Stress in Academic Life of Pharmacy Students: Psychophysiological Assessment via Cardiovascular Reactivity Experiment

By

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DEDICATION

This work is dedicated to my parents, father Yousif Nori Mahmood AlBaghdadi who strived to give me the best, and mother Afaf Murtadha AbuNayla; my own "soul out of my soul" and essence of my life; for her prayers, doaa', and unflagging love. I wish I can spend lifetime to serve and give back what my parents gave me in the past 25 years.

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
BSI	Brief Symptom Inventory
BP	Blood pressure
CARDIA	Coronary Artery Risk Development in Young Adults
CGPA	Cumulative Grade Point Average
CI	Confidence Interval
CO	Cardiac Output
CV	Cardiovascular
CVD	Cardiovascular disease
CVR	Cardiovascular reactivity
CVS	Cardiovascular system
DBP	Diastolic blood pressure
DESS	Dental Environmental Stress Survey
DSP	DeroGatis Stress Profile
ECG	Electrocardiography
EFA	Exploratory Factor Analysis
FPV	Finger Pulse Volume
Hassel-R	Medical education Hassels Scale
HP	Heart period
HPA	Hypothalamus-Pituitary-Adrenal
HPV	Heart period variability
HR	Heart rate
HRQOL	Health-Related Quality Of Life
HT	Hypertension
IBI	InterBeat Interval
IC	Identification Code
IQ	Intelligence quotient
LOC	Locus of control
MAP	Mean arterial pressure
math	Mental arithmetic test
MBP	Mean blood pressure
MVP	Mean venous pressure
PASAT	Paced Auditory Serial Addition
PCA	Principal component analysis
PEP	Pre-ejection period
Pharm.D.	Doctor of Pharmacy
PSS	Perceived Stress Scale
RSA	Respiratory sinus arrhythmia
SALS	Stress in Academic Life Scale
SBP	Systolic blood pressure
SCI	Social Competence Interview
SD	Standard deviation
SES	Socio-economic status
SLSI	Student Life Stress Inventory
SNS	Sympathetic nervous system
TPR	Total peripheral resistance

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LIST OF PUBLICATIONS/ PRESENTATIONS

Title	Seminar/Conference/Journal	Type of publication	Venue & Date
Construction and validation of the Stress in Academic Life Scale (SALS) among pharmacy undergraduate students: A pilot study	4th Asian Association of Schools of Pharmacy- 9th Malaysian Pharmaceutical Society Pharmacy Scientific Conference 2009	Oral Presentation	Vistana Hotel, Penang, Malaysia / 10 – 12th June 2009
Psychometric Properties for Development of Stress Questionnaire for Malaysian Pharmacy Undergraduate Students	9th ACCP (The 9th Asian Conference on Clinical Pharmacy)	Poster Presentation	COEX, Seoul, Korea / September 26-28, 2009
Constructing Stress in Academic Life Scale (SALS) to be used in cardiovascular reactivity to stress experiment: factor analysis and validation	Social Sciences Postgraduate National Seminar (SSPNS 09)	Oral Presentation	Gurney Hotel, Penang, Malaysia / 28 – 29th October 2009
Can self-reporting of stress task act as laboratory stressor? Investigating through CVR-stress experiment	1st Pharmaceutical Sciences Conference and Exhibition (PSCE)	Oral Presentation	Vistana Hotel, Penang, Malaysia / 27 – 28th September 2010
Assessment of the validity and reliability for a newly developed Stress in Academic Life Scale (SALS) for pharmacy undergraduates	**International Journal of Collaborative Research on Internal Medicine & Public Health**	**Peer-reviewed journal article**	**19th July 2010**
Can self-reporting of stress-measuring questionnaire act as laboratory stressor? Investigating through the psychophysiological CVR-stress experiment	**Journal of Experimental Social Psychology**	**Peer-reviewed journal article**	**Under review**
Assessment the racial difference in blood pressure reactivity among a sample of Malaysian adult students	**Health Expectations**	**Peer-reviewed journal article**	**Anticipated publication**
Association of stress with academic performance: Psychophysiological assessment via CVR-stress experiment	**Journal of School Health**	**Peer-reviewed journal article**	**Anticipated publication**

Tekanan / stres di dalam kehidupan akademik pelajar-pelajar Farmasi : Taksiran psikofisiologikal melalui kajian kereaktifan kardiovaskular

ABSTRAK

Kajian stres dan kajian kereaktifan kardiovaskular terhadap stres merupakan salah satu kajian utama di dalam perkhidmatan kesihatan pada masa sekarang. Ianya telah dapat 'menambah nilai' kefahaman tentang sikap dan sifat manusia terhadap cabaran kehidupan mereka sehari-hari. Ia juga seterusnya telah membantu dalam menjangkakan gejala awal terhadap risiko penyakit kardiovaskular (CVD). Stres kelakuan mahupun stres psikologi merupakan salah satu faktor yang menyumbang kepada perkembangan utama hipertensi (HT) di dalam individu yang dijangka mudah menghidap penyakit ini. Tekanan dan beban akademik yang keterlaluan telah mempengaruhi pelajar, dimana ia didapati menurunkan tahap motivasi mereka untuk mencapai kejayaan yang lebih cemerlang. Jenis-jenis stres yang tertentu telah ditaksir secara psikologi melalui kaedah soal-selidik , sementara stres secara keseluruhannya pula ditaksir secara fisiologi melalui kajian fisiologi (dengan bantuan kajian *CVR-stress experiments*).

