

AbuAlRub, R. F., & Al-Zaru, I. M. (2008). Job stress, recognition, job performance and intention to stay at work among Jordanian hospital nurses. *Journal of Nursing Management, 16*(3), 227-236.

Ainsworth, B., Haskell, W., Leon, A., Jacobs D., Montoye, H., Sallis, F., and Paffenbarger, R. (1993). Compendium of physical activities: classification of energy costs of human physical activities. *Medicine and Science in Sports & Exercise,* 25:71– 80.

Alberti, K., & Zimmet, P. (1998). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabetic Medicine, 15*(7), 539-553

Aldwin, C. M. (1999). *Stress, coping, and development: An integrative approach.* New York: Guilford.

Al-Hazza, M. H. (2006). The Arabic International Physical Activity Questionnaire (IPAQ). Retrieved from https://sites.google.com/site/theipaq/questionnaires

Allison, D. (2001). Missing data. Sage University papers series on applications in the social sciences. Thousand Oaks: Sage.

Al-Lawati, J. A., & Jousilahti, P. (2008). Body mass index, waist circumference and waist-to-hip ratio cut-off points for categorisation of obesity among Omani Arabs. *Public Health Nutrtion, 11*(1), 102-108.

Almadi, T., Cathers, I., & Chow, C. M. (2013a). An Arabic version of the effort-reward imbalance questionnaire: translation and validation study. *Psychological Reports, 113*(1), 1-16.

Almadi, T., Cathers, I., & Chow, C. M. (2013b). Associations among work-related stress, cortisol, inflammation, and metabolic syndrome. *Psychophysiology, 50*(9), 821-830.

Almadi, T., Cathers, I., & Chow, C. M. (2013c). An Arabic version of the Pittsburgh Sleep Quality Index: Translation and validation study. Manuscript submitted for publication.

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012a). An Arabic version of the perceived stress scale: Translation and validation study. *International Journal of Nursing Studies*, 49, 84–89.

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012b). The association between work stress and inflammatory biomarkers in Jordanian male workers. *Psychophysiology*, 49, 172–177.

Amatruda, J. M., Livingston, J. N., & Lockwood, D. H. (1985). Cellular mechanisms in selected states of insulin resistance: Human obesity, glucocorticoid excess, and chronic renal failure. *Diabetes Metabolism Reviews*, 1, 293–317.

Backhaus, J., Junghanns, K., Broocks, A., Riemann, D., & Hohagen, F. (2002). Test-retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. *Journal of Psychosomatic Research, 53*(3), 737-740

Balkau, B., & Charles, M.(1999). Comment on the provisional report from the WHO consultation. European Group for the Study of Insulin Resistance (EGIR). *Diabetic Medicine, 16*(5), 442-443.

Bartlett, M. S. (1954). A note on multiplying factors for various chi-squared approximations. *Journal of the Royal Statistical Society: Series B*, 16, 296-298.

Beck, J. G., & Sloan, D. M. (2012). *The Oxford Handbook of Traumatic Stress Disorders*: Oxford University Press, USA.

Beckstead, J.W., Yang, C.Y., Lengacher, C.A. (2008). Assessing cross-cultural validity of scales: a methodological review and illustrative example. *International Journal of Nursing Studies*, 45, 110–119.

Bellingrath, S., Weigl, T., & Kudielka, B. M. (2008). Cortisol dysregulation in school teachers in relation to burnout, vital exhaustion, and effort-reward-imbalance. *Biological Psychology*, 78, 104–113.

Bellingrath, S., Weigl, T., & Kudielka, B. M. (2009). Chronic work stress and exhaustion is associated with higher allostastic load in female school teachers. *Stress*, 12, 37–48.

Bjorntorp, P., & Rosmond, R. (1999). Hypothalamic origin of the metabolic syndrome X. *Annals of the New York Academy of Sciences, 892*, 297-307.

Bjorntorp, P., & Rosmond, R. (2000). Obesity and cortisol. *Nutrition, 16*(10), 924-936. doi: S0899-9007(00)00422-6

Black, P. H. (2002). Stress and the inflammatory response: A review of neurogenic inflammation. *Brain, Behavior, and Immunity*, 16,622–653.

Black, P. H. (2003). The inflammatory response is an integral part of the stress response: Implications for atherosclerosis, insulin resistance, type II diabetes and metabolic syndrome X. *Brain*, *Behavior*, and *Immunity, 17*(5), 350-364.

Blais, F., Gendron, L., Mimeault, V., & Morin, C. (1997). Evaluation of insomnia: validity of 3 questionnaires. *Revue de psychiatrie biologique et therapeutique, 23*, 447-453.

Blake, G. J., Rifai, N., Buring, J. E., & Ridker, P. M. (2003). Blood pressure, C-reactive protein, and risk of future cardiovascular events. *Circulation*, 108, 2993–2999.

Bosma, H., Peter, R., Siegrist, J., & Marmot, M. (1998). Two alternative job stress models and the risk of coronary heart disease. *American Journal of Public Health*, 88(1), 68-74.

Bouguerra, R., Alberti, H., Smida, H., Salem, L. B., Rayana, C. B., El Atti, J., . . . Alberti, K. G. (2007). Waist circumference cut-off points for identification of abdominal obesity among the tunisian adult population. *Diabetes*, *Obesity* & *Metabolism, 9*(6), 859-868.

Brantley, P., Thomason, B. (1995). *Stress and stress management. Handbook of Health and Rehabilitation Psychology.* New York: Plenum Press.

Brown, J. D., & Siegel, J. M. (1988). Exercise as a buffer of life stress: a prospective study of adolescent health. *Health Psychology, 7*(4), 341-353.

Bruce, B. E., Rodman, J., & Newman, J. (2007). Weight loss treatment and psychological well-being: A review and meta-analysis. *Journal of Health Psycholology*, 12, 66–82. doi: 10.1177/1359105307071741

Brunner, E. J., Hemingway, H., Walker, B. R., Page, M., Clarke, P., Juneja, M., . . . Marmot, M. G. (2002). Adrenocortical, autonomic, and inflammatory causes of the metabolic syndrome: nested case-control study. *Circulation, 106*(21), 2659-2665.

Buapetch, A., Lagampan, S., Faucett, J., & Kalampakorn, S. (2008). The Thai version of Effort-Reward Imbalance Questionnaire (Thai ERIQ): a study of psychometric properties in garment workers. *Journal of Occupational Health,* 50(6), 480-491.

Buysse, D., Hall, M., Strollo, P., Kamarck, T., Owens, J., Lee, L., . . . Matthews, K. (2008). Relationships between the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and clinical/polysomnographic measures in a community sample. *Journal Clinical Sleep Medicine, 4*, 563-571.

Buysse, D., Reynolds, C., Monk, T., Berman, S., & Kupfer, D. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, 28, 193–213.

Byles, J. E., Mishra, G. D., & Harris, M. A. (2005). The experience of insomnia among older women. *Sleep, 28*, 972-979.

Cameron, A. J., Magliano, D. J., Zimmet, P. Z., Welborn, T., & Shaw, J. E. (2007). The metabolic syndrome in Australia: prevalence using four definitions. *Diabetes Research* and *Clinical Practice, 77*(3), 471-478.

Cannon, W. (1929). *Bodily changes in pain, hunger, fear and rage.* New York: D. Appleton & Co.

Cannon, W. (1939). *The Wisdom of the Body* (2nd ed). New York: Norton Pubs.

Cattell, R. B. (1966). The screen test for the number of factors. *Multivariate Behavioral Research,* 1, 245-276.

Chaaya, M., Osman, H., Naassan, G., Mahfoud, Z., (2010). Validation of the Arabic version of the Cohen Perceived Stress Scale (PSS-10) among pregnant and postpartum women. *Bio Med Central Psychiatry*, 10, 111.

Chandola, T., Brunner, E., & Marmot, M. (2006). Chronic stress at work and the metabolic syndrome: Prospective study. *British Medical Journal* 332, 521–525.

Chang, E.C. (1998). Does dispositional optimism moderate the relation between perceived stress and psychological well being? A preliminary investigation. *Personality and Individual Differences*, 25, 233–240.

Charmandari, E., Tsigos, C., & Chrousos, G. (2005). Endocrinology of the stress response. *Annuual Reviwe Physiology, 67*, 259-284.

Child, D. (2006). *The essential of factor analysis (3rd edition).* New York: Continuum International.

Chor, D., Werneck, G. L., Faerstein, E., Alves, M. G., & Rotenberg, L. (2008). The Brazilian version of the effort-reward imbalance questionnaire to assess job stress. *Cadernos de Saúde Pública*, 24(1), 219-224.

Chrousos, G. , & Gold, P. (1992). The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. *Journal of the American Medical Association, 267*(9), 1244-1252.

Clow, A., Thorn, L., Evans, P., & Hucklebridge, F. (2004). The awakening cortisol response: Methodological issues and significance. *Stress*, 7, 29–37.

Cohen, F. (1984)." Coping" In J. D. Matarazzo, Weiss, S.M., Herd, J.A., Miller,N.E., & Weiss, S.M. (Ed.), *Behavioral Health: A Handbook of Health Enhancement and Disease Prevention*. New York: Wiley.

Cohen, S. (1986). Contrasting the Hassles Scale and the Perceived Stress Scale: Who is really measuring appraised stress? *American Psychologist, 41*, 716-718.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health* & *Social Behavior, 24*(4), 385-396.

Cohen, S., Tyrrell, D.A., Smith, A.P. (1993). Negative life events, perceived stress negative effect, and susceptibility to the common cold. *Journal of Personality and Social Psychology*, 64, 131–140.

Cohen, S., Williamson, G.M. (1988). Perceived stress in a probability sample of the United States. In: Spacapan, S., Oskamp, S. (Eds.). *The Social Psychology of Health*. Sage, Newbury Park, CA, pp 31–67.

Cole, J., Motivala, S., Buysse, D., Oxman, M., Levin, M., & Irwin, M. (2006). Validation of a 3-factor scoring model for the Pittsburgh sleep quality index. *Sleep*, 29.1,112-126

Cole, S.R. (1999). Assessment of differential item functioning in the Perceived Stress Scale-10. *Epidemiology and Community Health,* 53, 319–320.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., … Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports Exercise*, 35, 1381–1395.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika,* 16, 297-334.

Cruess, D.G., Antoni, M.H., Kumar, M., Ironson, G., McCabe, P., Fernandez, J.B., Fletcher, M., Schneiderman, N. (1999). Cognitive-behavioral stress management buffers decreases in dehydroepiandrosterone sulfate (DHEA-S) and increases in the cortisol/DHEA-S ratio and reduces mood disturbance and perceived stress among HIV seropositive men. *Psychoneuroendocrinology* , 24, 537–549.

David, M., & Sutton, C. D. (2004). *Social Research: The Basics*: SAGE Publications.

Devreux, I., Jacquerye, A., Kittel, F., Almazrooa, A., & Al-Awa, B. (2012). Measurement of rehabilitation services staffs' job satisfaction using the effort reward imbalance model in Saudi Arabia. *Research Journal of Medical Sciences,* 6(3), 87-92.

Dixon, J. B., Hayden, M. J., Lambert, G. W., Dawood, T., Anderson, M. L., Dixon, M. E., & O'Brien, P. E. (2008). Raised CRP levels in obese patients: Symptoms of depression have an independent positive association. *Obesity*, 16, 2010–2015.

Doi, Y., Minowa, M., Uchiyama, M., Okawa, M., Kim, K., Shibui, K., Kamei, Y. (*2000*). Psychometric assessment of subjective sleep quality using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) in psychiatric disordered and control subjects. *Psychiatry Research, 97*, 165-172.

Dragano, N., Knesebeck, O., Rödel, A., & Siegrist, J. (2003). Psychosocial work stress and musculosceletal disorders: significance for prevention. *Zeitschrift für Gesundheitswissenschaften, 11*(3), 196-207.

Dyck, D.G., Short, R., Vitaliano, P. (1999). Predictors of burden and infectious illness in schizophrenia caregivers. *Psychosomatic Medicine*, 61, 411–419.

Einhorn, D., Reaven, G., Cobin, R., Ford, E., Ganda, O., Handelsman, Y., Hellman R, … Wilson PW. (2003) American College of Endocrinology position statement on the insulin resistance syndrome. *Endocrine Practice* ,9:237-252.

Elgharib, N., Chi, D., Younis, W., Wehbe, S., & Krishnaswamy, G. (2003). C-reactive protein as a novel biomarker reactant can flag atherosclerosis and help predict cardiac events. *Postgraduate Medicine,* 114, 39–44.

Eller, N. H., Nielsen, S. F., Blond, M., Nielsen, M. L., Hansen, A. M., & Netterstrom, B. (2012). Effort reward imbalance, and salivary cortisol in the morning. *Biological Psychology*, 89, 342–348.

Enders, C. (2010). Applied missing data analysis. Guilford Press: New York.

Epel, E. S., McEwen, B., Seeman, T., Matthews, K., Castellazzo, G., Brownell, K. D., . . . Ickovics, J. R. (2000). Stress and body shape: stress-induced cortisol secretion is consistently greater among women with central fat. *Psychosomatic Medicine, 62*(5), 623-632.

Escobar, F., & Eslava, J. (2005). Colombian validation of the Pittsburgh Sleep Quality Index. *Revista de neurologia, 40*, 150-155.

Eskin, M., & Parr, D. (1996). Introducing a Swedish version of an instrument measuring mental stress. *Reports from the Department of Psychology*, 813, 1–9.

Esler, M., Jennings, G., Lambert, G., Meredith, I., Horne, M., & Eisenhofer, G. (1990). Overflow of catecholamine neurotransmitters to the circulation: source, fate, and functions. *Physiolgical Reviwes, 70*(4), 963-985.

Esposito, K., & Giugliano, D. (2004). The metabolic syndrome and inflammation : association or causation?, *Nutrition*, *Metabolism* and *Cardiovascular Diseases , 14*(5), 228-232.

Eum, K. D., Li, J., Lee, H. E., Kim, S. S., Paek, D.,. . . Cho, S. (2007). Psychometric properties of the Korean version of the effort-reward imbalance questionnaire: a study in a petrochemical company. *International Archives of Occupational and Environmental Health,* 80(8), 653-661.

EU-OSHA (2007). Expert forecast on emerging psychosocial risks related to occupational safety and health. Luxembourg: Office for Official Publications of the European Communities.

Ervin, B. (2009). Prevalence of metabolic syndrome among adults 20 years of age and over, by sex, age, race and ethnicity, and body mass index: United States, 2003-2006. National Health Statistics Reports. 13, 1-7

Fabrigar, L., MacCallum, R., Wegener, D. T., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods,* 4, 272-299.

Fan, L. B., Li, J., Wang, X. P., Shang, L., Gu, H. K., Zhang, H., . . . Mu, Y. Z. (2009). Association between job stress and blood lipids among university staff in Yunnan province. *Zhonghua Xin Xue Guan Bing Za Zhi, 37*(5), 454-457.

Field, A., Miles, J., & Filed, Z. (2012). Discovering Statistics Using R. London: SAGE

Flanagan, C. (2013). *Revise OCR AS Psychology:* Taylor & Francis

Folkman, S., & Moskowitz, J. T. (2004). Coping: pitfalls and promise. *Annu Rev Psychol, 55*, 745-774.

Ford, E., Giles, W., & Dietz, W. (2002). Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition

Examination Survey. *Journal of the American Medical Association, 287*(3), 356-359.

Ford, E., Giles, W., Myers, L., Rifai, M., Ridker, P., & Mannino, M. (2003). C-reactive protein concentration distribution among US children and young adults: Finding from the National Health and Nutrition Examination Survey, 1999–2000. *Clinical Chemistry*, 49, 1353–1357.

Friedman, M., & Rosenman, R. H. (1974). *Type A behavior and your heart*. New York: Knopf.

Fröhlich, M., Imhof, A., Berg, G., Hutchinson, W., Pepys, M., Boeing, H., & Koenig, W. (2000). Association between C-reactive protein and features of the metabolic syndrome: A population-based study. *Diabetes Care*, 12, 1835–1839.

Gabay, C., & Kushner, I. (1999). Acute-phase proteins and other systemic responses to inflammation. *The New England Journal of Medicine, 340*(6), 448-454.

Gami, A., Witt, B., Howard, D., Erwin, P., Gami, L. A., Somers, V., & Montori, V. (2007). Metabolic syndrome and risk of incident cardiovascular events and death: a systematic review and meta-analysis of longitudinal studies. *Journal of the American College of Cardiology*, *49*(4), 403-414. doi: S0735-1097(06)02658-1

Geffken, D. F., Cushman, M., Burke, G. L., Polak, J. F., Sakkinen, P. A., & Tracy, R. P. (2001). Association between physical activity and markers of inflammation in a healthy elderly population. *American Journal of Epidemiology* , 153, 242–250. doi:10.1093/aje/153.3.242

Gentry, W. D., & Kobasa, S. C. (1984). Social and psychological resources mediating stress-illness relationships in humans. In W. D. Gentry (Ed.), *Handbook of Behavioral Medicine*. New York: Guilford Press

Genuth, S., Alberti, K. G., Bennett, P., Buse, J., Defronzo, R., Kahn, R., . . . Zimmet, P. (2003). Follow-up report on the diagnosis of diabetes mellitus. *Diabetes Care, 26*(11), 3160-3167.

Gold, P. W., Goodwin, F. K., & Chrousos, G. P. (1988a). Clinical and biochemical manifestations of depression. Relation to the neurobiology of stress (1).*The New England Journal of Medicine, 319*(6), 348-353.

Gold, P. W., Goodwin, F. K., & Chrousos, G. P. (1988b). Clinical and biochemical manifestations of depression. Relation to the neurobiology of stress (2). *The New England Journal of Medicine, 319*(7), 413-420.

Griep, R. H., Rotenberg, L., Vasconcellos, A. G., Landsbergis, P., Comaru, C. M., & Alves, M. G. (2009). The psychometric properties of demand-control and effort–reward imbalance scales among Brazilian nurses. *International Archives of Occupational and Environmental Health*, 82, 1163–1172.

Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., . . . Costa, F. (2005). Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation, 112*(17), 2735-2752.

Grundy, S. (2008). *Metabolic syndrome pandemic.* Arteriosclerosis, Thrombosis, and Vascular Biology, *28, 629–36*

Gump, B. B., & Matthews, K. A. (2000). Are vacations good for your health? The 9-year mortality experience after the multiple risk factor intervention trial. *Psychosomatic Medicine, 62*(5), 608-612.

Hak, A. E., Stehouwer, C. D., Bots, M. L., Polderman, K. H., Schalkwijk, C. G., Westendorp, I. C., … Witteman, J. C. (1999). Associations of C-reactive

protein with measures of obesity, insulin resistance, and subclinical atherosclerosis in healthy, middle-aged women. *Arteriosclerosis, Thrombosis and Vascular Biology*, 19, 1986–1991.

Hamaideh, S. H. (2012). Occupational stress, social support, and quality of life among Jordanian mental health nurses. *Issues in Mental Health Nursing, 33*(1), 15-23. doi: 10.3109/01612840.2011.605211

Hambleton, R. K. (1994). Guidelines for adapting educational and psychological tests: a progress report. *European Journal of Psychological Assessment: Bulletin of the International Test Commission,* 10, 229-244.

Hamdan-Mansour, A. M., Al-Gamal, E., Puskar, K., Yacoub, M., & Marini, A. (2011). Mental health nursing in Jordan: an investigation into experience, work stress and organizational support. *International Journal of Mental Health Nursing*, 20(2), 86-94.

Hamer, M., Williams, E., Vuonovirta, R., Giacobazzi, P., Gibson, E. L., & Steptoe, A. (2006). The effects of effort-reward imbalance on inflammatory and cardiovascular responses to mental stress. *Psychosomatic Medicine, 68*(3), 408-413.

Han, T., Sattar, N., Williams, K., Gonzalez-Villalpando, C., Lean, M. E., & Haffner, S. M. (2002). Prospective study of C-reactive protein in relation to the development of diabetes and metabolic syndrome in the Mexico City Diabetes Study. *Diabetes Care*, *25*, 2016–2021.

Hanson, E. K., Schaufeli, W., Vrijkotte, T., Plomp, N. H., & Godaert, G. L. (2000). The validity and reliability of the Dutch Effort-Reward Imbalance Questionnaire. *Journal of Occupational Health Psychology,* 5(1), 142-155.

Hanson, R. L., Imperatore, G., Bennett, P. H., & Knowler, W. C. (2002). Components of the "metabolic syndrome" and incidence of type 2 diabetes. *Diabetes, 51*(10), 3120-3127.

Henry, J. P. (1992). Biological basis of the stress response. *Integrative Physiological and Behavioral Science, 27*(1), 66-83.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2005). *Applied Choice Analysis: A Primer*: Cambridge University Press.

Heraclides, A., Chandola, T., Witte, D. R., & Brunner, E. J. (2009). Psychosocial stress at work doubles the risk of type 2 diabetes in middle-aged women: evidence from the Whitehall II study. *Diabetes Care, 32*(12), 2230-2235.

Hewitt, P.L., Flett, G.L., Mosher, S.W. (1992). The Perceived Stress Scale: factor structure and relation to depression symptoms in a psychiatric sample. *Journal of Psychopathology and Behavioral Assessment*, 14, 247–257.

Hildrum, B., Mykletun, A., Hole, T., Midthjell, K., & Dahl, A. A. (2007). Age-specific prevalence of the metabolic syndrome defined by the International Diabetes Federation and the National Cholesterol Education Program: The Norwegian HUNT 2 study. *Bio Med Central Public Health*, 7, 220.

Hita-Contreras, F., Martinez-Lopez, E., Latorre-Roman, P. A., Garrido, F., Santos, M. A., & Martinez-Amat, A. (2014). Reliability and validity of the Spanish version of the Pittsburgh Sleep Quality Index (PSQI) in patients with fibromyalgia. *Rheumatol Int*. doi: 10.1007/s00296-014-2960-z.

Hoffmann, K., Mattheisen, M., Dahm, S., Nurnberg, P., Roe, C., Johnson, J., . . . Lindner, T. H. (2007). A German genome-wide linkage scan for type 2

diabetes supports the existence of a metabolic syndrome locus on chromosome 1p36.13 and a type 2 diabetes locus on chromosome 16p12.2. *Diabetologia, 50*(7), 1418-1422.

Holmes, D. S. (1994). Abnormal Psychology. *(2nd ed.) New York: Harper collins college publishers*.

Hosmer, D., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.), New York, NY: John Wiley and Sons.

Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic* Wiley

Hotamisligil, G. S., Peraldi, P., Budavari, A., Ellis, R., White, M. F., & Spiegelman B. M. (1996). IRS-1-mediated inhibition of insulin receptor tyrosine kinase activity in TNF-alpha- and obesity-induced insulin resistance. *Science*, 271, 665–668

Huang, P. L. (2009). A comprehensive definition for metabolic syndrome. *Disease Model Mechanisms, 2* (5-6), 231-237

Huffman, F. G., Whisner, S., Zarini, G. G., & Nath, S. (2010). Waist circumference and BMI in relation to serum high sensitivity C-reactive protein (hs-CRP) in Cuban Americans with and without type 2 diabetes. *International Journal of Environmental Research and Public Health*, 7, 842–852.

Hung, H. C., Yang, Y. C., Ou, H. Y., Wu, J. S., Lu, F. H., & Chang, C. J. (2013). The association between self-reported sleep quality and metabolic syndrome. *Public Library of Science one, 8*(1), e54304.

International Diabetes Federation (IDF).(2005). The IDF consensus worldwide definition of the the metabolic syndrome. Retrieved from http://www.idf.org/webdata/docs/Metabolic_syndrome_definition.pdf

Jennings, J. R., Muldoon, M. F., Hall, M., Buysse, D. J., & Manuck, S. B. (2007). Self-reported sleep quality is associated with the metabolic syndrome. *Sleep, 30*(2), 219-223.

Jialal, I., Devaraj, S., & Venugopal, S. K. (2004). C-reactive protein: Risk marker or mediator in atherothrombosis? *Hypertension*, *44*, 6–11. doi: 10.1161/01.HYP.0000130484.20501

Kaiser, H. F. (1970). A second generation little jiffy. *Phsychometrika,* 35, 401-415.

Kaiser, H. F. (1974). Analysis of factorial simplicity. *Psychometrika*, 39, 31-36.

Kamarck, T. W., Manuck, S. B., & Jennings, J. R. (1990). Social support reduces cardiovascular reactivity to psychological challenge: a laboratory model. *Psychosomatic Medicine, 52*(1), 42-58.

Karasek, R. A. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative Science Quarterly*, 24, 285–308.

Karasek, R. A., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life*. New York, NY. Basic Books.

Kasapis, C., & Thompson, P. D. (2005). The effects of physical activity on serum C-reactive protein and inflammatory markers: A systematic review. *Journal of American College of Cardiology*, 45, 1563–1569.

Kern, P. A., Ranganathan, S., Li, C., Wood, L., & Ranganathan, G. (2001). Adipose tissue tumor necrosis factor and interleukin-6 expression in human obesity and insulin resistance. *American Journal of Physiology—Endocrinology and Metabolism*, 280,E745–751.

Khader, Y., Bateiha, A., El-Khateeb, M., Al-Shaikh, A., & Ajlouni, K. (2007). High prevalence of the metabolic syndrome among Northern Jordanians.

Journal of diabetes and its complications, 21(4), 214-219. doi: S1056-8727(05)00153-4

Kiecolt-Glaser, J. K., Preacher, K. J., MacCallum, R. C., Atkinson, C., Malarkey, W. B., & Glaser, R. (2003). Chronic stress and age-related increases in the proinflammatory cytokine IL-6. *Proceedings of the National Academy of Sciences U S A*, 100, 9090–9095.

Kivimaki, M., Leino-Arjas, P., Luukkonen, R., Riihimaki, H., Vahtera, J., & Kirjonen, J. (2002). Work stress and risk of cardiovascular mortality: Prospective cohort study of industrial employees. *British Medical Journal*, 325, 857–861.

Klein, B., Klein, R., & Lee, K. (2002). Components of the metabolic syndrome and risk of cardiovascular disease and diabetes in Beaver Dam. *Diabetes Care, 25*(10), 1790-1794.

Kleinbaum, D., Kupper, L., Nizam, A., & Rosenberg, E. (2013). *Applied Regression Analysis and Other Multivariable Methods*: Cengage Learning.

Knudsen, H. K., Ducharme, L. J., & Roman, P. M. (2007). Job stress and poor sleep quality: data from an American sample of full-time workers. Social science & medicine*, 64*(10), 1997-2007. doi: S0277-9536(07)00067-6

Knutson, K., Ryden, A., Mander, B., & Van, C. (2006). Role of sleep duration and quality in the risk and severity of type 2 diabetes mellitus. *Archives of Internal Medicine, 166*(16), 1768-1774.

Koenig, W., Sund, M., Frohlich, M., Fischer, H. G., Lowel, H., Doring, A., Pepys, M. B. (1999). C-reactive protein, a sensitive marker of inflammation, predicts future risk of coronary heart disease in initially healthy middle-aged men: Results from the MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) Augsburg Cohort Study, 1984 to 1992. *Circulation*, 99,237–242.

Kosten, T. R., Mason, J. W., Giller, E. L., Ostroff, R. B., & Harkness, L. (1987). Sustained urinary norepinephrine and epinephrine elevation in post-traumatic stress disorder. *Psychoneuroendocrinology, 12*(1), 13-20.

Kotronoulas, G. C., Papadopoulou, C. N., Papapetrou, A., & Patiraki, E. (2011). Psychometric evaluation and feasibility of the Greek Pittsburgh Sleep Quality Index (GR-PSQI) in patients with cancer receiving chemotherapy. *Support Care Cancer, 19*(11), 1831-1840.

Krantz, D. S., & Manuck, S. B. (1984). Acute psychophysiologic reactivity and risk of cardiovascular disease: a review and methodologic critique. *Psychological Bulletin, 96*(3), 435-464.

Krieger, DT. (1975). Rhythms of ACTH and corticosteroid secretion in health and disease and their experimental modification. Journal of Steroid Biochemistry , 6,785-791

Kudielka, B. M., Broderick, J. E., & Kirschbaum, C. (2003). Compliance with saliva sampling protocols: Electronic monitoring reveals invalid cortisol daytime profiles in noncompliant subjects. *Psychosomatic Medicine*, 65, 313–319.

Kumari, M., Head, J., & Marmot, M. (2004). Prospective study of social and other risk factors for incidence of type 2 diabetes in the Whitehall II study. *Archives of Internal Medicine*, 164, 1873–1880.

Kuper, H., Singh-Manoux, A., Siegrist, J., & Marmot, M. (2002). When reciprocity fails: effort-reward imbalance in relation to coronary heart disease and health functioning within the Whitehall II study. *Occupational and Environmental Medicine, 59*(11), 777-784.

Laaksonen, D. E., Niskanen, L., Nyyssonen, K., Punnonen, K., Tuomainen, T. P., Valkonen, V. P.,. . . Salonen, J. T. (2004). C-reactive protein and the

development of the metabolic syndrome and diabetes in middle-aged men. *Diabetologia*, 47, 1403–1410.

Lai, H., & Good, M. (2005). Music improves sleep quality in older adults. *Journal of Advanced Nursing, 49*(3), 234-244.

Lakka, T., & Laaksonen, D. (2007). Physical activity in prevention and treatment of the metabolic syndrome. *Applied Physiology, Nutrition, and Metabolism*, 32, 76–88.

Lakka, H., Laaksonen, D., Lakka, T., Niskanen, L., Kumpusalo, E., Tuomilehto, J. Salonen, J. T. (2002). The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. *Journal of the American Medical Association, 288*(21), 2709-2716.

Lakka, T., Laaksonen, D., Lakka, H., Mannikko, Niskanen, L., Rauramaa,. . . Salonen, J. (2003). Sedentary lifestyle, poor cardiorespiratory fitness, and the metabolic syndrome. *Medicine* & Science in *Sports* & *Exercise, 35*(8), 1279-1286.

Lambillotte, C., Gilon, P., & Henquin, J. C. (1997). Direct glucocorticoid inhibition of insulin secretion. An in vitro study of dexamethasone effects in mouse islets. *Journal of Clinical Investigation, 99*(3), 414-423.

Larkin, K. T. (2005). Stress and hypertension: Examining the relation between psychological stress and high blood pressure (pp 21). Yale university press.

Lazarus, R.S. (1999). Stress and Emotion: A New Synthesis, New York: Springer Publishing.

Lazarus, R. S., & Folkman, S. (1984). *Stress, Appraisal, and Coping.* New York: Springer Publishing.

Lee, C. M., Huxley, R. R., Woodward, M., Zimmet, P., Shaw, J., Cho, N. H., . . . Colagiuri, S. (2008). Comparisons of metabolic syndrome definitions in four populations of the Asia-Pacific region. *Metabolic syndrome and Realted disorders, 6*(1), 37-46.

Lee, S., Crockett, M.S. (1994). Effect of assertiveness training on levels of stress and assertiveness experienced by nurses in Taiwan, Republic of China. *Issues in Mental Health Nursing,* 1 (5), 419–432.

Lee, E. (2012). Review of the psychometric evidence of perceived stress scale. *Asian Nursing Research*, 6, 121-2

Leka, S., & Jain, A. (2010). *Health impact of psychosocial hazards at work: an overview*. Retrieved from http://whqlibdoc.who.int/publications/2010/9789241500272_eng.pdf

Lemieux, I., Pascot, A., Prud'homme, D., Almeras, N., Bogaty, P., Nadeau, A., … Despres, J. P. (2001). Elevated C-reactive protein: Another component of the atherothrombotic profile of abdominal obesity. *Arteriosclerosis, Thrombosis and Vascular Biology*, 21,961–967.

Levenstein, S., Prantera, C., Varvo, V., Scribano, M.L. (1993). Development of the perceived stress questionnaire: a new tool for psychosomatic research. *Journal of Psychosomatic Research*, 37 (1), 19–32.

Li, J., Yang, W., Cheng, Y., Siegrist, J., & Cho, I. (2005). Effort-reward imbalance at work and job dissatisfaction in Chinese healthcare workers: a validation study. *International Archives of Occupational and Environmental Health,* 78, 198-204.

Little, J. & Donald, R. (2002). Statistical analysis with missing data. John Wiley & Sons, Inc: Hoboken.

Liu, H., Bravata, D. M., Cabaccan, J., Raff, H., & Ryzen, E. (2005). Elevated late-night salivary cortisol levels in elderly male type 2 diabetic veterans. *Clinical Endocrinology (Oxford)*, 63, 642–649.

Lorenzo, C., Okoloise, M., Williams, K., Stern, M. P., & Haffner, S. M. (2003). The metabolic syndrome as predictor of type 2 diabetes: the San Antonio heart study. *Diabetes Care, 26*(11), 3153-3159.

Lutgendorf, S. K., Garand, L., Buckwalter, K. C., Reimer, T. T., Hong, S. Y., & Lubaroff, D. M. (1999). Life stress, mood disturbance, and elevated interleukin-6 in healthy older women. *Journal of Gerontology: Series A Biological Sciences and Medical Sciences*, 54,M434–439.

Maes, M., Delange, J., Ranjan, R., Meltzer, H., Desnyder, R., Cooremans, W., & Scharpe, S. (1997). Acute phase proteins in schizophrenia, mania and major depression: Modulation by psychotropic drugs. *Psychiatry Research*, 66, 1–11.

Mason, J. (1968). A review of psychoendocrine research on the sympathetic-adrenal medullary system. *Psychosomatic Medicine, 30*(5), Suppl:631-653.

Mason, J.(1971). A re-evaluation of the concept of “non-specificity” in stress theory. *Journal of Psychiatric Research, 8*, 323-333.

