A STUDY OF STRESS LEVELS AND CORTISOL CHANGES IN FEMALE SHIFT WORKERS

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Thesis
entitled

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for the degree of Master of Science (Industrial Hygiene and Safety)
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A STUDY OF STRESS LEVELS AND CORTISOL CHANGES IN FEMALE SHIFT WORKERS

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ABTRACT

This research aimed to study stress levels and cortisol changes in female shift workers. The stress levels in female shift workers who worked in both morning and night shifts in toy manufacturing were measured using the Health Opinion Survey (H.O.S.). Cortisol excretion was measured in urine samples. Urine was collected during working time and workday off as follows: morning shift, night shift, morning shift day off, night shift day off, and samples provided after 2 consecutive days off were used as the baseline. Statistical analysis was performed using paired t-test and Wilcoxon Signed Ranks Test for analyzing cortisol excretion.

From the result of H.O.S., it was found that subjects were experiencing two levels of stress - either normal or moderate elevated. Cortisol excretion rates for samples taken at 20:00 hrs differed significantly between morning shift and night shift (P-value = 0.008). Cortisol excretion rates for samples taken at 08:00 hrs differed significantly between baseline and morning shift day off (P-value = 0.010). Cortisol excretion rates for samples taken at 05:00 and 24:00 hrs differed significantly between baseline and night shift day off (P-value = 0.034 and 0.034, respectively).

The results of the study showed that the cortisol levels of the subjects corresponded well with typical cortisol profiles. Nevertheless, cortisol excretion rates in female shift workers differed from typical profiles, especially for workers on night shifts. These findings showed that night shift workers were at greater risk of negative health effects than day workers. The cortisol excretion rates on morning shift day off and night day off did not return to baseline. It is recommended that longer resting time and more appropriate working periods be planned for these subjects.

KEY WORDS: CORTISOL / STRESS / SHIFT WORK / FEMALE WORKER

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การศึกษาระดับความเครียดและการเปลี่ยนแปลงของคอร์ติซอลในพนักงานหญิงที่ทำงานกะ
(A STUDY OF STRESS LEVELS AND CORTISOL CHANGES IN FEMALE SHIFT WORKERS)

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บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาระดับความเครียดและการเปลี่ยนแปลงของคอร์ติซอลในพนักงานหญิงที่ทำงานกะ ศึกษาในกลุ่มพนักงานหญิงที่ทำงานทั้งกะเช้าและกะดึกในโรงงานอุตสาหกรรมผลิตของเด็กเล่น ระดับความเครียดประเมินโดยการใช้แบบสอบถาม Health Opinion Survey (H.O.S.) และทำการตรวจวัดการหลั่งคอร์ติซอลในปัสสาวะ โดยเก็บตัวอย่างปัสสาวะในขณะทำงานและในวันพัก ดังนี้ ระหว่างทำงานกะเช้าและกะดึก, วันพักหลังจากการทำงานกะเช้าและกะดึก และจัดให้พนักงานพักติดต่อกัน 2 วันเพื่อตรวจวัดอัตราการหลั่งคอร์ติซอลพื้นฐาน วิเคราะห์ข้อมูลทางสถิติโดย Paired t-test และ Wilcoxon Signed Ranks Test เพื่อเปรียบเทียบค่าการหลั่งคอร์ติซอลในวันและเวลาต่าง ๆ

ผลการศึกษาพบระดับความเครียด 2 ระดับ คือ ระดับความเครียดปกติและปานกลาง อัตราการหลั่งคอร์ติซอลในวันทำงานกะเช้าแตกต่างจากวันทำงานกะดึกอย่างมีนัยสำคัญทางสถิติ ณ เวลา 20.00 น. (P-value = 0.008), อัตราการหลั่งคอร์ติซอลพื้นฐานแตกต่างจากวันพักหลังจากการทำงานกะเช้าอย่างมีนัยสำคัญทางสถิติ ณ เวลา 08.00 น. (P-value = 0.001) และอัตราการหลั่งคอร์ติซอลพื้นฐานแตกต่างจากวันพักหลังจากการทำงานกะดึกอย่างมีนัยสำคัญทางสถิติ ณ เวลา 05.00 และ 24.00 น. (P-value = 0.034 และ 0.034 ตามลำดับ)

จากการศึกษานี้แสดงให้เห็นว่า พนักงานมีรูปแบบการหลั่งของคอร์ติซอลเหมือนกับรูปแบบการหลั่งปกติ แต่เมื่อมีการทำงานกะการหลั่งของคอร์ติซอลจะมีการเปลี่ยนแปลงไปจากรูปแบบการหลั่งปกติ โดยเฉพาะอย่างยิ่งในขณะทำงานกะดึก แสดงให้เห็นว่าพนักงานที่ทำงานในเวลากลางคืนจะได้รับผลกระทบต่อสุขภาพมากกว่าพนักงานที่ทำงานในเวลากลางวัน และการหลั่งคอร์ติซอลในวันพักตามปกติไม่กลับลงมาสู่ระดับพื้นฐาน จึงควรมีการวางแผนจัดให้มีเวลาพักเพิ่มมากขึ้น

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LIST OF ABBREVIATIONS

17-OHCS	=	17,21-dihydroxy-20-ketone
ACTH	=	adrenocroticotropic hormone
A.M.	=	ante meridian
Bo	=	maximum binding
BUN	=	blood urea nitrogen
^{0}C	=	degree celsius
CRH	=	corticotrophin-releasing hormone
CPM	=	count per min
cm	=	centimeter
dB	=	decibel
dl	=	deciliter
DPC	=	Diagnostic Products Corperation
EOPs	=	endogenous opioid peptides
GAS	=	general adaptation syndrome
HOS	=	Health opinion surveys
HPA	=	hypothalamic-pituitary-adrenocortical axis
HPLC	=	high pressure liquid chromatography
hr	=	hour
kg	=	kilogram
max	=	maximum
mg	=	miligram
ml	=	milliliter
min.	=	minute
min	=	minimum
mm	=	millimeter
MOPG	=	methoxyhydroxyphenylglycol

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LIST OF ABBREVIATIONS (cont.)

μg	=	microgram
μl	=	microliter
ng	=	nanogram
nmol	=	nanomol
No.	=	number
NSB	=	non-specific binding
OSHA	=	Occupational Safety and Health Administration
P.M.	=	post meridian
PRL	=	prolactin
PSQI	=	Pittburgh sleep quality index
REA	=	radioenzymatic assay
RIA	=	radioimmunoassay
SAM	=	sympathetic-adrenal medullary system
SD.	=	standard deviation
SNS	=	sympathetic nervous system
T	=	total count
VMA	=	vanillylmandelic acid
WBGT	=	wet bulb glove temperature

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CHAPTER I
INTRODUCTION

1.1 Background and Rationale

Recently, pressures in a highly competition economy have led employers to reduce staff and increase shift work in an effort to cut costs and increase productivity. In many industries, such as the transport industry, essential services, and many factories use of the shift work is inevitable. Shift work is associated with risks to health, and safety particularly for night shift workers. Being awake for long periods of time disturbs the natural wake-sleep cycle and can result in reduced alertness. This disruption of the circadian rhythm has particularly negative health effects for people who work at night when their bodies are accustomed to sleeping. Nevertheless, in persons who work at night for long periods their circadian rhythm will change. Many studies indicate shift work affects workers' health. Shift work has negative effects on the digestive system, cardiovascular system, hormonal functions, reproductive functions, and can induce sleep disturbances, fatigue, and has particularly adverse effects on stress. Ohayon MM. et al. (1) showed that nighttime workers had sleep disturbance greater than daytime workers. Mazzetti PM. et al. (2) indicated that shift workers experience a larger incidence of digestive disturbances than non-shift workers. Tenkanen L. et al. (3) showed that shift workers have a 1.5 fold higher risk of coronary heart disease than day workers (95% confidence interval).

Recognition of stress among shift workers is essential for improving their work environments. Measurement stress is one method to evaluate stress conditions among workers.

There are many methods that researchers can use to evaluate physiological changes from stress. Evaluation of neuroendrocrine changes is one. Stress hormones are commonly used biomarkers such as melatonin, catecholamines and cortisol. Catecholamines are not good biomarkers because their levels fluctuate depending on environmental factors and they have a very short half-life. Cortisol is as good maker as

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melatonin. Its half-life is longer than that of catecholamines and levels increase in stressful situations. It can be measured in blood, saliva and urine samples. Evaluation of blood samples is better than evaluation of other samples, but is more stressful to subjects because it requires an invasive technique. Measuring cortisol in saliva samples is unreliable because the concentration of cortisol fluctuates with saliva flow. The most practical way to measure cortisol levels is using urine samples because it is non invasive, it dose not require medical personnel for data collection, and levels of cortisol in urine correlate well with levels in blood samples (4). Accordingly, Nealy JP. et al. (5) showed that correlation of cortisol levels between blood and urine was 0.99. A study by Kos-Kudal B. et al. (6) showed a correlation of 0.817. Therefore, this study will evaluate levels of free cortisol in urine samples.