Ada dua sebab kenapa Skala Stres Kehidupan Akademik* (Stress in Academic Life Scale = SALS) dibangunkan didalam kajian ini: untuk mengukur tahap stress serta mengenalpasti unsur-unsur atau pelopor utama stres yang boleh mempengaruhi pencapaian akademik seseorang pelajar. Sementara tujuan penggunaan kajian CVR-stres pula adalah untuk mendapatkan penilaian sebenar yang lebih jelas tentang peranan stres akademik di dalam kehidupan pelajar-pelajar farmasi terutamanya.

Dalam tempoh selama enam bulan, data telah diambil melalui keikutsertaan 488 pelajar didalam me-validasikan SALS serta mereka juga menjadi sebahagian daripada eksperimen fisiologi yang dibuat.

Di akhir kajian, didapati stres akademik secara relatifnya adalah rendah dikalangan pelajar- pelajar di Pusat Pengajian Farmasi di Universiti Sains Malaysia (mean score = 1.17 ±.40), tetapi ianya merupakan antara faktor penurunan pencapaian akademik mereka ($P < 0.001$; $r = -.204$). Dari sampel tersebut, dirumuskan terdapat kepelbagaian tindakbalas kardiovaskular hemodinamik pada kajian makmal yang akut (ujian mental aritmetik). Didalam metod kajian "self-reporting task" dimana peserta/ pelajar yang dikaji diminta memberikan laporan mengenai hal yang mereka alami, rasakan atau ingat berkaitan dengan suatu rangsangan tertentu, mendapati tiada aktiviti fisiologi di dalam penaksiran CVR-stres.

Jenis kaum pula telah ditentukan antara penanda awal utama kereaktifan yang tinggi ($P < 0.05$; kereaktifan sistolik). Pelajar dari kaum Cina didapati lebih reaktif stres terhadap tugas-tugas mental arimetik berbanding pelajar dari kaum Melayu. Ini dapat meletakkan mereka dalam keadaan risiko paling tinggi CVD pada masa akan datang didalam kehidupan mereka berbanding kaum-kaum lain, sementara tahap tahun pengajian pula adalah penanda awal dalam laporan kepelbagaian tahap-tahap stres akademik ($P < 0.005$; mean score = 1.29 ±.41).

Perbezaan telah dilaporkan didalam kajian bagi pelajar tahun dua dimana didapati mereka lebih mengalami stres akademik berbanding pelajar tahun lain. Stres akademik terhasil dari kurangnya motivasi untuk mencapai tahap kecemerlangan yang tinggi didalam pembelajaran.

Kajian yang ada pada masa sekarang menjelaskan dengan lebih terperinci perbezaan modulatori antara laporan tahap stres akademik dan laporan/keputusan kereaktifan

kardiovaskular terhadap stres yang diambil hasil daripada ujian makmal (‘*laboratory induced stress’*) Ianya menggambarkan metod-metod korelasi diantara laporan fisiologi dengan laporan peribadi (self-reporting). Apabila dibandingkan kedua-dua cara, stres akademik didapati tidak mempunyai hubungan yang besar di dalam respon stres keseluruhan bagi sampel-sampel kajian. Ini mungkin telah mengesahkan bahawa taksiran psikologi mempunyai stres akademik yang rendah.

Membandingkan hubungkait diantara prestasi akademik dan stres mungkin dapat meningkatkan kesedaran bagaimanakah caranya menghadapi dan menghalang tujuh penyebab utama stressor (bidang utama SALS).

Meramalkan bahawa jenis-jenis kaum mempunyai kesan terhadap HT pada masa hadapan juga akan menambahkan lagi kesedaran dan dapat memperbaiki persepsi keseluruhan terhadap penyakit kardiovaskular.

Stress in Academic Life of Pharmacy Students: Psychophysiological Assessment via Cardiovascular Reactivity Experiment

ABSTRACT

Research of stress and cardiovascular reactivity (CVR) is one of the pillars in the health care system. It enhances the understanding of human behavior towards daily challenges and needs. It goes further to anticipate precursor risk factors of future cardiovascular disease (CVD). Behavioral or psychological stress is one of many factors that could contribute to the development of essential hypertension (HT) in susceptible individuals. Excessive stress in academic life affects all the students and de-motivates them for gaining higher performance. Specific types of stress are assessed psychologically (by questionnaires), while total affecting stress is assessed physiologically (by the aid of CVR-stress experiments).

Two purposes were behind developing the Stress in Academic Life Scale (SALS) in this study: measuring stress, and identifying stressors that interfere with students' life and their academic achievement. CVR-stress experiment was employed to get clear evaluation of the role of academic stress on the general stress of pharmacy students.

For a period of six months, data was collected through participation of a total of 488 students in validation of SALS as well as being part of the physiological CVR-stress experiment.

The resulted level of academic stress was relatively low (mean score = 1.17 ±.40) among majority of students in School of Pharmaceutical Sciences at Universiti Sains Malaysia even though it is degrading factor for high academic performance ($P < 0.001$; $r = -.204$). The sample revealed a diverse hemodynamic cardiovascular

response to acute laboratory challenge (mental arithmetic test). Self-reporting of stress task has no physiological activity in the CVR-stress assessment. Race was significant precursor for heightened reactivity ($P < 0.05$; systolic reactivity). Chinese students are more reactive to mental arithmetic task than Malays that may put them at higher risk to get future CVD than Malay students.

Year of study was significant precursor for reporting variation in reporting level of academic stress ($P < 0.005$; mean score = 1.29 ±.41). The difference was reported by the second year of study which seemed to be more stressed academically than other course years. The academic stress is generated mainly by lack of motivation to achieve higher performance.