Mastorakos, G., Weber, J. S., Magiakou, M. A., Gunn, H., & Chrousos, G. P. (1994). Hypothalamic-pituitary-adrenal axis activation and stimulation of systemic vasopressin secretion by recombinant interleukin-6 in humans: Potential implications for the syndrome of inappropriate vasopressin secretion. *Journal of Clinical Endocrinology & Metabolism*, 79, 934–939.

McDade, T. W., Hawkley, L. C., & Cacioppo, J. T. (2006). Psychosocial and behavioral predictors of inflammation in middle-aged and older adults: The Chicago Health, Aging, and Social Relations study. *Psychosomatic Medicine*, 68, 376–381.

McEwen, B. S. (1998). Stress, adaptation, and disease. Allostasis and allostatic load. *Annals of the New York Academy of Sciences, 840*, 33-44.

McInnes, K. J., Kenyon, C. J., Chapman, K. E., Livingstone, D. E., Macdonald, L. J., Walker, B. R., & Andrew, R. (2004). 5alpha-reduced glucocorticoids, novel endogenous activators of the glucocorticoid receptor. *Journal Biolgical Chemistry , 279*(22), 22908-22912.

Meadows, K., Bentzen, N., & Touw-Otten, F. (1997). Cross-cultural issues: an outline of the important principles in establishing cross-cultural validity in health outcome assessment. In A. Hutchinson, N. Bentzen & C. König-Zahn (Eds.), *Cross Cultural Health Outcome Assessment. A User's Guide (Vol. 1). Groningen, Netherlands*: European Research Group on Health Outcomes.

Mickey, B. J., Zhou, Z., Heitzeg, M. M., Heinz, E., Hodgkinson, C. A., Hsu, D. T., . . . Zubieta, J. K. (2011). Emotion processing, major depression, and functional genetic variation of neuropeptide Y. *Archives of General Psychiatry, 68*(2), 158-166.

Miller, D. B., & O'Callaghan, J. P. (2002). Neuroendocrine aspects of the response to stress. *Metabolism, 51*(6 Suppl 1), 5-10.

Miller, M. A., & Cappuccio, F. P. (2007). Inflammation, sleep, obesity and cardiovascular disease. *Current Vascular Pharmacology, 5*(2), 93-102.

Mimura, C., & Griffiths, P. (2008). A Japanese version of the Perceived Stress Scale: cross cultural translation and equivalence assessment. *BioMed central Psychiatry*, 8, 85.

Moos, R. H., Brennan, P. L., Fondacaro, M. R., & Moos, B. S. (1990). Approach and avoidance coping responses among older problem and nonproblem drinkers. *Psychology and aging, 5*(1), 31-40.

Myers, H. F. (2009). Ethnicity- and socio-economic status-related stresses in context: an integrative review and conceptual model. *Journal of Behavioral Medicine, 32*(1), 9-19.

National Cholesterol Education Program. (2002). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report, *Circulation* (2002/12/18 ed., 106, 3143-3421).

Niedhammer, I., Siegrist, J., Landre, M. F., Goldberg, M., & Leclerc, A. (2000). Psychometric properties of the French version of the effort-reward imbalance model. *La Revue d'Epidémiologie et de Santé Publique,* 48(5), 419-437.

Norra, C., Kummer, J., Boecker, M., Skobel, E., Schauerte, P., Wirtz, M.,. . . Forkmann T. (2012). Poor sleep quality is associated with depressive symptoms in patients with heart disease. *International Journal of Behavioral Medicine, 19*(4), 526-534.

O'Connor,T., O'Halloran, D., Shanahan, F. *(2000).* The stress response and the hypothalamic–pituitary–adrenal axis: from molecule to melancholia. *The Quarterly journal of medicine*, 93, 323–333

Oh, S. W., Yoon, Y. S., Lee, E. S., Kim, W. K., Park, C., Lee, S., … Yoo, T. (2005). Association between cigarette smoking and metabolic syndrome: The Korea National Health and Nutrition Examination Survey. *Diabetes Care* ,28, 2064–2066.

Ohsawa, M., Okayama, A., Nakamura, M., Onoda, T., Kato, K., Itai, K., & Hiramori, K. (2005). CRP levels are elevated in smokers but unrelated to the number of cigarettes and are decreased by long-term smoking cessation in male smokers. *Preventive Medicine*, 41, 651–656.

Okun, M. L., Coussons-Read, M., & Hall, M. (2009). Disturbed sleep is associated with increased C-reactive protein in young women. *Brain, Behavior, and Immunity*, 23, 351–354.

Pacak, K., & Palkovits, M. (2001). Stressor specificity of central neuroendocrine responses: implications for stress-related disorders. *Endocrine Reviews, 22*(4), 502-548.

Pallant, J. (2001). *SPSS survival manual: a step-by-step guide to data analysis using SPSS for Windows (Version 10)*. Buckingham, UK: Open University Press.

Parker, J. , & Endler, N. S . (1996). *Handbook of coping: Theory, research, applications .* New York: John Wiley.

Patterson, T., Semple, S., Temoshok, L., Atkinson, J., McCutchan, J., Straits-Troster, K., Chandler, J., Grant, I. (1993) Depressive symptoms among HIV positive men: life stress, coping and social support. J Appl Biobehav Res,1(1):64-87

Papanicolaou, D. A., Wilder, R. L., Manolagas, S. C., & Chrousos, G. P. (1998). The pathophysiologic roles of interleukin-6 in human disease. *Annals of Internal Medicine*, 128, 127–137.

Pearson, T. A., Mensah, G. A., Alexander, R. W., Anderson, J. L., Cannon, R. O., 3rd, Criqui, M., & Vinicor, F. (2003). Markers of inflammation and cardiovascular disease: Application to clinical and public health practice: A statement for healthcare professionals from the Centers for Disease Control and Prevention and the American Heart Association. *Circulation*, 107,499–511.

Pedhazur, E. J., & Schmelkin,P. (1991). Measurement, design, and *analysis* Hillsdale , NJ: Lawrence Erlbaum Associates.

Penley, J. A., Tomaka, J., & Wiebe, J. S. (2002). The association of coping to physical and psychological health outcomes: a meta-analytic review. *Journal of behavioural medicine, 25*(6), 551-603.

Perry, C., Sattar, N., & Petrie, J. (2001). Adipose tissue: Passive sumper active pump. *Diabetes and Vascular Disease Research*, 1,110–114.

Peter, R., Alfredsson, L., Hammar, N., Siegrist, J., Theorell, T., & Westerholm, P. (1998). High effort, low reward, and cardiovascular risk factors in employed Swedish men and women: Baseline results from the WOLF Study. *Journal of Epidemiology and Community Health*, 52, 540–547.

Pickup, J., Mattock, M., Chusney, G., & Burt, D. (1997). NIDDM as a disease of the innate immune system: Association of acute-phase reactants and interleukin-6 with metabolic syndrome X. *Diabetologia 40*, 1286–1292.

Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., Von Auer, K., Jobst, S., … Kirschbaum, C. (1997). Free cortisol levels after awakening: A reliable biological marker for the assessment of adrenocortical activity. *Life Science*, 61,2539–2549.

Pruessner, M., Hellhammer, D. H., Pruessner, J. C., & Lupien, S. J. (2003). Self-reported depressive symptoms and stress levels in healthy young men: Associations with the cortisol response to awakening. *Psychosomatic Medicine*, 65, 92–99.

Qi, D., & Rodrigues, B. (2007). Glucocorticoids produce whole body insulin resistance with changes in cardiac metabolism. *American Journal of Physiology Endocrinology and Metabolism, 292*(3), E654-667.

Raikkonen, K., Matthews, K. A., & Kuller, L. H. (2007). Depressive symptoms and stressful life events predict metabolic syndrome among middle-aged women: A comparison of World Health Organization, Adult Treatment Panel III, and International Diabetes Foundation definitions. *Diabetes Care*, 30, 872–877.

Ramirez, M.T., Hernandez, R.L. (2007). Factor structure of the Perceived Stress Scale (PSS) in a sample from Mexico. *Spanish Journal of Psychology*, 10 (1), 199–206.

Reaven, G. (1988). Banting lecture 1988. Role of insulin resistance in human disease. *Diabetes, 37*(12), 1595-1607.

Remor, E. (2006). Psychometric properties of a European Spanish version of the Perceived Stress Scale (PSS). *The Spanish Journal of Psychology*, 9, 86–93.

Ridker, P. M., Buring, J. E., Cook, N. R., & Rifai, N. (2003). C-reactive protein, the metabolic syndrome, and risk of incident cardiovascular events: an 8-year follow-up of 14 719 initially healthy American women. *Circulation, 107*(3), 391-397.

Ridker, P. M., Cushman, M., Stampfer, M. J., Tracy, R. P., & Hennekens, C. H. (1997). Inflammation, aspirin, and the risk of cardiovascular disease in apparently healthy men. *New England Journal of Medicine*, *336*, 973–979.

Ridker, P. M., Rifai, N., Pfeffer, M. A., Sacks, F., & Braunwald, E. (1999). Long-term effects of pravastatin on plasma concentration of C-reactive protein. The Cholesterol and Recurrent Events (CARE) Investigators. *Circulation*, *100*, 230–235.

Rippe, J. (2012). Improved psychological well-being, quality of life, and health practices in moderately overweight women participating in a 12-week structured weight loss program. *Obesity*, 6, 208–218.

Rosmond, R. (2005). Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology, 30*(1), 1-10.

Rosmond, R., Dallman, M. F., & Bjorntorp, P. (1998). Stress-related cortisol secretion in men: relationships with abdominal obesity and endocrine, metabolic and hemodynamic abnormalities. *Journal of Clinical Endocrinology & Metabolism, 83*(6), 1853-1859.

Roth, S. & Cohen, L. (1986). Approach, avoidance, and coping with stress American Psychologist, 41, 813-819

R Rowland, J., Massie, J. (1998) Breast Cancer. In Holland JC (ed.) Psycho-oncology. New York: Oxford University Press

Rozanski, A., Blumenthal, J. A., Davidson, K., Saab, P., & Kubzansky, L. (2005). The epidemiology, pathophysiology, and management of psychosocial risk factors in cardiac practice: the emerging field of behavioral cardiology. *Journal of the American College of Cardiology, 45*(5), 637-651.

Saijo, Y., Kiyota, N., Kawasaki, Y., Miyazaki, Y., Kashimura, J., Fukuda, M., & Kishi, R. (2004). Relationship between C-reactive protein and visceral adipose tissue in healthy Japanese subjects. *Diabetes, Obesity and Metabolism*, 6, 249–258.

Sakkinen, P., Wahl, P., Cushman, M., Lewis, M., & Tracy, R. (2000). Clustering of procoagulation, inflammation, and fibrinolysis variables with metabolic factors in insulin resistance syndrome. *American Journal of Epidemiology , 152*(10), 897-907.

Salehi, M., Ferenczi, A., & Zumoff, B. (2005). Obesity and cortisol status. *Hormone and Metabolic Research, 37*(4), 193-197. doi: 10.1055/s-2005-861374

Sanchez-Chaparro, M. A., Calvo-Bonacho, E., Gonzalez-Quintela, A., Fernandez-Labandera, C., Cabrera, M., Sainz, J. C., … Roman-Garcia, J. (2008). Occupation-related differences in the prevalence of metabolic syndrome. *Diabetes Care*, 31, 1884–1885.

Sattar, N., Gaw, A., Scherbakova, O., Ford, I., O'Reilly, D. S., Haffner, S. M., . . . Shepherd, J. (2003). Metabolic syndrome with and without C-reactive protein as a predictor of coronary heart disease and diabetes in the West of Scotland Coronary Prevention Study. *Circulation, 108*(4), 414-419.

Sawant , A., Mankeshwar, R., Shah, S., Raghavan, R., Dhongde, G., Raje, H.,. . . . Ashavaid, T. (2011). Prevalence of metabolic syndrome in urban India. *Cholesterol*. 2011:920983,7

Schafer, L. & John, G. (2002). Missing data: our view of the state of the art Psychological Methods

Selye, H. (1936). A Syndrome Produced by Diverse Nocuous Agents. *Nature, 138*, 32.

Selye, H. (1956). The Stress of Life. New York: McGraw-Hill.

Selye, H. (1974). *Stress without distress*. Philadelphia: J. B. Lippincott Co.

Selvin, E., Paynter, N., & Erlinger, T. (2007). The effect of weight loss on C-reactive protein: A systematic review. *Archived Internal Medicine*. 167, 31–39. doi: 10.1001/archinte.167.1.31

Shen, B. J., Farrell, K. A., Penedo, F. J., Schneiderman, N., & Orth-Gomer, K. (2010). Waist circumference moderates the association between marital stress and C-reactive protein in middle-aged healthy women. *Annals of Behavioral Medicine*, 40, 258–264.

Siegrist, J. (1996). Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology*, 1, 27–41.

Siegrist , J. (2002), Effort-reward imbalance at work and health, in Pamela L. Perrewe, Daniel C. Ganster (ed.) *Historical and Current Perspectives on Stress and Health (Research in Occupational Stress and Well-being, Volume 2)*, Emerald Group Publishing Limited

Siegrist, J. (2001). *A theory of occupational stress.* In Jack Dunham (Ed.), *Stress in the workplace: Past, present and future.* London: Whurr. 52–66.

Siegrist, J. (2005), "Social reciprocity and health: new scientific evidence and *the* policy implications", Psychoneuroendocrinology, 30, 10, pp. 1033-8.

Siegrist, J., Starke, D., Chandola, T., Godin, I., Marmot, M., Niedhammer, I., & Peter, R. (2004). The measurement of effort–reward imbalance at work: European comparisons. *Social Science & Medicine*, 58, 1483–1499.

Simmons, B. L., & Nelson, D. L. (2001). Eustress at work: the relationship between hope and health in hospital nurses. *Health Care Management Review, 26*(4), 7-18.

Smith, J. A., Lumley, M. A., & Longo, D. J. (2002). Contrasting emotional approach coping with passive coping for chronic myofascial pain. *Ann Behav Med, 24*(4), 326-335

Song, C., Kenis, G., van Gastel, A., Bosmans, E., Lin, A., de Jong, R., . . . Maes, M. (1999) . Influence of psychological stress on immune-inflammatory variables in normal humans. Part II. Altered serum concentrations of natural anti-inflammatory agents and soluble membrane antigens of monocytes and T lymphocytes. *Psychiatric Research*, 85, 293–303.

Stauder, A.,& Konkoly¨, T.B. (2006) . Characteristics of the Hungarian version of the Perceived Stress Scale (PSS). *Menta´lhigie´ne´ e´s Pszichoszoma- tika*, 7, 203–216.

Steptoe, A., Cropley, M., Griffith, J., & Kirschbaum, C. (2000). Job strain and anger expression predict early morning elevations in salivary cortisol. *Psychosomatic Medicine*, 62, 286–292.

Steptoe, A., Kunz-Ebrecht, S., Owen, N., Feldman, P. J., Willemsen, G., Kirschbaum, C., & Marmot, M. (2003). Socioeconomic status and stress-related biological responses over the working day. *Psychosomatic Medicine, 65*(3), 461-470.

Steptoe, A., Siegrist, J., Kirschbaum, C., & Marmot, M. (2004). Effort reward imbalance, overcommitment, and measures of cortisol and blood pressure over the working day. *Psychosomatic Medicine*, 66, 323–329.

Sterling, P., & Eyer, J. (1988). Allostasis: A new paradigm to explain arousal pathology. New York: John Wiley & Sons.

Sternberg, E. M., Chrousos, G. P., Wilder, R. L., & Gold, P. W. (1992). The stress response and the regulation of inflammatory disease. *Annals of Internal Medicine*, 117, 854–866.

Suarez, E. C. (2004). C-reactive protein is associated with psychological risk factors of cardiovascular disease in apparently healthy adults. *Psychosomatic Medicine*, 66, 684–691.

Suleiman, K. H., Yates, B. C., Berger, A. M., Pozehl, B., & Meza, J. (2010). Translating the Pittsburgh Sleep Quality Index into Arabic. *Western Journal of Nursing Research, 32*(2), 250-268.

Tabachnick, B. G., & Fidall, L. S. (1996). Using multivariate statistics (3rd ed). New York: Harper Collins.

Tabachnick, B. G., & Fidell, L. S. (2001). Using multivariate statistics (4th ed). Boston, MA: Allyn and Bacon.

Tan, C. E., Ma, S., Wai, D., Chew, S. K., & Tai, E. S. (2004). Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? *Diabetes Care, 27*(5), 1182-1186.

Teran-Garcia, M., & Bouchard, C. (2007). Genetics of the metabolic syndrome. *Applied Physiology, Nutrition and Metabolism, 32*(1), 89-114.

The Australian Bureau of Statistics. (2002). ABS Labour Force Survey.retrived from: http://www.abs.gov.au/AUSSTATS/abs@.nsf/2f762f95845417aeca25706c00834efa/923ec292aba44932ca2570ec00006ee7!OpenDocument

The MacArthur Research Network on SES and Health. (2008). References to studies that examine the relationship between the Perceived Stress Scale and Biological or Verified Disease Outcomes. In: Psychosocial Notebook, Retrieved from http://www.macses.ucsf.edu/research/ psychosocial/pssref.php

The National Accreditation Authority for Translators and Interpreters Ltd, Australia (NAATI). (1977). Find a Translator or Interpreter. Available from http://www.naati.com.au.

Thurstone, L.L. (1947). Multiple Factor Analysis. Chicago: University of Chicago Press.

Tomlinson, J. W., Finney, J., Hughes, B. A., Hughes, S. V., & Stewart, P. M. (2008). Reduced glucocorticoid production rate, decreased 5alpha-reductase activity, and adipose tissue insulin sensitization after weight loss. *Diabetes, 57*(6), 1536-1543

Tsai, P., Wang, S., Wang, M., Su, C., Yang, T., Huang, C.,Fang, S. (2005). Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects. *Quality of Life Research, 14*(8), 1943-1952.

Tsigos, C., & Chrousos, G. P. (2002). Hypothalamic-pituitary-adrenal axis, neuroendocrine factors and stress. *Journal of Psychosomatic Research*, *53*(4), 865-871.

Tsutsumi, A., Ishitake, T., Peter, R., Siegrist, J., Matoba, T. (2001). The Japanese version of the Effort–Reward Imbalance Questionnaire: a study in dental technicians. *Work Stress,* 15, 86–9.

Tsutsumi, A., & Kawakami, N. (2004). A review of empirical studies on the model of effort-reward imbalance at work: Reducing occupational stress by implementing a new theory. *Social Science and Medicine*, 59, 2335–2359.

Vale, W., Spiess, J., Rivier, C., & Rivier, J. (1981). Characterization of a 41-residue ovine hypothalamic peptide that stimulates secretion of corticotropin and beta-endorphin. *Science, 213*(4514), 1394-1397.

Van de Kar, L. D., & Blair, M. L. (1999). Forebrain pathways mediating stress-hormone secretion. *Front Neuroendocrinol, 20*(1), 1-48. doi: S0091-3022(98)90172-8

Van de Vivjer, F., & Hambleton, R. K. (1996). Translating tests: some practical guidelines. *European Psychologist*, 1(2), 89-99.

Van Vegchel, N., De Jonge, J., Bosma, H., & Schaufeli, W. (2005). Reviewing the effort-reward imbalance model: Drawing up the balance of 45 empirical studies. *Social Science & Medicine*, 60, 1117–1131.

Villegas, R., Perry, I., Creagh, D., Hinchion, R., & O'Halloran, D. (2003). Prevalence of the metabolic syndrome in middle-aged men and women. *Diabetes Care, 26*(11), 3198-3199.

Visser, M., Bouter, L. M., McQuillan, G. M., Wener, M. H., & Harris, T. B. (1999). Elevated C-reactive protein levels in overweight and obese adults. *Journal of the American Medical Association*, 282, 2131–2135. doi: 10.1001/jama.282.22.2131

Vogelzangs, N., Suthers, K., Ferrucci, L., Simonsick, E. M., Ble, A., Schrager, M., . . . Penninx, B. W. (2007). Hypercortisolemic depression is associated with the metabolic syndrome in late-life. *Psychoneuroendocrinology, 32*(2), 151-159.

Von Dawans, B., Fischbacher, U., Kirschbaum, C., Fehr, E., & Heinrichs, M. (2012). The social dimension of stress reactivity: acute stress increases prosocial behavior in humans. *Psychological Science, 23*(6), 651-660. doi: 10.1177/0956797611431576

Voss, U., & Tuin, I. (2008). Relationship of Sleep Quality with Coping and Life Styles in Female Moroccan Immigrants in Germany. *Women's Health Issues , 18*(3), 210-216.

Unterbrink, T., Hack, A., Pfeifer, R., Buhl-Griesshaber, V., Muller, U., Wesche, H., . . . Bauer, J. (2007). Burnout and effort-reward-imbalance in a sample of 949 German teachers. *International* Archives of *Occupational* and *Environmental Health, 80*(5), 433-441.

Wada, K., Sakata, Y., Theriault, G., Aratake, Y., Shimizu, M., Tsutsumi, A., . . . Aizawa, Y. (2007). Effort-reward imbalance and social support are associated with chronic fatigue among medical residents in Japan. *Archives of Occupational and Environmental Health, 81*, 331-336.

Wener, M. H., Daum, P. R., & McQuillan, G. M. (2000). The influence of age, sex, and race on the upper reference limit of serum C-reactive protein concentration data from the third National Health and Nutrition Examination Survey (NHANES III). *Journal of Rheumatology*, 27, 2351–2359.

Wilson, P. W., Pencina, M., Jacques, P., Selhub, J., D'Agostino, R., Sr., & O'Donnell, C. J. (2008). C-reactive protein and reclassification of cardiovascular risk in the Framingham Heart Study. *Circulation: Cardiovascular Quality and Outcomes*, 1,92–97.

Wilson, P., D'Agostino, R., Parise, H., Sullivan, L., & Meigs, J. (2005). Metabolic syndrome as a precursor of cardiovascular disease and type 2 diabetes mellitus. *Circulation, 112*(20), 3066-3072.

World Health Organization (WHO). (2004). The international classification of adult underweight, overweight and obesity according to BMI. Retrieved from http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

Yasein, N., & Masa'd, D. (2011). Metabolic syndrome in family practice in Jordan: a study of high-risk groups. *Eastern Mediterranean Health Journal, 17*(12), 943-948.

Yoo, H. L., Eisenmann, J. C., & Franke, W. D. (2009). Independent and combined influence of physical activity and perceived stress on the metabolic syndrome in male law enforcement officers. *Journal of Occupational and Environmental Medicine*, 51, 46–53.

Yudkin, J. S., Stehouwer, C. D., Emeis, J. J., & Coppack, S. W. (1999). C-reactive protein in healthy subjects: Associations with obesity, insulin resistance, and endothelial dysfunction: A potential role for cytokines originating from adipose tissue? *Arteriosclerosis, Thrombosis and Vascular Biology*, 19, 972–978.

Yu, R. & Ho, S.(2010) Psychometric Evaluation of the Perceived Stress Scale in Early Postmenopausal Chinese Women,Psychology,1,1-8

Zhou, Z., Zhu, G., Hariri, A. R., Enoch, M. A., Scott, D., Sinha, R., . . . Goldman, D. (2008). Genetic variation in human NPY expression affects stress response and emotion. *Nature, 452*(7190), 997-1001.

APPENDIX A

ETHICS APRROVAL AND RELATED FORMS.

The University of Sydney

NSW 2006 Australia

Human Research Ethics Committee
www.usyd.edu.au/ethics/human
Manager: Gail Briody
Telephone: (02) 9351 4811
Email: gbriody@usyd.edu.au
Deputy Manager: Marietta Coutinho
Telephone: (02) 9306 7566
Email: mcoutinho@usyd.edu.au
Room 313, Level 3, Old Teachers College – A22

Human Secretariat
Telephone: (02) 9036 9309
(02) 9036 9308
(02) 9036 7274
Facsimile: (02) 9036 9310

13 August 2008

Dr. Chin Moi Chow
Discipline of Exercise and Sport Science
Faculty of Health Sciences
Cumberland Campus-C42.
The University of Sydney.

Dear Dr. Chow,

Title: ***The role of stress in the development of the metabolic syndrome***
Ref No.: ***11/2007/10356.***
Authorised Personnel: ***Dr. C.M. Chow***
Dr. I Cathers
Mr. T. Almadi
Mr. A. M.Hamdan-Mansour

The Executive Committee at its meeting on 21 July 2008, considered your request dated 3rd July 2008 (see attached) to modify the above protocol. The Executive Committee found that there were no ethical objections to the modifications and therefore recommends approval to proceed.

Chief Investigator / Supervisor's responsibilities to ensure that:

(1) All serious and unexpected adverse events should be reported to the HREC as soon as possible.

(2) All unforeseen events that might affect continued ethical acceptability of the project should be reported to the HREC as soon as possible.

(3) The HREC must be notified as soon as possible of any changes to the protocol. All changes must be approved by the HREC before continuation of the research project. These include:-

- If any of the investigators change or leave the University.
- Any changes to the Participant Information Statement and/or Consent Form.

(4) All research participants are to be provided with a Participant Information Statement and Consent Form, unless otherwise agreed by the Committee. The Participant Information Statement and Consent Form are to be on University of Sydney letterhead and include the full title of the research project and telephone contacts for the researchers, unless otherwise agreed by the Committee and the following statement must appear on the bottom of the Participant Information Statement. *Any person with concerns or complaints about the conduct of a research study can contact the Senior Ethics Officer, University of Sydney, on (02) 9351 4811 (Telephone); (02) 9351 6706 (Facsimile) or gbriody@usyd.edu.au (Email).*

(5) Copies of all signed Consent Forms must be retained and made available to the HREC on request.

(6) It is your responsibility to provide a copy of this letter to any internal/external granting agencies if requested.

(7) A report and a copy of any published material should be provided at the completion of the Project.

Yours sincerely

Professor D I Cook
Chairman
Human Research Ethics Committee

CC: Dr. Ian Cathers, Discipline of Exercise and Sport Science, Faculty of Health Sciences, Cumberland Campus-C42, The University of Sydney

Encl: Copy of approved Participant Information Sheet
Copy of approved Consent Form
Copy of approved Advertisement
Copy of approved instructions for the collection of saliva specimen
Copy of approved Screening Questionnaire.
Copy of Pittsburgh Sleep Quality Index Questionnaire
Copy of approved International Physical Activity Questionnaire.
Copy of approved Stress Questionnaire 1 (PSS)
Copy of approved Demographic Questionnaire

University of Jordan
Faculty of Nursing
Research Committee/ 2007-2008
Research Approval
Ethical Considerations and Scientific Merits

Date: 23.6.2008
Research / Project Title: The role of stress in the development of
Researcher: Tawfic Hamad Almoosh
Co – researcher/s: 1. _____ 3. _____
2. _____ 4. _____

Department: PhD student / University of Sydney.

Ethical Considerations:

The research committee has reviewed the proposal research/project and decided that the research presents no risks to human participants:

- Physical and/or psychological risks. YES (NO)
- Financial cost for participants. YES (NO)
- Risks related to invasion of privacy / confidentiality. YES (NO)
- Cultural compatibility. (YES) NO

Scientific merits: This research / project is:

- Relevant to nursing science. (YES) NO
- Original / replicable. (YES) NO
- Following scientific research methods. (YES) NO
- Applicable to nursing practice, education and administration. (YES) NO

Additional Remarks: No violation of Human Rights

Approving Signature of Committee Chair

[redacted]

Approval Date: 23.6.2008 Expiration Date: —
Renewal Date: _____ Expiration Date: _____

The University of Sydney

Faculty of Health Science
Discipline of Exercise and Sport Science - East Street-Lidcombe
PO Box 170 Lidcombe
NSW 1825 Australia

Research Study into the role of stress in the development of the metabolic syndrome

Participant Information Sheet

You are invited to take part in a research study into "The role of stress in the development of metabolic syndrome". The study objective is to investigate whether stress disturbs a specific hormonal balance in our body leading to the development of the metabolic syndrome. The study is being conducted by Tawfiq Almadi and will form the basis of his PhD Project; under the supervision of Dr Ian Cathers and Dr Chin-Moi Chow.

If you agree to participate in this study, you will be asked to complete the questionnaires about stress, your physical activity, sleep quality and demographic information (age, occupation type, job level and general health). This will take about 25 minutes to complete.

We will measure your height, weight, waist circumference and resting blood pressure. We will also collect a fasting blood sample (~10 mL) for the analysis of chemicals related to the metabolic syndrome. The sample will be drawn by Tawfiq Almadi and/or Dr Chin-Moi Chow who are qualified to perform venipuncture. With any blood collection procedure there is slight pain in needle insertion and a small risk of bruising. The measurements and blood collection will take about 15 minutes and this will be done at a time suitable for you. A light breakfast will be available following your blood collection. On one occasion at home, following waking, you will collect a sample of your saliva into a container provided. Instructions for salivary collection are attached.

You will not receive any direct benefits from this study. However your participation is extremely valuable to medical research and will help us to gain a better understanding of how stress may increase the risk of metabolic syndrome and cardiovascular diseases. All your blood, saliva tests and blood pressure measurements will be reviewed by a qualified General Practitioner to identify whether any of these are outside the normal range. If this is the case, a copy of your results will be sent both to you and another copy to your General Practitioner. If any of your results are outside the normal range, but you do not identify a personal General Practitioner we will send you a copy of your results and suggest that you seek medical advice from a **General practitioner**. If you would like the results of your tests even if they are within normal ranges, we can

post them to you. You need to keep in mind that these are research results and may not provide clinical evidence. You may wish to discuss them with your medical practitioner.

All aspects of the study, including results, will be strictly confidential and only the investigators named above will have access to the information. All information will be anonymous and we will only use a code for your data. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

Participation is completely voluntary and you may withdraw at any time without prejudice.

When you have read this information, Tawfiq Almadi is available to answer any questions you may have and discuss the study further. If you would like to know more at any stage, please feel free to contact Dr Ian Cathers, Chief Investigator, (02) 9351 9287. This information sheet is for you to keep.

Any person with concerns or complaints about the conduct of a research study can contact the Senior Ethics Officer, Ethics Administration, University of Sydney on (02) 9351 4811 (Telephone); (02) 9351 6706 (Facsimile) or gbriody@usyd.edu.au (Email).

The University of Sydney

Faculty of Health Science
Discipline of Exercise and Sport Science - East Street-Lidcombe
PO Box 170 Lidcombe
NSW 1825 Australia

دراسة بحثية في دور الإرهاقالنفســـــي في تطور المتلازمة الأيضية

بطاقة معلومات للمشارك Participant Information Sheet

أنت مدعو للمشاركة في دراسة بحثية في دور الإرهاق في تطور المتلازمة الأيضية.

– هدف الدراسة التحقق فيما إذا كان الإرهاق والضغوط النفسية تخل في اتزان هرموني محدد في أجسامنا مما يؤدي إلى الإصابة بالمتلازمة الأيضية.

هذه الدراسة يجريها توفيق الماضي وستكون الأساس لمشروعه للحصول على الدكتوراه بإشراف الدكتورة جن ميو جن.

إذا وافقت على المشاركة بهذه الدراسة سوف نطلب منك الإجابة على أسئلة تتعلق بالإرهاق و بنشاطك البدني وبنوعية نومك وعن معلوماتك الدمغرافية (مثل العمر ، نوع المهنة ، الدرجة الوظيفية ، والصحة العامة). للإجابة عن هذه الأسئلة نحتاج الى 25 دقيقة من وقتك.

– سوف نقوم بقياس طولك ووزنك ومحيط خصرك وضغط دمك. و سنقوم كذلك بسحب عينة دم منك 10 مل وأنت صائم (قبل أن تفطر) وذلك لإجراء فحوصات مخبرية تتعلق بالمتلازمة الأيضية. العينة سيقوم بسحبها منك توفيق الماضي وهو شخص مؤهل للقيام بسحب الدم. مع أي عملية سحب دم هناك فرصة قليلة للألم لنغز الإبرة وفرصة قليلة لحصول كدمة صغيرة. كل القياسات وعملية سحب الدم تستغرق 15 دقيقة وتجري بوقت يناسبك. ستقدم لك وجبة فطور خفيفة بعد إتمام سحب الدم منك.

- في إحدى المرات وفي البيت بعد أن تصحو من النوم صباحاً سوف تقوم بجمع عينات من اللعاب. ملاحظة : معلومات كيفية جمع اللعاب مرفقة لاحقا.

لن تتلقى أي فوائد مباشرة من هذه الدراسة ولكن مشاركتك تعد بغاية الأهمية للبحث الطبي وسوف تساعدنا لكسب فهم أفضل كيف أن الإرهاق قد يؤدي إلى زيادة فرص الإصابة بالمتلازمة الأيضية وأمراض القلب والأوعية الدموية.

سيقوم طبيب مؤهل بمراجعة كل نتائج فحوصات دمك ولعابك وضغط دمك لتحديد فيما إذا كانت النتائج خارج المستوى الطبيعي, في حالة إذا كان هناك أي نتيجة غير طبيعية سنرسل نسخة من نتائجك لك ونسخة إلى طبيبك العام.

إذا كانت إحدى هذه النتائج خارج المستوى الطبيعي ولم تحدد لنا اسم طبيبك العام سنرسل لك نسخة من نتائج فحوصاتك مع توصية بأن تطلب النصيحة الطبية من طبيبك العام. إذا اردت معرفة نتائج فحوصاتك حتى وان كانت في المستوى الطبيعي سنرسل لك بالبريد ولكن عليك أن تتذكر أن هذه النتائج هي نتائج بحث علمي وقد لا توفر لك دليل سريري. باستطاعتك مناقشة نتائج فحوصاتك مع طبيبك العام إذا أردت ذلك.