A study by Sluiter JK. et al. (7) evaluated coach drivers' work stress during work and in the course of recovering from work by measuring urinary catecholamines and cortisol. The study found that the mean excretion rates of adrenaline on the first working day were higher than at baseline. For both adrenaline and noradrenaline, the mean excretion rates on the first day off were lower than the baseline. For cortisol, the mean excretion rates on all working days were higher than at baseline. This study concluded that long distance coach drivers showed occupationally induced reactivity in rates of urinary excretion of adrenaline, noradrenaline and cortisol. The increased amount of time required for adrenaline levels to return to baseline after drivers stopped working indicated the presence of a fatigue and stress debt. From this study it was shown that the workers were experiencing high levels of stress. They required longer rest periods before returning to work. Thus, stress evaluation is necessary to predict factors that have adverse long-term effects on health.

In the current study, the researcher was interested in the association between stress levels and cortisol changes in female shift workers during morning and night shifts. Evaluation of stress levels will be done by comparing cortisol excretion in woman working morning shifts and night shifts, to cortisol excretion at baseline and on working day off. A cortisol profile will be created to indicate health effect by measuring cortisol excretion in urine samples and evaluating stress levels using the questionnaires.

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1.2 Objectives

1.2.1 General Objective

To determine stress levels and cortisol changes in female shift workers.

1.2.2 Specific Objectives

1.2.2.1 To determine stress levels in female shift workers.

1.2.2.2 To determine cortisol profiles in female shift workers.

1.2.2.3 To compare cortisol excretion rates between morning shift and night shifts in female shift workers.

1.2.2.4 To compare cortisol excretion rates at baseline to cortisol excretion rates on working day off in female shift workers.

1.3 Hypotheses

1.3.1 Cortisol excretion rates on morning shift differ from cortisol excretion rates on night shift.

1.3.2 Cortisol excretion rates at baseline differ from cortisol excretion rates on morning shift day off.

1.3.3 Cortisol excretion rates at baseline differ from cortisol excretion rates on night shift day off.

1.4 Variables

1.4.1 Independent Variables

1.4.1.1 Morning shift work

1.4.1.2 Night shift work

1.4.2 Dependent Variables

1.4.2.1 Stress levels

1.4.2.2 Cortisol excretion rates in urine

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1.5 Scope and Limitations of this Study

1.5.1 The study focused on stress levels and cortisol changes in female shift workers in toy manufactory, Chachoengsao Province.

1.5.2 The subjects were 20-35 years old, had no health problems and did not use medicines that interfere with cortisol secretion. Work characteristics of the subjects were the same.

1.5.3 General data were asks about general information of subjects. The general information are age, weight and height, marital status, education level, shift work experience, smoking habit, caffeine consumption, alcohol consumption, medicine use, and health problems.

1.5.4 Stress levels were determined using the Health Opinion Surveys (H.O.S) questionnaire that included physio-psychological health problems or psychosomatic symptoms associated with work related stress.

1.5.5 Cortisol excretion rates were analyzed by collecting urine to determine baseline levels, during morning shift, night shift and working day off.

1.5.6 Working conditions such as light intensity, heat stress, and noise levels were determined by TES-1334 light meter, Metrosonics hs-3700 portable heat stress monitor and noise dosimeter, respectively.

1.6 Outcomes and Benefits

1.6.1 To better understand stress situation, and health status among female shift workers.

1.6.2 To determine the profiles of cortisol in female shift workers.

1.6.3 To use this data to manage appropriate working and rest periods for shift workers.

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1.7 Glossary of Terms and Definition

Shift work: Shift work is work done during hours that differ from conventional work hours, extending the organization's operational time from 8 hours to 24 hours per day.

Morning shift: The hours from 8:00 am. to 5:00 pm.

Night shift: The hours from 12:00 am. to 8:00 am.

Stress: Stress is the body's natural reaction when there is an imbalance between the demands of the environment and the ability of the body to respond to those demands. Stress involves external stimuli, the physiological response to these stimuli, and psychological processes that mediate between stimulus and response. The psychological processes involve differences between individuals in their perception of the environmental demands and their own capacity to cope with them.

Stress levels: The levels of stress were evaluated using the Health Opinion Surveys (H.O.S) questionnaire. The questionnaire classified stress levels in 1 of 3 levels: normal, moderate, and high.

Cortisol: Cortisol is a steroid hormone secreted by the adrenal cortex. This hormone is an important member of the glucocorticoid group. Cortisol exhibits an important effect by increasing blood glucose, protein and fat metabolism.

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Cortisol excretion rate: Cortisol excretion rate in units of ng/min.

Cortisol excretion rate at baseline: In general this factory provides one day per week for day off. For baseline data workers are permitted to take a day off about two days (55 hrs) before collecting urine to determine cortisol excretion rate.

Cortisol excretion rate on morning shift day off: Cortisol excretion rate were measured in urine on the day off after six days of working morning shifts. Urine was collected 31 hrs. after the end of working morning shifts.

Cortisol excretion rate on night shift day off: Cortisol excretion rate were measured in urine on the day off after six days of working night shifts. Urine was collected 7 hrs. after the end of working night shifts.

Cortisol excretion changes: A difference excretion between baseline cortisol and cortisol excretion on working day off.

Radioimmunoassay A method to evaluate cortisol excretion rate. The reaction's principle reactants are unlabeled antigen, radiolabeled antigen, and a fixed quantity of antibody. The process involves competition between antigen and radiolabeled antigen to bind with a fixed quantity of antibody. After binding has reached equilibrium, the antibody-hormone complex (bound) is separated using a solid phase method.

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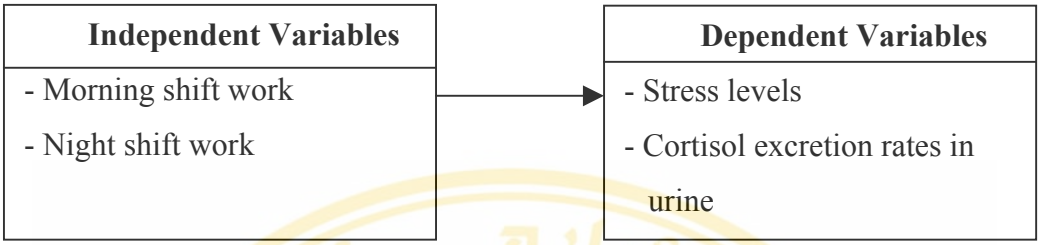
1.8 Conceptual Framework



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CHAPTER II
LITERATURE REVIEW

Shift work can have negative effects for health and well being due the stress derived from interference with psychological functions and social life. The physiological is changes during stress. That is, when an event or situation is stressful, a hormonal change occurs that appears to work either to motivate or to support coping with the stressor. Cortisol is one hormone that useful in explaining how stress affects. This hormone excretes in circadian rhythm that useful of this profile to diagnosis disorders especially stress conditions. So, the study about stress in shift workers by using a changes profile that to indicate health effect and situation of stress, health status in female shift workers for prevention and reduction stress at work.

2.1 Stress

Stress can be defined as many different terms. There are examples to arrive a definition of stress.

Encyclopedia of Occupational Health and Safety (8) defines stress as “a process in the body, to the body’s general plan for adapting to all the influences, changes, demand and strains to which it is exposed.”

Merriam Webster’s Medical Desk Dictionary (9) describe as “a physical, chemical, or emotional factor that cause bodily or mental tension and may be a factor in disease causation.”

In the term of stress at work U.S. National Institute of Occupational Safety and Health (10) defines job stress in “harmful physical and emotional response that occur when the requirements of the job do not match the capabilities, response, or needs of worker. Job stress can lead to poor health and even injury.”

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The stress reaction can describe on physiological process. The process can describe on the stages of response to stress.

2.1.1 Stages of Response of Stress (4)

The reaction of stress is a well-described on physiological process. It has been described as adaptive and enables the individual to mobile energy resourced in the body to deal with the stressor. It is only when the stressor is sustained without the opportunity for recovery that health problems occur, presumably because of continuous physiological arousal. It is general agreed that their two arousal pathways on the stress response. The first is sympathetic-adrenal medullary system (SAM) and second is hypothalamic-pituitary-adrenocortical axis (HPA).

2.1.1.1 Sympathetic-Adrenal Medullary System (SAM)

The SAM system reacts to various emergency states with increased secretion of the hormone epinephrine. There is a large body of evidence indicating increased output of epinephrine and norepinephrine in response to a variety of psychosocial stressors. Other components of the SAM response elicited by stressors include increased blood pressure, heart rate, sweating, and constriction of peripheral blood vessels. It has been claimed that if SAM activation is excessive, persistent over a period of time or repeated to often, it may in a sequence of response that culminate in illness.

2.1.1.2 Hypothalamic-Pituitary-Adrenocortical Axis (HPA).

Selye's early expose on the hormonal response of the HPA axis. This response is proceeding in a characteristic three-stage pattern referred to as the general adaptation syndrome (GAS.).