The present study explicates a modulatory comparison between reporting the level of academic stress and the cardiovascular reactivity to laboratory induced stress. It delineates a method for a reliable correlation between physiological findings and self-reporting one. When comparing both pathways, academic stress did not have association with the magnitude of general stress response among the investigated sample. This may confirm the psychological assessment in having low level of stress in academic life.

Collating the association between academic performance and stress may elevate the awareness about how to robust achievement by coping and interfering with the seven reported stressors (domains of SALS). Predicting the racial susceptibility of future HT will increase the awareness and ameliorate the overall perception about cardiovascular disease.

CHAPTER ONE

INTRODUCTION

1.1 Background

Research on stress and cardiovascular reactivity (CVR) falls under the psychophysiology branch of psychosomatic medicine or clinical psychology.

Psychophysiology is the study of relations between psychological manipulations and the resulting physiological responses measured in the living organism. Psychophysiology enhances the study of the relationship between mental and bodily processes that has been an issue of interest for scientists since many decades ago.

The word psychosomatic originated from the Latin *psychosoma* that stands for "Psych'' (mind) and "Soma'' which is body. Psychosomatic medicine is the study of the dependence between body and mind in terms of functional effects and health. Psychosomatic medicine is now a field along the borderline, concerned with the interrelationships between psychological and social factors, biological and physiological functions, and the development and causes of illness.

Studies of this kind of medicine are very wide and common but in the western world especially in the United States of America. In Malaysia, there are some limited trials of psychophysiology research which can be recognized under few known scientists who did their research abroad. Researchers who usually carry out such research work are psychiatrists, clinical physiologists, clinical psychologists, and clinical pharmacists, so it is a multi-disciplinary spectrum in public health.

Research on human stress is one of the cornerstones in the psychosomatic medicine. Stress is basically any situation that evokes negative thoughts and feelings in a person and is usually launched as a perceived concept. External stress demands result in a pathological process that tends to affect human homeostasis.

Studies of stress fall within the area of the psychophysiology division of psychosomatic medicine. However, researchers often focus on the cardiovascular system (CVS) with regard to its prominent role in the initial response to stressors. When such postulated effects are repeated in chronic activation, the prognosis to cardiovascular disease (CVD) occurs.

Educational stress during academic life affects all the students. Nowadays, stress is known as a required factor for achieving higher academic performance. Some reports of elevated stress levels among college students show causes of health-illness and other personal problems (Brian, 2004). Measuring the affecting stress on education may require gauging specific educational stress in addition to measuring the amount of physiological reactivity behind the overall affecting stress on the life of students. This physiological response is usually assessed using the CVR-stress experiment.

Studies on human CVR are found in plethora as they deal with predictive phenomena for human cardiovascular disorders. In addition, they help in the assessment of the level of affecting stress. The majority of CVR-stress experiment studies deal with the cause of some CVDs and particularly hypertension (HT). It is estimated that by 2025, more than 1.5 billion adults worldwide will be hypertensive (Gasperin, Netuveli, Dias-da-CostaI, & Pattussi, 2009). Early identification of the population at risk would lead to improved utilization of preventive measures (Israeli, *et al*., 2007). CVR-stress experiments help in building a prediction bridge between young healthy adults and middle-aged hypertensive patients.

1.2 Psychophysiology of the cardiovascular system during stress

The psychophysiological concept of stress became widely known in fifties of last century. Grinker and Speigel (1945) and Janis (1958) had suggested that stress is not a mere bio-physiological phenomenon but it is also a psychological action. Lazarus (1966) had further popularized the psychological attribute of his suggested stress model. Psychophysiological reactivity behind stress refers to the physiological activity that is caused by psychological stressors.

During stress, sympathetic nervous system (SNS) is activated, leading to elevation in the blood pressure (BP). This elevation is due to the sympathetic stimulation of the heart that directly leads to a faster heart rate (HR) and greater contractile force. The overall effect of hormones released by the adrenal glands during stress is generating emergent energy in the body. Epinephrine and norepinephrine act as beta agonists on the heart, therefore, inducing further increment in the HR and the myocardial contractile force. The effect of sympathetic stimulation on the vasculature is more complex, it can result in both vasoconstrictive and vasodilatory effects depending on which type of receptor is stimulated. Alpha adrenergic excitation of the vasculature by the agonist norepinephrine and epinephrine leads to vasoconstriction, while Beta adrenergic stimulation by the agonist epinephrine leads to vasodilatation. Old studies have implied that beta adrenergic reactivity is the major moderator of excessive CVR to stress (Sherwood, Allen, Obrist, & Langer, 1986).

In conjunction with the action of the sympathetic nervous system (SNS) on the heart and blood vessels, a pattern of mental activation known as the fight-or-flight reaction would dominate. During this reaction, certain hormones like adrenalin and cortisol are released; speeding up HR, slowing digestion, shunting blood flow to major muscle groups, changing various other autonomic nervous functions, and giving the

body a burst of energy and strength to fight as a reaction to stress (Cohen, Kessler, & Gordon, 1995).

1.3 Essence of stress

Lazarus and Folkman's (1984) definition of stress as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering wellbeing" is world wide accepted. Others define stress as any situation that evokes negative thoughts and feelings in a person which usually launched as a perceived concept. The Medical Subject Headings (MeSH) defines stress as a pathological process resulting from body's reaction to external demands and abnormal states that tend to affect its homeostasis (Gasperin, *et al*., 2009).

Stress can be understood as a result of the individuals' perception when they do not have the resources to cope with a perceived situation from the past, present or future. However, that perception is an individual difference property.

Stress is caused by fear, and the body's reaction to that fear is the instinctive preparation for the fight-or-flight reaction. This can be defined as the body's response to perceived threat or danger.