كل ما يتعلق بهذه الدراسة وكل النتائج ستكون سرية جداً لن يطلع عليها إلا الباحثون الذين ذكر أسماؤهم في هذه البطاقة.

فـــي كل المعلومات والبيانات التي تجمع منك لن يظهر اسمك وإنما سوف نستخدم بدل الاسم رقم رمزي.

تقرير عن هذه الدراسة قد يرسل للنشر ولكن لن يتم الإفصاح عن أسماء المشاركين في هذا البحث.

المشاركة في هذا البحث هي في شكل كامل تطوعية وباستطاعتك الانسحاب منها في أي وقت بدون أي إجراء ضدك.

عندما تقرأ هذه المعلومات سيكون توفيق الماضي متواجد للإجابة على أي سؤال لديك وباستطاعتك مناقشة الدراسة بشكل أعمق معه.

إذا أردت أن تعرف أكثر في أي مرحلة من البحث من فضلك لا تتردد بالاتصال بالدكتور. ايمن منصـــور احدالمشرفين على هذه الدراسة تلفون5355000 فرعي23108

أي شخص لديه قلق أو شكوى بشأن الطريقة التي تنفذ بها هذه الدراسة يستطيع الاتصال بالدكتورة ريماالصفدي رئيسة لجنة البحث العلمي في كلية التمريض بالجامعة الأردنية تلفون5355000 فرعي23180 او فاكس 5337883 او بالبريدالاكتروني r.safadi@ju.edu.jo

The University of Sydney

Faculty of Health Science
Discipline of Exercise and Sport Science - East Street-Lidcombe
PO Box 170 Lidcombe
NSW 1825 Australia

PARTICIPANT CONSENT FORM

RESEARCH STUDY INTO THE ROLE OF STRESS IN THE DEVELOPMENT OF THE METABOLIC SYNDROME

.

I,.....

have read and understood the information for participants on the above named research study and have discussed any questions I have with the researcher/s.

I am aware of the procedures involved in the study, including any inconvenience or risk, and their implications.

I freely choose to participate in this study and understand that I can withdraw without penalty at any time.

If any of my blood, saliva tests or blood pressure results are outside the normal range, I agree to having my results sent to both myself and my personal General Practitioner. If I have not identified a personal General Practitioner, I agree to have my results sent to myself with the suggestion that I seek medical advice from a General Practitioner.

I also understand that the research study is strictly confidential.

I hereby agree to participate in this research study.

Signature:.....

Name:.....

Date:.....

The University of Sydney

Faculty of Health Science
Discipline of Exercise and Sport Science – East Street-Lidcombe
PO Box 170 Lidcombe
NSW 1825 Australia

PARTICIPANT CONSENT FORM

نموذج موافقة على الاشتراك في بحث علمي
دراسة بحثية في دور الإرهاقالنفســـــي في تطور المتلازمة الأيضية

انا

.....

لقد قرأت وفهمت المعلومات الموجهة الى المشاركين في الدراسة المذكورة اعلاه وقد ناقشت اي اسئلة لي مع الباحث/ الباحثين. وانا على بينة من الاجراءات التي تنطوي عليها في الدراسه ، بما في ذلك اي ازعاج او خطر ، والآثار المترتبة عليها.

وانا اخترت بشكل حر المشاركة في هذه الدراسه ، وافهم اني استطيع الانسحاب منها دون عقوبة في اي وقت
.
اذا كان اي من نتائج فحوصات دمي او لعابي اوضغط دمي خارج المستوى الطبيعي ، اوافق على ارسال نسخة من نتائجي لي ونسخة إلى طبيبي العام، اذا كنت لم احدد شخصية طبيبي العام ، فانني اوافق على ان ترسل النتائج لي شخصيا مع توصية بالتماس المشوره الطبية من طبيب عام.

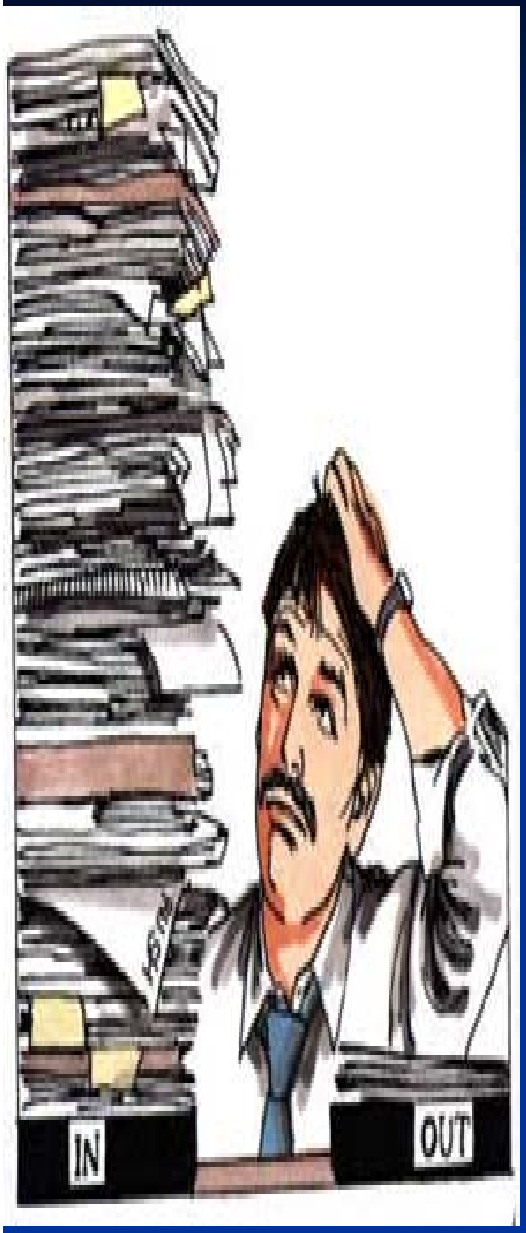
وأفهم ايضا ان الدراسه البحثيه هي سرية تماما

وبموجب هذا اوفق على المشاركة بهذة الدراسة البحثية.

التوقيع.....

الاسم.....

التاريخ.....



Is work Stress making us unhealthier?

Faculty of Health Science-Sydney University- is seeking volunteers to participate in this study investigating the relationship between stress and the development of obesity, increased cholesterol, blood pressure and disturbance in body glucose control.

We need around 30 min of your time and 10 mL of your blood. Eligible participants must be :

Male employees and more than 18 years old.

These tests will be done for you free of charge:

Blood cholesterol, triglycerides, glucose and inflammatory marker levels

To find out more about this study please call :

Tawfiq Almadi 04 0175 4434
talm3809@usyd.edu.au

هل يوثر الضغط النفسي على صحتنا

:

كلية العلوم الصحية جامعة سيدني – استراليا

نبحث عن متطوعين للمشاركة في هذه الدراسه لنتحقق من علاقة الضغط النفسي بتطوير السمنة ، وزيادة الكولسترول وضغط الدم واضطراب نسبة السكر بالدم.

نحن بحاجة لحوالى30 دقيقة من وقتك و 10مل من دمك

حتى تكون مؤهل للمشاركة :

يجب ان تكون موظفا رجلا ، عمرك اكثر من18عاما .

الفحوصات المخبرية التالية ستجرى لك با لمجان:

الكولسترول في الدم ، الدهنيا ت ، وسكر الدم ،ونسب مؤشرات الالتهابات في الدم.

لمعرفة المزيد حول هذه الدراسه يرجى الاتصال ب

توفيق

APPENDIX B

SCREENING AND DEMOGRAPHIC QUESTIONNAIRES

Screening Questionnaire

Code number:

This questionnaire will assess your suitability as a participant for this research study. Please answer all the questions. If you are in doubt about any of the questions you may consult with your general medical practitioner, or ask the researcher Tawfiq Almadi by calling or SMS mobile 04 0175 4434 or email: talm3809@usyd.edu.au

	Yes	**No**
1. Are you a male employee and more than 18 years old?	☐	☐
2. Are you willing to undergo measures of your body dimensions	☐	☐
3. Are you willing to complete the stress, sleep , physical activity, and demographic data questionnaires?	☐	☐
4. Are you willing to collect salivary samples and donate a 10 mL fasting blood sample?	☐	☐

If you answer 'No' to any of the above question, please do not proceed. You are not a potential subject, Thank you.

5. Do you have any of the following conditions?	Yes	No
Acute infection during the last 2 weeks	☐	☐
Liver diseases	☐	☐
Chronic viral illness	☐	☐
Known cardiovascular diseases **(excluding hypertension.)**	☐	☐
Rheumatoid arthritis and /or connective tissue disease (e.g., lupus erythematosus, Wegener's granulomatosis)	☐	☐
Sepsis and vasculitis	☐	☐
Tumor disease	☐	☐
Serious injury or surgical operation in the last 6 months	☐	☐
Neurological and/or endocrine conditions	☐	☐

If you answered 'Yes' to any of the above questions, please do not proceed. Thank you.

6. Do you take one or more of the following medications?	Yes	No
Aspirin or 3-hydroxy-3-methylglutaryl-coenzymeA reductase inhibitors - **"statins**"	☐	☐
Cholesterol lowering agents	☐	☐
Any sort of Glucocorticoids **-** "steroid"	☐	☐
Antidepressants or psychotropic medications	☐	☐

If you answered 'Yes' to any of the above questions, please do not proceed. Thank you.

7. Has your doctor ever said you have one or more of the following conditions? Please choose one of the following:

	0 I have never been diagnosed with this condition	1 Been diagnosed recently (less than one year)	2 Been diagnosed more than 1 year
Hypertension	☐	☐	☐
Noninsulin-dependent diabetes mellitus	☐	☐	☐
Insulin-dependent diabetes mellitus	☐	☐	☐

8. Which of these describes you? ☐ Current smoker ☐ Never smoke ☐ X-Smoker

How many cigarettes, cigars or pipefuls of tobacco did (do) you use daily? …….
(Circle type of usage)

If you are an ex-smoker:

How long ago did you stop? …….

For how long did (have) you smoke (d)? ……

9. Do you drink alcohol? Yes ☐ No ☐

If Yes, how many standard drinks would you have in a normal week? .....
"One standard drink:
A can of Beer (330mL) or a glass of table wine(100mL) or a nip of spirits (30mL)"

10. Please write down all of the medications that you take regularly and their doses:

Name of Medication	Doses

Screening Questionnaire استبيان تقيمي

الرقم الرمز:
سيقيم هذا الاستبيان اذا كنت المشارك المناسب لهذه الدراسه البحثيه. الرجاء الاجابه على جميع الاسئلة.
اذا كنت في شك حول اي من الاسئلة باستطعتك التشاور مع الطبيب العام الخاص بك ، أو اسئل الباحث توفيق الماضي بالاتصال او بارسال رسالة قصيره(SMS) بالهاتف الجوال ..... أو عن طريق البريد الألكتروني : [redacted]

ضع علامة X للاجابة التي تناسب وضعك	نعم	لا
1 -هل انت ذكر موظف وعمرك اكثر من 18 عاما؟		
2-هل انت على استعداد بالسماح باخذ قياسات لابعاد جسمك (الطول،محيط الخصر،الوزن)؟		
3-هل انت على استعداد لاكمال استبيان الضغط النفسي و استبيان النشاطات البدنية واستبيان النوم و البيانات الديموغرافيه		
4-هل انت على استعداد لجمع عينات من لعابك والتبرع بعينة من دمك (عشرة مل) وانت صائم؟		

اذا كنت اجبت ب 'لا' على أي سؤال أعلاه ، يرجى عدم المضي قدما, انت غير مناسب للاشتراك بهذه الدراسة.شكرا لك.

5-هل لديك احد الاعراض التالية نعم لا

(ضع علامة X للاجابة التي تناسب وضعك)

التهاب حاد خلال الاسبوعين الماضيين.

أمراض الكبد.

امراض فيروسيه مزمنه.

أمراض القلب والاوعيه الدمويه المعروفة (باستثناء ارتفاع ضغط الدم.)

التهاب المفاصل و / أو أمراض النسيج الضام (على سبيل المثال ، الذئبـــة الحماميه ، تورمات فيجنر).

التسمم والتهاب الاوعيه الدمويه.

أمراض الأورام.

جرح كبير او عملية جراحية في 6 أشهر الاخيرة.

اعراض تتعلق بالاعصاب و / أو الغدد الصماء.

اذا كنت اجبت ب" نعـم" على أي سؤال أعلاه ، يرجى عدم المضي قدما, انت غير مناسب للاشتراك بهذه الدراسة.شكرا لك.

6- هل تتناو ل واحدا او اكثر من الادوية التالية؟ نعم لا

ضع علامة X للاجابة التي تناسب وضعك

الاسبرين او استخدام عقار مثبط الهيدروكسى –3–ميثلجاواتل–كو انزيم ردكتاز (ستاتينز) علاج لمعالجة ارتفاع الكلوسترول

ادويه خفض الكولسترول

اي نوع من الهيدروكورتيزون او الكورتيزون او البريدنيزولون "الستيرويد"

مضادات الاكتئاب او المؤثرات العقليه

اذا كنت اجبت ب" نعـم" على أي سؤال أعلاه ، يرجى عدم المضي قدما, انت غير مناسب للاشتراك بهذه الدراسة.شكرا لك

7- هل قال طبيبك في اي وقت مضى ان لديك واحد او اكثر من الظروف الصحية التالية؟ ضع علامة X للاجابة التي تناسب وضعك	لم يتم أبداتشخيصي بهذاالظرف الصحي	تم تشخيصي بهذاالظرف الصحي منذ اقل من سنة	تم تشخيصي بهذاالظرف الصحي منذ اكثر من سنة
ارتفاع ضغط الدم			
داء السكري غير المعتمد على الانسولين (النوع الثاني)			
داء السكري المعتمد على الانسولين (النوع الاول)			

8-اي من هذه العبارات تصفك ؟	مدخن بالوقت الحالي	مدخن سابقا	لم ادخن ابدا

كم عدد السجائر او السيجار او كم غليون او ارجيلة تدخن (او كنت تدخن)يوميا .....

(ضع دائرة حول النوع الذي تستخدمه) السجائر او السيجار او غليون او ارجيلة

منذ متى بدأت التدخين؟.....

اذا كنت مدخن سابق منذ متى توقفت عن التدخين؟ .....

نعم لا

9-هل تشرب الكحول؟

اذا كان الجواب نعم. كم مشروبا عاديا من الكحول تحتسي في الاسبوع العادي.....

ملاحظة واحد مشروب عادي تعادل علبة واحدة بيرة بحجم 330مل او كاس مائدة من النبيذ بحجم 100مل او قدح من الويسكي بحجم 30مل

10-يرجى ان تكتب جميع الادوية التي تأخذها بانتظام والجرعات

اسم الدواء	**الجرعات**

Demographic –Questionnaire

Code Number:

To the Participant: We would appreciate you completing the following voluntary information below and returning it with the other questionnaires. The first page of this questionnaire will be permanently separated from the rest of the questionnaire. The personal information gathered in this manner will be only used for scientific research purpose. No personal information will be disclosed. Your name will be concealed and only a code number will be used.

Surname: *(Please Print)*	First name: *(Please Print)*
Middle name(s): *(Please print)*:	Date of birth (dd/mm/yy):
Country of birth:	Age:

Mailing Address State Postcode
Phone Home : ( ) Work : ( ) Mobile: Email:

Your General Practitioner Name : Address: State: Postcode : Phone:

Do you wish to have the results of your blood, saliva and blood pressure tests sent to you even if they are normal?	Yes ☐	No ☐

What is your ethnicity: *Tick only one*

☐	☐	☐	☐	☐	☐	☐
Anglo-Saxon	South-East Asian	Indian sub-continent	South American	Middle east or North Africa.	Aboriginal or Torres Strait Islander	Other (specify the origin country ……..)

How do you classify your job?	☐ Office worker ☐ Labor worker
Are you working	☐ Full time ☐ Part Time ☐ casual
Are you working?	☐ Day time ☐ Night time ☐ Shift (day and night)
Are you working for	☐ Public sector ☐ Private sector ☐ Sole trader ☐ other

Demographic –Questionnaire **الاستبيان الديموغرافي**

الرقم الرمز

الى المشارك : اننا نقدر لك تطوعك باكمال المعلومات الواردة ادناه واعادتها مع غيرها من الاستبيانات .
الصفحه الاولى من هذا الاستبيان سيتم فصلها بشكل كلي و دائم عن بقية الاستبيان.
المعلومات الشخصيه التي تجمع بهذه الطريقة سوف تستخدم فقط لاغراض البحث العلمي.لا معلومات شخصية سيتم الكشف عنها. اسمك سيتم اخفاءه سنستخدم فقط الرقم الرمز

إسم الشخص: **إسم** الأسرة:

تاريخ الميلاد :

إسم الأب وإسم الجد :

اليوم الشهر السنة

العمر : مكان الولادة :

العنوان البريدي

المدينة الرمز ا لبريدي

رقم الجوال ( ) هاتف العمل ( ) هاتف البيت ( )

Email:

معلومات عن طبيبك العام

اسمه :

عنوانه:

هل ترغب في الحصول على نتائج اختبارات الدم ، وضغط الدم واللعاب الخاصة بك ان ترسل اليك حتى لو كانت طبيعية؟

☐ نعم ☐ لا

ما هو اصلك؟

☐ اردني

☐ عربي (اكتب اسم بلدك الاصل) ☐ اخرى (حدد بلد الاصل)

.....

أي من الفئات الأتية يصف عملك الأساسي جيداً خلال الأشهر الاثني عشر الأخيرة؟

☐ موظف حكومي
☐ موظف قطاع خاص
☐ صاحب العمل

☐ بدون اجر
☐ من فئة اخرى (اكتبها.....)

هل تعمل

☐ بدوام كامل ☐ بدوام جزئي ☐ العمل بدوام عرضي

هل تعمل

☐ مكتـــبي عمل ☐ عامل يدوي

هل تعمل

☐ في ساعات النهار فقط

☐ بنظام الورديات (الليل والنهار) ☐ في ساعات الليل فقط

APPENDIX C

VALIDATED QUESTIONNAIRES

ENGLISH VERSION OF PERCEIVED STRESS SCALE (PSS)

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate *how often* you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

	Questions	0	1	2	3	4
1	In the last month, how often have you been upset because of something that happened unexpectedly?					
2	In the last month, how often have you felt that you were unable to control the important things in your life?					
3	In the last month, how often have you felt nervous and "stressed"?					
4	In the last month, how often have you dealt successfully with day to day problems and annoyances?					
5	In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?					
6	In the last month, how often have you felt confident about your ability to handle your personal problems?					
7	In the last month, how often you felt that things were going your way?					
8	In the last month, how often have you found that you could not cope with all the things that you had to do?					
9	In the last month, how often have you been able to control irritations in your life?					
10	In the last month how often have you felt that you were on the top of things?					
11	In the last month, how often have you been angered because of things that happened that were outside of your control?					
12	In the last month, how often have you been thinking about things that you have to accomplish?					
13	In the last month, how often have you been able to control the way you spend your time?					
14	In the last month, how often have you felt difficulties were pilling up so high that you could not overcome them?					

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behaviour, 24*, 385-396. Reprinted with permission of The American Sociological Association

ARABIC VERSION OF PERCEIVED STRESS SCALE (PSS) مقياس الشعور بالإرهاق النفســـــي

الأسئلة في هذا الاستبيان تتعلق بأحاسيسك وأفكارك خلال الشهر الماضي. ويطلب منك في كل سؤال أن تبين كم مرة أحسست أو فكرت بطريقة معينة. وإن كانت بعض الأسئلة متشابهة، غير أن هناك اختلافات بينها، لذلك المرجو منك أن تتعامل مع كل سؤال على أساس أنه سؤال مستقل. والطريقة المثلى هي أن تجيب على كل سؤال بسرعة، أي أن لا تحاول أن تحسب بالضبط عدد المرات التي أحسست بشيء معين، بل أن تجيب على السؤال بتقدير معقول. للإجابة على كل سؤال من الأسئلة التالية، اختر اجابة واحدة

		لم يحدث أبدا	تقريبا لم يحدث أبدا	احيانـــا	في كثير من الأحيان ولكن الى حد ما	كثيرا جدا
1	**خلال الشهر الماضي كم مرة أزعجك حدوث شيء غير متوقع؟**					
2	**خلال الشهر الماضي كم مرة عادة شعرت بأنك لا تســـــتطيعالتحكم في الأمور المهمة في حياتك؟**					
3	**خلال الشهر الماضي كم مرة عادة أحسست(بالتوتر) بالعصبية والإجهاد ؟**					
4	**خلال الشهر الماضي كم مرة عادة تعاملت بنجاح مع أمور الحياة المزعجة أو المقلقة؟**					
5	**خلال الشهر الماضي كم مرة عادة أحسست أنك نجحت بمواجهة التغييرات المهمة التي حدثت في حياتك؟**					
6	**خلال الشهر الماضي كم مرة عادة أحسست بأنك واثق من قدرتك على معالجة مشاكلك الشخصية؟**					
7	**خلال الشهر الماضي كم مرة عادة أحسست أن الأمور كانت تسير لصالحك؟**					
8	**خلال الشهر الماضي كم مرة عادة أحسست أنك لا تستطيع القيام بكل الأشياء التي كان عليك أن تقوم بها؟**					
9	**خلال الشهر الماضي كم مرة عادة استطعت السيطرة على الأمور المزعجة(المثيرة) في حياتك؟**					
10	**خلال الشهر الماضي كم مرة عادة أحسست أنك مسيطر على الأمور؟**					
11	**خلال الشهر الماضي كم مرة عادة غضبت بسبب وقوع أشياء خارجة عن إرادتك؟**					
12	**خلال الشهر الماضي كم مرة عادة فكرت في الأمور التي عليك إنجازها ؟**					
13	**خلال الشهر الماضي كم مرة عادة تمكنت من التحكم في طريقة قضاء وقتك؟**					
14	**خلال الشهر الماضي كم مرة عادة أحسست أن المصاعب كانت تتراكم إلى درجة لا تستطيع التغلب عليها ؟**					

English Version Effort –Reward Imbalance Questionnaire

The following items refer to your present occupation. For each of the following statements, please indicate to what degree it reflects your situation. Thank you for answering all statements!

Effort Items (1-6)		Disagree	Agree I am not at all distressed	Agree I am somewhat distressed	Agree I am distressed	Agree I am very distressed
1	I have constant time pressure due to a heavy work load.					
2	I have many interruptions and disturbances in my job					
3	I have a lot of responsibility in my job.					
4	I am often pressured to work overtime.					
5	My job is physically demanding.					
6	Over the past few years, my job has become more and more demanding.					

Reward Items (7-17)		Agree	Disagree I am not at all distressed	Disagree I am somewhat distressed	Disagree I am distressed	Disagree I am very distressed	Not applicable (no superiors or no colleagues)
7	I receive the respect I deserve from my superiors.						
8	I receive the respect I deserve from my colleagues.						
9	I experience adequate support in difficult situations.						
		Disagree	Agree, but I am not at all distressed	Agree, and I am somewhat distressed	Agree, and I am distressed	Agree, and I am very distressed	
10	I am treated unfairly at work.						
11	My job promotion prospects are poor.						
12	I have experienced or I expect to experience an undesirable change in my work situation.						
13	My job security is poor.						

		Agree	Disagree, but I am not at all distressed	Disagree, and I am somewhat distressed	Disagree, and I am distressed	Disagree, and I am very distressed
14	My current occupational position adequately reflects my education and training.					
15	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.					
16	Considering all my efforts and achievements, my job prospects are adequate.					
17	Considering all my efforts and achievements, my salary/income is adequate.					

Over commitment		Strongly Disagree	Disagree	Agree	Strongly Agree
18	I get easily overwhelmed by time pressures at work.				
19	As soon as I get up in the morning I start thinking about work problems.				
20	When I get home, I can easily relax and 'switch off' work. (R)				
21	People close to me say I sacrifice too much for my job.				
22	Work rarely lets me go; it is still on my mind when I go to bed.				
23	If I postpone something that I was supposed to do today I'll have trouble sleeping at night.				

(R); reverse scoring

Source : Siegrist, J., Starke, D., Chandola, T., Godin, I., Marmot, M., Niedhammer, I., Peter, R. , 2004. The measurement of Effort-Reward imbalance at work: European comparisons. *Social Science and Medicine*, 58, 1483-1499.

Arabic version Effort –Reward Imbalance questionnaire.

النسخة العربية من استبيان عدم التوازن بين الجهد و ا لمكافأة

الأسئلة التالية تتعلق بوظيفتك الحالية. المرجو منك أن تحدد إلى أي مدى يناسب (يعكس) كل تصريح من التصريحات التالية وضعيتك المهنية. المرجو منك أن تجيب على كل التصريحات بوضع اشارة(×) في المربع الذي يناسب اجابتك وشكرا.

	الجهد Effort items (1-6)	غير متفق	متفق، ولكني لست متضايقا	متفق، وأنا متضايق إلى حد ما	متفق، وأنا متضايق	متفق، وأنا متضايق جدا
1	دائما أحس بضغط الوقت بسبب كثرة العمل	□	□	□	□	□
2	كثيرا ما اقاطع او ازعج بينما أزاول عملي	□	□	□	□	□
3	مسؤولياتي كثيرة في العمل	□	□	□	□	□
4	في أحيان كثيرة أجد نفسي مجبرا على العمل ساعات إضافية	□	□	□	□	□
5	وظيفتي تتطلب جهدا جسديا كبيرا.	□	□	□	□	□
6	خلال السنوات الماضيةأصبحت وظيفتي تتطلب أكثر فأكثر	□	□	□	□	□

	المكافأة Reward items (7-17)	متفق	غير متفق، ولكني لست متضايقا	غير متفق، وأنا متضايق إلى حد ما	غير متفق، وأنا متضايق	غير متفق، وأنا متضايق جدا	لا ينطبق هذا علي (ليس لدي رؤساء عمل او زملاء عمل)
7	رؤسائي في العمل يبدون تجاهي الاحترام الذي أستحق	□	□	□	□	□	□
8	زملائي في العمل يبدون تجاهي الاحترام الذي أستحقه	□	□	□	□	□	□
9	أتلقى الدعم المناسب في الظروف الصعبة.	□	□	□	□	□	

		غير متفق	متفق، ولكني لست متضايقا	متفق، وأنا متضايق إلى حد ما	متفق، وأنا متضايق	متفق، وأنا متضايق جدا
10	تتم معاملتي بشكل غير عادل في العمل.	□	□	□	□	□
11	فرصتي في العمل محدودة في مجال الترقي	□	□	□	□	□
12	تعرضت أو أتوقع أن أتعرض لتغيير غير مرغوب فيه في وضعيتي في العمل.	□	□	□	□	□
13	الامان الوظيفي ضعيف.(اي ان ضمانات استمرار الوظيفة ضعيفة.واحتمال ان تفقد وظيفتك كبير)	□	□	□	□	□

		متفق	غير متفق، ولكني لست متضايقا	غير متفق، وأنا متضايق إلى حد ما	غير متفق، وأنا متضايق	غير متفق، وأنا متضايق جدا
14	وظيفتي الحالية تتوافق مع مؤهلاتي الدراسية و التدريبية.	□	□	□	□	□
15	بالنظر إلى كل مجهوداتي ومنجزاتي، أتلقى الاحترام والتقدير اللذين أستحقهما في العمل.	□	□	□	□	□
16	بالنظر إلى كل مجهوداتي ومنجزاتي، فإن فرص الترقية بالنسبة لي مناسبة.	□	□	□	□	□
17	بالنظر إلى كل مجهوداتي ومنجزاتي، فإن راتبي/دخلي مناسب.	□	□	□	□	□

الافراط بالالتزام Over commitment		غير متفق بتاتا	غير متفق	متفق	متفق تماما
18	يغلبني بسهولة ضغط الوقت في العمل.(أي أحس كثيرا بأني غير قادر على القيام بكمية العمل المطلوبة في الوقت المحدد)	□	□	□	□
19	بمجرد ان استيقظ من النوم صباحا أبدأ التفكير في مشاكل العمل	□	□	□	□
20	عندما أصل إلى البيت أستطيع الاسترخاء و بسهولة أتوقف عن التفكير بالعمل	□	□	□	□
21	الناس المقربون مني يقولون إنني أضحي بأكثر من اللازم في سبيل وظيفتي	□	□	□	□
22	يظل فكري مشغولا بالعمل معظم الاوقات وحتى عند النوم	□	□	□	□
23	إذا أجلت عمل شيء كان من المفروض أن أعمله اليوم سيصعب علي النوم	□	□	□	□

ENGLISH VERSION PITTSBURGH SLEEP QUALITY INDEX (PSQI)

Code Number: _____ Date: _____

Instructions

The following relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions:

1. During the past month, when have you usually gone to bed at night?
USUAL BED TIME_____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
NUMBER OF MINUTES_____

3. During the past month, when have you usually gotten up in the morning?
USUAL GETTING UP TIME_____

4. During the past month, how many hours of *actual sleep* did you get at night? (This may be different than the number of hours you spend in bed.)
HOURS OF SLEEP PER NIGHT_____

5-For each of the following questions, tick the one best response. Please answer all questions.

During the past month, how often have you had trouble sleeping because you …..

a-Cannot get to sleep within 30 minutes

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

b. Wake up in the middle of the night or early morning

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

c. Have to get up to use the bathroom

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

d. Cannot breathe comfortably

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

e. Cough or snore loudly

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

F-Feel too cold

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

g. Feel too hot

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

h. Had bad dreams

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

h. Have pain

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

j. Other reason (please describe): ----------

How often during the past month have you had trouble sleeping because of this?

Not during the Past month	Less than once a week	Once or twice a week	3 or more times a week

6-During the past month, how would you rate sleep quality overall?

Very good fairly good fairly bad Very bad

7-During the past month, how often have you taken medicine (prescribed or over the counter) to help you sleep?

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

8-During the past month, how often have you had trouble staying awake while driving, eating meals or engaging in social activities?

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

9-During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

Not during the past month	Less than once a week	Once or twice a week	3 or more times a week

Reference:

Buysse, D. J., Reynolds, C. F. 3rd., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193-213. doi: 0165-1781(89)90047-4 [pii]

ARABIC VERSION PITTSBURGH SLEEP QUALITY INDEX (PSQI)

مؤشر بترسبورج لنوعية النوم

التعليمات: فيما يلي أسئلة تتعلق بنومك الاعتيادي خلال **الشهرالماضي** فقط. لهذا نرجو منك أن تحدد الجواب الأكثر مناسبة لأغلبية الأيام والليالي خلال **الشهر الماضي** الرجاء أن تجيب على كل الأسئلة:

1. خلال الشهر الماضي .في أي وقت عادةً كنت تذهب للنوم عندالليل؟ **وقت النوم الاعتيادي:**

_____

2. خلال الشهر الماضي كم من الوقت (عدد الدقائق) كنت تحتاج عادةً لكي تغفو نائما كل ليلة؟ **عدد الدقائق:** _____

3. خلال الشهر الماضي في أي وقت كنت تنهض من النوم(في الصباح)؟ **ساعة النهوض:**

_____

4. خلال الشهر الماضي كم ساعة نمت فعلا في كل ليلة (ملاحظة :ربما يختلف عدد ساعات النوم عن عدد الساعات التي تقضيها في الفراش)**.؟ عدد ساعات النوم في كل ليلة** _____

5. أجب على كل سؤال من الأسئلة التالية بوضع علامة (X) في مربع الاجابة الأكثر مناسبة لحالتك الرجاء أن تجيب على جميع الأسئلة.

خلال الشهر الماضي كم مرة وجدت صعوبة في النوم لأنك :

	لم يحدث ذلك في خلال الشهرالماضي	**أقل من مرة في الأسبوع**	**مرة أو مرتين في الأسبوع**	**ثلاث مرات أو أكثر في الأسبوع**
أ- لم تستطع النوم في ظرف 30 دقيقة	☐	☐	☐	☐
ب- استيقظت في الليل أو في الصباح الباكر	☐	☐	☐	☐
ج- اضطررت للذهاب إلى المرحاض (الحمام)	☐	☐	☐	☐
د- لم تكن تستطيع التنفس بسهولة	☐	☐	☐	☐
هـ- كنت تسعل أو تشخر بشكل مسموع	☐	☐	☐	☐
و- شعرت بالبرد الشديد	☐	☐	☐	☐
ز- شعرت بالحر الشديد	☐	☐	☐	☐
ح- رأيت أحلاماً مزعجة	☐	☐	☐	☐
ط- شعرت بالألم	☐	☐	☐	☐
ي- لسبب آخر (الرجاء تحديده)				
ك- خلال الشهر الماضي ، كم كانت تواجهك مشاكلُ في النوم لهذا السبب (لسبب الذي حددته في السؤال السابق السؤال ي)؟	☐	☐	☐	☐

6. خلال **<u>الشهر الماضي</u>** . كيف تقيم نوعية نومك بصفة عامة؟

☐ جيد جدا ☐ جيد إلى حد ما ☐ سيء إلى حد ما ☐ سيء جدا

	لم يحدث ذلك في خلال الشهرالماضي	**أقل من مرة في الأسبوع**	**مرة أو مرتين في الأسبوع**	**ثلاث مرات أو أكثر في الأسبوع**
7- خلال **<u>الشهر الماضي</u>** كم مرة تناولت **دواء لكي يساعدك على النوم** (سواء بوصفة طبيب أو بدونها) ؟	☐	☐	☐	☐
8- **خلال <u>الشهرالماضي</u>** كم مرة وجدت صعوبة في البقاء يقظا(اي مغالبة النعاس) بينما كنت تقود (السياقة) أو خلال تناولك وجبات الطعام أو في **خلال مشاركتك** في نشاط اجتماعي؟	☐	☐	☐	☐
9- **خلال <u>الشهرالماضي</u>** هل وجدت صعوبة في الحفاظ على الحماس والنشاط عند القيام بأشغال ما؟	☐	☐	☐	☐

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking .

   _____ **days per week**

   ☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7-During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., & Oja, P. (2002).International Physical Activity Questionnaires (IPAQ) .Retrieved from http://www.ipaq.ki.se/questionnaires/IPAQ_S7S_FINAL_MAY_01.pd

الاستبيان العالمي للنشاطات البدنية (IPAQ)
International Physical Activity Questionnaire (IPAQ)

نحن مهتمون بالتعرف على أنواع النشاطات البدنية التي يمارسها الناس كجزء من حياتهم اليومية. هذه الأسئلة سوف تستفهم عن الوقت الذي قضيته في ممارسة نشاطاتٍ بدنيةً بشكل فاعل خلال **الأيام السبعة الماضية**. الرجاء الإجابة على كل سؤال حتى لو لم تعتبر نفسك شخصاً غير نشيط بدنياً. الرجاء التفكير حول النشاطات التي تقوم بها خلال العمل، و ما تقوم به كجزء من أعمالك المنزلية أو في حديقة المنزل، و الانتقال من مكان إلى آخر و كذلك وقت الفراغ المخصص للتسلية أو التمارين أو الرياضة.
فكر بجميع الأنشطة البدنية التي تتطلب جهداً **بدنياً مرتفع الشدة** والتي قمت بها خلال **الأيام السبعة الماضية**. المقصود بالأنشطة البدنية عالية الشدة هو كل ما يشير إلى النشاطات التي تتطلب جهداً بدنياً صعباً وتجعلك تتنفس بصعوبة أكثر من الوضع الطبيعي. فكر فقط بالنشاطات التي قمت بها لفترة لا تقل عن عشر دقائق في كل مرة.

1.كم يوماً من **الأيام السبعة** الماضية مارست فيها نشاطات **بدنية عالية الشدة** مثل رفع الأشياء الثقيلة أوالحَفر أو الرياضة الهوائية أو قيادة الدراجة الهوائية بسرعة؟

عدد الأيام خلال الأسبوع ----------

إذا لم تقم بأية أنشطة بدنية عالية الشدة ← **انتقل إلى السؤال رقم 3.**

2.كم كنت تقضي من الوقت في ممارسة النشاطات البدنية عالية الشدة في كل يوم من الأيام التي ذكرتها؟

-------- ساعات في اليوم --------- دقائق في اليوم لا أدري/لست متأكدا ☐

فكر بالنشاطات **المعتدلة الشدة** التي قمت بها خلال **الأيام السبعة الماضية**. النشاطات **المعتدلة** تعني تلك النشاطات التي تتطلب جهداً بدنياً معتدلاً والذي يجعلك تتنفس بشكل أصعب قليلاً من الوضع الطبيعي. فكر فقط بالنشاطات التي قمت بها لفترة لا تقل عن عشر دقائق في كل مرة.

3.كم يوماً من **الأيام السبعة الماضية** قمت خلالها بنشاطات بدنية **معتدلة** مثل رفع أثقال خفيفة، أو قيادة الدراجة الهوائية بسرعة معتادة أو رياضة التنس الثنائية؟ لا يشمل ذلك المشي.

عدد الأيام خلال الأسبوع ----------

إذا لم تقم بأية بفعاليات معتدلة ← **انتقل إلى السؤال رقم 5.**

4.كم كنت تقضي من الوقت في ممارسة النشاطات البدنية المعتدلة في كل يوم من الأيام التي ذكرتها؟

--------ساعات في اليوم --------- دقائق في اليوم ☐ لا أدري/لست متأكدا

فكر في الوقت الذي قضيته في ممارسة **المشي** خلال **السبعة أيام الماضية**. وهذا يتضمن التمشي في العمل وفي البيت، والمشي عند الانتقال من مكان إلى آخر، وأي نوع من المشي قمت به لمجرد التسلية أو الرياضة أو قضاء وقت الفراغ.

5.خلال السبعة أيام الماضية، كم يوماً تمشيت لفترة لا تقل عن 10 دقائق في كل مرة؟

عدد الأيام خلال الأسبوع ----------

إذا لم تقم بأي نوع من المشي ← **انتقل إلى السؤال رقم 7.**

6.كم من الوقت عادةً كنت تقضي في التمشي في كل يوم من الأيام التي ذكرتها؟

--------ساعات في اليوم ---------- دقائق في اليوم ☐ لا أدري/لست متأكدا

السؤال الأخير هو حول الوقت الذي قضيته جالساً خلال أيام الأسبوع (نهارات ايام الاسبوع) للأيام السبعة الماضية. هذا يشمل وقت الجلوس في العمل و البيت والدراسة وخلال وقت الفراغ. وقد يشمل كذلك الوقت الذي قضيته جالساً على مكتب (منضدة) أو خلال زيارة الأصدقاء أو القراءة أو الجلوس أو الاستلقاء لمشاهدة التلفاز.

7.خلال الأيام السبعة الماضية، كم كنت تقضي من الوقت جالساً في اليوم؟

--------ساعات في اليوم ---------- دقائق في اليوم ☐ لا أدري/لست متأكدا

هذه هي نهاية الاستبيان، شكرا على المشاركة.

Questionnaires (IPAQ) .Retrieved from http://www.ipaq.ki.se/questionnaires

APPENDIX D

CORTISOL COLLECTION INSTRUCTIONS

The University of Sydney

Faculty of Health Science
-
Discipline of Exercise and Sport Science - East Street
PO Box 170 Lidcombe
NSW 1825 Australia

Instructions for the collection of saliva specimen

We have provided you with a small plastic container in which to collect your saliva.

The label on the container is like this:

Code number :	Waking Time :
Date Saliva Collected:	Time Saliva Collected:

Saliva specimen collection times:

- Immediately on waking
- At exactly 10 min from waking
- At exactly 20 min from waking

Should you miss the collection time, please collect the specimen on another day.

TIMING OF SALIVA COLLECTION IS CRUCIAL.
DAYLIGHT EXPOSURE AFFECTS THE MEASURE IN THE SALIVA.

Provided are:

- 3 labelled plastic containers and cotton roll for saliva collection.
  Each label has:
  - TIME (0 or 10 or 20 min)
  - Time Saliva Collected
  - Waking Time
  - Date Saliva Collected
- A plastic bag
- Sunglasses to wear for the entire period of saliva collection.

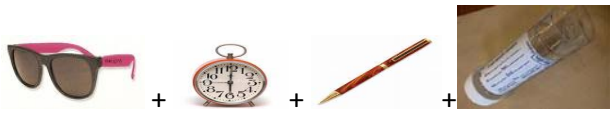
You can do your normal morning activities BUT

NO food or drinks or smoking.

NO exercise.
NO teeth brushing.
NO sample collection if you have blood from any injury in your mouth.

Instructions for collection of saliva specimen

1. Upon awakening, please put on the sunglasses.



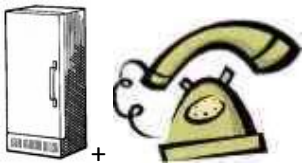
2. Write down your waking time on the container marked with 0 min.
- Open the container, pull out the cotton roll and place it in your mouth.
- Roll the cotton roll around with your tongue and gently chew to stimulate saliva production. This will take about one minute.
- Then spit the cotton into the O min container and cap the container tightly.

3. After exactly 10 minutes from waking, open the container marked 10min and collect the 2nd sample as before.

4. After exactly 20 minutes from waking, open the container marked 20min and collect the 3rd sample as before.

5. Place all of the containers in the plastic bag provided.

6. Immediately place the plastic bag of saliva samples in your freezer At home



7-Bring your saliva samples along to your blood collection appointment which is at …… a.m, on date…….. In room:.....
If you are unable to attend your appointment, please simply leave your samples in your home freezer, and as soon as possible please call or SMS Tawfiq ....., or email (talm3809@usyd.edu.au) to make another appointment.

The University of Sydney

Faculty of Health Science
Discipline of Exercise and Sport Science - East Street
PO Box 170 Lidcombe
NSW 1825 Australia

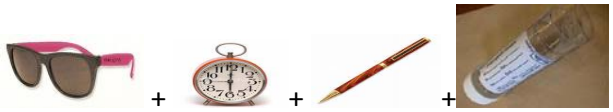
Instructions for the collection of saliva specimen **تعليمات جمع عينات اللعاب**

أوقات جمع عينات اللعاب :-

- على الفور عند الاستيقاظ من النوم صباحاً.
- بعد 10 دقائق بالضبط من الاستيقاظ.
- بعد 20 دقيقة بالضبط من الاستيقاظ.

إذا حصل أن فات موعد جمع أي عينة ولم تجمعها الرجاء جمع العينات من جديد في يوم آخر.

*** توقيت جمع العينات أمر بالغ الأهمية والتعرض لضوء النهار يؤثر على المادة المراد فحصها في اللعاب.**



يتم تزويدك بـ :-

1- ثلاث أنابيب بداخل كل أنبوبة لفة من القطن كتب على الأنبوبة

أ- وقت جمع العينة (الوقت صفر أو 10 دقائق أو 20 دقيقة).

ب- وقت جمع العينة.

ج- وقت استيقاظك من النوم.

د- **تاريخ** جمع العينات.

2- كيس بلاستيك.

3-نظارات شمسية توضع على عينيك من لحظة استيقاظك حتى لحظة جمع آخر عينة.

باستطاعتك القيام بكل ما تريد ذلك الصباح ولكن :

1) لا تأكل.
2) لا تشرب.
3) لا تمارس أي تمرين رياضي.
4) لا تفرشي أسنانك.

5) لا تجمع أي عينة إذا كان هناك أي دم في فمك من أي جرح.

تعليمات جمع العينة :

1) عند الاستيقاظ ضع النظارة الشمسية على عينيك فوراً.

2) اكتب وقت استيقاظك على الأنبوبة المعلمة بصفر دقيقة ، ضع اللفافة القطنية في فمك وحركها وامضغها بلطف لمدة دقيقة واحدة ثم ابصقها بالأنبوبة وأغلق الأنبوبة.

3) بعد 10 دقائق من استيقاظك افتح الأنبوبة المعلم عليها بـ 10 دقائق ، ضع اللفافة القطنية في فمك وحركها وامضغها بلطف لمدة دقيقة واحدة ثم ابصقها بالأنبوبة وأغلق الأنبوبة.

4) بعد 20 دقيقة من الاستيقاظ افتح الأنبوبة الثالثة المكتوب عليها 20 دقيقة واجمع العينة الثالثة بنفس الأسلوب الذي جمعت فيه العينة الأولى والثانية.

5) ضع الأنابيب جميعها في الكيس البلاستيك وضع الكيس في الفريزر في ثلاجة بيتك حتى يحين موعد سحب الدم. الرجاء إحضار عينات لعابك في موعد سحب الدم في اليوم..... والساعة...

إذا لم يكن باستطاعتك أن تحضر موعد سحب الدم الرجاء الاحتفاظ بعينات اللعاب في فريز ثلاجتك والاتصال بتوفيق الماضي أو إرسال رسالة قصيرة له على الرقم ..... أو بالبريد الإلكتروني thmadi@yahoo.com وذلك لتحديد موعد سحب دم آخر لك.

APPINDEX E

PUBLISHED ARTICLES AND STATEMENTS OF CO-AUTHORSHIP

An Arabic version of the perceived stress scale: translation and validation study.

As a co-author of the above article, I confirm that Tawfiq Almadi has made the following contributions:

- Conception and design of the research
- Analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- A corresponding author for communication with journal.

The article has been published in the *International Journal of Nursing Studies.*

Signed.... [redacted] 21/10/2013

Signed.... [redacted] 21/10/2013

Signed.... [redacted] 21/10/2013

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An Arabic version of the Perceived Stress Scale: Translation and validation study

Tawfiq Almadi [a,*], Ian Cathers [a], Ayman M. Hamdan Mansour [b], Chin Moi Chow [a]

[a] Discipline of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, PO Box 170, Lidcombe, NSW 1825, Australia
[b] Department of Community Health, Faculty of Nursing, University of Jordan, Amman, Jordan

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ABSTRACT

Background: The Perceived Stress Scale has been designed to measure the degree to which situations in a person's life are perceived as stressful.
Objective: The paper describes the development of an Arabic version of the Perceived Stress Scale.
Design: A translation process with cross-cultural considerations was employed to produce an Arabic version of the Perceived Stress Scale.
Settings: Participants were asked to complete the Arabic version Perceived Stress Scale twice in their homes.
Participants: The Jordanian study population for the Arabic version Perceived Stress Scale validation consisted of 126 volunteers (74 male, 52 female). Ninety participants completed the scale twice (55 male, 35 female), of whom 58 were high schools teachers and 32 technical workers. Arabic was the first language of all participants and all gave informed consent.
Results: The Arabic version Perceived Stress Scale reliability and validity were evaluated. Prior to an exploratory factor analysis, the suitability of data for factor analysis was assessed with acceptable results. The exploratory factor analysis showed two factors with eigenvalues greater than 1.0 (45.0% of variance). The Cronbach's alpha coefficients were 0.74 (Factor 1), 0.77 (Factor 2) and 0.80 for the Arabic version Perceived Stress Scale overall. The test–retest reliability had an intra-correlation coefficient of 0.90.
Conclusions: The Arabic version Perceived Stress Scale showed an adequate reliability and validity. Therefore, the Arabic Perceived Stress Scale is considered a suitable instrument to assess perceived stress in Arabic people.

What is already known about the topic?

- The Perceived Stress Scale (PSS-14) is a psychological tool for measuring the perception of stress.
- The Scale has been translated into several languages and has demonstrated good reliability and internal consistency.
- There is no Arabic version of the PSS-14.

What this paper adds

- The development of a translated Arabic version of the PSS-14.
- The Arabic version of the PSS-14 demonstrated good reliability and internal consistency.

1. Introduction

Stress may be considered a stimulus, a response or an interaction process between the individual and his environment (Brantley and Thomason, 1995). Lazarus (1999) and Lazarus and Folkman (1984) take the latter

* Corresponding author.
E-mail addresses: talm3809@uni.sydney.edu.au (T. Almadi), ian.cathers@sydney.edu.au (I. Cathers), a.mansour@ju.edu.jo (A.M. Hamdan Mansour), chin-moi.chow@sydney.edu.au (C.M. Chow).

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view that psychological stress is a dynamic interaction between the individual and his environment, and they proposed that stress is neither an environmental stimulus nor a psychological response, but rather a relationship between environmental demands and the ability to deal with them. Thus, stress is seen as a transaction between individual and environment. In other words, the environment provides the initial stimulus, but the key determinants of stress are the way the individual perceives the environment and his ability to cope with the stress. Based on this transactional definition of stress, Cohen et al. (1983) designed the Perceived Stress Scale (PSS) and later Levenstein et al. (1993) published the Perceived Stress Questionnaire (PSQ), which are self-reported measures of the degree to which situations in an individual's life are perceived as stressful. Both the PSS and PSQ have been translated into many languages and applied in different settings. Due to the length of the PSQ (30 items), we chose the shorter PSS (14 items) to be translated and validated. PSS items were designed to assess the degree to which individuals found their life unpredictable, uncontrollable, and overloaded. These issues have been repeatedly found to be central components of the experience of stress (Cohen et al., 1983). The PSS has been applied in a variety of studies including those linking stress to psychological or physiological disorders and depression symptoms (Chang, 1998); detecting the stress level of schizophrenia caregivers (Dyck et al., 1999); assessing the stress level of HIV-infected patients (Cruess et al., 1999); correlation between stress and increased susceptibility to respiratory diseases (Cohen et al., 1993); and also to the anti-inflammatory response (Song et al., 1999).

The PSS assesses the level of perceived stress experienced over the previous month, and has three versions: the PSS-14 (Appendix B), PSS-10 and PSS-4 with 14 and 10 and 4 items respectively. The PSS-14 has seven positive and seven negative items. The tool has demonstrated good reliability coefficients with Cronbach's alpha ranging from 0.75 to 0.91 (Cohen et al., 1983; Cohen and Williamson, 1988; Cole, 1999). The PSS has been translated into several languages including Spanish (Remor, 2006), Swedish (Eskin and Parr, 1996), Chinese (Lee and Crockett, 1994), and Japanese (Mimura and Griffiths, 2008). Thus, its application has particular value in cross-cultural studies, since it has been used in a wide range of cultures. While there has been one validation study of an Arabic version of the PSS-10 (Chaaya et al., 2010), there is no evaluated Arabic version of the PSS-14. This paper reports the development of a translated Arabic version of the PSS-14 together with testing for reliability and validity.

2. Methods

2.1. Translators

Professional translators were recruited through The National Accreditation Authority for Translators and Interpreters Ltd (NAATI) web site (www.naati.com.au). The translators were selected in accordance with the following criteria: (1) accredited by NAATI and (2) hold a postgraduate degree in translation. Non-professional translators, which included bilingual academic and health professionals, were recruited through collegial contacts of the study coordinator and all worked within the Australian university system. Nonprofessional translators married couple translators were recruited through Arabic community centers in Australia. Each married couple had one native English speaker and one Arabic native speaker, who was educated in an English speaking country (Australia). The married couples had been asked to discuss the meaning of scale items. Married couples were specifically chosen in an attempt to avoid more formal language used less frequently by the general public.

2.2. Translation

The repeated forward–backward translation procedure was adopted (Meadows et al., 1997) for the translation of the PSS into Arabic. The process of producing the Arabic PSS version involved seven stages (Fig. 1).

2.2.1. Stage 1: English to Arabic translations

Twelve people (three professional translators, three academics, and three married couples) were involved in Stage 1 of the Arabic PSS version. All translators were asked to avoid a literal translation and to ensure that the translation used simple language providing equivalence in the meaning of questions and rating scales. Each married couple had one native English speaker and one Arabic native speaker, who were educated in an English speaking country (Australia). The married couples worked as a team in translating the English version into Arabic.

2.2.2. Stage 2: Arabic version (1)

One of the authors (TA) and one health academic, both bilingual in Arabic and English, unified the nine Arabic translations produced from Stage 1 into a single translated version (Arabic version (1)).

2.2.3. Stage 3: Arabic version (2)

Another couple, both bilingual health professionals – one of them experienced in the use of psychological research studies within the Arabic community, and familiar in psychological terminology in both Arabic and English and not employed for Stages 1 or 2 – compared Arabic version (1) to the English original. They evaluated the clarity of writing and equivalence in the meaning of questions and answers. Unclear or ambiguous Arabic expressions were modified to produce Arabic version (2).

2.2.4. Stage 4: 1st back translation of Arabic to English

A further two independent translators, one professional translator and one a bilingual health academic, both blind to the original English version, back-translated Arabic version (2) into English.

2.2.5. Stage 5: identification of discrepancies in back translation

Two health academics (native English speakers) compared the original English version and the two back-translated versions, and checked for equivalence in the meaning of scales, questions and the answer options. They

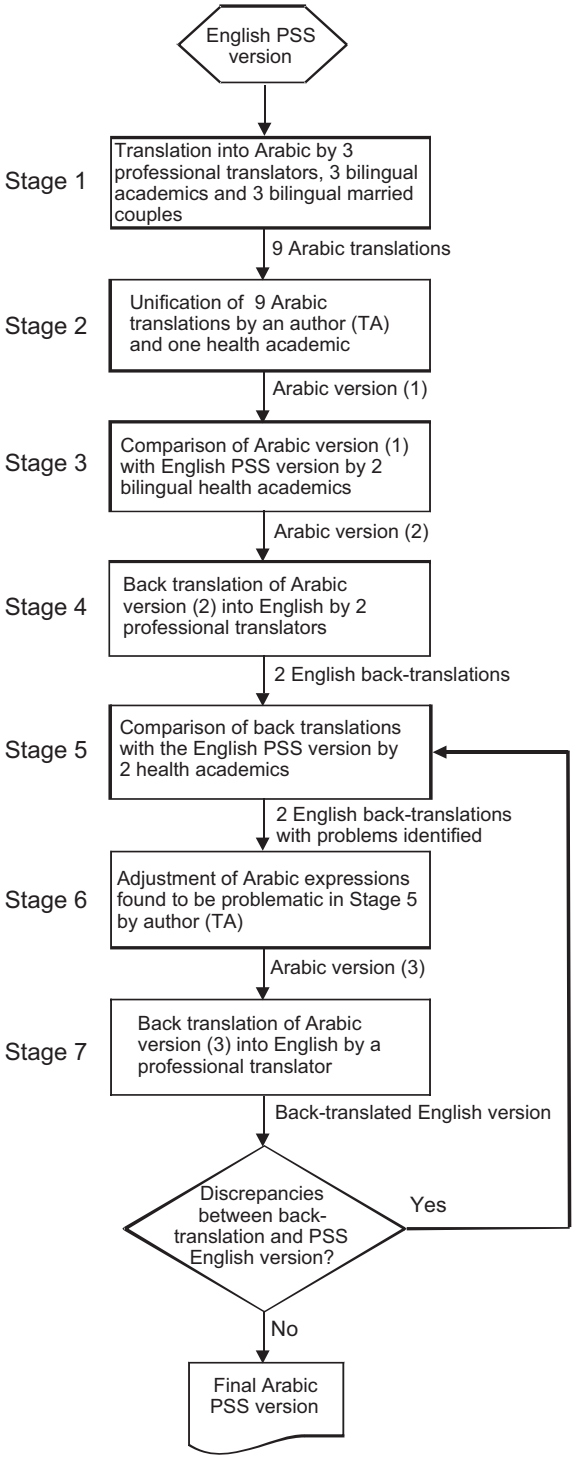

Fig. 1. Translation process.

identified discrepancies between the original and the back-translated versions.

2.2.6. Stage 6: Arabic version (3)

To resolve the discrepancies identified in Stage 5, the author (TA) adjusted the Arabic expressions that were found to be ambiguous or unclear, using alternative Arabic expressions from the nine translations produced in Stage 1, and resulting in Arabic version (3).

2.2.7. Stage 7: 2nd back translation of Arabic to English

One of the professional translators from Stage 4 was asked to do a back-translation into English a second time. Stages 5, 6, and 7 were repeated until all ambiguous and unclear statements were resolved and a final consensus version was obtained. See Appendix B for the final Arabic PSS.

2.3. Participants

The study population for the Arabic PSS validation consisted of 126 volunteers (74 male, 52 female) who were teachers and technical staff from three high schools located in the city of Zarka, Jordan. All subjects had at least a high school education certificate. Thirty-six subjects were excluded because they did not answer all the Arabic PSS questions. Ninety participants completed the Arabic PSS twice (55 male, 35 female; mean age of 35.2 ± 10.1 years), of whom 58 were teachers and 32 were technical staff. Arabic was the first language of all participants and all gave informed consent. The study was approved by the Human Research Ethics Committees of The University of Sydney and Jordan University.

2.4. Procedure

Permission from the principals at the three high schools was obtained to conduct the study. The study coordinator (TA) personally approached teaching and technical staff in the staff room at each school. The questionnaires and study information sheet – including information about the PSS questionnaire, the need for an Arabic version, and the contact details of the study coordinator – were handed to staff who agreed to participate in the study. Informed consent was obtained from all participants. All participants were asked to complete the Arabic PSS questionnaire at home as well as some additional questions regarding the participant's sex, age, education level and current job. Participants returned the questionnaire by mail or in-person to the study coordinator during a subsequent weekly visit to the school (4 visits for each school). After an average of 14 days from the completion of the first testing, a second Arabic PSS questionnaire was given to each participant for completion. Confidentiality of participants was assured by the use of identification codes which were known only by one of the authors.

2.5. Statistical analysis

The internal consistency was assessed by the Cronbach's alpha coefficient and the test–retest reliability was assessed by the intra-class correlation coefficient (SPSS version 17, SPSS Inc.). Prior to an exploratory factor analysis the suitability of data for such a factor analysis was assessed by the (1) correlation between the scale items (Tabachnick and Fidall, 1996), (2) Kaiser–Meyer–Oklin (KMO) sample adequacy measure (Kaiser, 1970,

1974), and (3) Bartlett's test (Bartlett, 1954). To examine the factorial structure of the scales, an exploratory factor analysis using principal factors extraction was undertaken. Factors with eigenvalues greater than 1.0 were retained (Fabrigar et al., 1999) and the varimax rotation method was used to obtain clear factorial structures.

3. Results

Table 1 shows the internal consistency and test–retest reliability of the Arabic PSS. Inspection of the strength of correlation between the 14 items revealed the presence of many correlation coefficients of 0.3 and above, which is considered adequate (Tabachnick and Fidall, 1996). The Kaiser–Meyer–Oklin value was 0.71, which exceeded the minimum recommended value of 0.60, and the Barlett's test of sphericity reached statistical significance, $p < 0.001$ (Pallant, 2001). Therefore, all assessment results supported the suitability of the study data for factorial analysis.

Principle components analysis revealed the presence of four components with eigenvalues exceeding 1, explaining 31%, 14%, 10% and 9% of the variance. An inspection of the Scree plot (Fig. 2) (Catell, 1966) revealed a break after the second component. Varimax rotation was performed. The rotated solution (Table 2) revealed the presence of a simple structure (Thurstone, 1947), and the rotated major two components explained 45% of the variance. All the seven items of negative perception (1, 2, 3, 8, 11, 12, and 14) loaded highly on the first component and explained 23% of the variance, while all the other seven items of positive perception (4, 5, 6, 7, 9, 10, and 13) loaded strongly on the second component and explained 22% of the variance.

4. Discussion

The Principle Factors Analysis results indicated that the Arabic PSS items can be loaded on four components (factors), but the Scree plot (Fig. 2) revealed a break after the second component, so it was decided to retain the first and second (the largest two) components for extraction and rotation by the varimax rotation method. The two component solution of the PSS were also adopted in other PSS versions: Japanese, Spanish, and English, and similar items loading on the two components have been reported as the Arabic PSS in the current study (Hewitt et al., 1992; Mimura and Griffiths, 2008; Ramirez and Hernandez, 2007). The varimax rotation showed that the Arabic PSS and the English PSS have almost the same loading except for item 7 (Table 2).

In the present study, the Arabic PSS showed that the loading of positive and negative items is consistent with the original English PSS, except for the loading of item 7 (Table 2). However, the loading of Arabic PSS-14 items, including item 7, is consistent with the versions in Japanese, Spanish and Hungarian (Mimura and Griffiths, 2008; Remor, 2006; Stauder and Konkolÿ, 2006).

Internal consistency of the Arabic PSS, assessed by the Cronbach's alpha coefficient of both components, was acceptable (0.74 and 0.77) and for the Arabic PSS-14 scale overall (0.80). These values are close to those for the widely used original English version which was from 0.80 to 0.86 (Cohen et al., 1983, Hewitt et al., 1992). These values show that the Arabic PSS-14 and its components have good internally consistency. Additional test–retest reliability/stability assessment was performed using intra-correlation coefficient, which was high, reflecting high reliability of the scale (Table 1).

Table 1
Mean scores (SD), range, Cronbach's alpha coefficient, and intra-class correlation coefficients (ICC) for the Arabic PSS-14.

Mean (SD)	Range	Cronbach's alpha	ICC (95%CI)
26.3 (8.2)	8–47	0.80	0.90 (0.87–0.93)

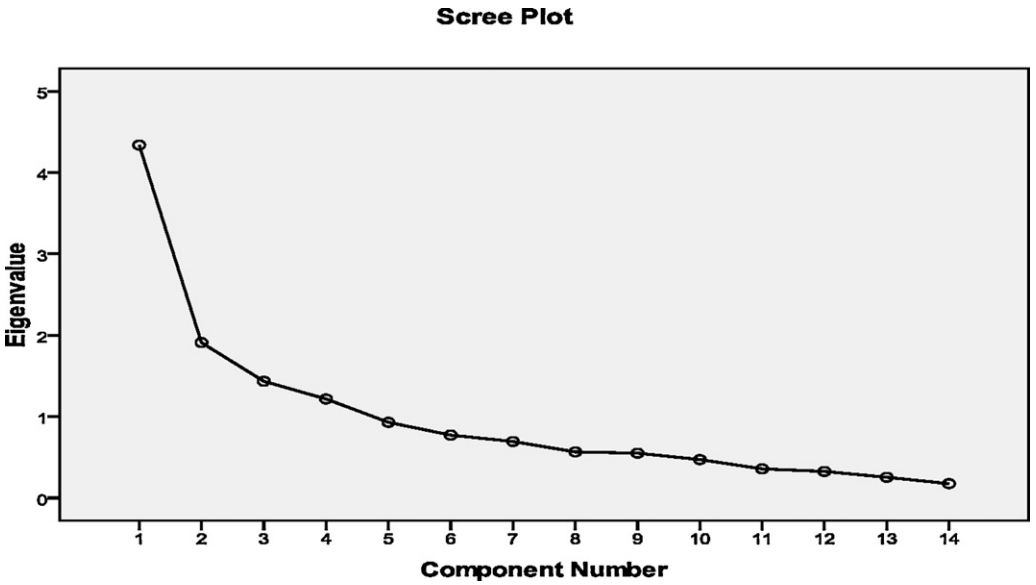

Fig. 2. Scree test for the APSS.

Table 2
Comparison of the varimax rotation of the two factor solutions for Arabic PSS-14 and English PSS-14.

Item	Varimax rotation of the two factor solution for Arabic PSS-14		Varimax rotation of the two factor solution for English PSS-14, $n = 96$ (adapted from Hewitt et al., 1992)	
	Component one (positive perception items)	Component two (negative perception items)	Component one (positive perception items)	Component two (negative perception items)
1	0.63	0.02	0.74	0.03
2	0.59	0.17	0.79	0.01
3	0.68	0.11	0.80	0.14
4	0.20	0.55	−0.27	0.68
5	0.19	0.73	0.16	0.83
6	0.05	0.65	0.34	0.65
7	0.25	0.52	0.49	0.38
8	0.60	0.18	0.66	−0.02
9	−0.09	0.47	0.12	0.63
10	−0.01	0.64	Not reported	
11	0.66	0.16	0.55	−0.24
12	0.54	0.21	Not reported	
13	0.21	0.72	Not reported	
14	0.55	−0.24	0.66	0.33
Cronbach's alpha	0.74	0.77	0.81	0.72

While there has been one validated Arabic version of the PSS-10 (Chaaya et al., 2010), up to now, there is no Arabic version of the PSS-14. The current validated Arabic PSS-14 provides an important tool for comparison with other ethnic/language groups, since the longer 14 item version is more commonly used in health studies (see, for example, references on Macarthur Research Network on SES and Health (2008)), Furthermore, the Arabic PSS-14 has higher internal consistency, reliability and stability values than the Arabic PSS-10, while having similar factorial analysis results. A concerted effort was made to produce an Arabic translation of the PSS with a wide range of translators involved in the process (married couples, professional translators, and academics with experience in psychological scales). The translation process had a balanced treatment of both linguistic and cross-cultural considerations (Hambleton, 1994; Van de Vivjer and Hambleton, 1996). This was achieved by using three married couples with a native English speaker and an Arabic native speaker to discuss word meanings in the PSS and identify equivalent Arabic words. In addition, professional translators were used to further improve the translation from a linguistic point of view. Despite these steps having been taken, the influence of cultural differences on both the experience of stress, and responses to it, cannot be eliminated. A further study using a larger sample size is needed to assess the cross-cultural validity of this scale using confirmatory factorial analysis as described by Beckstead et al. (2008). Future studies could also examine convergent validity by assessing correlations between Arabic PSS scores and other scales measuring perceived stress.

In summary, this Arabic version of the PSS-14 has good internal consistency and reliability. The factorial structure was similar to the PSS translated into other languages, and further establishes its value in cross-cultural studies. We consider this Arabic version of the PSS a suitable instrument to assess perceived stress for Arabic people.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ijnurstu.2011.07.012.

References

Bartlett, M.S., 1954. A note on multiplying factors for various chi squared approximations. Journal of the Royal Statistical Society Series B 16, 296–298.
Beckstead, J.W., Yang, C.Y., Lengacher, C.A., 2008. Assessing cross-cultural validity of scales: a methodological review and illustrative example. International Journal of Nursing Studies 45, 110–119.
Brantley, P.J., Thomason, B.T., 1995. Stress and stress management. In: Goreczny, A.J. (Ed.). Handbook of Health and Rehabilitation Psychology. New York, Plenum Press.
Catell, R.B., 1966. The screen test for the number of factors. Multivariate Behavioral Research 1, 245–276.
Chaaya, M., Osman, H., Naassan, G., Mahfoud, Z., 2010. Validation of the Arabic version of the Cohen Perceived Stress Scale (PSS-10) among pregnant and postpartum women. BMC Psychiatry 10, 111.
Chang, E.C., 1998. Does dispositional optimism moderate the relation between perceived stress and psychological well being? A preliminary investigation. Personality and Individual Differences 25, 233–240.
Cohen, S., Kamarck, T., Mermelstein, R., 1983. A global measure of perceived stress. Journal of Health and Social Behavior 24, 385–396.
Cohen, S., Tyrrell, D.A., Smith, A.P., 1993. Negative life events, perceived stress negative effect, and susceptibility to the common cold. Journal of Personality and Social Psychology 64, 131–140.

Cohen, S., Williamson, G.M., 1988. Perceived stress in a probability sample of the United States. In: Spacapan, S., Oskamp, S. (Eds.), The Social Psychology of Health. Sage, Newbury Park, CA, pp. 31–67.

Cole, S.R., 1999. Assessment of differential item functioning in the Perceived Stress Scale-10. Epidemiology and Community Health 53, 319–320.