1) The stage of alarm reaction. In the first stage of GAS call alarm reaction, the body releasing adrenaline and a variety of other psychological mechanisms to combat the stress and to stay in control. This is called fight and flight response. The muscle tension, the heart beats faster, the breathing and perspiration increase, the eyes dilate, and the stomach may clench. Once the cause of the stress removed, the physiological go back normal. If the cause for the stress is not removed, GAS goes to its second stage.

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2) The stage of resistance or adaptation. This is the body's response to long term protection. It secretes further hormones the increase blood sugar levels to sustain energy and raise blood pressure. The adrenal cortex produces hormones called corticosteroids for the resistance reaction. Overuse by the body's defense mechanism in this phase eventually leads to disease. If this adaptation phase continues of a prolonged periods of relaxation and rest to counterbalance the stress response, sufferers become prone to fatigue, concentration lapses, irritability and lethargy as the effort to sustain arousal slides into negative stress.

3) The stage of exhaustion. In this stage, the body has run out of its reserve of body energy and immunity. Mental, physical and emotional resources suffer heavily. The body experiences "adrenal exhaustion". The blood sugar levels decrease as the adrenals become depleted, leading to decreased stress tolerance, progressive mental and physical exhaustion, illness and collapse.

However, modern knowledge of the impacts of stress generated hormones and neuroendrocrines on immune functioning, cardiovascular processes, etc. lead us to conclude that prolonged exposure to stressors and prolonged resistance can potentiate a variety of disease. By progressing through these stages the normal physiological.

2.1.2 Factor of Stress (12)

Environmental situations, events potentially or factor capable of producing the state of stress are recognized as "stressors." Stressors may be physical or psychosocial in origin and both or risks can affect physical and psychosocial health, and may interact with each other. Physical stressors may include biological, biomechanical, chemical and radiological, or psychosocial hazards. Psychosocial hazards are those aspects of work design and the organization and management of work, and their social and environmental contexts, which have the potential for causing psychological, social or physical harm. However, the physical hazards can lead to psychological injury.

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2.1.2.1 Factor from Work (12)

A step to find stress factors in the workplace were necessary to collect data about work characteristics, co-worker and supervisors, hazardous exposure in work condition, etc. Procedures to collection data should include the observation, the interview, the questionnaires or other instruments. There are many factors that can cause stress in the workplace.

1) Work Characteristics: shift work is a major factor that can cause stress at work. Its can effects to circadian rhythm, disturbance sleeps and affect on physiological changes, workload including over and light workload.

2) Physical and environmental conditions: poor, unsanitary or unsafe working conditions, lack of privacy, improper lighting, and poor ventilation and temperature control.

3) Psychological: harassment, inadequate job skills, role conflicts, conflict with co-workers and supervisors, and lack of adequate breaks.

4) Organizational: policies and procedures, schedules, deadlines, repetitive work, unreasonable workloads, inadequate pay and benefits.

5) Socio-cultural: lack of support from supervisors or co-workers, overly authoritative or crisis-centered management style.

6) Interpersonal: lack of respect, lifestyle, and financial or family problems.

7) Work setting: lack of job security, lack of control over one's job.

2.1.2.2 Supplement Factor

Supplement factors are not direct factor from work but it can support with psychosocial factors that can causes more effect to stress. For example, type A person can promoting stress and risk factor to cardiovascular disease, level of anxious, level of stress endure, family problem, social problem, economic problem and other.

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2.1.3 Biological Effects of Stress (13)

2.1.3.1 Neurological Effect

In response to the stress situation, a part of the brain called the hypothalamic-pituitary-adrenal (HPA) system is activated by releasing of steroid hormones and cortisol. The HPA systems trigger the production and release of steroid hormones (glucocorticoids), including the primary stress hormone, cortisol. Cortisol is very important in body systems (heart, lungs, circulation, metabolism, immune systems, and skin) to deal quickly with the stress. The HPA system also excretes norepinephrine, and epinephrine. Catecholamines activate an area inside the brain called the amygdala, which apparently triggers an emotional response to a stressful event.

2.1.3.2 Effects on Long and Short Term Memory

During the stressful event, catecholamines also suppress activity in areas at the front of the brain concerned with short-term memory, concentration, inhibition, and rational thought. This sequence of mental events allows a person to react quickly to the stress, either to fight or to flee from it.

2.1.3.3 Pulmonary and Cardiovascular Effect

The stress response also affects the heart, lungs, and circulation. At the stress situation, the heart rate and blood pressure increase instantaneously. Breathing becomes rapid and the lungs take in more oxygen. The spleen discharges red and white blood cells, allowing the blood to transport more oxygen throughout the body. Blood flow increase, priming the muscles, lungs, and brain for added demands.

2.1.3.4 Immunological Effect

The steroid hormones are parts of the immune system, so that specific infection fighters; including important white blood cells or other immune molecules can be redistributed. These immune systems are sent to the body's front lines where injury or infection is most likely, such as the skin, the bone marrow, and the lymph nodes.

2.1.3.5 Effect of Mouth and Throat

As the stress, fluids is diverted from nonessential locations, including the mouth. This causes dryness and difficulty in talking. In addition, stress can cause spasms of the throat muscles, making it difficult to swallow

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2.1.3.6 Dermal Effect

The stress effect diverts blood flow away from the skin to support the heart and muscle tissues. The physical effect is a cool, clammy, sweaty skin.

2.1.3.7 Metabolism Effect

Stress shuts down digestive activity, a nonessential body function during short-term periods of physical exertion or crisis.

2.2 Shift Work (14,15)

Shift work includes any arrangement of daily working hours that differs from conventional work hours, extending the organization's operational time from 8 hours to 24 hours per day. Working irregular can have negative consequences for health and well being due to the stress derived from interference with psychological functions and social life. The adopted shift systems may have very different features in particular: work characteristics, environment and social. If the works have more rest period or light workload it can be uses 2-shift system, 12 hours/shift, but extent period making workers exposure hazardous with a long period. With a result of exposure standards for hazardous substances are based on an 8 hours day, 40 hours week. Most people will be affected by working shift work. The interaction between health and safety effects and the impacts on family and social life can have significant outcomes for the general health of those working shift works.

2.2.1 Model of Stress in Shift Work (16)

Many research has shown that there is considerable variability in the extent to which individuals successfully adapt to their work pattern describe two models of "stress and strain" which attempt to account for the various effects of shift work on individuals. The first model is Colquhoun's and Rutenfranz' (1980) stress and strain model. This model asserts that detrimental effects do not arise from the objective stresses of shift work only, but also from the subjective strain that develops within an individual who is trying to cope with the disturbed pattern of sleep and activity that the job requires. This model identifies intervening coping variables that can affect strain

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(perceived adjustment), even when the stress (shift schedule) remains the same. Intervening variables in the model include psychological characteristics of the individual, domestic circumstances, and characteristics of the job. (Figure 2-1)

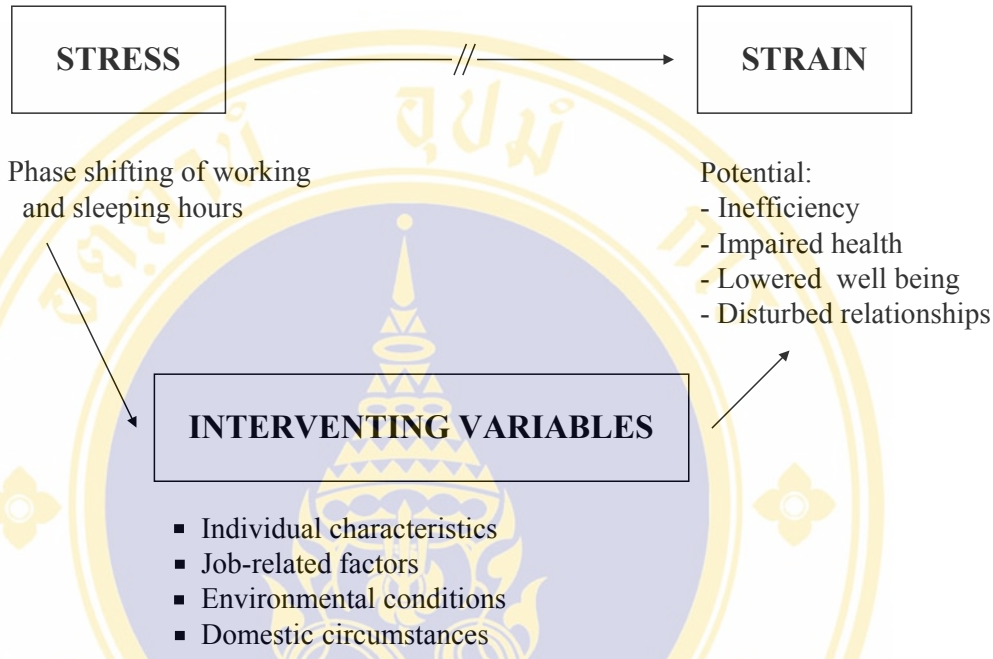

Figure 2-1. The stress and strain model of Colquhoun and Rutenfranz'

The second framework presented by Monk and Folkard is Monk's model of coping (Figure 2-2). This model views shift work strain as a function of three basic stress: circadian factors, sleep factors, and social-domestic factors. All three are interrelated in this model, so all three must be functioning well for strain to be entirely absent. For example, circadian rhythms may be well aligned, and sleep undisturbed, but such gains cannot be at the expense of marital harmony, or it is hypothesized that strain will persist.