Bodily reactions to stress include arousal (vigilance), depression, anxiety, boredom, anger, mistrust, physical and other general discomfort. When the perceived threat is gone, CVS is designed to return to normal function via the relaxation response, and particularly, the cardiovascular recovery. In the case of chronic stress, the recovery often is slow, and attributes to the future damage to the blood vessels.

As stress is a phenomenon that people face every day. It can either serve as a motivation if it is controlled, or it can interfere with the daily performance (sleep,

appetite, and mood) if it is in excess. Some stress is desirable to prevent boredom and under-stimulation, but the persistence of stress-related symptoms may result in mental and/or physical illness, and diminish efficiency during working or learning (Al-Omari, 2005).

1.4 What is stressor?

Stressor is any challenge that tarnishes the easeful relationship between the person and the environment. The challenge can result in either a beneficial or a harmful outcome (Waldstein, Neumann, & Merrill, 1998). Different types of stressors produce anxiety in individuals, which in turn generates feelings of apprehension that can ultimately lead to negative physical, emotional, and behavioral mal-symptoms (Boyd & Nihart, 1998). When emotional or behavioral stressors prevail, psychological stress appears.

Studies associated with types of stressor are important to shed light to program coordinators and health-care professionals. Stressors in academic life are as diverse as the universities and colleges, and are often identified more frequently than other factors of stress (Robotham, 2008).

1.5 Stress in academic life

One measure of excessive stress is the distress that may deliver inability to perform school work and fear of academic failure or even it contributes to dropping out. Students face many variables of stress that altogether contribute to academic stress.

The workplace and environment are major factors in stress. Common stressors that trap college students within the academic environment include many domains. When a family decides the course for their son, he may live in stress for the whole

candidature when not interested in that course. Other examples of stress in academic life may extend to" high academic ambition, confusing assignment guidelines, perception about the curriculum structure and career benefits of it, concerns about faculty/advisor relations especially when unsupportive to students. Financial burden, peers pressure, romantic problems in the school, general social mistreatment, and others are some interpersonal stressors. For health care students, the picture is similar academically but with added clinical training related stress. Skills and attitudes required in medical training, burden behind the perceived lack of proper clinical knowledge, inadequate clinical supervision to act as healthcare professional, and inability to match between clinical and academic materials may be some rolling domains that cause extra stress.

High level of stress may impact a negative or positive effect on thinking and learning. It is known that high level stress makes learning difficult and therefore highly stressed students might get bad performance in comparison to their spent efforts.

There is a model, which is useful in understanding stress among students, called person environmental model that states: when students appraise their education as challenge, stress can bring them a sense of competence and an increased capacity to learn. But when education is seen as a threat, stress can elicit feelings of helplessness and foreboding sense of loss.

Whitman, *et al*. (1984) have suggested that students under high and low stress learn the least whereas students under moderate stress learn the most. The most significant outcome of high stress for many students; in addition to the behavioral, cognitive, and other physiological sequels; is the reduction in their academic Cumulative Grade Point Average (CGPA). Stress has another impact on health of students through

activation of autonomic nervous system that can result in maladaptive outcomes such as impaired immunity, increased vulnerability to new diseases and more rapid progression of existing illness (Loft, *et al*., 2007).

1.6 Chronic and background stress

Stressful events that extend for a long period of time can change one's life and lead to chronic health-related consequences. This type of stress alters the shape of physiological reactivity as well as the physiological recovery due to the difference in threshold and therefore adaptation to what happens in normal daily stress. Events that may cause chronic stress include major predestinations such as death of close buddy, getting divorced, moving away from home, long-term wars, serious chronic illnesses, long-term financial struggles, spending years in jail, and many others (Wong, Perry, & Hockenberry, 2002).

Lepore, *et al*. (1997) used a structured interview in order to determine the duration of each reported stressor. He classified high impact stressors into three durations:

* episodic stressors (the ones lasting less than a month),
* intermediate-length stressors (the ones lasting 1 to 8 months), and
* background stressors (the ones lasting 9 months or longer).

A stressor lasting for one year but ending 6 months ago (before the time of assessment) would likely have a very different effect on the experimental CVR than a stressor lasting for one year but currently ongoing. However, both have been classified as chronic in the literature. By making sense of that, scientists loaded academic stress under chronic stress if it is continuous and frequent in students' life. Domain examples of background stressors in the reviewed studies for college students are restricted to family, finance, health, and environment related stressors.

Examinations were argued not to be part of chronic stress unless the accumulated suffering is more than one year. Thus investigators are concerned about the role of behavioral stress in academic life which may lead to the development of essential HT. In other aspects, Gump, and Matthews (1999) reported that academic examinations cannot be loaded under chronic stress even though such stress lasts for more than a year.

It has been suggested that chronic exposure to psychological stress can cause increased BP and increase the risk of having HT (Linden & Moseley, 2006). Most stressors associated with the development of CVD or overall mortality are chronic (Player, King, Mainous III, & Geesey, 2007; Schwartz, *et al*., 2003). Job strain, marital stress, or financial strains are examples of chronic stress that has been associated with the development of CVD (Steptoe, Brydon, & Kunz-Ebrecht, 2005).