Cruess, D.G., Antoni, M.H., Kumar, M., Ironson, G., McCabe, P., Fernandez, J.B., Fletcher, M., Schneiderman, N., 1999. Cognitive-behavioral stress management buffers decreases in dehydroepiandrosterone sulfate (DHEA-S) and increases in the cortisol/DHEA-S ratio and reduces mood disturbance and perceived stress among HIV seropositive men. Psychoneuroendocrinology 24, 537–549.

Dyck, D.G., Short, R., Vitaliano, P., 1999. Predictors of burden and infectious illness in schizophrenia caregivers. Psychosomatic Medicine 61, 411–419.

Eskin, M., Parr, D., 1996. Introducing a Swedish version of an instrument measuring mental stress. Reports from the Department of Psychology 813, 1–9.

Fabrigar, L., MacCallum, R., Wegener, D.T., Strahan, E.J., 1999. Evaluating the use of exploratory factor analysis in psychological research. Psychological Methods 4, 272–299.

Hambleton, R.K., 1994. Guidelines for adapting educational and psychological tests: a progress report. European Journal of Psychological Assessment (Bulletin of the International Test Commission) 10, 229–244.

Hewitt, P.L., Flett, G.L., Mosher, S.W., 1992. The Perceived Stress Scale: factor structure and relation to depression symptoms in a psychiatric sample. Journal of Psychopathology and Behavioral Assessment 14, 247–257.

Kaiser, H.F., 1970. A second generation little jiffy. Phsychometrika 35, 401–415.

Kaiser, H.F., 1974. Analysis of factorial simplicity. Psychometrika 39, 31–36.

Lazarus, R.S., 1999. Stress and Emotion: A New Synthesis. Springer, New York.

Lazarus, R.S., Folkman, S., 1984. Stress, Appraisal, and Coping. Springer, New York.

Lee, S., Crockett, M.S., 1994. Effect of assertiveness training on levels of stress and assertiveness experienced by nurses in Taiwan, Republic of China. Issues in Mental Health Nursing 1 (5), 419–432.

Levenstein, S., Prantera, C., Varvo, V., Scribano, M.L., 1993. Development of the perceived stress questionnaire: a new tool for psychosomatic research. Journal of Psychosomatic Research 37 (1), 19–32.

Ramirez, M.T., Hernandez, R.L., 2007. Factor structure of the Perceived Stress Scale (PSS) in a sample from Mexico. Spanish Journal of Psychology 10 (1), 199–206.

Meadows, K., Bentzen, N., Touw-Otten, F., 1997. Cross-cultural issues: an outline of the important principles in establishing cross-cultural validity in health outcome assessment. In: Hutchinson, A., Bentzen, N., König-Zahn, C. (Eds.), Cross Cultural Health Outcome Assessment; A User's Guide, vol. I. European Research Group on Health Outcomes, pp. 34–40.

Mimura, C., Griffiths, P., 2008. A Japanese version of the Perceived Stress Scale: cross cultural translation and equivalence assessment. BMC Psychiatry 8, 85.

Pallant, J., 2001. SPSS Survival Manual. A Step by Step Guide to Data Analysis Using SPSS for Windows (Version 10) Open University Press, Buckingham.

Remor, E., 2006. Psychometric properties of a European Spanish version of the Perceived Stress Scale (PSS). The Spanish Journal of Psychology 9, 86–93.

Song, C., Kenis, G., van Gastel, A., Bosmans, E., Lin, A., de Jong, R., Neels, H., Scharpe, S., Janca, A., Yasukawa, K., Maes, M., 1999. Influence of psychological stress on immune-inflammatory variables in normal humans. Part II. Altered serum concentrations of natural anti-inflammatory agents and soluble membrane antigens of monocytes and T lymphocytes. Psychiatric Research 85, 293–303.

Stauder, A., Konkolÿ, T.B., 2006. Characteristics of the Hungarian version of the Perceived Stress Scale (PSS). Mentálhigiéné és Pszichoszomatika 7, 203–216.

Tabachnick, B.G., Fidall, L.S., 1996. Using Multivariate Statistics. Harper Collins, New York.

The MacArthur Research Network on SES and Health, 2008. References to studies that examine the relationship between the Perceived Stress Scale and Biological or Verified Disease Outcomes. In: Psychosocial Notebook, Retrieved from http://www.macses.ucsf.edu/research/psychosocial/pssref.php.

The National Accreditation Authority for Translators and Interpreters Ltd, Australia (NAATI), 1977. Find a Translator or Interpreter. Available from http://www.naati.com.au.

Thurstone, L.L., 1947. Multiple Factor Analysis. University of Chicago Press, Chicago.

Van de Vivjer, F., Hambleton, R.K., 1996. Translating tests: some practical guidelines. European Psychologist 1, 89–99.

An Arabic version of the Effort reward imbalance: translation and validation study.

As a co-author of the article, I confirm that Tawfiq Almadi has made the following contributions:

- Conception and design of the research
- Analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- A corresponding author for communication with journal

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AN ARABIC VERSION OF THE EFFORT-REWARD IMBALANCE QUESTIONNAIRE: TRANSLATION AND VALIDATION STUDY[1]

TAWFIQ ALMADI, IAN CATHERS, AND CHIN MOI CHOW

Discipline of Exercise and Sport Science
Faculty of Health Sciences
The University of Sydney

Summary.—An Arabic version of the Effort-Reward Imbalance Questionnaire was developed and validated through a translation process with cross-cultural considerations. The translated questionnaire was evaluated for reliability and validity. A Principal Components Analysis was conducted following assessment of the suitability of data for factor analysis. Components with high eigenvalues were extracted, followed by Varimax rotation. Three components with eigenvalues greater than 1.0 (50% of variance) were indicated. The analysis showed Cronbach's α coefficients of .82 for the Effort scale, .88 for the Reward scale, and .74 for the Overcommitment scale. The test-retest reliability was high with intra-correlation coefficients of ≥.86. The Arabic version of the Effort-Reward Imbalance Questionnaire showed adequate reliability and validity and is a suitable instrument to assess work stress in Arabic-speaking people.

The adverse physical health effects of psychosocial stress in the workplace has mainly been investigated through two theoretical models: the demand-control model (Karasek, 1979; Karasek & Theorell, 1990) and the effort-reward imbalance model (Siegrist, 1996). The demand-control model emphasises psychological demands of work and job control by the individual, where high job demand with little control over work produces job strain. The effort-reward imbalance model, on the other hand, assesses three aspects of work stress: "effort," "reward," and "overcommitment." It is based on the notion of social reciprocity whereby effort is reciprocated by socially defined reward. Effort represents the job demands and/or obligations that are imposed on the employee, while reward includes such things as salary, bonus money, esteem, job security, and career opportunities. The effort-reward imbalance model claims that a lack of reciprocity between effort and reward at work, with high effort and low reward, elicits sustained stress reactions (distress). In addition, the model assumes that distress will be higher in more highly over-committed employees than in less over-committed employees.

Whilst the demand-control model emphasizes task-level control, the effort-reward imbalance model emphasizes employees' rewards (Siegrist,

[1]Address correspondence to Tawfiq Almadi, Discipline of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, P.O. Box 170, Lidcombe, NSW 1825, Australia or e-mail (talm3809@uni.sydney.edu.au).

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2001; Tsutsumi & Kawakami, 2004). Thus, the effort-reward imbalance has advantages over the demand-control model, since it has focused attention on stressors such as payment adequacy, job insecurity, job changes, and job promotion prospects (Griep, Rotenberg, Vasconcellos, Landsbergis, Comaru, & Alves, 2009). The Effort-Reward Imbalance Questionnaire consists of 23 items measuring work effort, reward, and over commitment; many studies have supported its validity for evaluating stress in the working environment (Tsutsumi & Kawakami, 2004; Unterbrink, Hack, Pfeifer, Buhl-Griesshaber, Müller, Wesche, *et al*., 2007). Employees who scored high on the questionnaire were at higher risk of health disorders (Bosma, Peter, Siegrist, & Marmot, 1998; Dragano, Knesebeck, Rödel, & Siegrist, 2003; Wada, Sakata, Theriault, Aratake, Shimizu, Tsutsumi, *et al*., 2007).

In this study, the Effort-Reward Imbalance Questionnaire–English Version (Siegrist, *et al*., 2004), was translated into the Arabic language and validated. The questionnaire has been translated into several languages including French (Niedhammer, Siegrist, Landre, Goldberg, & Leclerc, 2000), Japanese (Tsutsumi, Ishitake, Peter, Siegrist, & Matoba, 2001), Dutch (Hanson, Schaufeli, Vrijkotte, Plomp, & Godaert, 2000), Chinese (Li, Yang, Cheng, Siegrist, & Cho, 2005), Brazilian (Chor, Werneck, Faerstein, Alves, & Rotenberg, 2008), Thai (Buapetch, Lagampan, Faucett, & Kalampakorn, 2008), and Korean (Eum, Li, Lee, Kim, Paek, Siegrist, *et al*., 2007). Thus, its application has particular value in cross-cultural studies, since it has been used in a wider range of cultures than most other measures. Nevertheless, there are an increasing number of studies that assess work stress within Arabic countries using the English version of the questionnaire. Consequently, only those who understand written English could take part in those studies (Hamdan-Mansour, Al-Gamal, Puskar, Yacoub, & Marini, 2011; Devreux, Jacquerye, Kittel, Almazrooa, & Al-Awa, 2012). Such findings may not be generalized to the whole population, since those who understand English may be among higher socio-economic groups with more education. Unfortunately, the research is limited by the fact that there is as yet no Arabic version of the Effort-Reward Imbalance Questionnaire. This paper reports the development of a translated Arabic version of the Effort-Reward Imbalance Questionnaire, together with testing for internal consistency reliability and validity.

Method

Effort-Reward Imbalance Questionnaire

The questionnaire consists of 23 items with three scales: 6 items measure Effort, 11 measure Reward, and 6 measure Overcommitment (see Appendix A). The items of the Effort and Reward scales are rated

in two steps. In Effort and Reward scales, in a first step, the respondents are asked whether the item content describes a typical experience in their workplace. If the participants "disagree" with the content of the question then the item is scored 1. If the participants "agree," then in a second rating step, they are asked to rate the distress associated with this experience by choosing one of four options: 2: I am not at all distressed, 3: I am somewhat distressed, 4: I am distressed, or 5: I am very distressed. For the Over-commitment scale, ratings are 1: Strongly disagree, 2: Disagree, 3: Agree, 4: Strongly agree.

A summary score is computed for each scale, which ranges between 6 and 30 for Effort, 11 and 55 for Reward, and 6 to 24 for Over-commitment (after reverse scoring Item 3). The effort-reward ratio (ER ratio) is calculated by dividing the total Effort score by the Reward score with a correction factor for the different number of items in each scale: ER ratio = (effort score / reward score x 1.834).

Translation

For the translation into Arabic, a repeated forward-backward translation technique was used (Meadows, Bentzen, & Touw-Otten, 1997). The translation process involved seven stages using professional translators, bilingual academics, bilingual married couples, and bilingual health professionals, which had been used in validation of the Arabic Perceived Stress Questionnaire–14 (Almadi, Cathers, Hamdan Mansour, & Chow, 2012), as described below in detail.

Stage 1: English to Arabic translations.—Translators were from different sectors: professional translators, academics, and married couples. All translators were instructed to use simple language in translating items and avoid formal Arabic words as much as possible. Each bilingual (English-Arabic) married couple worked together on the translation as one team. The couples consisted of one Arabic native speaker and one English native speaker, and both were educated in an English-speaking country (Australia). Each couple was instructed to discuss the item expressions and their meaning. Then the Arabic spouse was instructed to write down the Arabic translation resulting from this discussion.

Stage 2: first Arabic version.—The study coordinator (TA) and one university academic, both bilingual in Arabic and English, integrated the nine Arabic translations from Stage 1 into a single translated Version 1.

Stage 3: second Arabic version.—Another two translators, both bilingual health professionals, not employed in previous translation projects, evaluated Arabic Version 1 against the English original. Of these two translators, one was an experienced psychology researcher within the Arabic community and was familiar with Arabic and English psychology terminology.

Both assessed the simplicity of writing and similarity in the meaning of questionnaire items and response options. Any problematic Arabic expressions were modified to produce the Arabic Version 2.

Stage 4: first back-translation of Arabic to English.—Two independent translators, one a professional translator and the other a health academic, who had not been employed in previous translation stages, but who had not seen the original English version, were asked to back-translate the Arabic Version 2 into English.

Stage 5: identification of discrepancies in back-translation.—Two native English speakers, both health academicians, compared the two back-translated versions against the original English version, and checked for similarity in the meanings of the questionnaire items and the response options. They identified differences between the original and the back-translated versions.

Stage 6: Arabic version 3.—To resolve the differences found in Stage 5, the first author (TA) changed the Arabic terms that were identified as problematic, using alternative Arabic terms from the nine translations formed in Stage 1, to produce Arabic Version 3.

Stage 7: second back-translation.—The same professional translator involved in Stage 4 was requested to carry out a back-translation into English a second time. Previous Stages 5, 6, and 7 were repeated until all problems were resolved and a final agreed-upon version was obtained (see Appendix B).

Participants

Participants were recruited from three Jordanian high schools in Zraka city. They were required to be over 18 years old with a minimum education level of high school certificate, to have Arabic as their native language, and to be willing to complete the questionnaire twice. Participants (N = 126) agreed to be involved in the study (74 men, 52 women), with 96 participants (61 men, 35 women) completing the questionnaires twice. The participants (M age = 35.1 yr., SD = 10.0) were teachers (81%) with a minimum qualification of diploma in teaching and technical staff (19%). The Human Research Ethics Committees of both The University of Sydney and Jordan University approved the study protocol. Written consent was obtained from all participants and school administrations.

Procedure

The participants completed the Arabic Effort-Reward Imbalance Questionnaire and demographic questionnaires at home and returned them by mail or in person to the first author (TA). After a two-week period, the participants repeated the process by responding to the same questionnaire. Participants' identities were coded for anonymity.

Statistical Analysis

Internal consistency reliability was assessed by Cronbach's α coefficient (1951) and the item-total correlation coefficient. Test-retest reliability was assessed by the intra-class correlation coefficient. Prior to the factor analysis, the data were evaluated by performing correlations between the scale items (Tabachnick & Fidell, 1996). The Kaiser-Meyer-Oklin (KMO) sample adequacy index was > 0.6 (Kaiser, 1970, 1974) and Bartlett's sphericity test was statistically significant (Bartlett, 1954).

The principal component analysis (PCA) was conducted to examine the component structure of the 23 items of the Arabic Effort-Reward Imbalance Questionnaire. Three criteria were used for deciding the number of components to be retained for extraction and rotation. Components with high eigenvalues (> 1.0) according to Kaiser's criterion were extracted (Kiaser, 1974). The Cattell's Scree plot (Cattell, 1966) was used to produce a plot of each component's eigenvalues, followed by graph inspection for a break point in the data, where the curve began to level. The number of data points above the break represented the components retained for extraction and rotation. Based on these two criteria, the potential number of components to be rotated was identified. These components were then rotated by the Varimax rotation (Fabrigar, MacCallum, Wegerner, & Strahan, 1999). In addition, the contents of items essentially matched the previous loadings of items within the three components (Effort, Reward, and Overcommitment) (Siegrist, 1996). Items with loadings above 0.32 were assumed to load on a given component (Tabachnick & Fidell, 2001). The above methods of factor analysis using PCA, extraction method, rotation methods, and loading criterion were the same as those employed in previous studies that validated the Effort-Reward Imbalance Questionnaire in Japanese (Tsutsumi, *et al*., 2001), Brazilian (Chor, *et al*., 2008), and Korean (Emu, *et al*., 2007). Data were analyzed using the Statistical Package for Social Science (SPSS) Version 17.0 (SPSS).

Results

Table 1 shows the mean values, standard deviations, and range of each scale of the Effort-Reward Imbalance Questionnaire for the sample. The sample had low work-related Reward scores, and the mean effort-reward ratio was high ($M = 1.48$, $SD = 0.61$).

TABLE 1
Mean Scores, Standard Deviations, and Range of Scores For the Three Scales ($N = 96$)

Scale	*M*	*SD*	Range
Effort	15.3	4.4	8.0–27.0
Reward	21.3	8.7	10.0–46.0
Over-commitment	13.7	3.5	8.0–22.0

Intercorrelations between the Effort-Reward Imbalance Questionnaire items indicated many correlation coefficients above the threshold of .30, which is considered adequate. The Kaiser-Meyer-Oklin value of 0.76 exceeds the minimum suggested value of 0.60. Barlett's test of sphericity was significant ($p < .001$) (Pallant, 2001).

Internal consistency was assessed by item-total correlations and Cronbach's α coefficients for the Effort-Reward Imbalance Questionnaire scales are given in Table 2. All item-total correlations were above 0.3 and all the Cronbach's α coefficients were higher than 0.7, suggesting considerable consistency of items contributing to their respective scales. The test-retest reliability/stability assessment as measured by the intra-correlation coefficient (ICC) was high (Table 2), reflecting good reliability.

The principal component analysis identified six components with Eigenvalues >1, which explained 26.3%, 14.2%, 10.3%, 6.1%, 5.1%, and 4.4% of the variance, respectively. The scree plot showed a break after the third component. In addition, the content of items matched the loadings of items within three components as reported in the original theoretical model of Siegrist (1996), so only the first three components were retained for the Arabic Effort-Reward Imbalance Questionnaire for rotation by the Varimax method.

According to the Varimax rotation (Table 3), 50% of the variance was explained by the three major rotated components. Effort items (ERI1–ERI6) loaded on the second component and accounted for 16% of variance. Reward items (ERI7–ERI14) loaded on the first component and accounted for 22% of variance. Overcommitment items (OC1–OC6) loaded strongly on the third component and explained 13% of the variance. Items ERI9 and OC1 had additional loadings on a second component.

Discussion

The results of this preliminary psychometric study indicated that the internal consistency and test-retest reliability of the Arabic version of the Effort-Reward Imbalance Questionnaire were satisfactory, and its factor structure was consistent and reflected the theoretical components of the effort-reward imbalance model well.

It was noted that the mean effort-reward ratio was high (ER ratio = 1.48) when compared to the large-scale Whitehall study using the English version of the Effort-Reward Imbalance Questionnaire (ER ratio = 0.44) (Siegrist, *et al.*, 2004), and the study where participants were teachers (ER ratio = 0.70) (Bellingrath, Weigl, & Kudielka, 2008). However, the ER ratio obtained for this study was comparable to that reported in Arabic hospital workers (ER ratio = 1.21) (Devreux, *et al.*, 2012). The results of this study suggest that Jordanian workers have higher work stress and lower job satisfaction than workers in other nations. Additional research is

TABLE 2
ITEM-TOTAL CORRELATIONS AND CRONBACH'S α COEFFICIENTS FOR THE ARABIC EFFORT-REWARD IMBALANCE QUESTIONNAIRE (N = 96), WITH SUMMARY ITEM CONTENT

Scale	Item	Item–total Correlations
	Cronbach's α = .82, test-retest ICC = .86 (95%CI = .80, .90)	
Effort		
	ERI 1: constant time pressure	.65
	ERI 2: interruptions and disturbances	.68
	ERI 3: a lot of responsibility	.59
	ERI 4: pressured to work overtime	.51
	ERI 5: physically demanding	.53
	ERI 6: increasingly demanding	.67
	Cronbach's α = .88, test-retest ICC = .87 (95%CI = .81, .91)	
Reward		
	ERI 7: receive respect from superiors	.56
	ERI 8: receive respect from colleagues	.42
	ERI 9: supported in difficult situations	.67
	ERI 10: treated unfairly	.61
	ERI 11: poor job promotion prospects	.76
	ERI 12: expecting undesirable change	.64
	ERI 13: poor employment security	.57
	ERI 14: position adequately reflects education and training	.50
	ERI 15: receive deserved respect and prestige	.71
	ERI 16: considering effort, adequate promotion prospects	.57
	ERI 17: considering effort, adequate salary/income	.48
	Cronbach's α = .74, test-retest ICC = .92 (95%CI = .88, .95)	
Over–commitment		
	OC 1: overwhelmed by time pressures at work	.32
	OC 2: think about work as soon as get up in morning	.64
	OC 3: at home, able to relax and "switch off" work	.44
	OC 4: people say I sacrifice too much for job	.33
	OC 5: work on my mind at bedtime	.48
	OC 6: deferred work task leads to trouble sleeping	.65

recommended to explore the moderators (baseline variables of age, gender, and occupational type) of the work-stress relationship (high effort-reward ratio) and its long-term health effects on workers in Jordan.

Internal consistency reliability of the Arabic Effort-Reward Imbalance Questionnaire scales was satisfactory and reliability/stability assessment was high. The PCA indicated that the Arabic Effort-Reward Imbalance

TABLE 3
VARIMAX ROTATION OF THREE-FACTOR SOLUTION FOR THE ARABIC VERSION OF EFFORT-REWARD IMBALANCE QUESTIONNAIRE

Item	Component One	Component Two	Component Three	Communalities h^2
ERI 1	.15	**.79**	.14	.66
ERI 2	.17	**.79**	.14	.67
ERI 3	.09	**.74**	–.19	.59
ERI 4	–.20	**.67**	.22	.54
ERI 5	.04	**.64**	.11	.42
ERI 6	.09	**.73**	.04	.54
ERI 7	**.64**	.02	.12	.43
ERI 8	**.54**	.05	–.17	.32
ERI 9	**.69**	.31	.09	.59
ERI 10	**.65**	.25	.11	.49
ERI 11	**.79**	.20	.08	.67
ERI 12	**.70**	.12	.16	.53
ERI 13	**.69**	–.11	.01	.49
ERI 14	**.54**	.08	.29	.38
ERI 15	**.81**	–.04	.05	.65
ERI 16	**.69**	–.11	0.02	.49
ERI 17	**.54**	.16	.19	.35
OC 1	.23	***.37***	***.40***	.35
OC 2	.10	.06	**.79**	.64
OC 3	.15	.20	**.57**	.39
OC 4	.09	.16	**.45**	.24
OC 5	.03	.16	**.73**	.56
OC 6	.02	.08	**.82**	.68
h^2	6.05	3.26	2.36	11.67
% of Variance	26.30	14.20	10.30	50.80

Note.—Loadings with an absolute value > .30 are in boldface. Item OC1 has a notable cross-loading (italics).

Questionnaire items load on six components with eigenvalues above 1.0, the first three of the six components explained 50% of the variance, and the next three components explained 15%. The first three components were extracted, and the Varimax rotation indicated that the Reward, Effort, and Overcommitment items loaded strongly on Components 1, 2, and 3, respectively. This factor solution of the Arabic Effort-Reward Imbalance Questionnaire was consistent with the effort-reward imbalance model as well as with validations of Chinese, Korean, and Thai language versions (Li, *et al*., 2005; Eum, *et al*., 2007; Buapetch, *et al*., 2008).

While the factorial pattern of the scales (Effort, Reward and Overcommitment) was clearly reflected in PCA, an interesting exception was observed concerning Reward Item OC1 (overwhelmed by pressure), which loaded equally on the Effort and Overcommitment components. Interestingly, OC1 loaded in the same way in both the Chinese and Korean validation studies (Li, *et al*., 2005; Eum, *et al*., 2007), suggesting the possibility that the item may not transfer well to other languages. However, a re-run of the factor analysis of the questionnaire, after removal of item OC1, did not affect the questionnaire in terms of number of components, structure, or other items' loadings, which may indicate that OC1 could be evenly construed as an Effort or Overcommitment item. The problem with OC1was not reported in the English version of Effort-Reward Imbalance Questionnaire; Overcommitment items were consistently found to load highly on one component in many studies using the English version as reported by Siegrist (2004). Similarly, the Effort and Reward items of the English version loaded strongly on separate components. In the communalities analysis, some items did not reach the cut-off point of 0.40 (Tabachnick & Fidell, 2001), although there was not a need to eliminate those items or repeat the component analysis, since all of those items loaded in their proposed latent component. According to Child (2006, p. 47), it was not recommended to eliminate the item from the analysis unless the item's communality was less than 0.2. None of the Arabic Effort-Reward Imbalance Questionnaire items' communalities were less than 0.24.

A strength of this study was the translation process, which involved a broad range of translators with different backgrounds (academic and health) to provide a balanced treatment of linguistic and cross-cultural considerations (Hambleton, 1994; van de Vivjer & Hambleton, 1996). In addition, the use of informal language was encouraged in the translation process. Married couples were engaged to translate, who in general tended to use the informal, relaxed conversational language in their own home. Notably, in a translation process, it is difficult to eliminate the influence of cultural differences on both the experience of stress and responses to it: in Item OC1, the translation of the term "time pressure" in the original English version became "work pressure" in the back-translation from Arabic to English; the term "overwhelmed" is used only to express an emotion in the Arabic culture. To overcome this difficulty, an explanation was added to indicate that the item was about the subject's feeling of not being able to carry out the required work in a set time. For another example, the Arabic translation of Item ERI13 "My job security is poor" has two different meanings in Arabic: as both "job security" or "physical protection of the work place provided for the employees,"

and the latter meaning is more prevalent in Arabic culture. Thus, a short explanation was added to indicate that the item was about continuation of the position. Although the back-translation of Item ERI9 agrees with the original English version, it is not clear why Item ERI9 loaded equally on both the Effort and Reward components.

Although the sample was relatively small, it was comparable to that of the Japanese validation study (Tsutsumi, *et al*., 2001), and larger than that of the Brazilian study (Chor, *et al*., 2008). Future studies should use larger samples to enable confirmatory factorial analysis of the questionnaire, in addition to examining discriminate validity. This sample consisted mostly of schoolteachers, who have a middle class socioeconomic status within the Jordanian community. It is not clear to what extent the Arabic Effort-Reward Imbalance Questionnaire results can be generalized to lower or higher socioeconomic groups or other types of work.

It is worth mentioning that there was a relatively high failure rate of returning the second questionaries (32%) from female participants. However, no obvious reasons or major changes or sudden accidents were recorded that may have affected the work environment during the two study weeks beginning September 2009. The demographics (job type and mean age) were similar for the women who completed the evaluations and those who dropped out in the second evaluation. Any self-selective bias among the women completing the questionnaires twice cannot be ruled out.

Conclusion

The Arabic Effort-Reward Imbalance Questionnaire has satisfactory psychometric properties as the results are in line with with those available from studies testing translations into other languages. The Arabic version of the questionnaire is appropriate for evaluation of work stress among Arabic-speaking employees.

REFERENCES

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012) An Arabic version of the Perceived Stress Scale: translation and validation study. *International Journal of Nursing Studies,* 49(1), 84-89. DOI: 10.1016/j.ijnurstu.2011.07.012.

Bartlett, M. S. (1954) A note on multiplying factors for various chi-squared approximations. *Journal of the Royal Statistical Society: Series B*, 16, 296-298.

Bellingrath, S., Weigl, T., & Kudielka, B. M. (2008) Cortisol dysregulation in school teachers in relation to burnout, vital exhaustion, and effort-reward-imbalance. *Biological Psychology,* 78(1), 104-113.

Bosma, H., Peter, R., Siegrist, J., & Marmot, M. (1998) Two alternative job stress models and the risk of coronary heart disease. *American Journal of Public Health*, 88(1), 68-74.

Buapetch, A., Lagampan, S., Faucett, J., & Kalampakorn, S. (2008) The Thai version of Effort–Reward Imbalance Questionnaire (Thai–ERIQ): a study of psychometric properties in garment workers. *Journal of Occupational Health,* 50(6), 480-491.

Cattell, R. B. (1966) The scree test for the number of factors. *Multivariate Behavioral Research,* 1, 245-276.

Child, D. (2006) *The essentials of factor analysis.* (3rd ed.) New York: Continuum International.

Chor, D., Werneck, G. L., Faerstein, E., Alves, M. G., & Rotenberg, L. (2008) The Brazilian version of the Effort–Reward Imbalance Questionnaire to assess job stress. *Cadernos de Saúde Pública*, 24(1), 219-224.

Cronbach, L. J. (1951) Coefficient alpha and the internal structure of tests. *Psychometrika,* 16, 297-334.

Devreux, I., Jacquerye, A., Kittel, F., Almazrooa, A., & Al-Awa, B. (2102) Measurement of rehabilitation services staffs' job satisfaction using the effort–reward imbalance model in Saudi Arabia. *Research Journal of Medical Sciences,* 6(3), 87-92.

Dragano, N., Knesebeck, O., Rödel, A., & Siegrist, J. (2003) Psychosocial work stress and musculosceletal disorders: significance for prevention. *Zeitschrift für Gesundheitswissenschaften,* 11(3), 196-207.

Eum, K. D., Li, J., Lee, H. E., Kim, S. S., Paek, D., Siegrist, J., & Cho, S. (2007) Psychometric properties of the Korean version of the Effort–Reward Imbalance Questionnaire: a study in a petrochemical company. *International Archives of Occupational and Environmental Health,* 80(8), 653-661.

Fabrigar, L., MacCallum, R., Wegener, D. T., & Strahan, E. J. (1999) Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods,* 4, 272-299.

Griep, R. H., Rotenberg, L., Vasconcellos, A. G., Landsbergis, P., Comaru, C. M., & Alves, M. G. (2009) The psychometric properties of Demand–control and Effort–reward Imbalance Scales among Brazilian nurses. *International Archives of Occupational and Environmental Health,* 82(10), 1163-1172.

Hambleton, R. K. (1994) Guidelines for adapting educational and psychological tests: a progress report. *European Journal of Psychological Assessment: Bulletin of the International Test Commission,* 10, 229-244.

Hamdan-Mansour, A. M., Al-Gamal, E., Puskar, K., Yacoub, M., & Marini, A. (2011) Mental health nursing in Jordan: an investigation into experience, work stress and organizational support. *International Journal of Mental Health Nursing*, 20(2), 86-94.

Hanson, E. K., Schaufeli, W., Vrijkotte, T., Plomp, N. H., & Godaert, G. L. (2000) The validity and reliability of the Dutch Effort–Reward Imbalance Questionnaire. *Journal of Occupational Health Psychology,* 5(1), 142-155.

Kaiser, H. F. (1970) A second generation little jiffy. *Phsychometrika,* 35(4), 401-415.

Kaiser, H. F. (1974) Analysis of factorial simplicity. *Psychometrika,* 39, 31-36.

Karasek, R. (1979) Job demands, job decision latitude, and mental strain: implications for job redesign. *Administrative Science Quarterly,* 24(2), 285-308.

Karasek, R., & Theorell, T. (1990) *Healthy work: stress, productivity, and the reconstruction of working life*. New York: Basic Books.

Li, J., Yang, W., Cheng, Y., Siegrist, J., & Cho, I. (2005) Effort–reward imbalance at work and job dissatisfaction in Chinese healthcare workers: a validation study. *International Archives of Occupational and Environmental Health,* 78, 198-204.

Meadows, K., Bentzen, N., & Touw-Otten, F. (1997) Cross-cultural issues: an outline of the important principles in establishing cross-cultural validity in health outcome assessment. In A. Hutchinson, N. Bentzen, & C. König-Zahn (Eds.), *Cross Cultural Health Outcome Assessment: a user's guide.* Vol. 1. Groningen, Netherlands: European Research Group on Health Outcomes.

NIEDHAMMER, I., SIEGRIST, J., LANDRE, M. F., GOLDBERG, M., & LECLERC, A. (2000) Psychometric properties of the French version of the effort–reward imbalance model. *La Revue d'Epidémiologie et de Santé Publique,* 48(5), 419-437.

PALLANT, J. (2001) *SPSS survival manual: a step-by-step guide to data analysis using SPSS for Windows (Version 10)*. Buckingham, UK: Open University Press.

SIEGRIST, J. (1996) Adverse health effects of high-effort/low-reward conditions at work. *Journal of Occupational Health Psychology,* 1, 27-43.

SIEGRIST, J. (2001) A theory of occupational stress. In J. Dunham (Ed.), *Stress in the workplace: past, present and future.* London: Whurr. Pp. 52-66.

SIEGRIST, J., STARKE, D., CHANDOLA, T., GODIN, I., MARMOT, M., NIEDHAMMER, I., & PETER, R. (2004) The measurement of effort-reward imbalance at work: European comparisons. *Social Science and Medicine,* 58, 1483-1499.

TABACHNICK, B. G., & FIDELL, L. S. (1996) *Using multivariate statistics.* (4th ed.) New York: Harper Collins.

TABACHNICK, B. G., & FIDELL, L. S. (2001) *Using multivariate statistics*. (4th ed.) Boston, MA: Allyn and Bacon.

TSUTSUMI, A., ISHITAKE, T., PETER, R., SIEGRIST, J., & MATOBA, T. (2001) The Japanese version of the Effort–Reward Imbalance Questionnaire: a study in dental technicians. *Work Stress,* 15, 86-9.

TSUTSUMI, A., & KAWAKAMI, N. (2004) A review of empirical studies on the model of effort–reward imbalance at work: reducing occupational stress by implementing a new theory. *Social Science & Medicine,* 59, 2335-2359.

UNTERBRINK, T., HACK, A., PFEIFER, R., BUHL-GRIESSHABER, V., MÜLLER, U., WESCHE, H., FROMMHOLD, M., SCHEUCH, K., SEIBT, R., WIRSCHING, M., & BAUER, J. (2007) Burnout and effort–reward imbalance in a sample of 949 German teachers. *International Archives of Occupational and Environmental Health*, 80(5), 433-441.

VAN DE VIJVER, F., & HAMBLETON, R. K. (1996) Translating tests: some practical guidelines. *European Psychologist*, 1(2), 89-99.

WADA, K., SAKATA, Y., THERIAULT, G., ARATAKE, Y., SHIMIZU, M., TSUTSUMI, A., TANAKA, K., & AIZAWA, Y. (2007) Effort–Reward imbalance and social support are associated with chronic fatigue among medical residents in Japan. *Archives of Occupational and Environmental Health*, 81, 331-336.