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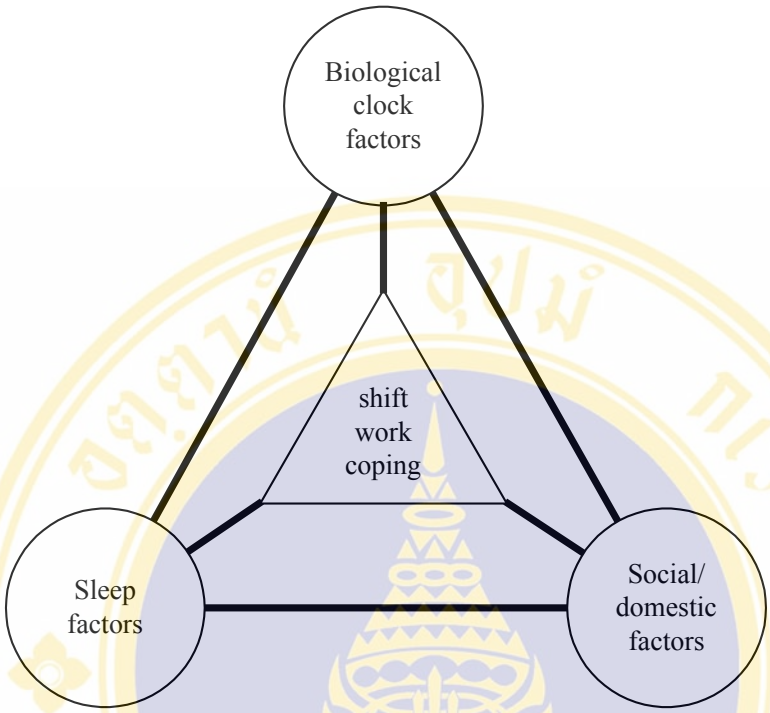

Figure 2-2. A schematic model of three interactive factors determining shift work strain

2.2.2 Shift Work and Circadian Clock (17)

Humans have natural body rhythms, which are regulated by a circadian clock in the brain. These are called circadian rhythms. Over a 24 hours period, the circadian clock regulates sleep/wake patterns, body temperature, hormone levels, digestion and many other functions. Depending on the time of day or night, the human body is programmed for periods of wakefulness and sleep, high and low body temperature, high and low digestive activity and so on. Adults tend naturally to sleep by midnight, wake near dawn and stay awake through the day. This pattern is repeated every 24 hours. Body temperature is at its lowest between 2 am and 6 am. The ability to concentrate and perform tasks is also at its lowest in these early hours of the morning, paralleling the fall in core body temperature.

Work/rest schedules caused by shift work disrupt the circadian clock, causing symptoms similar to jet lag. Generally, no complete physiological (body

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function) adaptation takes place for the majority of night shift workers. A majority of night shift workers suffer ongoing sleep problems.

2.2.3 Health Effects from Shift Work

Shift work can have negative effects for health and well being due to the stress derived from interference with physiological and psychological function. Shift work can cause a variety of health problems such as:

2.2.3.1 Sleep Problem

Sleep disturbances are the primary physical complaint of shift workers. As many as 60 to 70 percent of shift workers complain of sleep disruption (17). Sleep is a complex process that involves stages of deep and light sleep that occur over a full sleep cycle, which takes about 8 hours for most adults. The later stages of this cycle are crucial for physical recovery and psychological adjustment. Without enough sleep, the human brain may spontaneously shift into sleep in order to meet its need. This might only last a few seconds or might stretch to several minutes. These involuntary sleep episodes can occur while standing, operating machinery or driving. Sleep during daylight hours following night shifts is difficult. Most shift night workers sleep an hour or two less in daylight than they normally would, and the quality of their sleep is worse (17). This is largely due to mismatched circadian rhythms and to external cues (light, food, noise, and temperature) around the worker while trying to rest. Together with social factors, this explains why many shift workers suffer from chronic sleep problems. Continued poor quality sleep is a strong predictor of psychological and physical ill health. Physical and psychological effects associated with sleep difficulties include fatigue, dizziness, inability to concentrate, perceptual changes, mood changes, gastric problems and disturbance of eating habits.

2.2.3.2 Digestive Disorders

The timing of meals is important for both physiological and social perspectives. Shift work, particularly night work, can continually disrupt eating patterns. Digestive function is performed by circadian rhythms and is reduced at night. Eating large meals, or intake of coffee and other drinks containing caffeine to stay alert at night, can result in a range of symptoms such as digestion, abdominal pains

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and bowel disturbances. Studies show that shift workers are more likely to display these symptoms than day workers (2). Mott et al. found that 75 percent of rotating shift workers showed at least some disturbance in appetite and digestion. In the medium to long term, more serious diseases of the gastrointestinal tract may develop (17).

2.2.3.3 Cardiovascular Disorders

The stress associated with shift work may have both direct and indirect adverse effects on the cardiovascular system. Heart disease is an added risk. Increased consumption of fast foods, especially those high in fats, can increase cholesterol levels in the blood stream, leading to coronary heart disease. Higher levels of smoking among shift workers exacerbate the danger. On the other hand, it is possible that increased secretion of cathecholamines and cortisol, as stress mediator, affect blood pressure, heart rate and lipid and glucose metabolism. The Helinski Heart Study of the Finnish population found that over a five-year period, rotating shift workers had a 40 to 50 percent increased risk of heart disease compared to day workers. A study of female shift workers showed that American nurses who worked rotating shifts for six years or more had a 51 percent higher coronary heart disease risk (18).

2.2.3.4 Effects on Women

A study of the effects of night work on women found that the incidence of irregular menstrual cycle was significantly higher in women working nights than in women working during the day (17). The results indicate that night work may suppress ovarian function by affecting hormone levels, which are governed by the circadian rhythms. While evidence of adverse effects of shift work on pregnancy is mixed. These include standing for long periods; working in heat and cold; lifting or other physically demanding tasks; and exposure to chemical, biological and radiation hazards. There are may affect the health and safety of the pregnant women, the development of the fetus, and may also have health implications for breast-feeding.

2.2.3.5 Fatigue

Fatigue is tiredness that results from physical and/or mental exertion (10). The level of fatigue will depend on the workload imposed by a job, the length of shift, previous hours and days worked, and the time of day or night. Jobs which require standing for lengthy periods, frequent manual handling or repetitive

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movements, or heavy work which is physically demanding can lead to increased fatigue on long shifts or shifts with overtime. Monotonous work or work where a high level of attention and alertness is required can also increase fatigue.

Rosters must be designed to minimize sleep debt and fatigue. Rest days should be distributed throughout the roster cycle to allow recovery before fatigue becomes acute. An accumulation of rest days as a result of extended periods of shift work should be avoided. The accumulation of rest days cannot compensate for daily fatigue. This is particularly important when considering compressed working weeks. Lack of sleep and fatigue in combination can adversely affect job performance, risking individual health and safety and the safety of others.

2.2.3.6 Stress (16)

Among studies of rotating shift workers, stress has been found to be highest on the midnight shift and lowest on days. Similarly, Zedeck et al. (1983) found that tension, irascibility and lack of enthusiasm were greatest for rotators on the midnight shift, and lowest on the day shift. Psychological stress has been reported to be lower for day workers than for employees who work fixed afternoons or midnight. rotating shifts. Smith et al. (19) found significantly higher depression and anger in afternoon workers, as compared to day workers; however, night and rotating workers did not differ significantly from day workers on the same measures. Barton et al. (20) also reported lower psychological stress among employees on fixed night shifts when compared to employees on rotating schedules.

2.2.4 Effect on Family and Social Life

Most of human society is geared towards the daylight hours. That is when most of the work is done. The early evening is for social life, and nighttime is for sleeping. Studies show that many shift workers suffer from additional stress caused by missing out important parts of their social life. Shift workers commonly cite difficulty maintaining friendships, keeping the kids quiet during the day, accomplishing household duties, and finding time for a satisfying marriage. Work by Bohle and Tilley (21) indicated that work-family conflict was significantly higher for afternoon workers, as compared to workers on either days or other non-day shifts, and that work-

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family conflict was a good predictor of psychological symptoms for afternoon workers.

2.2.5 Effect on Performance Efficiency

Human error is an important factor in work accidents and may depend on sleep and sleep related factors, as well as on circadian rhythms in alertness and performance capabilities. In general, performance efficiency appears to parallel the circadian rhythm in body temperature. It can peak earlier or later in the day depending on the demands of the task, on the length time that has elapsed since the individual concerned woke from their last proper sleep, and on the individual's general level of arousal and motivation. The desynchronization of circadian rhythms in combination with the associated sleep deficit and fatigue may significantly impair work efficiency. Accordingly Vidacek S. et.al.(22) shows that the productivity on night shift was significantly lower than morning shift and afternoon shift.