1.7 The stress response

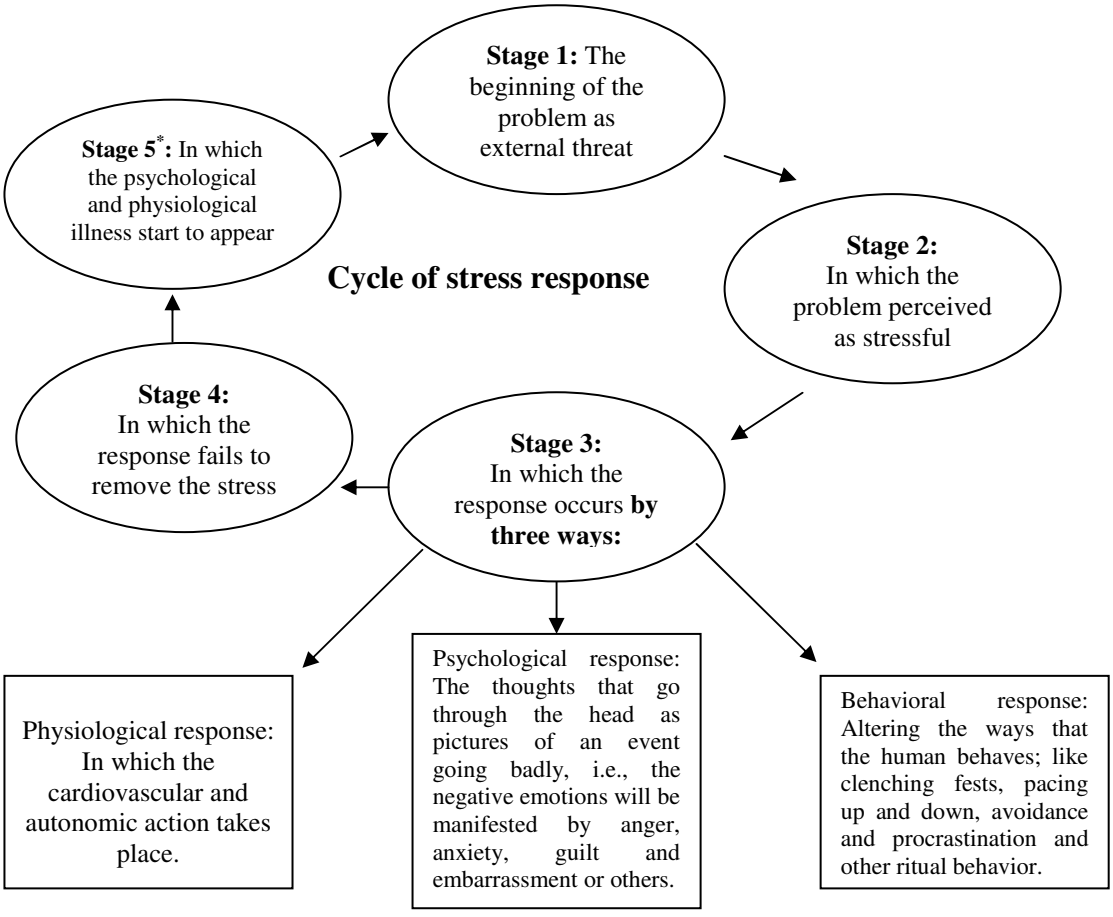
Human possesses a complicated and efficient alarm system. The alarm signals which are transmitted to the brain and processed in the hypothalamus by the aid of circulatory and nervous system will in turn alert the rest of the body to outside dangers. When this alarm system is activated and the involved glands, organs, and muscles prepare for fight-or-flight, stress appears. The natural real life fight-or-flight response is to prepare the organism for immediate physical action which is, to fight or to easier flee which is flight.

Three stages had been suggested to imagine the stress model of response: the first concept emphasizes stressful events, the second on consequences beyond that stress, and the third on individual appraisal to situations (Dunn & Ritter, 1995).

It is now well established that the physiological stress-response may differ individually according to each person. Selye, *et al.*'s (1981) model of stress had opened future work towards attention about the nature of variant psychological and emotional stressors.

The stress response can and cannot remove the stress faced by an individual. Stress has physiological effects on human body, a psychological response will be encountered also by imagining the images and feelings behind the situation.

Palmer and Strickland (1996) suggested a stress model to have five stages of human response to stressful situation.



* If the situation reached step 5, the stress would remain, and the body would stay in a state of high alert if he still perceives the event as threatening (Palmer & Puri, 2006).

Figure 1.1 Stages of stress response according to Palmer and Strickland model

1.8 Assessment of stress

When a person is living under stress due to single or multiple stressors, perception towards reporting high stress would enhance his/her ability to know more about the problem so that they can cope with it. The physiological reactivity would report higher response to any analogue stressor during laboratory assessment among respondents who are under vigorous challenge in their lives. Assessment of the real level of stress requires both psychological self-reporting or interview, and the physiological measurement of CVR to an induced acute stress.

1.8.1 Assessment of stress by psychological means

Stress is not an entity which can be measured directly (Heins, Fahey, & Leiden, 1984). Psychological stress is usually assessed by reporting the perceptions of an individual using a number of items that can be grouped collectively as stress scale or stress questionnaire. Data collected by means of self-reporting questionnaire is considered as efficient to reflect what is exactly required to measure especially when the variables of interest are known (Sekaran, 2006). Administration of a specific stress questionnaire would help in determining the type of particular stress. Hence, academic stress questionnaire usually consists of a number of academic-life daily situations and events that are summarized by individual items that require answering them.

There are many general (designed for all individuals), and academic (designed specifically for students) scales that measure stress. In consequence, there are numerous studies that were carried out to measure students' stress using scales which are not specific to academia.

An example of the general scale is the Brief Symptom Inventory (BSI) which was developed by Derogatis and Spencer (1992). This inventory consists of 53 items that measure general psychological distress based on four point rating scale. Another inventory is the Personal View Survey II (PVS II) that was invented by Maddi (1997) to measure the hardiness of the individual; the harder the individual, the less the perceived stress.

Many other general scales which were also used in surveying stress among college students include Weekly Stress Inventory (WSI); which measures the physical and psychological aspect of stress on a weekly basis, and the Daily Hassle Scale (DHS) that is used widely by some researchers as it deals with measuring general psychological symptoms and subjective distress.