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APPENDIX A

ENGLISH VERSION EFFORT–REWARD IMBALANCE QUESTIONNAIRE

The following items refer to your present occupation. For each of the following statements, please indicate to what degree it reflects your situation. Thank you for answering all statements!

Please indicate to what extent you personally agree or disagree with these statements. Thank you for answering all statements.

	Effort Items	Disagree	Agree, I am not at all distressed.	Agree, I am somewhat distressed.	Agree, I am distressed.	Agree, I am very distressed.
1	I have constant time pressure due to a heavy work load.					
2	I have many interruptions and disturbances in my job.					
3	I have a lot of responsibility in my job.					
4	I am often pressured to work overtime.					
5	My job is physically demanding.					
6	Over the past few years, my job has become more and more demanding.					

	Reward Items	Agree	Disagree, I am not at all distressed.	Disagree, I am somewhat distressed.	Disagree, I am distressed.	Disagree, I am very distressed.	Not applicable (no superiors or no colleagues)
7	I receive the respect I deserve from my superiors.						
8	I receive the respect I deserve from my colleagues.						
9	I experience adequate support in difficult situations.						

		Disagree	Agree, but I am not at all distressed.	Agree, and I am somewhat distressed.	Agree, and I am distressed.	Agree, and I am very distressed.
10	I am treated unfairly at work.					

(continued on next page)

Note.—R = Reverse-scored item. Source: Siegrist, Starke, Chandola, Godin, Marmot, Niedhammer, *et al.* (2004).

APPENDIX A (CONT'D)
ENGLISH VERSION EFFORT–REWARD IMBALANCE QUESTIONNAIRE

		Disagree	Agree, but I am not at all distressed.	Agree, and I am somewhat distressed.	Agree, and I am distressed.	Agree, and I am very distressed.
11	My job promotion prospects are poor.					
12	I have experienced or I expect to experience an undesirable change in my work situation.					
13	My job security is poor.					
		Agree	**Disagree, but I am not at all distressed.**	**Disagree, and I am somewhat distressed.**	**Disagree, and I am distressed.**	**Disagree, and I am very distressed.**
14	My current occupational position adequately reflects my education and training.					
15	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.					
16	Considering all my efforts and achievements, my job prospects are adequate.					
17	Considering all my efforts and achievements, my salary/income is adequate.					
	Over-commitment	**Strongly Disagree**	**Disagree**	**Agree**	**Strongly Agree**	
18	I get easily overwhelmed by time pressures at work.					
19	As soon as I get up in the morning I start thinking about work problems.					

(continued on next page)

Note.—R = Reverse-scored item. Source: Siegrist, Starke, Chandola, Godin, Marmot, Niedhammer, *et al.* (2004).

APPENDIX A (CONT'D)
ENGLISH VERSION EFFORT–REWARD IMBALANCE QUESTIONNAIRE

	Over-commitment	Strongly Disagree	Disagree	Agree	Strongly Agree
20	When I get home, I can easily relax and 'switch off' work. (R)				
21	People close to me say I sacrifice too much for my job.				
22	Work rarely lets me go; it is still on my mind when I go to bed.				
23	If I postpone something that I was supposed to do today I'll have trouble sleeping at night.				

Note.—R = Reverse-scored item. Source: Siegrist, Starke, Chandola, Godin, Marmot, Niedhammer, *et al.* (2004).

APPENDIX B
Arabic Version Effort–Reward Imbalance Questionnaire

النسخة العربية من استبيان عدم التوازن بين الجهد و ا لمكافأة :

الأسئلة التالية تتعلق بوظيفتك الحالية. المرجو منك أن تحدد إلى أي مدى يناسب (يعكس) كل تصريح من التصريحات التالية وضعيتك المهنية. المرجو منك أن تجيب على كل التصريحات بوضع اشارة(×) في المربع الذي يناسب اجابتك وشكرا.

	الجهد Effort	غير متفق	متفق، ولكني لست متضايقا	متفق، وأنا متضايق إلى حد ما	متفق، وأنا متضايق	متفق، وأنا متضايق جدا
1	دائما أحس بضغط الوقت بسبب كثرة العمل					
2	كثيرا ما اقاطع او ازعج بينما أزاول عملي					
3	مسؤولياتي كثيرة في العمل					
4	في أحيان كثيرة أجد نفسي مجبرا على العمل ساعات إضافية					
5	وظيفتي تتطلب جهدا جسديا كبيرا.					
6	خلال السنوات الماضيةأصبحت وظيفتي تتطلب أكثر فأكثر					
	المكافأة Reward	متفق	غير متفق، ولكني لست متضايقا	غير متفق، وأنا متضايق إلى حد ما	غير متفق، وأنا متضايق	غير متفق، وأنا متضايق جدا
7	رؤسائي في العمل يبدون تجاهي الاحترام الذي أستحق					
8	زملائي في العمل يبدون تجاهي الاحترام الذي أستحقه					
9	أتلقى الدعم المناسب في الظروف الصعبة.					
		غير متفق	متفق، ولكني لست متضايقا	متفق، وأنا متضايق إلى حد ما	متفق، وأنا متضايق	متفق، وأنا متضايق جدا
10	تتم معاملتي بشكل غير عادل في العمل.					
11	فرصتي في العمل محدودة في مجال الترقي					
12	تعرضت أو أتوقع أن أتعرض لتغيير غير مرغوب فيه في وضعيتي في العمل.					
13	الامان الوظيفي ضعيف.(اي ان ضمانات استمرار الوظيفة ضعيفة.واحتمال ان تفقد وظيفتك كبير)					
		متفق	غير متفق، ولكني لست متضايقا	غير متفق، وأنا متضايق إلى حد ما	غير متفق، وأنا متضايق	غير متفق، وأنا متضايق جدا
14	وظيفتي الحالية تتوافق مع مؤهلاتي الدراسية و التدريبية.					
15	بالنظر إلى كل مجهوداتي ومنجزاتي، أتلقى الاحترام والتقدير اللذين أستحقهما في العمل.					
16	بالنظر إلى كل مجهوداتي ومنجزاتي، فإن فرص الترقية بالنسبة لي مناسبة.					
17	بالنظر إلى كل مجهوداتي ومنجزاتي، فإن راتبي/دخلي مناسب.					
	الافراط بالالتزام Over-commitment	غير متفق بتاتا	غير متفق	متفق	متفق تماما	
18	يغلبني بسهولة ضغط الوقت في العمل.(اي أحس كثيرا بأني غير قادر على القيام بكمية العمل المطلوبة في الوقت المحدد)					
19	بمجرد ان استيقظ من النوم صباحا أبدأ التفكير في مشاكل العمل					
20	عندما أصل إلى البيت أستطيع الاسترخاء و بسهولة أتوقف عن التفكير بالعمل					
21	الناس المقربون مني يقولون إنني أضحي بأكثر من اللازم في سبيل وظيفتي					
22	يظل فكري مشغولا بالعمل معظم الاوقات وحتى عند النوم					
23	إذا أجلت عمل شيء كان من المفروض أن أعمله اليوم سيصعب علي النوم					

The association between work stress and inflammatory biomarkers in Jordanian male workers.

As a co-author of the above article, I confirm that Tawfiq Almadi has made the following contributions:

- Conception and design of the research
- Analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- A corresponding author for communication with journal.

The article has been published in *Psychophysiology*.

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The association between work stress and inflammatory biomarkers in Jordanian male workers

TAWFIQ ALMADI,[a] IAN CATHERS,[a] AYMAN M. HAMDAN MANSOUR,[b] AND CHIN MOI CHOW[a]

[a]Discipline of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, Lidcombe, Australia
[b]Department of Community Health, Faculty of Nursing, University of Jordan, Amman, Jordan

Abstract

The study aimed to establish the association of work stress, expressed as effort-reward imbalance (ERI), and C-reactive protein (CRP) in 152 healthy Jordanian male employees. Self-report work stress, anthropometric data, and blood for CRP analysis were collected. A significant correlation between ERI and CRP ($r = 0.29$, $p < .01$), and between waist circumference with CRP ($r = 0.44$, $p < .01$) was found. Central obesity explained most of the variance in CRP after controlling for various covariates, and ERI was not a significant predictor of CRP ($\Delta R^2 = 0.02$; $\beta = 0.15$, $p = .052$). However, when only the centrally obese group was considered, ERI accounted for 5.0% of the variability in the CRP ($\beta = 0.24$, $p < .05$). Results of this study confirm previous findings that obesity is significantly associated with CRP, and support the notion that higher ERI amongst obese workers is one small but significant predictor of increased levels of CRP.

Descriptors: Biochemical, Psychopathological

Physiological factors (obesity, low physical activity, or smoking) and psychological stress may contribute to inflammation with increased levels of inflammatory markers such as C-reactive protein (CRP) (Bellingrath, Weigl, & Kudielka, 2009; Geffken et al., 2001; Ohsawa et al., 2005; Visser, Bouter, McQuillan, Wener, & Harris, 1999). Notably, chronic stress was significantly associated with higher CRP among subjects with central obesity, suggesting that obese subjects may have an increased vulnerability to manifesting a higher degree of inflammation (Dixon et al., 2008; Shen, Farrell, Penedo, Schneiderman, & Orth-Gomer, 2010). Chronic inflammation contributes to the pathogenesis of cardiovascular disease (CVD) (Ridker, Cushman, Stampfer, Tracy, & Hennekens, 1997), coronary heart disease (Koenig et al., 1999), type 2 diabetes (Han et al., 2002), and metabolic syndrome (Laaksonen et al., 2004). It is well established that CRP is strongly associated with and predicts CVD independently of physiological risk factors (Suarez, 2004).

Considerable theoretical attention has been paid in recent years to the role of psychosocial stress in the development of chronic inflammation. Black (2002) hypothesized that repeated episodes of acute or chronic stress can lead to a chronic inflammatory process that in turn is implicated in cardiovascular metabolic disorders. According to Black's hypothesis, stress can induce an inflammatory process called the acute phase response that prepares the body to deal with injury, infection, and psychological stress. The acute phase response is characterized by the production of proinflammatory cytokines, which are the inducers of acute phase proteins such as CRP (Gabay & Kushner, 1999).

The work stress effort-reward-imbalance (ERI) model was introduced by Siegrist (1996) to provide a framework for examining work stress and its contribution to the development of disease. In the ERI model, effort is reciprocated by socially defined rewards. Efforts represent job demands and/or obligations that are imposed on the employee, while rewards include money, esteem, job security, and career opportunities. A lack of reciprocity between effort and reward at work (i.e., high effort and low reward) leads to a state of emotional stress (distress) and ill-health. In addition, the model assumes that distress will be higher in highly overcommitted employees than less overcommitted employees.

Little attention has been given to the effect of chronic work stress in a normal work environment on the inflammatory process in healthy men. There have been only a few studies that investigated the association between ERI and CRP. A cross-sectional study of German school teachers with high ERI showed significantly higher CRP compared to teachers with low ERI (Bellingrath et al., 2009). Furthermore, individuals with a high ERI had an increased plasma level of CRP following a mental stress task compared to those with a low ERI (Hamer et al., 2006). In this current field study of a Jordanian cohort, we collected data on work stress (ERI and overcommitment), as well as data with a possible impact on work stress and CRP association including age (Wener, Daum, & McQuillan, 2000), smoking, perceived stress (McDade, Hawkley, & Cacioppo, 2006), physical activity (Kasapis & Thompson, 2005), sleep (Okun, Coussons-Read, & Hall, 2009), blood

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Address correspondence to Tawfiq Almadi, Discipline of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, P.O. Box 170, Lidcombe, NSW 1825, Australia. E-mail: talm3809@uni.sydney.edu.au

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pressure (Blake, Rifai, Buring, & Ridker, 2003), and biochemical indices of glucose and lipids (Fröhlich et al., 2000).

This study sought to answer the following questions: (a) Does chronic work stress measured by ERI predict an increase in the inflammatory marker, CRP; and (b) Does accompanying central obesity predict a greater degree of inflammation? The study-specific hypotheses are: ERI is positively associated with CRP, and centrally obese workers show a stronger association between ERI and CRP than nonobese workers.

Methods

Participants

Healthy Jordanian male workers ($n = 264$) were recruited from the veterinary, agricultural, textile, and poultry industries. Self-reported questionnaires were used to exclude all cases with physical or psychological conditions known to influence CRP plasma levels (Gabay & Kushner, 1999; Maes et al., 1997). Subjects were encouraged to seek information from their family physician or the study physician if they were in doubt about these conditions. Nineteen subjects were excluded based on their medical conditions, which included inflammatory diseases, CVD, previous stroke, rheumatic disease, liver disease, viral or recent infection, connective tissue disease, peripheral blood disease, tumor, neurological and endocrine disease, recent injury or surgical operation, and mental or psychological problems. The study excluded all subjects taking medications including those with effects on the inflammatory response, cholesterol-lowering agents, steroids, reductase inhibitors (statins), nonsteroidal anti-inflammatory drugs (NSAIDs) or analgesic medications, antidepressants, sedatives, antipsychotic medications, and hormone and hormone-related therapy (Elgharib, Chi, Younis, Wehbe, & Krishnaswamy, 2003; Ridker et al., 1997; Ridker, Rifai, Pfeffer, Sacks, & Braunwald, 1999).

Demographic Data

Data on age, race, work characteristics (full-time/part-time, night/day shift), smoking status, and alcohol intake were collected using self-reported questionnaires.

Study Questionnaires

Four questionnaires were administered to subjects: (1) work stress related to ERI and work overcommitment (Siegrist, 1996); (2) Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983); (3) the short version International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003); and (4) the Pittsburg Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The official Arabic version of IPAQ and its scoring system are available at the IPAQ web site (www.ipaq.ki.se). The PSS, ERI, and PSQI have undergone a translation process that was examined for factorial structure, and tested for reliability. The translation and validation process for these questionnaires are described in separate reports and have been submitted for publication.

Work stress was measured by the Arabic translated version of the ERI questionnaire, with an internal reliability as measured by Cronbach's alpha coefficient of 0.85. The ERI contains 17 items: "effort" with 6 items and "reward" with 11 items. Items on the effort scale were answered in two steps. First, participants agreed or disagreed whether the item content reflected their typical work situation. Those who agreed that it was typical were also asked to evaluate the extent to which these conditions produced distress using a 4-point rating scale, with higher scores indicating higher distress. The 11 items measuring reward are framed similarly, but the coding is reversed, so that a lower summary score for reward indicates a higher subjective rating of distress due to low reward. The overall ERI score was calculated as effort divided by reward; a score of one represents a balance of effort and reward, whereas higher scores reflect a perceived disproportionate effort. In addition, participants were asked to respond to six additional questions on work overcommitment scored on a 4-point scale and with a total score range of 0–24. A higher overcommitment score indicates high-risk conditions for physical or mental disorders (Van Vegchel, de Jonge, Bosma, & Schaufeli, 2005). Perceived stress was assessed by an Arabic translated version of PSS-14 (Cronbach's alpha coefficient = 0.68). The scale has 14 items related to the level of perceived stress experienced over the previous month and measures the degree to which situations in a person's life are perceived as stressful. Each item is answered on a 5-point response giving a scale range of 0–56, with a high score representing a high perceived stress level (Cohen et al., 1983). Participants were asked to answer questions regarding their physical activity level using the validated Arabic version of the IPAQ. The questionnaire contains items about physical activity patterns over the previous week in four domains: work, home, leisure, and travel. IPAQ provides a score of energy expenditure expressed as MET-min/week, computed by multiplying the metabolic equivalent (MET) intensity of the activity × the number of minutes per week the activity was performed. A MET is defined as the number of calories consumed by an individual per minute in an activity relative to the basal metabolic rate. Therefore, one MET is the energy consumption of that individual while at complete rest. Based on this MET-min/week calculation, the IPAQ allows classification of subjects' physical activity level into three categories: low (less than 600 accumulated over a week), moderate (between 600 and 1500 accumulated over a week), and high (more than 1500 accumulated on 3 days, or more than 3000 accumulated over a week). Sleep quality was measured by an Arabic translated version of the PSQI (Cronbach's alpha coefficient = 0.66). The scale is a 19-item questionnaire about sleep quality in the previous month. Subscale scores of 0 to 3 were generated for seven components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The sum of responses of all seven components yields a global score of sleep quality. A subject with a global PSQI score greater than 5 is considered to be a poor sleeper, while a subject with a value less than 5 is considered to be a good sleeper (Buysse et al., 1989). In the analyses of this study, the global PSQI score was used as a continuous variable.

Physiological and Biochemical Measurements

Following an overnight fast, subjects attended a private room at their worksites between 6.30 am to 8.30 am. Subjects were seated for at least 5 min before blood pressure was measured with a standard mercury sphygmomanometer. Weight and height were measured with a calibrated balance beam scale and stadiometer, respectively. The waist circumference was obtained by measuring at the narrowest point of the abdomen, between the lower costal (tenth rib) and the iliac crest, using a flexible nonelastic measuring tape. Body mass index (BMI) was calculated as mass (kg) divided by height squared (m^2). Fasting venous blood samples were then

Table 1. *Psychological, Physical, Physiological, and Biochemical Characteristics of Jordanian Male Workers (n = 152)*

	Mean (*SD*)
Effort/rewards ratio	1.24 (0.41)
Overcommitment	14.5 (3.5)
Perceived stress	25.8 (6.3)
Age (year)	35.4 (9.0)
Body mass index (kg.m^{-2})	26.8 (3.8)
Waist circumference (cm)	93.0 (11.4)
Physical activity (MET-min/week)	1136 (1741)
Sleep quality	5.10 (2.53)
Fasting blood glucose (mg/dL)	89.6 (12.0)
Cholesterol (mg/dL)	187.3 (37.3)
High-density lipoprotein (mg/dL)	43.2 (9.4)
Low-density lipoprotein (mg/dL)	112.7 (30.9)
Triglycerides (mg/L)	146.9 (82.4)
CRP (mg/L)	3.14 (2.58)

collected in plain tubes and centrifuged at 1500 g for 10 min at room temperature, and the serum samples were frozen at –20°C until assayed. High-sensitivity CRP was determined with an automated Roche Diagnostics modular analyzer (Roche, Switzerland), using a particle-enhanced immunoturbidimetry method with a measuring range of 0.085–1600 mg/L. Blood glucose and blood lipid profile (total cholesterol, high-density lipoprotein, triglycerides, and low-density lipoprotein) were determined with an Accent 200 automated chemistry analyzer (PZ Cormay S.A., Poland) using an enzymatic kit (Randox, UK). Data collection and blood analysis were performed during the period of September to October 2007.

Statistical Analyses

Subjects with CRP levels of 10 mg/L or more were excluded ($n = 25$) from the analysis, as such values were likely to be related to acute infections or other acute inflammatory conditions (Ford et al., 2003; Jialal, Devaraj, & Venugopal, 2004). Additionally, participants ($n = 87$) with missing data for one or more study parameters were excluded. Thus, data from 152 subjects were used in the final analysis. The distributions of CRP and triglycerides were skewed and therefore log-transformed before analysis.

All of the analyses were conducted with SPSS (IBM, SPSS version 17). Descriptive statistics were determined and *t* tests were used to compare the means of the main variables for the high ERI group (ERI > 1) and the low effort group (ERI ≤ 1), and the intercorrelations between CRP and all study variables were examined. Hierarchical linear regressions were used to examine the relationship between ERI and CRP for the whole study population and were repeated separately for the obese and nonobese subgroups. The following covariates were used in the regression analyses as they showed an association with the inflammatory factor, CRP: waist circumference, age, glucose, cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and blood pressure. Statistical significance was accepted at $p < .05$, and descriptive results are expressed as mean ± SD.

Results

The mean age of the 152 male Jordanian workers was 35.3 ± 8.9 years with a high proportion (71.9%) aged between 26 and 45. In this cohort, 75.2% were blue-collar workers (factory manual workers), 87.6% worked for private companies, and 98.7% were full-time workers. Table 1 shows the psychological, physical, physiological, and biochemical characteristics among Jordanian male workers. The mean BMI was 26.8 ± 3.8 kg.m^{-2}. According to the World Health Organization's definition of obesity (30 ≤ BMI < 40 kg.m^{-2}) (WHO, 2004), 22.2% of the sample were obese. According to the International Diabetes Federation (2005), 51% of the sample satisfied the criteria of high waist circumference of ≥ 94 cm, and 11.1% satisfied the criteria of raised blood pressure (systolic BP > 130 or diastolic BP > 85 mmHg or currently taking medication for previously diagnosed hypertension). According to IPAQ, 58.7% had a low physical activity level. The PSQI indicated that 47.4% were classified as poor sleepers (PSQI > 5). The data revealed 49.7% were active smokers, and none took alcohol. In addition, the median for triglycerides was 120 mg/dL and the interquartile range was 87–198 mg/dL, while the values for CRP were 2.04 mg/L and 1.13–4.66 mg/L, respectively.

Work Stress and CRP

The log-transformed CRP (CRP log) showed a significant correlation with ERI (Table 2). When the workers were divided into high stress (ERI > 1, $n = 108$) and low stress (ERI ≤ 1, $n = 44$), the values for CRP were 3.38 (± 2.26) mg/L and 2.54 (± 2.22) mg/L, respectively, and were significantly different for the two groups ($p < .05$). CRP log was positively correlated with age, BMI, waist circumference, hypertension, glucose, cholesterol, and triglycerides, but negatively correlated with HDL (Table 2).

Table 3 shows the hierarchical linear regression of CRP. In Step 1, all covariates of CRP were entered including age, hypertension, waist circumference, fasting blood glucose, cholesterol, HDL, and triglycerides. These variables explained a significant proportion of variance in CRP with $R^2 = 0.245$ (standard error of the estimate, SEE = 0.78; $F(1,151) = 6.74$, $p < .01$). In Step 2, ERI ratio was forced in the regression analysis in addition to all covariates of CRP and, as a result, the whole model was not a significant predictor of CRP ($R^2 = 0.265$; SEE = 0.77; $F(1,151) = 3.85$, $p = .052$). ERI alone did not significantly predict CRP ($\Delta R^2 = 0.020$, $\beta = 0.15$; $t(151) = 1.96$, $p = .052$). However, this analysis demonstrated that the strongest predictor of CRP was waist circumference. For the measures of obesity, BMI, and waist circumference, we applied

Table 2. *Correlations Between CRP log with Physical, Physiological, and Biochemical Variables*

	CRP log	*p* value
Effort/reward ratio	0.294	<.01
Perceived stress	–0.049	ns
Overcommitment	–0.060	ns
Age (year)	0.264	<.01
BMI (kg.m^{-2})	0.430	<.01
Waist circumference (cm)	0.441	<.01
Hypertension (yes/no)	0.231	<.01
Smoking (yes/no)	–0.096	ns
Physical activity (MET-min/week)	–0.017	ns
Sleep quality	–0.041	ns
Fasting blood glucose (mg/dL)	0.248	<.01
Total cholesterol (mg/dL)	0.193	<.01
Triglycerides-log (mg/dL)	0.249	<.01
High-density lipoprotein (mg/dL)	–0.161	<.01

Note. ns = not significant.

Table 3. *Hierarchical Linear Regression of CRP log*

	Step 1		Step 2	
	B ± SEE	β	B ± SEE	β
Age	0.005 ± 0.008	0.05 ns	0.005 ± 0.008	0.06 ns
Waist circumference (cm)	0.024 ± 0.007	0.04**	0.021 ± 0.007	0.28*
Hypertension (yes/no)	0.347 ± 0.212	0.13 ns	0.258 ± 0.215	0.09 ns
Fasting blood glucose (mg/dL)	0.008 ± 0.006	0.11 ns	0.006 ± 0.006	0.09 ns
Total cholesterol (mg/dL)	0.003 ± 0.003	0.14 ns	0.003 ± 0.003	0.12 ns
Triglycerides (mg/dL)	–0.021 ± 0.155	–0.02 ns	–0.004 ± 0.154	–0.01 ns
High-density lipoprotein (mg/dL)	–0.011 ± 0.009	–0.12 ns	–0.011 ± 0.009	–0.11 ns
Effort/reward ratio			0.324 ± 0.166	0.15*
R^2	0.245**		0.265 ns	

Notes. β = standardized coefficients; B = unstandardized coefficients; SEE = standard error of the estimate; ns = not significant; $\Delta R^2 = 0.020$ for Step 2.
*$p < .05$. **$p < .001$.

waist circumference in the linear regression analysis but not BMI to avoid colinearity, since both measures were highly correlated ($r = 0.83$) and related.

In a separate analysis, the above hierarchical linear regression was repeated using data only from subjects with central obesity (waist circumference ≥ 94 cm; $n = 78$). The data showed that only ERI, and not other variables, were significantly associated with CRP, accounting for 5.0% of the variability in the CRP ($\beta = 0.241$; $t(78) = 2.161$, $p = .034$). On the other hand, when only subjects without central obesity (waist circumference < 94 cm, $n = 74$) were analyzed, waist circumference and not ERI or any other variable was significantly positively associated with CRP ($\beta = 0.369$; $t(74) = 2.733$, $p < 0.01$).

Discussion

The key finding of this study is that work stress as measured by ERI as well as obesity measures (BMI and waist circumference), biochemical indices (cholesterol, triglycerides), and hypertension were significantly correlated with CRP. Central obesity explained most of the variance in CRP after controlling for other covariates. To our knowledge, this is the first study that has reported the CRP values for Jordanians. The median value of CRP agreed with that reported for a large American cohort, the Framingham Heart Study (Wilson et al., 2008). The strong association between waist circumference and CRP found in this study confirms previous such findings (Huffman, Whisner, Zarini, & Nath, 2010), and suggests that at least half of the current Jordanian cohort may be at risk of metabolic syndrome, since visceral obesity also predicts the metabolic syndrome (Han et al., 2002). The physiological basis for the association of ERI and CRP hinges upon the relationship between proinflammatory cytokines, CRP, and stress that is attended by the hypothalamic-pituitary-adrenal (HPA) and sympathetic axes. This system stimulates an increased production of proinflammatory cytokines (Black, 2002), which have been associated with a number of psychosocial stressors including symptoms of depression, posttraumatic stress disorder, and caregiving for a spouse with dementia (Kiecolt-Glaser et al., 2003; Lutgendorf et al., 1999).

The current results are compatible with the hypothesis that, at least in part, the association of ERI with CRP is due to the mediating role of risk factors, in particular, visceral obesity. We found that when considering only subjects with central obesity, ERI was significantly associated with CRP and accounted for 5.0% of its variability. When considering subjects without central obesity, ERI was not significantly associated with CRP. Our findings implicate work stress as an added stressor in obese individuals that may augment the degree of inflammation and future risk of metabolic syndrome. Further, it is noted that central fat secretes proinflammatory cytokines (Kern, Ranganathan, Li, Wood, & Ranganathan, 2001). These proinflammatory cytokines not only induce CRP production by the liver (Papanicolaou, Wilder, Manolagas, & Chrousos, 1998), but also stimulate the HPA axis and activate cortisol secretion (Mastorakos, Weber, Magiakou, Gunn, & Chrousos, 1994). Therefore, proinflammatory cytokines play a critical role in the development of risk factors of metabolic syndrome such as glucose intolerance and dyslipidemia (Pickup, Mattock, Chusney, & Burt, 1997).

Generally, participants in the present study who displayed a high ERI showed an elevated CRP without any study provocation. These results have provided evidence that low-grade inflammation was predicated by work stress and lend support to previous findings, which found that men with higher ERI demonstrated greater CRP responses when subjected to mental stress tasks (Hamer et al., 2006). However, these authors did not find a relationship between ERI and CRP at baseline. Their study subjects were healthy, nonsmokers of younger age, with a healthier BMI than the current study. Most importantly, they experienced less work stress (ERI) when compared with the current study's subjects. Furthermore, the current study did not involve additionally imposed mental stress tasks. Since work occupies a large portion of our lives, chronic work-related stress could have a negative impact on our health, and is an added health risk in the presence of obesity. Evidence provided in this study for an association between CRP and work stress in apparently healthy individuals without known diseases supports the notion that work stress mediates an inflammatory process, which predisposes susceptible individuals to CVD and metabolic syndrome. Additionally, the current findings highlight the importance of evaluating the role of psychological stress especially in overweight and obese workers and those in the early stages of CVD, and for occupational health bodies to adopt CRP as a biochemical measure to determine the impact of work stress on the general worker. One limitation of this study lies with its relatively small sample size, although it is larger than some other studies of psychosocial factors and CRP (McDade et al., 2006; Suarez, 2004). We were also able to replicate many of the known associations with CRP (e.g., BMI, waist circumference, age, glucose, and lipids). A further limitation was that only one inflammatory marker (CRP) was examined, although other inflammatory markers are similarly predictive of diseases and play a role in CVD development (Pearson et al., 2003). However, CRP is considered to be the

strongest predictor of future CVD and metabolic syndrome when compared with other inflammatory markers. The strength of this study is that it is the first field study that demonstrates a positive relationship between work stress and the inflammatory marker CRP in a Jordanian cohort, and reports the CRP values for a healthy Jordanian working group. In summary, we found that work stress predicts a small inflammatory response in a sample of overweight or centrally obese Jordanian workers.

References

Bellingrath, S., Weigl, T., & Kudielka, B. M. (2009). Chronic work stress and exhaustion is associated with higher allostastic load in female school teachers. *Stress*, *12*, 37–48. doi: 10.1080/10253890802042041

Black, P. H. (2002). Stress and the inflammatory response: A review of neurogenic inflammation. *Brain, Behavior, and Immunity*, *16*, 622–653. doi: 10.1016/S0889-1591(02)00021-1

Blake, G. J., Rifai, N., Buring, J. E., & Ridker, P. M. (2003). Blood pressure, C-reactive protein, and risk of future cardiovascular events. *Circulation*, *108*, 2993–2999. doi: 10.1161/01.CIR.0000104566.10178.AF

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*, 193–213. doi: 10.1016/0165-1781(89)90047-4

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., & Oja, P. (2003). International physical activity questionnaire: 12-Country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*, 1381–1395. doi: 10.1249/01.MSS.0000078924.61453.FB

Dixon, J. B., Hayden, M. J., Lambert, G. W., Dawood, T., Anderson, M. L., Dixon, M. E., & O'Brien, P. E. (2008). Raised CRP levels in obese patients: Symptoms of depression have an independent positive association. *Obesity*, *16*, 2010–2015. doi: 10.1038/oby.2008.271

Elgharib, N., Chi, D., Younis, W., Wehbe, S., & Krishnaswamy, G. (2003). C-reactive protein as a novel biomarker reactant can flag atherosclerosis and help predict cardiac events. *Postgraduate Medicine 114*, 39–44. doi: 10.3810/pgm.2003.12.1547

Ford, E., Giles, W., Myers, L., Rifai, M., Ridker, P., & Mannino, M. (2003). C-reactive protein concentration distribution among US children and young adults: Finding from the National Health and Nutrition Examination Survey, 1999–2000. *Clinical Chemistry*, *49*, 1353–1357. doi: 10.1373/49.8.1353

Fröhlich, M., Imhof, A., Berg, G., Hutchinson, W., Pepys, M., Boeing, H., & Koenig, W. (2000). Association between C-reactive protein and features of the metabolic syndrome: A population-based study. *Diabetes Care*, *12*, 1835–1839. doi: 10.2337/diacare.23.12.1835

Gabay, C., & Kushner, I. (1999). Acute-phase proteins and other systemic responses to inflammation. *New England Journal of Medicine*, *340*, 448–454.

Geffken, D. F., Cushman, M., Burke, G. L., Polak, J. F., Sakkinen, P. A., & Tracy, R. P. (2001). Association between physical activity and markers of inflammation in a healthy elderly population. *American Journal of Epidemiolog,y 153*, 242–250. doi: 10.1093/aje/153.3.242

Hamer, M., Williams, E., Vuonovirta, R., Giacobazzi, P., Gibson, L., & Steptoe, A. (2006). The effects of effort-reward imbalance on inflammatory and cardiovascular responses to mental stress. *Psychosomatic Medicine*, *68*, 408–413. doi: 10.1097/01.psy.0000221227.02975.a0

Han, T., Sattar, N., Williams, K., Gonzalez-Villalpando, C., Lean, M. E., & Haffner, S. M. (2002). Prospective study of C-reactive protein in relation to the development of diabetes and metabolic syndrome in the Mexico City Diabetes Study. *Diabetes Care*, *25*, 2016–2021.

Huffman, F. G., Whisner, S., Zarini, G. G., & Nath, S. (2010). Waist circumference and BMI in relation to serum high sensitivity C-reactive protein (hs-CRP) in Cuban Americans with and without type 2 diabetes. *International Journal of Environmental Research and Public Health*, *7*, 842–852. doi: 10.3390/ijerph7030842

International Diabetes Federation. (2005). The International Diabetes Federation consensus worldwide definition of the metabolic syndrome. Retrieved from http://www.idf.org/metabolic-syndrome

Jialal, I., Devaraj, S., & Venugopal, S. K. (2004). C-reactive protein: Risk marker or mediator in atherothrombosis? *Hypertension*, *44*, 6–11. doi: 10.1161/01.HYP.0000130484.20501

Kasapis, C., & Thompson, P. D. (2005). The effects of physical activity on serum C-reactive protein and inflammatory markers: A systematic review. *Journal of American College of Cardiology*, *45*, 1563–1569. doi: 10.1016/j.jacc.2004.12.077

Kern, P. A., Ranganathan, S., Li, C., Wood, L., & Ranganathan, G. (2001). Adipose tissue tumor necrosis factor and interleukin-6 expression in human obesity and insulin resistance. *American Journal of Physiology—Endocrinology and Metabolism*, *280*, E745–751.