2.2.6 Prevention Stress in Shift Workers (17)

Since shift work is risk factors for health and well-being, therefore the medical reviews need to be carried out with the aim of informing the workers concerned and giving them suggestions and guidelines on how to cope with shift work. The main guidelines for designing shift systems according to psycho physiological criteria are:

2.2.6.1 Length of Shifts and Working Hours

It is recommended that the maximum hours to be worked in a day or a week should not exceed the following:

1) maximum of 6 consecutive 8-hour shifts
2) maximum of 2 consecutive night shifts
3) maximum of 2 consecutive 12-hour shifts
4) maximum 12 hours overtime per week
5) maximum 12 hours work per day (including overtime) except in

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emergency circumstances

6) maximum 48 hours rostered work per week.

In emergency circumstances a maximum 60 hours work in one week may be necessary. It should not be worked on a regular basis or in consecutive weeks.

2.2.6.2 Split or Broken Shifts

Split or broken shifts should be avoided wherever possible. As they are usually arranged to cover periods of peak activity, they put employees at risk of work overload. They can result in inadequate rest and make participation in family and social life difficult.

2.2.6.3 Overtime

Overtime should not extend the length of shifts beyond the maximum lengths recommended above. A supervisor should be responsible for monitoring the overall work pattern when overtime shifts are introduced. Records should be kept of the hours individual employees have worked. Where overtime is performed, it should be limited to a maximum of 12 hours per week. Overtime after 12 hour shifts is a high-risk and should never be worked other than in emergencies. Employers need to establish systems, which provide for employee to cover emergencies or possible absences on incoming crews.

2.2.6.4 Night Work

Night work should be avoided wherever possible. Each hour of night work should be regarded as imposing a greater workload than the same hour (3 am versus 3 pm) during a day shift, so workload demands at both enterprise and individual levels should be lower at night. The number of consecutive night shifts should be minimized to no more than two nights. The maximum length for night shifts should not exceed 8 hours. In addition, the volume of work should be organized to ensure that the number of employees needed to work at night is kept to minimum. Staffing levels must be kept high enough to ensure employees are not overloaded with work, are not at risk from increased exposure to other hazards and are not working in isolation. Work which is physically or mentally demanding, monotonous or requires high vigilance can lead to fatigue which will be worsened by night work. Bonus or incentive schemes or other pressures to achieve productivity are not suitable for night work.

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Night work should be organized to allow and encourage employees to take rest breaks and pauses, away from workstations. All breaks and pauses should be increased in number and duration compared to day shifts. Short naps may be helpful during night shifts, particularly on extended shifts. Where practicable, facilities for sleep breaks should be provided.

2.2.6.5 Breaks During Shifts

Adequate and regular rest breaks and pauses are essential for occupational health and safety requirements. Meal breaks or rest breaks should not be traded off for an early finish time. The number and duration of breaks during a shift should be adapted to the type of work, workload and length of shift. Longer and more regular rest breaks and pauses are needed the longer the shift. It is recommended that breaks during shifts should at least include:

1) on 8 hour shifts, one meal break of at least 30 minutes, plus two shorter breaks totaling at least 30 minutes

2) on 10 hour shifts, two meal breaks of at least 30 minutes each, plus two other short breaks totaling 20 minutes

3) on 12 hour shifts, one meal break of 45 minutes and another of at least 30 minutes, plus two or more shorter breaks totaling a minimum of 30 minutes.

The number and length of breaks during a shift is based on the physiological need for food and fluids at regular intervals. Most people would eat at least two meals during a 10 to 12 hour period of wakefulness. The maximum amount of time an employee should work without a break is 2.5 hours. All breaks should be taken away from the workstation. Breaks at the workstation are of poorer quality and do not provide adequate rest.

2.2.6.6 Breaks Between Shifts

Breaks between shifts should not be less than 12 hours. On rosters with extended shifts, this minimum break (12 hours) should be alternated with a break of at least 24 hours. In emergencies where a worker needs to remain on duty after a shift, the minimum break between shifts should never be less than 10 hours and should be compensated as soon as possible with a longer break.

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2.2.6.7 Rest Days

Days off between blocks of shifts should be evenly distributed. Compressing working weeks to produce longer breaks may sound appealing, but is an occupational health and safety hazard. Accumulation of rest days cannot compensate for daily fatigue. Good roster design should result in at least one full and two half weekends off in every four. Shift systems, which allow at least two whole weekends off per month, are preferable.

Work should be organized to ensure that the number of employees rostered to work on weekends as minimum as possible. However, those working must not be overloaded.

2.2.6.8 Timing of Shift

For the best occupational health and safety outcomes, it is recommended that shifts should not start between midnight and 6 am. This is to ensure an opportunity for adequate night rest.

2.2.6.9 Rotating Shifts

If a rotating three shift system is day, afternoon, and night, the rotation should be in the order to morning, afternoon and night, respectively. This is a forward rotation; as in forward on the clock face. If shift start times vary throughout a sequence of shifts, they should commence with an early start and move progressively later. Changes from a late start to an early start reduce the number of rest hours between shifts.

2.2.6.10 Roster Pattern and Length of Cycle

Rosters should be regular, to avoid disruptions to rest and sleep periods and for better organization of private, family and social life. It is generally preferable that the roster cycle be as short as possible, while remaining consistent with the recommendations above under ‘length of shift’. Roster details should be available to employees well in advance and maximum notice should be given regarding changes in the roster.

2.2.6.11 Exchange of Shifts

Exchange of shifts for special reasons should be allowed, provided the change is not result in excessive daily or weekly hours for any employee. A supervisor should be responsible for monitoring the effect on individual roster patterns. Exchange

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of shifts should not occur if it results in two or more continuous shifts being worked (i.e. no break between) or if recommended maximum hours were exceeded.

2.3 Cortisol and Stress

The first use of hormones as explanatory mechanisms in models of stress was Cannon's (1914) depiction of epenephrine as a primary mobilizer of the emergency response. In 1976 Selye's model of stress also was based on neuroendrocrine changes, but he focused on a different system (11). These changes were considered to be consequences of extend and unusually intense activity in the pituitary-adrenal cortisol system and the resulting massive release of corticosteriods. This part will review to provide an overview of cortisol function and relation with stress including relation of shift work with stress.

2.3 1 Cortisol (23,24,25)

Cortisol is a steroid hormone, compound with number 21 carbon secreted by the zona fasciculata of adrenal cortex. This hormone is most important in glucocorticoid group. It shows an important effect in increasing blood glucose concentration and has effect on both protein and fat metabolism. The metabolites of cortisol are tetrahydrocortisol glucoronide which product in liver and excreted in urine.

2.3.1.1 Synthesis of Cortisol

Cortisol synthesis can be described in five steps. First, esterified cortisol is hydrolyzed, and free cholesterol is actively transported to the mitochondria. Second, the cholesterol is then transported across the outer mitochondrial membrane the inner mitochondrial membrane, where the adrenoxin reductase and adrenoxin is localized. Third, the initial reaction that converts cholesterol to Δ^5-pregnenolone is catalyzed by a side chain cleavage enzyme P-450_{scc}, also know as 20,22-desmolase. This intramitochondrial complex carries out successive hydroxylations, followed by cleavage of the cholesterol side chain. Fourth, the Δ^5-product, pregnenolone, is then converted to 11-deoxycortisol by in the endoplasmic recticulum. Fifth, 11-deoxycortisol is transferred back to the mitochondria and hydroxylated in the 11 position. The end product is cortisol, rapidly diffuses out of the cell. The last and most

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critical step in glucocorticoid synthesis, 11-hydroxylation, is efficient in humans; 95% of the 11-deoxycortisol formed is converted to cortisol. Figure 2-3 shown the synthesis of glucocorticoids in the zona fasciculata.