1.8.2 Measurement of the physiological reactivity to stress

Stress can be detected physiologically by the utility of monitoring cardiovascular response to an induced acute stress by the action of the laboratory-based CVR-stress experiment. When somebody manifests an explicit hyper-reactivity, this person may live under stress at that particular time of assessment. This detection reflects the total perceived stress and not particular to the kind of accompanying distress. By the combination of physiological arousal and the psychological measures of stress, the level and affecting type of stress can be estimated.

1.8.2.1 Cardiovascular reactivity (CVR) to stress

The most important neurobiological system that works during stress is the Hypothalamus-Pituitary-Adrenal (HPA) axis (Holsboer, 1999). When this axis is activated peripherally during or after stress stimulation, it releases many hormones

like cortisol and adrenaline to enhance the cardiovascular (CV) reaction to the situation.

Recent researches focus upon the underlying psychophysiological links between certain "psychological" and those "physiological" mechanisms behind high cardiovascular response (hyper-reactivity) which have collectively shown a direct contribution to anticipate the mechanism of development of the CVD.

Estimating behavioral stress is undertaken through CVR-stress experiment using one or more analogue stressors. There are two reasons to focus on the laboratory-based induced acute stress: first, it is similar to real-life conditions which evoke cardiovascular increment; and second, it can evoke sympathetically mediated cardiovascular changes which mimic borderline HT. Stress in academic life particularly written or oral examinations that students undergo during their candidature may share such properties of induced acute stress.

1.8.2.2 The concept of cardiovascular reactivity

CVR is a psychophysiological construction that refers to changes in cardiovascular activity caused by psychological challenge. It is the magnitude and pattern of individual's physiological responsivity resulting from exposure to a discrete or continuous environmental stimulus (Kelsey, Ornduff, & Alpert, 2007; Trieber, *et al*, 1990).

Individuals differ in the degree of CVR to psychological stimuli (Fahrenberg, Foerster, & Wilmers, 1995). CVR is a pattern of an individual's hemodynamic responses to behavioral stressors that potentially plays a role as a marker or mechanism in the pathogenesis of development CVD (Manuck, Kamarck, Kasprowicz, & Waldstein, 1993). The magnitude of the responsivity can identify

individuals or subgroups with an increased risk of CVD (Lovallo & Gerin, 2003). The issue of linkage between cardiovascular hyper-reactivity as risk marker or causal factor for CVD had been considered in plethora of longitudinal trials (Turner, 1994; Kelsey, Ornduff, & Alpert, 2007).

Many variables can act as moderators for CVR, these include: gender, race, stamina, age, socioeconomic status, personality measures like Type A trait or hostility, psychological disorders such as depression and anxiety, menstrual cycle phase, social support, family history of CVD, effectors on adrenoceptor function like vagal control of cardiac function, peripheral physiologic activity, vascular responsivity associated with central adiposity and insulin resistance, and many others (Matthews, *et al*., 1986).

1.8.2.3 History of the CVR-stress experiment

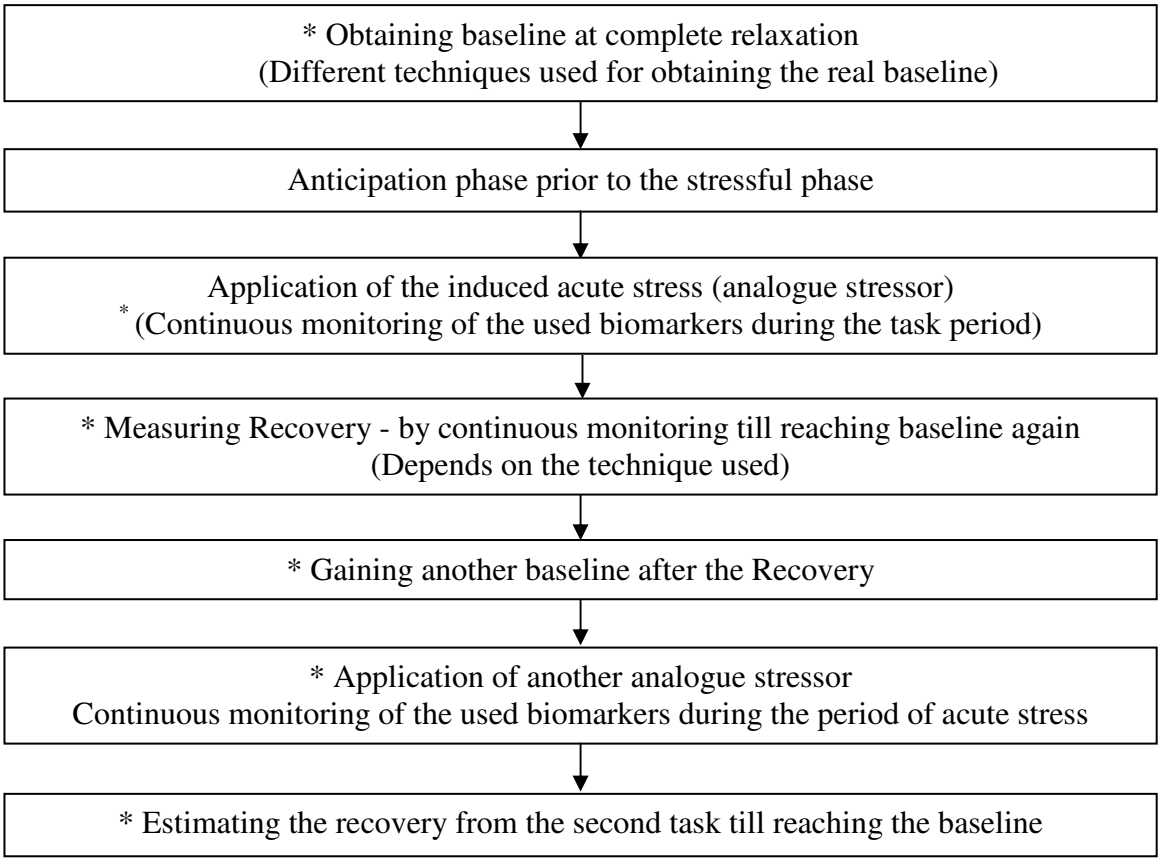
As cited by Lovallo (2005); from 1930s, Hines and Brown expressed the idea that a large BP response to the immersion of a hand or foot in ice water signaled elevated risk of future hypertension. Till today, CVR studies are conducted to estimate the exact period of time till the hyper-reactive individual will develop CVD.