Kiecolt-Glaser, J. K., Preacher, K. J., MacCallum, R. C., Atkinson, C., Malarkey, W. B., & Glaser, R. (2003). Chronic stress and age-related increases in the proinflammatory cytokine IL-6. *Proceedings of the National Academy of Sciences U S A*, *100*, 9090–9095. doi: 10.1073/pnas.1531903100

Koenig, W., Sund, M., Frohlich, M., Fischer, H. G., Lowel, H., Doring, A., & Pepys, M. B. (1999). C-reactive protein, a sensitive marker of inflammation, predicts future risk of coronary heart disease in initially healthy middle-aged men: Results from the MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) Augsburg Cohort Study, 1984 to 1992. *Circulation*, *99*, 237–242.

Laaksonen, D. E., Niskanen, L., Nyyssonen, K., Punnonen, K., Tuomainen, T. P., Valkonen, V. P., & Salonen, J. T. (2004). C-reactive protein and the development of the metabolic syndrome and diabetes in middle-aged men. *Diabetologia*, *47*, 1403–1410. doi: 10.1007/s00125-004-1472-x

Lutgendorf, S. K., Garand, L., Buckwalter, K. C., Reimer, T. T., Hong, S. Y., & Lubaroff, D. M. (1999). Life stress, mood disturbance, and elevated interleukin-6 in healthy older women. *Journal of Gerontology: Series A Biological Sciences and Medical Sciences*, *54*, M434–439. doi: 10.1093/gerona/54.9.M434

Maes, M., Delange, J., Ranjan, R., Meltzer, H., Desnyder, R., Cooremans, W., & Scharpe, S. (1997). Acute phase proteins in schizophrenia, mania and major depression: Modulation by psychotropic drugs. *Psychiatry Research*, *66*, 1–11. doi: 10.1016/S0165-1781(96)02915-0

Mastorakos, G., Weber, J. S., Magiakou, M. A., Gunn, H., & Chrousos, G. P. (1994). Hypothalamic-pituitary-adrenal axis activation and stimulation of systemic vasopressin secretion by recombinant interleukin-6 in humans: Potential implications for the syndrome of inappropriate vasopressin secretion. *Journal of Clinical Endocrinology & Metabolism*, *79*, 934–939. doi: 10.1210/jc.79.4.934

McDade, T. W., Hawkley, L. C., & Cacioppo, J. T. (2006). Psychosocial and behavioral predictors of inflammation in middle-aged and older adults: The Chicago health, aging, and social relations study. *Psychosomatic Medicine*, *68*, 376–381. doi: 10.1097/01.psy.0000221371.43607.64

Ohsawa, M., Okayama, A., Nakamura, M., Onoda, T., Kato, K., Itai, K., & Hiramori, K. (2005). CRP levels are elevated in smokers but unrelated to the number of cigarettes and are decreased by long-term smoking cessation in male smokers. *Preventive Medicine*, *41*, 651–656. doi: 10.1016/j.ypmed.2005.02.002

Okun, M. L., Coussons-Read, M., & Hall, M. (2009). Disturbed sleep is associated with increased C-reactive protein in young women. *Brain, Behavior, and Immunity*, *23*, 351–354. doi: 10.1016/j.bbi.2008.10.008

Papanicolaou, D. A., Wilder, R. L., Manolagas, S. C., & Chrousos, G. P. (1998). The pathophysiologic roles of interleukin-6 in human disease. *Annals of Internal Medicine*, *128*, 127–137.

Pearson, T. A., Mensah, G. A., Alexander, R. W., Anderson, J. L., Cannon, R. O., 3rd, Criqui, M., & Vinicor, F. (2003). Markers of inflammation and cardiovascular disease: Application to clinical and public health practice: A statement for healthcare professionals from the Centers for Disease Control and Prevention and the American Heart Association. *Circulation*, *107*, 499–511. doi: 10.1161/01.CIR.0000052939.59093.45

Pickup, J., Mattock, M., Chusney, G., & Burt, D. (1997). NIDDM as a disease of the innate immune system: Association of acute-phase reactants and interleukin-6 with metabolic syndrome X. *Diabetologia 40*, 1286–1292. doi: 10.1007/s001250050822

Ridker, P. M., Cushman, M., Stampfer, M. J., Tracy, R. P., & Hennekens, C. H. (1997). Inflammation, aspirin, and the risk of cardiovascular disease in apparently healthy men. *New England Journal of Medicine*, *336*, 973–979.

Ridker, P. M., Rifai, N., Pfeffer, M. A., Sacks, F., & Braunwald, E. (1999). Long-term effects of pravastatin on plasma concentration of C-reactive protein. The Cholesterol and Recurrent Events (CARE) Investigators. *Circulation*, *100*, 230–235.

Shen, B. J., Farrell, K. A., Penedo, F. J., Schneiderman, N., & Orth-Gomer, K. (2010). Waist circumference moderates the association between marital stress and C-reactive protein in middle-aged healthy women. *Annals of Behavioral Medicine*, *40*, 258–264. doi: 10.1007/s12160-010-9211-7

Siegrist, J. (1996). Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology*, *1*, 27–41. doi: 10.1037/1076-8998.1.1.27

Suarez, E. C. (2004). C-reactive protein is associated with psychological risk factors of cardiovascular disease in apparently healthy adults. *Psychosomatic Medicine*, *66*, 684–691. doi: 10.1097/01.psy.0000138281.73634.67

Van Vegchel, N., de Jonge, J., Bosma, H., & Schaufeli, W. (2005). Reviewing the effort reward imbalance model: Drawing up the balance of 45 empirical studies. *Social Science & Medicine*, *60*, 1117–1131. doi: 10.1016/j.socscimed.2004.06.043

Visser, M., Bouter, L. M., McQuillan, G. M., Wener, M. H., & Harris, T. B. (1999). Elevated C-reactive protein levels in overweight and obese adults. *Journal of the American Medical Association*, *282*, 2131–2135. doi: 10.1001/jama.282.22.2131

Wener, M. H., Daum, P. R., & McQuillan, G. M. (2000). The influence of age, sex, and race on the upper reference limit of serum C-reactive protein concentration. *Journal of Rheumatology*, *27*, 2351–2359.

World Health Organization (WHO). (2004). The international classification of adult underweight, overweight and obesity according to BMI. Retrieved from http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

Wilson, P. W., Pencina, M., Jacques, P., Selhub, J., D'Agostino, R., Sr., & O'Donnell, C. J. (2008). C-reactive protein and reclassification of cardiovascular risk in the Framingham Heart Study. *Circulation: Cardiovascular Quality and Outcomes*, *1*, 92–97. doi: 10.1161/CIRCOUTCOMES.108.831198

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Associations among work-related stress, cortisol, inflammation, and metabolic syndrome.

As a co-author of the article, I confirm that Tawfiq Almadi has made the following contributions:

- Conception and design of the research
- Analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- A corresponding author for communication with journal.

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Associations among work-related stress, cortisol, inflammation, and metabolic syndrome

TAWFIQ ALMADI, IAN CATHERS, AND CHIN MOI CHOW
Discipline of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, Lidcombe, Australia

Abstract

This cross-sectional study examined the relationship between work-related stress, cortisol, and C-reactive protein (CRP) in predicting metabolic syndrome (MtS). Self-reported work stress measured by the effort reward imbalance ratio (ERI), anthropometric data, CRP, and saliva cortisol were collected from 204 healthy Jordanian male workers. ERI and cortisol were significantly associated with the presence of MtS (*OR* = 4.74, 95% CI: 2.13–10.55; *OR* = 3.03, 95% CI: 2.08–4.40; *OR* = 11.50, 95% CI: 2.16–59.14, respectively). The odds of MtS in men with high ERI and high cortisol were significantly higher than that of men with low ERI and low cortisol (*OR* = 11.50, 95% CI: 2.16–59.14). CRP was significantly associated with MtS (*OR* = 2.51, 95% CI: 1.50–4.20). The odds of MtS were significantly higher in centrally obese men with both high ERI and CRP level. Thus, high ERI along with high cortisol or high CRP increases the risk for MtS, especially among centrally obese men.

Descriptors: Psychopathological, Biochemical

Work-related stress may adversely affect physical health (Leka & Jain, 2010). Psychological stress in the workplace has mainly been investigated through two theoretical models, the demand-control (DC) model (Karasek, 1979; Karasek & Theorell, 1990) and the effort-reward imbalance (ERI) model (Siegrist, 1996). The DC model emphasizes task-level control, whereas the ERI model emphasizes employee perception of effort-reward imbalance (Tsutsumi & Kawakami, 2004). Effort-reward imbalance is a serious form of psychological work-related stress, since workers may feel undercompensated for their efforts. The ERI model has advantages over the DC model in that ERI focuses on stressors such as adequate payment, job security, job changes, and job promotion prospects (Griep et al., 2009). A high level of ERI is associated with components of metabolic syndrome (MtS), namely, hypertension (Peter et al., 1998), high body mass index (BMI) (Kivimaki et al., 2002), increased triglyceride level (Fan et al., 2009), and high fasting glucose (Kumari, Head, & Marmot, 2004).

Stress activates two fundamental axes, the hypothalamus-pituitary-adrenal (HPA) axis and the sympathomedullo-adrenal (SMA) axis (Figure 1). Altered activity of both the HPA and SMA axes predisposes an individual to increased risk of developing MtS (Bjorntorp & Rosmond, 2000). However, these two axes act through separate pathways, one through hypercortisolemia, and the other through cytokines and inflammatory reactions (Bellingrath, Weigl, & Kudielka, 2009; Black, 2003; Sternberg, Chrousos, Wilder, & Gold, 1992; Yudkin, Stehouwer, Emeis, & Coppack, 1999).

The first pathway through hypercortisolemia involves increases in cortisol levels. Elevated cortisol levels increase glucose production within liver cells resulting in hyperglycemia. In addition, increased cortisol levels inhibit insulin secretion from pancreatic β-cells, as well as inhibit muscle glucose uptake. These effects lead to impaired glucose tolerance and insulin resistance (Amatruda, Livingston, & Lockwood, 1985). Cortisol also stimulates the breakdown of stored triglycerides in the adipose tissue, resulting in an increase in free fatty acids in the plasma. A higher level of free fatty acids prevents the release of insulin, further worsening glucose intolerance and insulin resistance. Density of cortisol receptors is higher in intra-abdominal (visceral) fat than in other fat deposits, and the activity of cortisol in fat accumulation is accentuated in visceral adipose tissue (Bjorntorp & Rosmond, 2000; Salehi, Ferenczi, & Zumoff, 2005), suggesting a mechanism by which excessive cortisol causes further abdominal obesity (Qi & Rodrigues, 2007).

The second pathway involves cytokines that induce acute phase proteins, such as C-reactive protein (CRP) (Gabay & Kushner, 1999). CRP, one of the best characterized systemic inflammatory biomarkers, may interfere with insulin signaling and downregulate corticosteroid-binding globulin, resulting in increased free cortisol levels and consequently insulin resistance as well as other manifestations of MtS (Hotamisligil et al., 1996).

Furthermore, proinflammatory cytokines inhibit lipoprotein lipase activity and increase the concentration of nonesterified fatty acids, contributing to dyslipidemia and insulin resistance (Perry, Sattar, & Petrie, 2001). Central obesity amplifies the release of

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Address correspondence to: Tawfiq Almadi, Discipline of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, P.O. Box 170, Lidcombe, NSW 1825, Australia. E-mail: talm3809@uni.sydney.edu.au

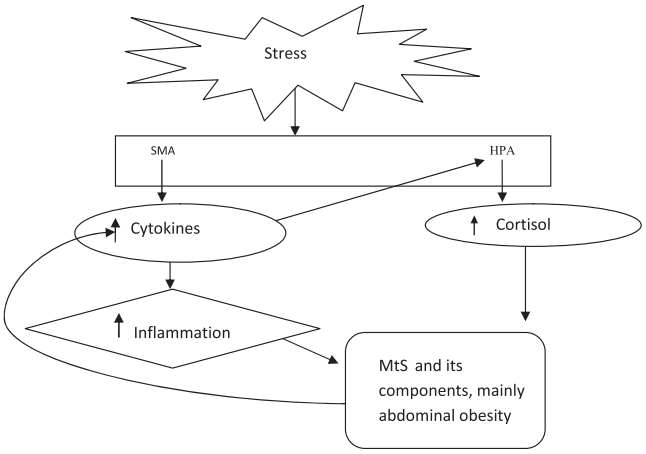

Figure 1. Stress and MtS pathways.

proinflammatory cytokines (Kern, Ranganathan, Li, Wood, & Ranganathan, 2001). Notably, the relationship between stress and inflammation markers (such as CRP) is observed mostly among subjects with central obesity (Almadi, Cathers, Hamdan Mansour, & Chow, 2012b; Shen, Farrell, Penedo, Schneiderman, & Orth-Gomer, 2010).

High stress levels as measured by the ERI (Bellingrath et al., 2009) and mood disturbance (Lutgendorf et al., 1999) induce low-grade inflammatory responses with increased production of proinflammatory cytokines (Black, 2002). Subsequently, these cytokines induce an increase in CRP production (Gabay & Kushner, 1999). This increase in CRP is thought to contribute to the pathogenesis of MtS (Laaksonen et al., 2004). Therefore, in this study, we sought to explore the links between chronic work stress as measured by ERI and the MtS through the stress marker cortisol and the inflammatory marker CRP. These links are explored specifically in obese subjects. The current study sought to answer the following questions: (a) Does ERI predict an increased likelihood of MtS and its components? (b) Does ERI that is associated with a high level of cortisol predict a greater likelihood of MtS and its components? (c) Does ERI that is associated with a high level of CRP predict an increased likelihood of MtS and its components? (d) Does the high CRP in central obesity predict a greater likelihood of MtS compared to noncentral obesity?

Method

Participants

Healthy Jordanian male workers ($N = 264$) were recruited from the veterinary, agricultural, textile, and poultry industries. Screening questionnaires were used to exclude all men with conditions known to influence cortisol secretion and increase CRP plasma levels. Excluded conditions included physical and endocrine abnormality, depression or other mental and psychiatric conditions, substance abuse, inflammatory diseases, CVD, previous stroke, rheumatic disease, diabetes mellitus, liver disease, viral or recent infection, connective tissue disease, peripheral blood disease, tumor, neurological and endocrine disease, and recent injury or surgical operation. We also excluded all male workers on steroid-based medications, hormone or hormone-related therapy, cholesterol-lowering agents, antidepressants, psychotropic medications, or on any medications or drugs that can affect cortisol or lipid levels. Finally, subjects were also excluded if they were taking medications that affected inflammatory response, reductase inhibitors (statins), nonsteroidal antiinflammatory drugs (NSAIDs), analgesic medications, antidepressants, sedatives, antipsychotic medications, or if they had acute illness or were employed in night shifts (Elgharib, Chi, Younis, Wehbe, & Krishnaswamy, 2003; Gabay & Kushner, 1999; Liu, Bravata, Cabaccan, Raff, & Ryzen, 2005; Ridker, Cushman, Stampfer, Tracy, & Hennekens, 1997; Ridker, Rifai, Pfeffer, Sacks, & Braunwald, 1999). All subjects gave informed consent for this study, which was approved by the Human Research Ethics Committee of The University of Sydney and Jordan University.

Materials and Procedures

Information was collected on age, race, work characteristics (full-time/part-time), smoking status (current smoker, nonsmoker), and alcohol intake. Four self-reported questionnaires in Arabic were administered: the Effort-Reward Imbalance (ERI) questionnaire (Siegrist, 1996); the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983); the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003); and the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

The Arabic version of the ERI questionnaire (Almadi, Cathers, & Chow, 2012a) has a Cronbach's alpha coefficient of 0.82. It contains 17 items, 6 are related to "effort" and 11 items are related to "reward." The items of effort and reward include five responses and are answered in two steps. In the first step, the respondents are asked whether the item content describes a typical experience in their workplace. If the participants agree, they are asked about the level of distress by choosing one item of a 4-point Likert scale, ranging from 1 (*I am not at all distressed*) to 4 (*I am very distressed*). The ERI ratio was calculated as Effort/Reward × Correction Factor (correcting for the difference in the numbers of items of the two scales: effort and reward). A ratio of 1 represents a balance of effort and reward, whereas a ratio greater than 1 reflects disproportionate effort. Individuals with an ERI ratio ≥ 1 were classified as the stressed group, and the remainder with a ratio < 1 were in the nonstressed group. Participants were also asked to respond to six additional questions on work "overcommitment," which was scored on a 4-point Likert scale, ranging from 1 (*full disagreement with the statement*) to 4 (*full agreement*). Higher overcommitment scores indicate high-risk conditions for physical or mental disorders (Van Vegchel, de Jonge, Bosma, & Schaufeli, 2005).

Perceived stress was assessed by the Arabic version of the PSS (Almadi, Cathers, Hamdan Mansour, & Chow, 2012a) with a Cronbach's alpha coefficient of 0.68. The scale measures the level of perceived stress experienced over the previous month, and consists of 14 items with a 5-point Likert scale, ranging from 0 (*never*) to 4 (*very often*). A high score represents a high level of perceived stress (Cohen et al., 1983).

Participants were asked to answer questions regarding their amount of physical activity using the Arabic version of the IPAQ (Al-Hazza, 2006). The IPAQ has undergone extensive validation and reliability assessment, and it contains items pertaining to physical activity patterns over the previous week in four areas: work, home, leisure, and travel (Craig et al., 2003).

Sleep quality was measured by the Arabic translated version of the PSQI (Almadi, Cathers, & Chow, 2012b), with Cronbach's alpha coefficient of 0.66. The PSQI is a 19-item questionnaire about sleep quality in the previous month. The total scores of all

items are computed to generate seven component scores with subscale scores of 0 to 3 for the seven components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. The sum of responses of all seven components yields a global score of sleep quality. A subject with a global PSQI score greater than 5 is considered to be a poor sleeper, and a subject with a value of ≤ 5 is considered to be a good sleeper (Buysse et al., 1989).

In addition to the self-reported measures, male subjects also provided biologic and physiologic data. Subjects were seated for at least 5 min in a private room before blood pressure was measured with a standard commercial sphygmomanometer (Accoson, UK). Subject height and weight were recorded, and the waist circumference was obtained by measuring at the narrowest point between the lower costal (tenth rib) and the iliac crest. BMI was calculated as weight (kg) divided by height squared (m^2). Venous fasting blood samples were collected in plain tubes and centrifuged at 3,000 rpm for 10 min at room temperature, and serum samples were frozen at −20°C until assayed. Fasting blood glucose (FBG) and blood lipid profile (total cholesterol, high-density lipoprotein, triglycerides, and low-density lipoprotein) were determined (Accent 200 automated chemistry analyzer, Poland) using an enzymatic method kit. High-sensitivity CRP was determined (Automated Roche Diagnostics modular analyzer, Roche, Switzerland) using a particle-enhanced immunoturbidimetry method with a measuring range of 0.085–1,600 mg/L.

Subjects also provided self-sampling of saliva for cortisol assessment. Cortisol assessment through saliva sampling has the advantage of easy and noninvasive sample collection in ambulatory settings. Subjects were given clear written instructions with graphic illustrations in addition to verbal instructions. Instructions provided the method of saliva collection, with emphasis on the importance of timing of saliva collection, and all necessary precautions associated with the collection. Samples were collected using cotton dental rolls that were chewed by subjects for 1 min. Cotton rolls were then stored in Salivette tubes (Sarstedt Pty Ltd., Australia). Participants were instructed to give three saliva samples in a working day. The first sample was collected immediately after early morning awakening, while they were in bed (sitting up). Subsequent samples were taken at 10 and 20 min after awakening, but before brushing their teeth, eating, drinking, smoking, doing physical activity, having a shower, or exposing their eyes to direct room artificial light or sunlight (Clow, Thorn, Evans, & Hucklebridge, 2004). Participants were asked to time their saliva collection accurately and write the time of awakening and the time of collection of each sample. Salivette tubes were bagged and stored in their home freezer until they came for their morning blood collection appointment.

Saliva samples were centrifuged for 15 min at 3,000 rpm, and salivary cortisol was measured immediately once the laboratory received the samples. Salivary cortisol levels were measured on an automated immunoassay analyzer (Elecsys, Roche, Germany).

The area under the curve (AUC) was calculated using the measurements of cortisol concentration over the three time points of 0, 10, and 20 min (Pruessner, Hellhammer, Pruessner, & Lupien, 2003). The AUC for cortisol level after awakening was used as the index of HPA axis activity (Clow et al., 2004; Pruessner et al., 1997; Steptoe, Cropley, Griffith, & Kirschbaum, 2000). This index shows a high degree of intraindividual stability when measured over several days or weeks (Pruessner et al., 1997).

For cortisol analysis, there were 204 subjects, 60 were excluded due to insufficient or missing cortisol samples, or missing data for one or more of the main parameters. CRP analysis was performed for 225 subjects of the study sample. Subjects with CRP levels of 10 mg/L or more were excluded ($n = 25$) from further analysis because they are likely to be related to acute infections or other acute inflammatory conditions (Ford et al., 2003; Jialal, Devaraj, & Venugopal, 2004). Participants ($n = 54$) with missing data for one or more of the study's main parameters were excluded. Thus, data from 146 subjects were used in the final analysis.

MtS was defined according to the International Diabetes Federation (IDF, 2005) criteria of central obesity (waist circumference of ≥ 94 cm for men), plus any two of the following four factors: triglyceride (TG) level of ≥ 150 mg/dL, HDL cholesterol of < 40 mg/dL, blood pressure (systolic blood pressure [SBP] level of ≥ 130 or diastolic blood pressure [DBP] level of ≥ 85 mm Hg), or fasting plasma glucose of ≥ 100 mg/dL.

Statistical Analyses

Baseline characteristics were compared across stress groups (ERI ≥ 1 and ERI < 1), and two-tailed p values were calculated using independent sample t tests. We compared the MtS across work stress and saliva cortisol (AUC) tertiles or CRP tertiles using chi-square and Fisher's exact tests. The distributions of CRP, physical activity score, and triglycerides were skewed and were therefore log-transformed before analysis.

The independent associations of ERI ratio, cortisol (AUC), and CRP with MtS were calculated, adjusting for potential confounders: age (Hildrum, Mykletun, Hole, Midthjell, & Dahl, 2007; Wener, Daum, & McQuillan, 2000), smoking (Kasapis & Thompson, 2005; McDade, Hawkley, & Cacioppo, 2006; Oh et al., 2005), physical activity (Lakka & Laaksonen, 2007), perceived stress (Yoo, Eisenmann, & Franke, 2009), sleep (Jennings, Muldoon, Hall, Buysse, & Manuck, 2007; Okun, Coussons-Read, & Hall, 2009), awakening time (Clow et al., 2004), work type (Sanchez-Chaparro et al., 2008), and work overcommitment (Steptoe, Siegrist, Kirschbaum, Marmot, 2004). Independent variables including the ERI ratio, cortisol (AUC), CRP, awakening time, age, type of work, physical activity, and overcommitment scores that were at 25% level of significance during univariate logistic regression were carried forward to multivariable binary logistic regression for adjustment (Hosmer & Lemeshow, 2000). PSS score, PSQI, smoking status, and education level with a significance level $> 25\%$ were excluded from further analysis. We used multivariable binary logistic regression analysis to adjust for the confounding factors. In addition, we included an interaction term in the multivariable logistic regression model to assess the possible interaction between the ERI ratio and cortisol or CRP. We also conducted separate analyses for the stress groups and for central obesity groups. Multivariable linear regression analysis was also carried out to evaluate the association between ERI ratio and cortisol (AUC), as well as between ERI ratio and CRP with each of the five components of MtS. For linear regression analysis, each component, as dependent variable, was taken on a continuous scale. A two-tailed p value of $\leq 5\%$ was considered significant during multivariable regression analysis. All statistical analyses were performed in SPSS (version 19, IBM).

Results

Participant Characteristics

The majority of Jordanian workers who participated in this study (74%) were aged 26–45 years. In terms of type of work, 74% were

engaged in manual work, 88% worked for private companies, and 99% were full-time workers. Table 1 displays the means and standard deviations for all of the study variables.

Using the World Health Organization's definition of obesity (BMI ≥ 30 < 40 kg/m^2) (WHO, 2004), 25% of the sample was classified as obese. Based on the International Diabetes Federation criteria of MtS (IDF, 2005), 54% of the sample had a waist circumference of ≥ 94 cm, 42% had high triglycerides (≥ 150 mg/dL), 25% had high glucose levels (≥ 100 mg/dL), 48% had low HDL cholesterol levels (< 40 mg/dL), and 18% had high blood pressure. Therefore, 32% fit the criteria of having MtS. A large proportion of the sample (62%) was not very physically activity (< 600 MET-min/week), 54% were active smokers, but none reported consuming alcohol. We found that 51% were poor sleepers (PSQI > 5). High work-related stress, based on an ERI ratio ≥ 1, was prevalent in 65% of the subjects.

Comparison of the Stressed and Nonstressed Groups

Table 1 shows the comparison of stressed (ERI ratio ≥ 1) and nonstressed subjects (ERI ratio < 1). We found that stressed subjects had significantly higher waist circumference, BMI, systolic blood pressure, cortisol levels at 10 min, cortisol levels at 20 min, and cortisol (AUC). In addition, the stressed group had significantly more cases of MtS ($n = 51$) than the nonstressed subjects ($n = 14$, $p < .05$).

ERI and MtS

ERI and MtS through the cortisol pathway. Multiple regression analysis (Table 2) shows that the ERI ratio was significantly associated with MtS, even after adjusting for age, type of work, physical activity, awakening time, and work overcommitment. However, adding cortisol expressed in AUC to the model considerably attenuated the association between the ERI ratio and MtS. In addition, the interaction between cortisol (AUC) and ERI was significantly associated with MtS.

The prevalence of MtS differed significantly across work-stressed (ERI) groups and saliva cortisol (AUC) tertiles ($p \leq .001$; Figure 2). The majority of MtS cases was present in the highest cortisol (AUC) tertile and stressed group. After adjustment for age, type of work, physical activity, awakening time, and work overcommitment, the highest cortisol (AUC) tertile significantly predicted MtS ($OR = 11.50$, 95% CI: 2.16–59.14) in subjects who had high stress. In contrast, there was no association between cortisol (AUC) and MtS in the nonstressed group. Stressed subjects with either middle or low cortisol (AUC) tertile did not differ from the nonstressed subjects for all tertiles of cortisol (AUC) (Figure 2).

ERI and MtS through inflammatory pathway. Overall, the mean CRP ($n = 146$) was 2.04 ± 0.82. There was a significant difference between the mean values of CRP for the stressed group (2.14 ± 0.8, $n = 98$) compared to the nonstressed group (1.85 ± 0.82, $n = 48$; $p \leq .05$). A significant difference in mean CRP was also observed between the MtS group (2.47 ± 0.67, $n = 43$) and the group without MtS (1.87 ± 0.82, $n = 103$; $p \leq .001$).

Table 3 shows the regression analysis of ERI adjusted for CRP. The ERI ratio after adjustment for other factors remained significantly associated with MtS. In addition, CRP was significantly associated with MtS. However, further adjusting by entering CRP into the model resulted in the association between ERI ratio and MtS being attenuated. The interaction between ERI ratio and CRP levels in predicting the chance of MtS was significant.

Accordingly, we stratified our logistic regression analyses to compare the stressed and nonstressed group. For the stressed group, the adjusted CRP remained associated with MtS, but there was no association in the nonstressed group (Table 3). Fisher's

Table 1. *Psychological, Physical, Physiological, and Biochemical Characteristics of Jordanian Male Workers* (n = *204) Comparison Between Stressed and Nonstressed Group*

	$n = 204$ Mean (*SD*)	Stressed ($n = 132$) Mean (*SD*)	Nonstressed ($n = 72$) Mean (*SD*)	p*
Age (year)	35.3 (8.8)	35.6 (9.1)	34.7 (8.1)	*ns*
Waist (cm)	94.1 (12.6)	96.2 (12.3)	90.3 (12.1)	≤ .001
BMI (kg.m^{-2})	26.9 (3.7)	27.4 (3.6)	26.0 (3.6)	< .05
Perceived stress	25.6 (6.9)	25.3 (6.7)	26.1 (7.2)	*ns*
Overcommitment	14.3 (3.9)	14.1 (3.7)	14.7 (4.1)	*ns*
Physical activity (MET-min/week)	1,210 (1,948)	1,138 (1,946)	1,341 (1,958)	*ns*
Total sleep quality	5.4 (3.1)	5.3 (2.9)	5.7 (3.3)	*ns*
Fasting blood glucose(mg/dL)	91.1 (12.2)	91.9 (12.4)	89.6 (11.3)	*ns*
Low-density lipoprotein (mg/dL)	111.2 (31.6)	111.9 (33.3)	109.9 (28.3)	*ns*
Total cholesterol (mg/dL)	187.1 (36.6)	188.3 (39.9)	184.8 (29.6)	*ns*
High-density lipoprotein (mg/dL)	42.1 (8.7)	42.2 (8.7)	41.9 (8.8)	*ns*
Triglycerides (mg/dL)	155.3 (85.4)	155.9 (84.9)	154.3 (86.9)	*ns*
Systolic blood pressure (mmHg)	122 (9)	120 (8)	123 (9)	< .05
Diastolic blood pressure (mmHg)	80 (6)	81 (8)	81 (5)	*ns*
Saliva cortisol 0 time (nmol/L)	11.3 (5.2)	11.8 (5.6)	10.4 (4.3)	*ns*
Saliva cortisol 10 time (nmol/L)	14.7 (6.6)	15.5 (7.1)	13.2 (5.3)	< .05
Saliva cortisol 20 time (nmol/L)	18.2 (7.9)	19.1 (8.5)	16.6 (6.4)	< .05
(Δ cortisol) (20 min–0 min) (nmol/L)	6.9 (4.9)	7.3 (5.1)	6.2 (4.1)	*ns*
Cortisol° (nmol/L)	305.9 (139.4)	326.9 (153.3)	267.3 (99.2)	< .05

Note. ns = not significant.
*Two-tailed p value based on independent sample t test.
°Cortisol calculated from area under the curve (AUC).

Table 2. *Association Between Work Stress, Cortisol, and Metabolic Syndrome (*n = *192)*

	Unadjusted *OR* (95% CI)	Adjusted+ *OR* (95% CI)	Adjusted++ *OR* (95% CI)
Effort-reward ratio[a]	4.78* (2.31–9.88)	4.74* (2.13–10.55)	2.80** (1.15–6.78)
Cortisol°	3.03* (2.08–4.40)	2.86* (1.92–4.25)	
Effort-reward ratio and cortisol interaction	1.84* (1.50–2.26)	1.83* (1.47–2.28)	
Stressed group ($n = 126$)			
Cortisol°	3.96* (2.39–6.56)	3.90* (2.23–6.81)	
Effort-reward ratio and cortisol interaction	2.12* (1.60–2.81)	2.14* (1.53–2.98)	
Nonstressed group ($n = 66$)			
Cortisol	1.23 *ns* (0.68–2.20)	1.15 *ns* (0.52–2.55)	
Effort-reward ratio and cortisol interaction	1.32 *ns* (0.75–2.32)	1.15 *ns* (0.55–2.39)	

Note. ns = not significant.
[a]per one unit increase in the effort reward ratio (0.1). °per *SD* increase in the area under the curve (AUC) of three timed cortisol measurements.
+Adjusted for age, type of work, physical activity, awakening time, and work overcommitment. ++Adjusted for age, type of work, physical activity, awakening time, work overcommitment, and cortisol expressed in AUC.
*$p \leq .001$. **$p < .05$.

exact test showed that MtS was most prevalent among stressed subjects in the highest CRP tertile (Figure 3; $p \leq .001$).

ERI and MtS Components

ERI and MtS components through the cortisol pathway. Table 4 shows that the ERI ratio was associated with the MtS components of waist circumference and SBP after adjusting for age, type of work, physical activity, awakening time, and work overcommitment. The adjusted cortisol level AUC showed a significant positive association with waist circumference, SBP, and FBG, and a negative association with HDL. Moreover, there was a significant interaction between ERI ratio and cortisol AUC level in predicting the level of waist circumference, SBP, FBG, and HDL.

High cortisol AUC level was significantly associated with large waist circumference, high triglyceride level, low HDL level, high SBP, and high DBP only in the stressed group (Table 4). In contrast, in the nonstressed group, cortisol (AUC) was not associated with any of the MtS components (Table 4).

ERI and MtS components through the inflammatory pathway. Table 4 shows that CRP was associated with waist circumference and triglycerides. There was a significant interaction between ERI ratio and CRP levels in predicting the levels of waist circumference, triglycerides, and SBP.

In the stressed group, the CRP levels were higher than in the nonstressed group. Within the stressed group, CRP was significantly associated with waist circumference (Table 4). In the nonstressed group, CRP was only associated with triglyceride level.