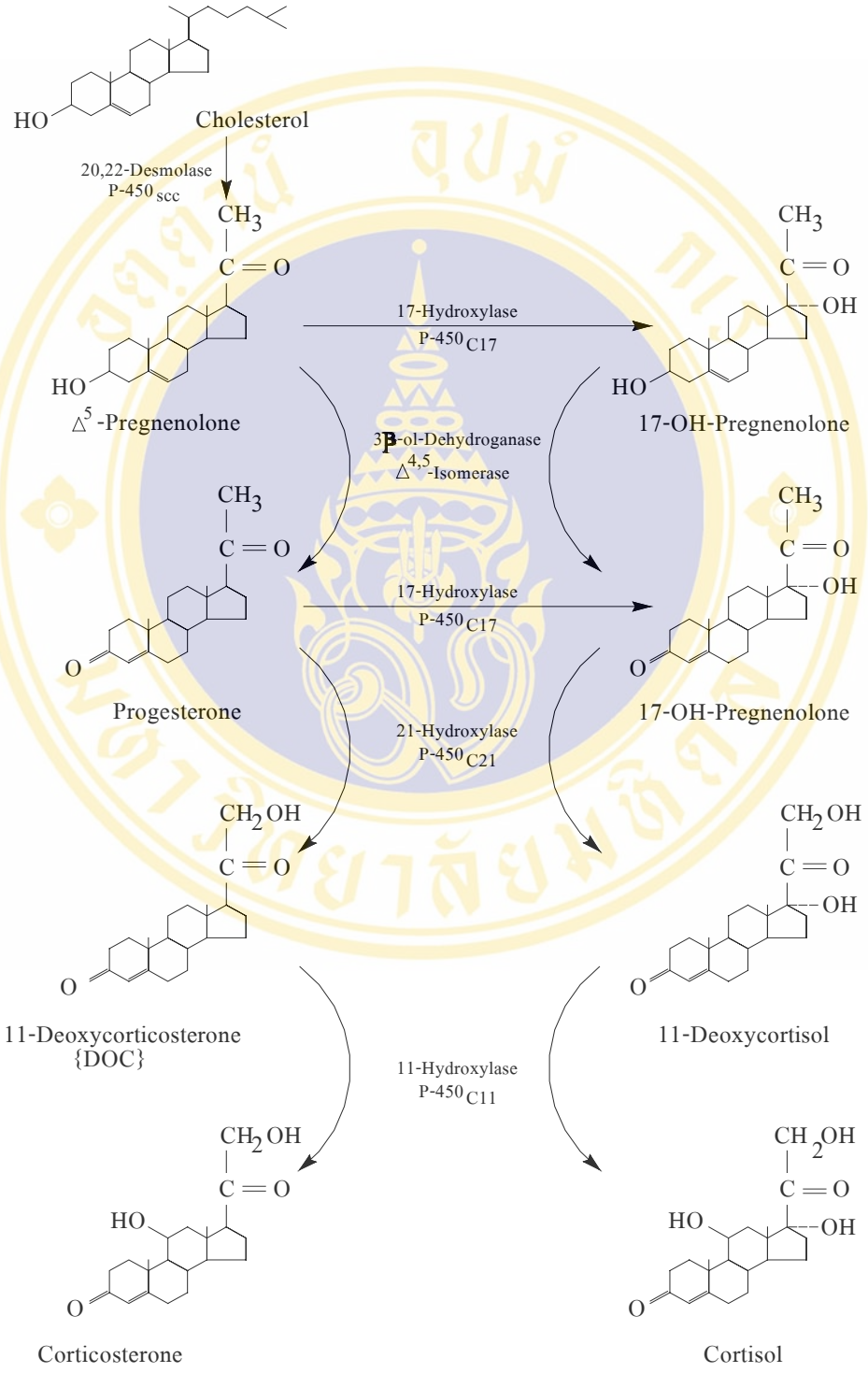

Figure 2-3. Synthesis of cortisol in the zona fasciculata

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The average normal 8 AM plasma levels of cortisol and other adrenal steroids in human, as well as their estimated secretion rates, are given in Table 2-1. The dominance of cortisol over corticosterone as a glucocorticoid in evident.

Table 2-1. Average 8 AM plasma concentration and secretion rates of adrenocortical steroids in adult humans

Hormone	Plasma concentration (μg/dl)	Secretion rate (mg/dl)
Cortisol	13	15
Corticosterone	1	3
11-Deoxycortisol	0.16	0.40
Deoxycorticosterone	0.07	0.20
Aldosterone	0.009	0.15
18-OH Corticosterone	0.009	0.10
Dehydroepiandrosterone sulfate	115	15

2.3.1.2 Regulation of Cortisol Secretion

Cortisol excretion is under control of adrenocoticotropic hormone (ACTH) from hypothalamus. Hormone level is depending on the ACTH level. Excretion of ACTH is circadian rhythm or diurnal rhythm. It's high in the early morning and low in the late evening, which shows in Figure 2-4. This diurnal rhythm is controlled by environmental changes e.g. a length of day (light), change time to sleep, a starvation and stress. These condition cans effect on corticotropin-releasing hormone (CRH) level too. Cortisol decreasing level cans stimuli excretion rate of CRH and ACTH.

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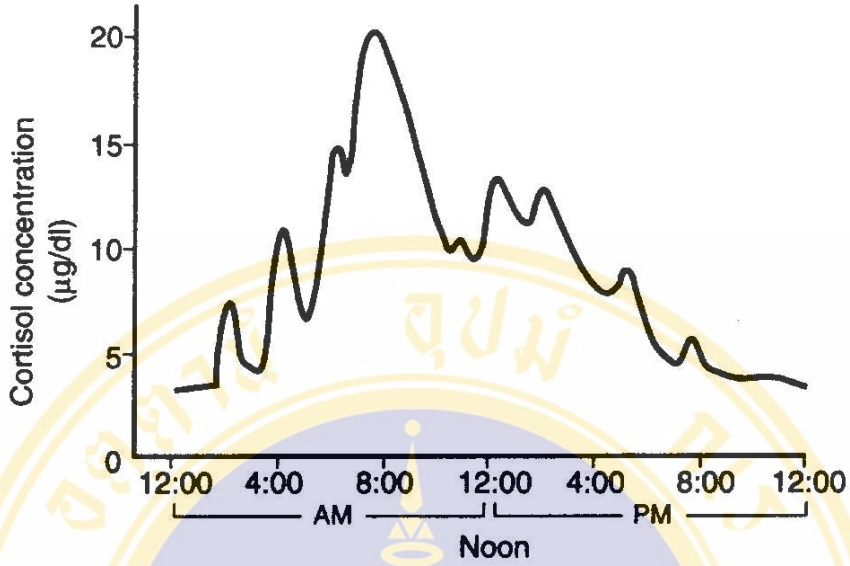

Figure 2-4. Diurnal rhythm of cotisol.

Figure 2-5. shows the overall system for control of cortisol secretion. The key to this control is the excitation of the hypothalamus by different type of stress. Stress stimuli activate the entire system to cause rapid release of cortisol, and the cortisol in turn initiates a series of metabolic effects directed toward relieving the damaging nature of the stressful state. In addition, there is direct feedback of the cortisol to both the hypothalamus and the anterior pituitary gland to decrease the concentration of cortisol in the plasma at times when the body is not experiencing stress. However, the stress stimuli are the prepotent ones; they can always break through the direct inhibitory feedback of cortisol, causing either periodic exacerbations of cortisol secretion at multiple times during the day (Figure2-4) or prolonged cortisol secretion in times of chronic stress.

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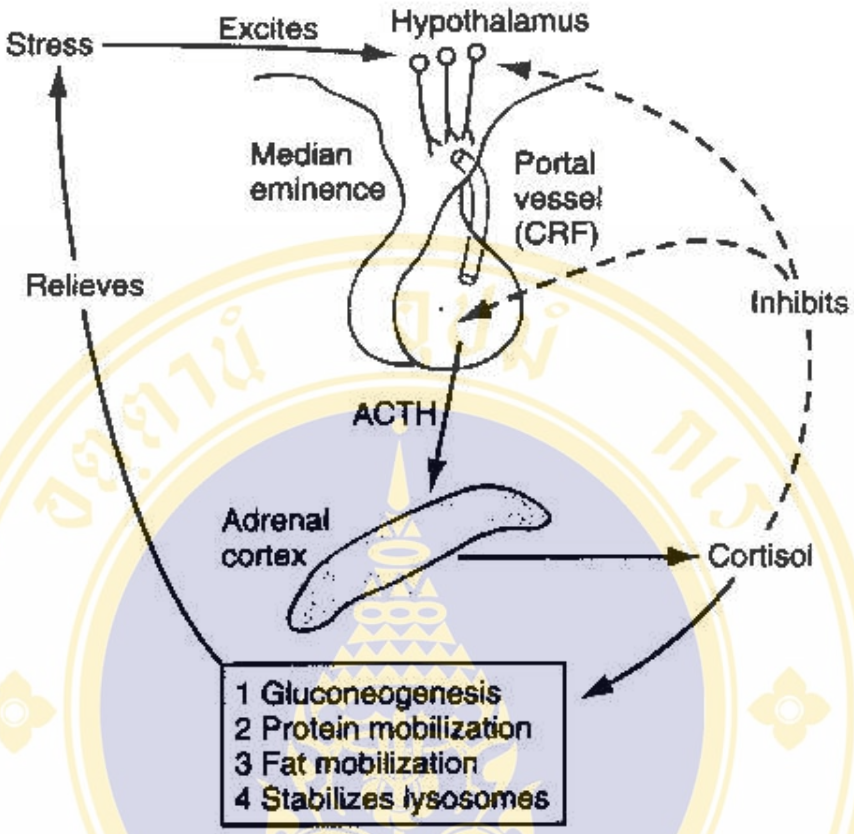

Figure 2-5. Mechanism for regulation of glucocorticoid secretion. ACTH, adrenocorticotropic hormone; CRF, corticotrophin-releasing factor.

2.3.1.3 Transport and Fate of Cortisol (25,26)

Cortisol combines in the blood mainly with glucose called corisol binding globulin or transcortin and to a lesser extent with albumin. About 94% are normally transported in the bound form and about 6% are free form. In both the combined and free forms, the hormones are transported throughout the extracellular fluid compartment. Binding hormone may serve as a reservoir to lesson rapid fluctuation in free hormone concentrations, as would occur for example, with cotisol during brief periods of stress and episode secretion of ACTH. This reservoir function may also help to ensure a relative uniform distribution of cotisol to the tissues.