1.8.2.4 Construction of the CVR-stress experiment

CVR experiment is a quantified laboratory context that involves arithmetic difference between measurement of any CV parameter such as HR obtained in a baseline period to that monitored during exposure of an eliciting stimulus (induced acute stress). Estimating the difference between the readings during proper relaxed baseline with the readings during application of the analogue stressor is the

magnitude of the calculated reactivity. This magnitude of reactivity is particular for each of the used parameters in measuring CVR like BP and HR reactivities.

Assessment of CVR is usually done by administration of one or more of the valid analogue stressors (laboratory challenge). Recording a baseline is usually done before administering the challenges and within a completely relaxed manner. Essential steps of the experiment are summarized by the following flowchart:



* Each step should result with one aggregated reading (whether maximum, average, or other technique)

Figure 1.2 CVR-stress experiment flow chart

The evaluation of anticipatory and recovery measures is an extra assessment technique of CVR. The magnitude (reactivity) and time (recovery) of CV responses during acute stress may therefore lead to a more useful model of the stress-disease relationship.

1.8.2.5 Measures used in the CVR-stress experiment

CVR can be estimated by monitoring one or more of physiological/ cardiac biomarkers like: Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP), Pre-ejection Period (PEP), Interbeat interval (IBI), Cardiac output (CO), Heart rate variability (HRV), Total Peripheral Resistance (TPR); TPR = MAP (Mean Arterial Pressure – MVP (Mean Venous Pressure) / CO, Electrocardiography (ECG) and impedance cardiographic data, Salivary cortisol (as indicator of HPA axis), and many others.

These biomarkers are usually monitored continuously for an already set period of time during the laboratory session. SBP, DBP, and HR are the basic parameters that can be used as standard measures of CVR by continuous monitoring. Systolic and diastolic blood pressure can be measured at the brachial artery, using an occlusion cuff to permit oscillometric determinations, or in conjunction with stethoscope or microphone for the detection of Korotkoff sounds used in the auscultatory method.

The experiment normally uses a psychological measure of stress to compare both results of psychological and physiological outcome.

1.8.2.6 Types of the acute stressors used in CVR-stress experiment

CVR is usually conceptualized as an individual difference or trait characteristic, and it is usually measured by examining changes in cardiovascular function elicited by aversive, challenging, or engaging laboratory tasks (Treiber, *et al*., 2003). CVR varies pathway as a function of task demands and other characteristics, including psychological versus physical demands, active versus passive coping (Kamarck & Lovallo, 2003; Kelsey, Ornduff, McCann, & Reiff, 2001). The idea of administering analogue stressors is to reflect the reactivity provoked by the person's biological

system in the real field. Kamarck and Lovallo (2003) defined the challenges used in CVR-stress experiments as situations that are motivationally relevant (i.e. posing negative or positive consequences of importance to the individual) and that require adaptive (cognitive or motor) responding.

Stressors used in the laboratory to induce acute stress can be grouped under four basic criteria: The first is based on the type of response, which will either require mental (cognitive), physical, or physiological effort when responding. The second way to categorize is according to the continuity of the situation (possibility to repeat the challenge within short period or not); to continuous and discrete. The third grouping is according to the sociology of the challenge, to social and unsocial stressor (but it is not popular and not applicable to all tasks). The forth way is the ability to control the task, this has active coping task (like cognitive tasks) and passive coping tasks (like cold pressure task) (figure 1.3).