In a separate analysis, the binary regression was repeated only among subjects with upper tertile waist circumference of ≥ 98.5 cm ($n = 49$). The data showed that, after adjustment, CRP was significantly associated with MtS ($OR = 4.26$, 95% CI: 1.40–13.05; $p < .05$), but was no longer significantly associated

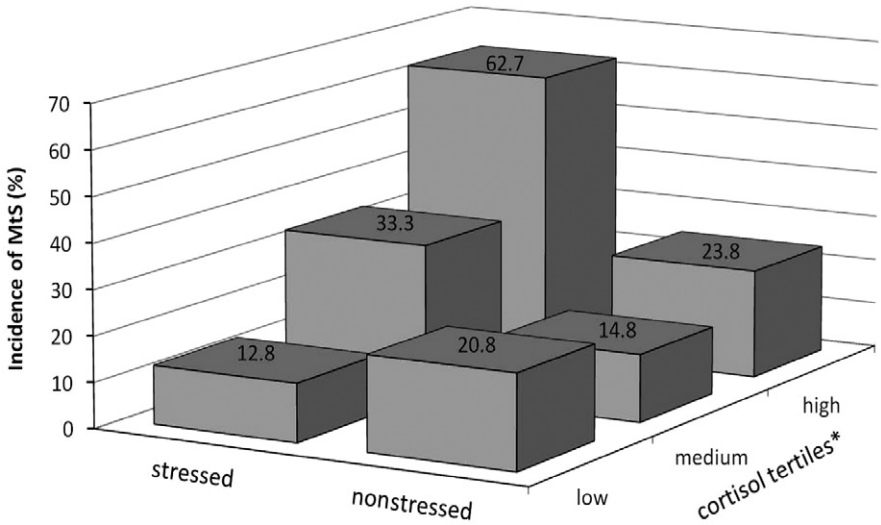

Figure 2. Incidence of MtS across work stress status and tertiles of cortisol. *Cortisol calculated from area under the curve (AUC). Low cortisol tertile < 230.5 nmol/L, middle tertile ≥ 230.5 < 340 nmol/L, high tertile ≥ 340 nmol/L.

Table 3. *Association Between Work Stress, C-Reactive Protein, and Metabolic Syndrome (*n = *146)*

	Unadjusted *OR* (95% CI)	Adjusted+ *OR* (95% CI)	Adjusted++ *OR* (95% CI)
Effort-reward ratio[a]	2.65** (1.13–6.25)	3.35** (1.32–8.53)	2.36 *ns* (0.89–6.24)
C-reactive protein[1]	2.49 * (1.55–4.01)	2.51* (1.50–4.20)	
Effort-reward ratio and C-reactive protein interaction	1.80* (1.33–2.42)	1.85* (1.33–2.57)	
Stressed group ($n = 98$)			
C-reactive protein	3.02* (1.67–5.47)	4.14* (1.99–8.62)	
Effort-reward ratio and C-reactive protein interaction	1.80* (1.34–2.42)	2.03* (1.39–2.98)	
Nonstressed group ($n = 48$)			
C-reactive protein	1.28 *ns* (0.53–3.06)	5.62 *ns* (0.67–47.40)	
Effort-reward ratio and C-reactive protein interaction	0.79 *ns* (0.35–1.78)	1.90 *ns* (0.46–7.87)	

Note. *ns* = not significant.
[a]per one unit increase in the effort reward ratio (0.1). [1]per one unit increase in C-reactive protein, Log(1 mg/L).
*$p \leq .001$. **$p < .05$.
+Adjusted for age, type of work, physical activity, awakening time, and work overcommitment. ++Adjusted for age, type of work, physical activity, awakening time, work overcommitment, and Log value of C-reactive protein.

among subjects in the middle tertile waist circumference, 88.0 cm to 98.5cm group ($n = 45$). The middle waist circumference tertile but not the lower tertile (waist circumference of < 88cm, $n = 52$) was used as the reference group, since none of the subjects on the lower tertile group had MtS.

ERI, MtS, and Inflammation with Central Obesity

Further analysis of subjects with upper tertile waist circumference (≥ 98.5cm) and high stress (ERI ≥ 1, $n = 39$) showed that, after adjustment for other factors, CRP was significantly associated with MtS (*OR* = 5.23, 95% CI: 1.41–19.45, $p < .05$). This association was not significant in the nonstressed group (ERI < 1, $n = 9$).

The interaction between CRP and cortisol (AUC) was a significant predictor of MtS for the stressed group, even after adjustment for other factors ($p \leq .001$), whereas the prediction was not significant for the nonstressed group.

Cortisol Measurement Immediately on Awakening and MtS

Adjustment for cortisol using cortisol measured at awakening (time = 0) attenuated the association between ERI and MtS (*OR* = 3.70, 95% CI: 1.60–8.60, $p < .05$). Even after adjustment for the confounders, the cortisol at time = 0 remained significantly associated with MtS (*OR* = 1.93, 95% CI: 1.35–2.76, $p \leq .001$). In addition, the interaction between ERI ratio and cortisol time = 0 was significantly associated with MtS (*OR* = 1.68, 95% CI: 1.35–2.10, $p \leq .001$). Among the stressed group, the adjusted cortisol at time = 0 and the interaction between cortisol at time = 0 and ERI was significantly associated with MtS (*OR* = 2.39, 95% CI: 1.47–3.90, $p \leq .001$; *OR* = 1.89,

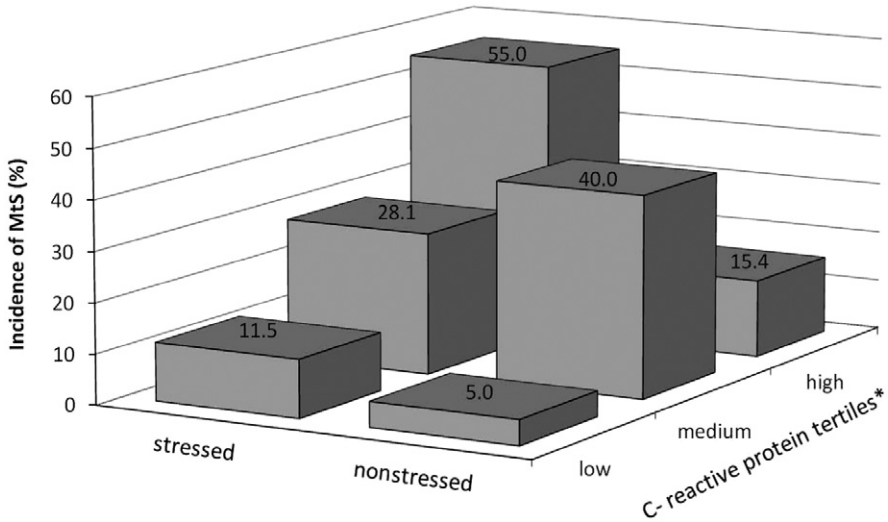

Figure 3. Incidence of MtS across work stress status and tertiles of CRP. *Low C-reactive protein tertile < 1.44 mg/L, middle tertile ≥ 1.44 < 3.50 mg/L, high tertile ≥ 3.50 mg/L.

Table 4. *Associations Between Work Stress, Cortisol, C-Reactive Protein, and Components of Metabolic Syndrome, Adjusted for Age, Type of Work, Physical Activity, Wakening Time, and Work Overcommitment*

	Waist circumference		Triglycerides		HDL		SBP		DBP		FBG	
	ß	*t*	ß	*t*	ß	*t*	ß	*t*	ß	*t*	ß	*t*
Effort-reward ratio[a]	.22*	3.61	.02 *ns*	0.28	–.01 *ns*	0.01	.18**	0.24	.02 *ns*	0.24	.12 tr	1.79
Cortisol°	.17*	2.81	.08 *ns*	1.14	–.20**	–2.67	.26*	3.60	.12 *ns*	1.54	.14**	2.10
C-reactive protein[1]	.31*	4.22	.23**	2.66	–.16 tr	–1.84	.11 *ns*	1.26	.05 *ns*	0.54	.11 *ns*	1.30
Effort-reward ratio and cortisol interaction	.25*	4.00	.11 *ns*	1.45	–.15**	–2.00	.28*	3.87	.11 *ns*	1.43	.17**	2.46
Effort-reward ratio and C-reactive protein interaction	.32*	4.33	.18**	2.07	–.12 *ns*	–1.39	.19**	2.18	.54 ns	0.61	.13 *ns*	1.56
Stressed group												
Cortisol	.17**	2.18	.18**	2.06	–.25*	–2.70	.28**	3.14	.24**	2.75	.15 tr	1.87
Effort-reward ratio and cortisol interaction	.23**	2.86	.19**	2.09	–.20**	–2.19	.25**	2.70	.23**	2.46	.19**	2.28
C-reactive protein	.38*	4.20	.20 tr	1.91	–.20 tr	–1.96	.13 *ns*	1.23	.16 *ns*	1.58	.06 *ns*	0.67
Effort-reward ratio interaction C-reactive protein	.34*	3.97	.16 *ns*	1.58	–.19 tr	–2.37	.09 *ns*	0.90	.16 *ns*	1.55	.14 tr	1.76
Nonstressed group												
Cortisol	.14 *ns*	1.33	–.18 *ns*	–1.41	–.16 *ns*	–1.22	.07*ns*	0.52	–.08 *ns*	0.57	.04 *ns*	0.31
Effort-reward ratio and interaction cortisol	.19 tr	1.90	–.13 *ns*	–1.05	–.22 *ns*	–1.71	.06 *ns*	0.47	–.12 *ns*	0.39	–.01 *ns*	–0.10
C-reactive protein	.15 *ns*	1.07	.48**	2.88	.24 *ns*	1.31	.09 *ns*	0.51	.15 *ns*	0.79	.23 *ns*	1.22
Effort-reward ratio and interaction C-reactive protein	.12 *ns*	0 .96	.41**	2.97	–.31**	–2.03	–.01 *ns*	–0.04	–.21 *ns*	–1.27	.19 *ns*	1.16

Note. ß = standardized coefficients; *t* = *t* value; tr = trend ($p > .05 \leq .08$); *ns* = not significant.
[a]per one unit increase in the effort reward ratio (0.1). °per *SD* increase in the area under the curve (AUC) of three timed cortisol measurements. [1]per one unit increase in C-reactive protein, Log(1 mg/L).
*$p \leq .001$. **$p < .05$.

95% CI: 1.37–2.61, $p \leq .001$, respectively). In contrast, there was no association between cortisol at time = 0 or the interaction between cortisol at time = 0 and ERI with MtS in the nonstressed group.

Change in Cortisol Level and MtS

When change in cortisol level (Δ cortisol) (expressed as cortisol level at 20 min—cortisol level at time = 0) was used in the regression analysis instead of the cortisol (AUC), the association between the ERI ratio and MtS was attenuated (*OR* = 3.26, 95% CI: 1.41–7.50, $p < .05$). Change in cortisol was significantly associated with MtS (*OR* = 2.00, 95% CI: 1.37–2.93, $p \leq .001$). Further, there was a significant interaction between ERI ratio and change in cortisol and of MtS (*OR* = 1.69, 95% CI: 1.33–2.14, $p \leq .001$). Among the stressed group, we found a significant association between change in cortisol level and MtS (*OR* = 2.49, 95% CI: 1.48–4.17, $p \leq .001$). In addition, the interaction between change in cortisol and ERI was significantly associated with MtS (*OR* = 1.67, 95% CI: 1.26–2.22, $p \leq .001$). In contrast, no such associations were found in the nonstressed group.

Discussion

Despite overall good health, a high proportion of Jordanian workers in this study had large waist circumference, undertook little physical activity, and were active smokers. When stratified by ERI ratio, there were clear differences in waist circumference, BMI, SBP, cortisol at awakening, and CRP. In accordance with the stress model, the HPA axis and the SMA axis become activated, resulting in effects on cortisol and CRP, which are central to the development of MtS. In this study, we established a relationship between work-related stress, cortisol, and CRP in predicting MtS.

First, we showed that a high level of work-related stress (ERI ratio ≥ 1) was significantly associated with a large waist circumference, high DBP, and, to some extent, with high FBG level, as well as with a greater number of cases of MtS. These results are consistent with studies examining the relationship between chronic stress and MtS (Chandola, Brunner, & Marmot, 2006; Raikkonen, Matthews, & Kuller, 2007). In contrast, nonstressed subjects (ERI ratio < 1) showed no association with the MtS or any of its components.

To our knowledge, this is the first study addressing this link through two pathways, the HPA and SMA pathways, through their effects on the endocrine system (cortisol) and inflammatory markers (CRP). Rosmond (2005) has hypothesized that stress-related high cortisol secretion is strongly associated with MtS. Few studies have investigated cortisol levels at awakening and ERI association, and some showed positive associations (Eller et al., 2012). However, other studies have shown inconsistent findings for cortisol levels on awakening that were associated with ERI (Bellingrath, Weigl, & Kudielka, 2008; Steptoe et al., 2004). These inconsistent findings may be due to improper saliva cortisol collection, such as noncompliance with saliva sampling procedures or incorrect timing of sample collection. It can be difficult to guarantee true cortisol levels collected in ambulatory settings (Kudielka, Broderick, & Kirschbaum, 2003). Exposure to light following morning awakening may also affect the morning cortisol levels (Clow et al., 2004). In this study, the cortisol samples were collected with care, but while all precautions were taken, subjects' compliance could not be guaranteed. Although the awakening response of cortisol measured by AUC shows a high degree of intraindividual stability when measured over several days or weeks (Pruessner et al., 1997), this stability has not been tested in the current study, where only one set of samples was taken for the AUC analysis.

We further demonstrated the possible role of saliva cortisol and CRP in the development of MtS. Adjusting for saliva cortisol or CRP attenuated the association between stress and MtS. CRP elevation may also be a result of activation of the stress system (HPA and SMA) (Bruce, Rodman, & Newman, 2007; Rippe, 2012). Although hypercortisolemia-related stress appears to be a specific risk factor for MtS, the association for high CRP-related stress was only found in those with central obesity, consistent with many other studies (Hak et al., 1999; Lemieux et al., 2001; Saijo et al., 2004). A mechanism that explains the elevated CRP levels is that adipose tissues secrete proinflammatory cytokines (Kern et al., 2001), which in turn induce the synthesis and secretion of CRP by the liver (Papanicolaou, Wilder, Manolagas, & Chrousos, 1998). A synergistic effect of central obesity and work stress, acting together to intensify CRP production, is highly plausible (Dixon et al., 2008; Laaksonen et al., 2004; Visser, Bouter, McQuillan, Wener, & Harris, 1999). Indeed, weight loss was not only associated with a decrease in CRP level (Selvin, Paynter, & Erlinger, 2007), but also a reduction in psychological stress (Bruce et al., 2007; Rippe, 2012). This attenuates HPA and SMA activation, and in turn reduces cytokines and CRP production. In addition, visceral fat loss may lead to a decreased number of glucocorticoid receptors within visceral areas. Eventually, decreases in cortisol activity may lead to less abdominal fat deposition.

There are additional limitations to our study, such as the relatively small sample size, particularly the small number of centrally obese subjects, which limits the statistical power of this study. The strength of this study is the application of strict subject inclusion/exclusion criteria that excluded all medical conditions that may elevate cortisol or CRP level. The ERI questionnaire is a commonly used scale that is designed to measure work stress, which has been linked to poor health outcomes. Thus, persons with psychiatric diagnoses of work-related stress would be expected to show a stronger positive association with MtS. In addition, this study indicated that Jordanian workers reported a generally high level of work stress when assessed on the ERI questionnaire compared to other cohorts from European countries (Siegrist et al., 2004). This higher level of stress suggests Jordanian workers had higher perceived work effort and higher job demand, but job satisfaction was lower than workers in the samples from other nations. Additional research is recommended to explore the work-stress relationship (high ERI ratio) and its long-term health impact on workers in Jordan.

In conclusion, our results suggest that work-related stress, and its resulting hypercortisolemia and augmented CRP, synergistically contribute to the development of MtS in middle-aged Jordanian workers. High work-related stress in the presence of central obesity predisposes Jordanian workers to increased risk of MtS, potentially working through inflammatory pathways. These measures could also lead to an increased risk for developing cardiovascular disease or diabetes. These findings have important health implications for stress at work. Further research involving prospective studies should confirm our findings and investigate the causality and direction of the relationships among ERI, cortisol, inflammation (CRP), central obesity, and MtS.

References

Al-Hazza, M. H. (2006). The Arabic International Physical Activity Questionnaire (IPAQ). Retrieved from https://sites.google.com/site/theipaq/questionnaires

Almadi, T., Cathers, I., & Chow, C. M. (2012a). An Arabic version of the Effort Reward scale: Translation and validation study. Manuscript submitted for publication.

Almadi, T., Cathers, I., & Chow, C. M. (2012b). An Arabic version of the Pittsburgh Sleep Quality Index: Translation and validation study. Manuscript submitted for publication.

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012a). An Arabic version of the perceived stress scale: Translation and validation study. *International Journal of Nursing Studies*, *49*, 84–89. doi: 10.1016/j.ijnurstu.2011.07.012

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012b). The association between work stress and inflammatory biomarkers in Jordanian male workers. *Psychophysiology*, *49*, 172–177. doi: 10.1111/j.1469-8986.2011.01296.x

Amatruda, J. M., Livingston, J. N., & Lockwood, D. H. (1985). Cellular mechanisms in selected states of insulin resistance: Human obesity, glucocorticoid excess, and chronic renal failure. *Diabetes Metabolism Reviews*, *1*, 293–317.

Bellingrath, S., Weigl, T., & Kudielka, B. M. (2008). Cortisol dysregulation in school teachers in relation to burnout, vital exhaustion, and effort-reward-imbalance. *Biological Psychology*, *78*, 104–113. doi: 10.1016/j.biopsycho.2008.01.006

Bellingrath, S., Weigl, T., & Kudielka, B. M. (2009). Chronic work stress and exhaustion is associated with higher allostastic load in female school teachers. *Stress*, *12*, 37–48. doi: 10.1080/10253890802042041

Bjorntorp, P., & Rosmond, R. (2000). Obesity and cortisol. *Nutrition*, *16*, 924–936. doi: 10.1016/S0899-9007(00)00422-6

Black, P. H. (2002). Stress and the inflammatory response: A review of neurogenic inflammation. *Brain, Behavior, and Immunity*, *16*, 622–653. doi: 10.1016/S0889-1591(02)00021-1

Black, P. H. (2003). The inflammatory response is an integral part of the stress response: Implications for atherosclerosis, insulin resistance, type II diabetes and metabolic syndrome X. *Brain, Behavior, and Immunity*, *17*, 350–364. doi: 10.1016/S0889-1591(03)00048-5

Bruce, B. E., Rodman, J., & Newman, J. (2007). Weight loss treatment and psychological well-being: A review and meta-analysis. *Journal of Health Psycholology*, *12*, 66–82. doi: 10.1177/1359105307071741

Buysse, D. J., Reynolds, C. F., III, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*, 193–213. doi: 10.1016/0165-1781(89)90047-4

Chandola, T., Brunner, E., & Marmot, M. (2006). Chronic stress at work and the metabolic syndrome: Prospective study. *British Medical Journal*, *332*, 521–525. doi: 10.1136/bmj.38693.435301.80

Clow, A., Thorn, L., Evans, P., & Hucklebridge, F. (2004). The awakening cortisol response: Methodological issues and significance. *Stress*, *7*, 29–37. doi: 10.1080/10253890410001667205 35V1GGLHNGU4AVL4

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., . . . Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports Exercise*, *35*, 1381–1395. doi: 10.1249/01.MSS.0000078924.61453.FB

Dixon, J. B., Hayden, M. J., Lambert, G. W., Dawood, T., Anderson, M. L., Dixon, M. E., & O'Brien, P. E. (2008). Raised CRP levels in obese patients: Symptoms of depression have an independent positive association. *Obesity*, *16*, 2010–2015. doi: 10.1038/oby.2008.271

Elgharib, N., Chi, D., Younis, W., Wehbe, S., & Krishnaswamy, G. (2003). C-reactive protein as a novel biomarker reactant can flag atherosclerosis and help predict cardiac events. *Postgraduate Medicine*, *114*, 39–44.

Eller, N. H., Nielsen, S. F., Blond, M., Nielsen, M. L., Hansen, A. M., & Netterstrom, B. (2012). Effort reward imbalance, and salivary cortisol in the morning. *Biological Psychology*, *89*, 342–348. doi: 10.1016/j.biopsycho.2011.11.007

Fan, L. B., Li, J., Wang, X. P., Shang, L., Gu, H. K., Zhang, H., . . . Mu, Y. Z. (2009). Association between job stress and blood lipids among

university staff in Yunnan province. *Zhonghua Xin Xue Guan Bing Za Zhi*, *37*, 454–457.

Ford, E., Giles, W., Myers, G., Rifai, N., Ridker, P. M., & Mannino. D. M. (2003). C-reactive protein concentration distribution among US children and young adults: Finding from the National Health and Nutrition Examination Survey, 1999–2000, *Clinical Chemistry*, *49*, 1353–1357.

Gabay, C., & Kushner, I. (1999). Acute-phase proteins and other systemic responses to inflammation. *New England Journal of Medicine*, *340*, 448–454.

Griep, R. H., Rotenberg, L., Vasconcellos, A. G., Landsbergis, P., Comaru, C. M., & Alves, M. G. (2009). The psychometric properties of demand-control and effort–reward imbalance scales among Brazilian nurses. *International Archives of Occupational and Environmental Health*, *82*, 1163–1172. doi: 10.1007/s00420-009-0460-3

Hak, A. E., Stehouwer, C. D., Bots, M. L., Polderman, K. H., Schalkwijk, C. G., Westendorp, I. C., . . . Witteman, J. C. (1999). Associations of C-reactive protein with measures of obesity, insulin resistance, and subclinical atherosclerosis in healthy, middle-aged women. *Arteriosclerosis, Thrombosis and Vascular Biology*, *19*, 1986–1991.

Hildrum, B., Mykletun, A., Hole, T., Midthjell, K., & Dahl, A. A. (2007). Age-specific prevalence of the metabolic syndrome defined by the International Diabetes Federation and the National Cholesterol Education Program: The Norwegian HUNT 2 study. *BioMed Central Public Health*, *7*, 220. doi: 10.1186/1471-2458-7-220

Hosmer, D., & Lemeshow, S. (2000). *Applied logistic regression* (2nd ed.). New York, NY: John Wiley and Sons.

Hotamisligil, G. S., Peraldi, P., Budavari, A., Ellis, R., White, M. F., & Spiegelman B. M. (1996). IRS-1-mediated inhibition of insulin receptor tyrosine kinase activity in TNF-alpha- and obesity-induced insulin resistance. *Science*, *271*, 665–668.

International Diabetes Federation (IDF). (2005). The International Diabetes Federation consensus worldwide definition of the metabolic syndrome. Retrieved from http://www.idf.org/metabolic-syndrome

Jennings, J. R., Muldoon, M. F., Hall, M., Buysse, D. J., & Manuck, S. B. (2007). Self-reported sleep quality is associated with the metabolic syndrome. *Sleep*, *30*, 219–223.

Jialal, I., Devaraj, S., & Venugopal, S. K. (2004). C-reactive protein: Risk marker or mediator in atherothrombosis? *Hypertension*, *44*, 6–11. doi: 10.1161/01.HYP.0000130484.20501.df

Kasapis, C., & Thompson, P. D. (2005). The effects of physical activity on serum C-reactive protein and inflammatory markers: A systematic review. *Journal of American College of Cardiology*, *45*, 1563–1569. doi: 10.1016/j.jacc.2004.12.077

Karasek, R. A. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative Science Quarterly*, *24*, 285–308.

Karasek, R. A., & Theorell, T. (1990). *Healthy work: Stress, productivity, and the reconstruction of working life*. New York, NY. Basic Books.

Kern, P. A., Ranganathan, S., Li, C., Wood, L., & Ranganathan, G. (2001). Adipose tissue tumor necrosis factor and interleukin-6 expression in human obesity and insulin resistance. *American Journal of Physiology, Endocrinology, and Metabolism*, *280*, E745–E751.

Kivimaki, M., Leino-Arjas, P., Luukkonen, R., Riihimaki, H., Vahtera, J., & Kirjonen, J. (2002). Work stress and risk of cardiovascular mortality: Prospective cohort study of industrial employees. *British Medical Journal*, *325*, 857–861. doi: 10.1136/bmj.325.7369.857

Kudielka, B. M., Broderick, J. E., & Kirschbaum, C. (2003). Compliance with saliva sampling protocols: Electronic monitoring reveals invalid cortisol daytime profiles in noncompliant subjects. *Psychosomatic Medicine*, *65*, 313–319.

Kumari, M., Head, J., & Marmot, M. (2004). Prospective study of social and other risk factors for incidence of type 2 diabetes in the Whitehall II study. *Archives of Internal Medicine*, *164*, 1873–1880. doi: 10.1001/archinte.164.17.1873.

Laaksonen, D. E., Niskanen, L., Nyyssonen, K., Punnonen, K., Tuomainen, T. P., Valkonen, V. P., . . . Salonen, J. T. (2004). C-reactive protein and the development of the metabolic syndrome and diabetes in middle-aged men. *Diabetologia*, *47*, 1403–1410. doi: 10.1007/s00125-004-1472-x

Lakka, T., & Laaksonen, D. (2007). Physical activity in prevention and treatment of the metabolic syndrome. *Applied Physiology, Nutrition, and Metabolism*, *32*, 76–88.

Leka, S., & Jain, A. (2010). *Health impact of psychosocial hazards at work: An overview*. Retrieved from World Health Organization http://whqlibdoc.who.int/publications/2010/9789241500272_eng.pdf

Lemieux, I., Pascot, A., Prud'homme, D., Almeras, N., Bogaty, P., Nadeau, A., . . . Despres, J. P. (2001). Elevated C-reactive protein: Another component of the atherothrombotic profile of abdominal obesity. *Arteriosclerosis, Thrombosis and Vascular Biology*, *21*, 961–967.

Liu, H., Bravata, D. M., Cabaccan, J., Raff, H., & Ryzen, E. (2005). Elevated late-night salivary cortisol levels in elderly male type 2 diabetic veterans. *Clinical Endocrinology (Oxford)*, *63*, 642–649. doi: 10.1111/j.1365-2265.2005.02395.x

Lutgendorf, S. K., Garand, L., Buckwalter, K. C., Reimer, T. T., Hong, S. Y., & Lubaroff, D. M. (1999). Life stress, mood disturbance, and elevated interleukin-6 in healthy older women. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *54*, M434–M439.

McDade, T. W., Hawkley, L. C., & Cacioppo, J. T. (2006). Psychosocial and behavioral predictors of inflammation in middle-aged and older adults: The Chicago Health, Aging, and Social Relations study. *Psychosomatic Medicine*, *68*, 376–381. doi: 10.1097/01.psy.0000221371.43607.64

Oh, S. W., Yoon, Y. S., Lee, E. S., Kim, W. K., Park, C., Lee, S., . . . Yoo, T. (2005). Association between cigarette smoking and metabolic syndrome: The Korea National Health and Nutrition Examination Survey. *Diabetes Care 28*, 2064–2066. doi: 10.2337/diacare.28.8.2064

Okun, M. L., Coussons-Read, M., & Hall, M. (2009). Disturbed sleep is associated with increased C-reactive protein in young women. *Brain, Behavior, and Immunity*, *23*, 351–354. doi: 10.1016/j.bbi.2008.10.008

Papanicolaou, D. A., Wilder, R. L., Manolagas, S. C., & Chrousos, G. P. (1998). The pathophysiologic roles of interleukin-6 in human disease. *Annals of Internal Medicine*, *128*, 127–137.

Perry, C., Sattar, N., & Petrie, J. (2001). Adipose tissue: Passive sumper active pump. *Diabetes and Vascular Disease Research*, *1*, 110–114.

Peter, R., Alfredsson, L., Hammar, N., Siegrist, J., Theorell, T., & Westerholm, P. (1998). High effort, low reward, and cardiovascular risk factors in employed Swedish men and women: Baseline results from the WOLF Study. *Journal of Epidemiology and Community Health*, *52*, 540–547. doi: 10.1136/jech.52.9.540

Pruessner, J. C., Wolf, O. T., Hellhammer, D. H., Buske-Kirschbaum, A., Von Auer, K., Jobst, S., . . . Kirschbaum, C. (1997). Free cortisol levels after awakening: A reliable biological marker for the assessment of adrenocortical activity. *Life Science*, *61*, 2539–2549. doi: 10.1016/S0024-3205(97)01008-4

Pruessner, M., Hellhammer, D. H., Pruessner, J. C., & Lupien, S. J. (2003). Self-reported depressive symptoms and stress levels in healthy young men: Associations with the cortisol response to awakening. *Psychosomatic Medicine*, *65*, 92–99.

Qi, D., & Rodrigues, B. (2007). Glucocorticoids produce whole body insulin resistance with changes in cardiac metabolism. *American Journal of Physiology—Endocrinology and Metabolism*, *292*, E654–E667.

Raikkonen, K., Matthews, K. A., & Kuller, L. H. (2007). Depressive symptoms and stressful life events predict metabolic syndrome among middle-aged women: A comparison of World Health Organization, Adult Treatment Panel III, and International Diabetes Foundation definitions. *Diabetes Care*, *30*, 872–877. doi: 10.2337/dc06-1857

Ridker, P. M., Cushman, M., Stampfer, M. J., Tracy, R. P., & Hennekens, C. H. (1997). Inflammation, aspirin, and the risk of cardiovascular disease in apparently healthy men. *New England Journal of Medicine*, *336*, 973–979.

Ridker, P. M., Rifai, N., Pfeffer, M. A., Sacks, F., & Braunwald, E. (1999). Long-term effects of pravastatin on plasma concentration of C-reactive protein. The Cholesterol and Recurrent Events (CARE) Investigators. *Circulation*, *100*, 230–235.

Rippe, J. (2012). Improved psychological well-being, quality of life, and health practices in moderately overweight women participating in a 12-week structured weight loss program. *Obesity*, *6*, 208–218. doi: 10.1002/j.1550-8528.1998.tb00339.x

Rosmond, R. (2005). Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology*, *30*, 1–10.

Sanchez-Chaparro, M. A., Calvo-Bonacho, E., Gonzalez-Quintela, A., Fernandez- Labandera, C., Cabrera, M., Sainz, J. C., . . . Roman-Garcia, J. (2008). Occupation-related differences in the prevalence of metabolic syndrome. *Diabetes Care*, *31*, 1884–1885. doi: 10.2337/dc08-0431

Salehi, M., Ferenczi, A., & Zumoff, B. (2005). Obesity and cortisol status. *Hormone and Metabolic Research*, *37*, 193–197. doi: 10.1055/s-200s-861374

Saijo, Y., Kiyota, N., Kawasaki, Y., Miyazaki, Y., Kashimura, J., Fukuda, M., & Kishi, R. (2004). Relationship between C-reactive protein and

visceral adipose tissue in healthy Japanese subjects. *Diabetes, Obesity and Metabolism*, *6*, 249–258. doi: 10.1111/j.1462-8902.2003.0342.x

Selvin, E., Paynter, N., & Erlinger, T. (2007). The effect of weight loss on C-reactive protein: A systematic review. *Archived Internal Medicine*. *167*, 31–39. doi: 10.1001/archinte.167.1.31

Shen, B. J., Farrell, K., Penedo, F. J., Schneiderman, N., & Orth-Gomer, K. (2010). Waist circumference moderates the association between marital stress and C-reactive protein in middle-aged healthy women. *The Society of Behavioral Medicine*, *1*, 1–7. doi: 10.1007/s12160-010-9211-7

Siegrist, J. (1996). Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology*, *1*, 27–41.

Siegrist, J., Starke, D., Chandola, T., Godin, I., Marmot, M., Niedhammer, I., & Peter, R. (2004). The measurement of effort–reward imbalance at work: European comparisons. *Social Science & Medicine*, *58*, 1483–1499.

Steptoe, A., Cropley, M., Griffith, J., & Kirschbaum, C. (2000). Job strain and anger expression predict early morning elevations in salivary cortisol. *Psychosomatic Medicine*, *62*, 286–292.

Steptoe, A., Siegrist, J., Kirschbaum, C., & Marmot, M. (2004). Effort reward imbalance, overcommitment, and measures of cortisol and blood pressure over the working day. *Psychosomatic Medicine*, *66*, 323–329.

Sternberg, E. M., Chrousos, G. P., Wilder, R. L., & Gold, P. W. (1992). The stress response and the regulation of inflammatory disease. *Annals of Internal Medicine*, *117*, 854–866.

Tsutsumi, A., & Kawakami, N. (2004). A review of empirical studies on the model of effort-reward imbalance at work: Reducing occupational stress by implementing a new theory. *Social Science and Medicine*, *59*, 2335–2359. doi: 10.1016/j.socscimed.2004.03.030

Van Vegchel, N., De Jonge, J., Bosma, H., & Schaufeli, W. (2005). Reviewing the effort-reward imbalance model: Drawing up the balance of 45 empirical studies. *Social Science & Medicine*, *60*, 1117–1131. doi: 10.1016/j.socscimed.2004.06.043

Visser, M., Bouter, L. M., McQuillan, G. M., Wener, M. H., & Harris, T. B. (1999). Elevated C-reactive protein levels in overweight and obese adults. *Journal of the American Medical Association*, *282*, 2131–2135. doi: 10.1001/jama.282.22.2131

Wener, M. H., Daum, P. R., & McQuillan, G. M. (2000). The influence of age, sex, and race on the upper reference limit of serum C-reactive protein concentration data from the third National Health and Nutrition Examination Survey (NHANES III*). Journal of Rheumatology*, *27*, 2351–2359.

World Health Organization (WHO). (2004). The international classification of adult underweight, overweight and obesity according to BMI. Retrieved from http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

Yoo, H. L., Eisenmann, J. C., & Franke, W. D. (2009). Independent and combined influence of physical activity and perceived stress on the metabolic syndrome in male law enforcement officers. *Journal of Occupational and Environmental Medicine*, *51*, 46–53.

Yudkin, J. S., Stehouwer, C. D., Emeis, J. J., & Coppack, S. W. (1999). C-reactive protein in healthy subjects: Associations with obesity, insulin resistance, and endothelial dysfunction: A potential role for cytokines originating from adipose tissue? *Arteriosclerosis, Thrombosis and Vascular Biology*, *19*, 972–978.

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As a co-author of the above article, I confirm that Tawfiq Almadi has made the following contributions:

- Conception and design of the research
- Analysis and interpretation of the findings
- Writing the paper and critical appraisal of content
- A corresponding author for communication with journal

The article has been submitted for publication.

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