The adrenal steroids are degraded mainly in the liver and conjugated especially to form glucoronic acid and to a lesser extent, sulfates. About 25% of these

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conjugates are excreted in the bile and then in the feces and remaining 75% in the urine. The conjugated forms of these hormones are inactive.

The concentration of cortisol on the blood is 12 mg/100 ml, and the secretion rate averages 15-20 mg/day. Excretion values for corticosteroids will be noted that the mean excretion in males of different ages tends to be higher than that in females. In both sexes readings rise sharply at the time of puberty and reach their maximum between the ages of 20 and 30 with advancing years the excretion of total corticosterroids falls progressively. The levels of hormone in females are stable with advancing age. Excretion rate of free cortisol in are averages 10 – 100 μg/day.

2.3.1.4 Factor of Cortisol

There are many factors that can effect on cortisol excretion rates such as: caffeine consumption, smoking, gender different and environmental conditions. From a study of Chris F.(27) show that caffeine can block the action of adenosine, it also stimulates the adrenal glands to produce stress hormones. Baron JA. et al.(28) assessed the association between cigarette smoking and basal levels of adrenal cortisol hormones in postmenopausal smokers and postmenopausal nonsmokers. The results indicated that cigarette smoking causes a generalized disturbance in adrenal cortical hormone levels. Shamim W. et al.(29) studied gender differences in the urinary excretion rates of cortisol and androgen metabolites. The result indicated that the median urinary metabolite of total cortisol metabolite was 6,965 μg/day for men and 4,595 μg/day for women. This showed significant differences in the steroid metabolite excretion profiles between men and woman. Deane R. et al.(30) assessment the levels of urinary stress hormones in male and female nurses for determine their contribution to sex-determined health outcomes by assessing the levels of urinary stress hormones, adrenaline, noradrenaline and cortisol. Urinary cortisol, adrenaline and noradrenaline levels were all increased with age in both sexes. These hormones were lower in premenopausal women compared with male nurses of similar age. This study concludes that the gender difference can effect on the secretion of cortisol and adrenaline. Accordingly Van CE. et al.(31) and Raven PW. et al (32) indicated that women had slightly lower mean cortisol levels than men in the same age range.

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Environment is one factor that can effect on cortisol excretion rates. Vangelova K. et al.(33) investigated the effect of long term repeated heat exposure on the excretion rates of cortisol and cathcholamine of workers in glass manufacturing unit. The workers had moderate workload and measuring heat exposure by Wet Bulb Glob Temperature. A result shown that work in conditions of overheats is associated with highly cortisol and cathcholamine.

The study of Koller M et al. (50) shows that hormonal phase positions coincided significantly with light exposure. Accordingly Hollwich F et al. (51) shows that Increasing the intensity of artificial light with "neon-tubes" (fluorescent tubes) leads to "light stress" proved by increased hormone production - especially the stress hormone Cortisol.

From the profile of cotisol which excreted in diurnal rhythm and changes with all factors above. That useful to used this profile to diagnosis disorders. For example, measured urine free cortisol for diagnosis stress. So, this study was interested to study stress in females shift workers by using a changes profile of urine cortisol and the stress questionnaire.

2.3.1.5 Effect of Cortisol (25)

Cortisol is essential for life. It's maintains glucose production from protein, facilitates fat metabolism, supports responsiveness of the vascular tree, modulates central nervous system function and profoundly affects the immune system. In addition, cortisol affects skeletal turnover, muscle function, and renal function. The net effects of its metabolic actions is catabolic or antianabolic. The term permissive has been used to describe many of cortisol's action, implying that the hormone may not directly initate so much as allow certain processes to occur. Figure 2-6 shown overview of cortisol effects on various tissues, organ and system.

1) Effect on metabolism. Cortisol acts permissively to facilitate the mobilization of fuels. The nocturnal surge in cortisol supports the enhancement of gluconeogenesis, lipolysis, and ketogenesis necessary for overnight metabolic stability. The most important overall action of cortisol is to facilitate the conversion of protein to glycogen. Cotisol enhances the mobilization of muscle protein for gluconeogenesis by accelerating protein degradation and inhibiting protein synthesis. Cortisol further stimulates the transformation of the proteolytically derived amino acid

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into glucose precursors, thence into glucose. Cortisol also plays a somewhat analogous and permissive role in fat metabolism. Thus, during fasting, cortisol permits accelerated release of stored energy in the form of fatty acids and of glycerol for gluconeogenesis. Cortisol promotes mobilization of fatty acid from adipose tissues especially extremities and promotes accumulation of fat in the abdomen and above the clavicles

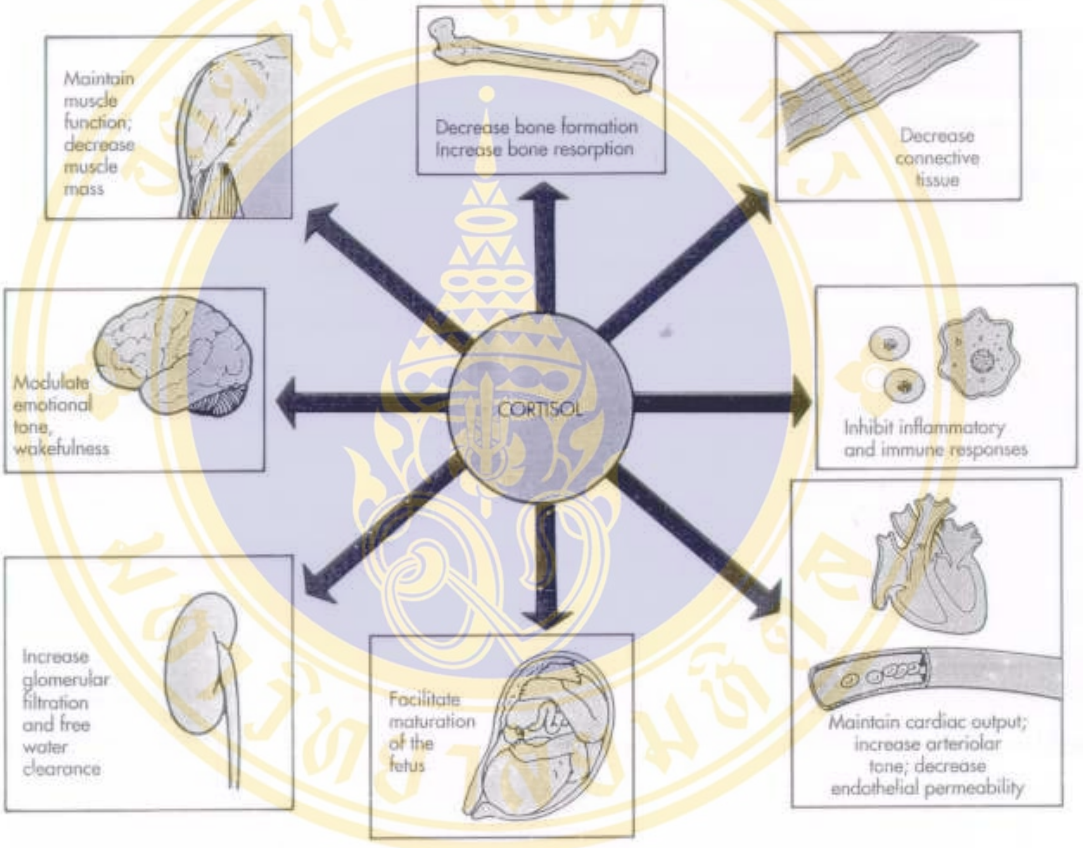

Figure 2-6. Overview of cortisol effects on various tissues, organs, and system.

2) Effects on muscle. Cortisol maintains the contractility and work performance of skeletal and cardiac muscle. In addition, an access cortisol can decrease muscle protein synthesis, increase muscle catabolism and consequently reduces muscle mass and muscle strength.

3) Effects on bone. Cortisol inhibits bone formation by several mechanisms. First, cortisol reduces the synthesis of type I collagen, the fundamental

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component of bone matrix. Second, cortisol decreases the rate of differentiation of osteoprogenitor cells to active osteoblasts. Third, cortisol decreases the absorption of calcium from the intestinal tract. Cortisol additionally increases the rate of bone resorption. Thus, one major consequence of cortisol excess is an overall reduction in bone mass.

4) Effects on the fetus. Cortisol facilitates in utero maturation of the central nervous system, retina, skin, gastrointestinal tract and lungs.

5) Effects on vascular system. Cortisol is requires for the maintenance of normal blood pressure. Cortisol decreases production of vasodilator prostaglandins and helps to maintain the blood volume by decreasing the permeability of the vascular endothelium.

6) Effects on the central nervous system. Cortisol modulates excitability, behavior, and mood of individuals. In excess, cortisol can cause insomnia, strikingly elevated or depress moods and decrease memory function. Cortisol also specifically decreases the ability to detect taste, olfactory, auditory and visual stimuli. On the other hand, cortisol improves the ability to integrate those sensations that are perceived and to organ appropriate responses.