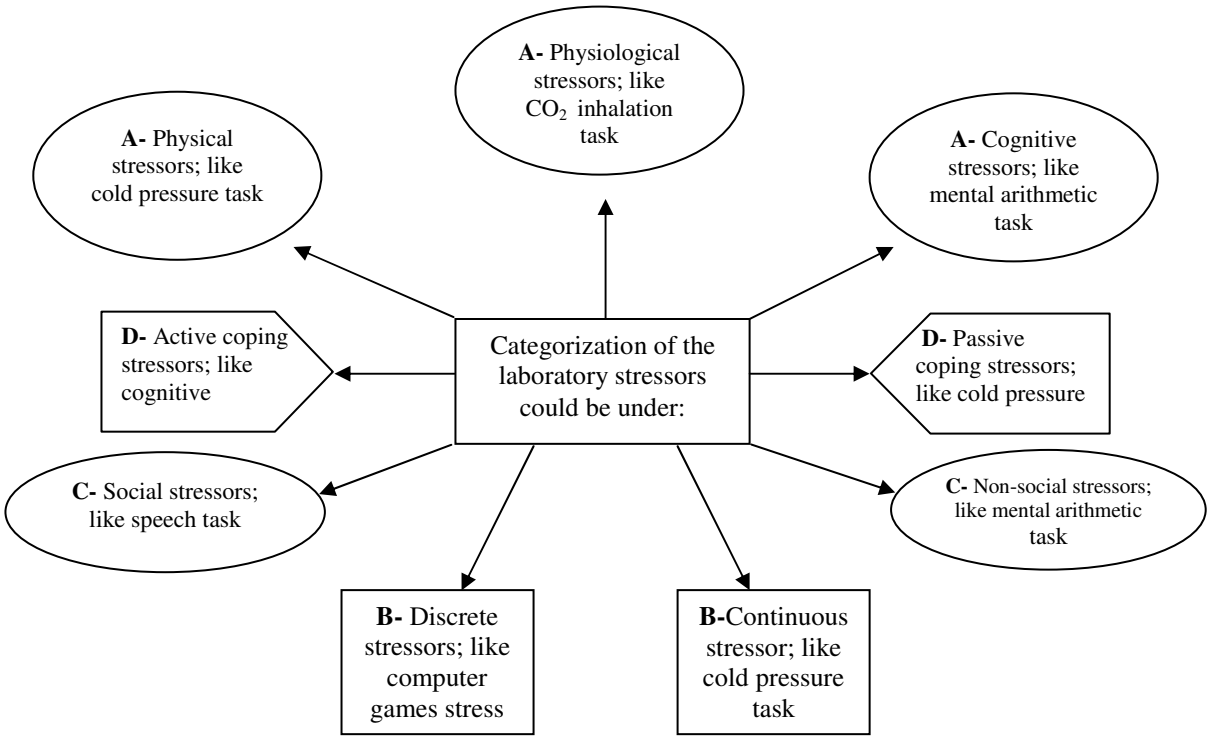


Figure 1.3 Categorization of analogue stressors according to four (A, B, C, D) suggested domains

There is plenty of existing modes of inducing stress during the experimental session. For the instance; bicycle ergometer stress test, reaction time task, reading aloud task (which is also cognitive task), cold pressor task, stroop color-word test, psychomotor task (tracking task), marksmanship task (target test), video games task, mental arithmetic task, Raven's matrices, visual short-term memory task (scanning), isometric handgrip, negative affect provocation task, skin temperature, car-driving simulation, Social Competence Interview (SCI), mirror tracing task, etc. All can be considered as analogue stressors for the CVR-stress experiment.

To date, trials and experiments are done frequently to discover and establish novel, standard, and reliable laboratory tasks that are applicable to all individuals to produce consistent results in all cases.

Reliability and test-retest internal consistency should be done after establishment of the physiological effect of any newly tested challenge. Each one of the stress tasks has its own limitations and advantages over usage in targeted population of respondents. Cardiovascular adaptation to some tasks is also available and can affect the responsivity. Like in the mental arithmetic task; mathematics students are less prone to have hyper-reactivity than normal individuals while computer game addicts are less reactive than the non-players when using computer game tasks. This gives a justification about the reason of not finding a universal analogue stressor used in all CVR-stress experiments till today.

1.9 Coping with stress

Coping is a dynamic process which occurs within the person-environment model according to Whitman (1984). Coping behaviors are directly related to characteristics of the source of stress as well as on the individual himself. It can be considered as an

individual skill to diminish the threat by self-overcome. Research on coping is oriented toward personality traits, an approach that assumes individual's behavior is similar in different situations. There are many types of coping techniques; unhealthy and healthy; physical and emotional, and many others (Khuan, 1985).

Solutions suggested for reducing distress among college students include stress inoculation like informing students at the beginning about the difficulties they might face and encourage them to develop their own strategies to achieve personal goals. Others include improving campus mental health services and organizing peer counseling and self-help groups. If the students informed what to expect and what can be done to improve their performance, the chances to reach distress will be quite low. Although some stress is necessary, the amount of stress can overwhelm student's ability to cope because even good quality teaching cannot be overestimated alone as a key to preventing and minimizing distress among students.

1.10 Statement of the problem

Studying the association between academic stress and academic performance is a useful attempt to check the welfare of students as well as any negative/ positive effect on their academic achievement. Assessment of such effect of the academic stress requires evaluation of the real overall level of stress both psychologically and physiologically. This will provide useful insights in estimating a real mental state of individuals who may not choose to identify themselves as 'stressed out' during self-reporting process.

There is an obvious gap in the explicitly designed literature of stress when comparing any population of students in the health-care professional system with pharmacy students, also the majority of research have been conducted for medical, dental, and

nursing students (Floyd, 1991; Kjeldstadli, *et al*., 2006; Pau, Rowland, Sudeshni, & AbdulKadir, 2007).

The appearing feature behind studying stress in health-care professional students is the lack of consistency in the results of surveys even when it is conducted within similar populations (like within medical students from different universities). This fluctuation in the magnitude of stress or types of stressor may be due to using non specific stress measuring tools to each population. This gives a prominent need for providing a special tool for each population of health-care professional students to understand stress and how it affects their candidature. In summary, pharmacy undergraduate programme lacks a specific stress measuring scale and therefore, there is a need to create one.

Assessing the reactivity to psychological stress remains a significant indicator for prediction of the risk of future CVD worldwide. Besides, there is a currently paucity of data regarding the magnitude of cardiovascular/physiological reactivity for Chinese and Malays in Malaysia. Therefore, studying CVR will be useful in predicting some individual risk factors of future CVD based on the magnitude of response.

1.11 Aim of the study

The aim of this research is to identify the affecting level of stress in academic life and evaluate its association with academic performance among pharmacy undergraduate students. Assessment of academic stress would be achieved by exploring the contributing factors which cause distress in the lives of students. Physiological response to acute stress may give a comparative picture for the affecting level of stress as well.