7) Effects on inflammatory and immune system. Cortisol has a profound influence on the complex set of reactions evoked by tissue trauma, chemical irritants, infection, or foreign proteins. The immediate local reaction to injury consists of dilation of capillaries and changes in the endothelial cell membranes that increase microvascular permeability and enhance the trapping of circulating leukocytes at the site of injury. These reactions, mediated by prostaglandins, thromboxanes, leukotrienes, nitric oxide, and platelet-activating factor, are profoundly inhibited by cortisol and all currently available synthetic glucocorticoids that are used therapeutically.

2.3.1.6 Cortisol Excretion Disorders (24)

In excess, cortisol can cause Cushing's disease and deficiency can cause Addison's disease. These diseases are cause from hormone production disorder. From this cause it found increase urine free cotisol. It's useful to diagnosis in human especially in female between 20 – 60 years. Table 2-2 shows disorders of exceed or deficiency cortisol level.

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Table 2-2. Disorders of exceed or deficiency cortisol level.

Conditions	Deficiency	Exceed
Blood glucose	Hypoglycemia	Hyperglycemia
Insulin responsed	Increased insulin excretion	Decreased insulin excretion
Lipidemia	Hypolipidemia	Hyperlipidemia
Fat in body	Skiny extrimities	Moon face, buffalo hump
	Weigh loss	Obesity
	Hypotension	Hypertension
	Fatigue	Muscle weakness
	Hyponatremia	Hypernatremia
	Hyperkalemia	Hypokalemia
	Decreased cellular extrafluid	Increased cellular extrafluid
	Easy fatigue	Anxiety, depression
	Autoimmune disease	Anti-inflammation

2.3.2 Cortisol and Stress

A study of cortisol and stress was begun since late 1970s. Most of this work has pursued the possible role of HPA disregulation in depression.(5). Relatively pronounced HPA activation being more frequents and of longer duration among depressed then among other psychiatric patients and normal. (34). Sachar EJ. indicated that anxious patients tend to have higher cortisol levels than normal controls. (35)

Physiological will be changes during stress. That is, when an event or situation is stressful, a cascade of hormonal changes occurs that appears to work either to motivate or to support coping with the stressor. The sympathetic nervous system (SNS) activity increases with a corresponding increase in catecholamines release and whole-body activation. At the same time, SNS arousal, together with other neuroendrocrine changes, increases the availability of glucose and otherwise supports whatever coping responses are applied. The activating functions of SNS activity alone serve to heighten the strength and speed of these responses, and other changes are intimately involved in metabolic regulation during stress (5).

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Almost type of stress, whether physical or neurogenic, causes an immediate and marked increase in ACTH secretion by the anterior pituitary gland, followed within minutes by greatly increased adrenocortical secretion of cortisol. This demonstrated dramatically by the experiment show in Figure 2-7 in which corticosteriod formation and secretion increased six folds in a rat within 4 to 20 minutes after fracture of two leg bones. Some of the difference type of stress that increase cortisol release such as trauma of almost type, infection, intense heat or cold, infection of norepinephrine and other symphathomimetic drugs, surgery, almost any debilitating disease etc (25).

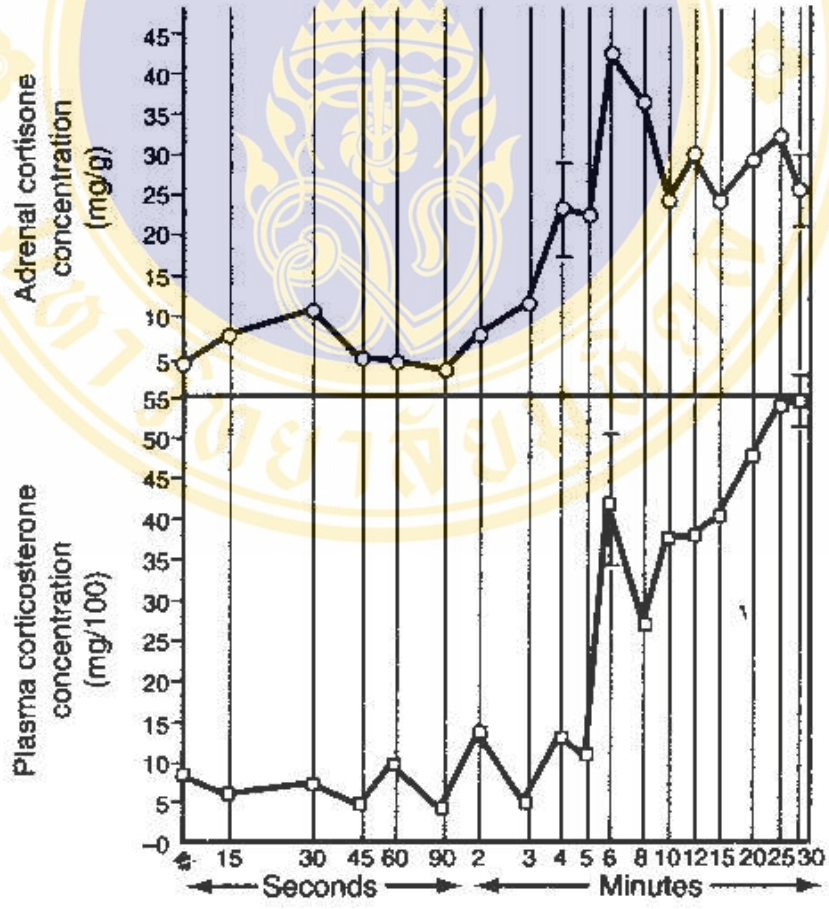

Figure 2-7. Rapid reaction of the adrenal cortex of a rat to stress caused by fracture of the tibia fibula at time zero. (In the rat corticosterone is secreted in the place of cortisol)

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Even thought we know that cortisol secretion often increases greatly in stressful situations, it not sure why this is of significant benefit to the animals. One possibility is that the glucocorticoids causes rapid mobilization of amimo acids and fats to making energy and synthesis other compound, including glucose, need by the different tissues of the body. Indeed, it has been shown in a few instances that damaged tissues that are momentarily depleted of proteins can use the newly available amino acids to form new proteins that are essential to the lives of the cells. But all this is mainly supposition. It is supported only by the fact that cortisol usually does not mobilize the basic functional proteins of the cells, such as the muscle contractile proteins and the proteins of neurons, until almost all other proteins have been released. This preferential effect of cortisol on mobilizing labile proteins could make amino acids available to needy cells to synthesize substances essential to life.

Physiologic stress can increases ACTH and adrenocortical secretion. Almost type of physical and mental stress can lead within minutes to greatly enhanced secretion of ACTH and consequently cortisol as well, often increasing cortisol secretion as much as 20-fold. This effect was demonstrated forcefully by the rapid and strong adrenocotical secretory response after trauma show in Figure 2-8.

Mental stress can cause an equally rapid increase in ACTH secretion. This is believed to result from increased activity in the limbic system, especially in the region of the amygdala and hippocampus, both of these then transmitting signals to the posterior medial hypothalamus.

2.4 Measuring Stress (5)

Three broad traditions of assessments the role of stress on disease risk can be distinguished. First, the environmental tradition focuses on assessment of environmental events or experiment that a normatively (objective) associated with substantial adaptive demands. The common techniques are checklist measurement of stressful life events, interview measurement of stressful measurement, daily and within-day event measurement, and measurement of chronic stress. Second, the psychological tradition focuses on individuals subjective evaluations of their abilities to cope with demands posed by specific events or experiences. The measurement

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techniques are measurement of stress appraisal and measurement of affective response. Finally, the biological tradition focuses on activation of specific physiology system that has been repeatedly shown to be modulated by both psychologically and physically demanding conditions. The measurement techniques are measurement of stress hormone response, measurement of cardiovascular response, and measurement of immune response.

In this parts will focuses on biological perceived by measurement of stress hormone.

2.4.1 Measurement Stress Hormone

A common stress hormone for assessment stress are cathecholamines, epinephrine, norepinephrine, corticosteriods, and their metabolites, endrogenous peptide and serotonin including growth hormone, thyroid-stimulating, insulin and others have been measured as they change in blood, urine and saliva concentration during stress.

2.4.1.1. Cathecholamines

One of the more common and frequently used measured of hormone activity in stress is the assessment of circulating or excreted levels of epinephrine and norepinephrine.

1) Plasma and urinary cathecholmines

Circulating level of cathecholmines can be measured by assaying blood samples, but the half-life of epinephrine and norepinephrine are very short (1-3 minutes). As a result, measures from blood reflect acute states. Determinations of levels of epinephrine and norepinephrine in the blood reflect recent levels of sympathetic nervous system (SNS) activity and should not necessarily be considered as indicating anything more than a transient of momentary state. For study of the effects of chronic stress, these blood measures are not particularly useful because of considerable fluctuation and intra individual variability in epinephrine and norepinephrine levels. Levels of cathecholmines also can be estimated by measuring free epinephrine and norepinephrine in the urine. The levels of free cathecholmines in urine are low but consistent fraction as free epinephrine and norepinephrine, and although these are not necessary accurate measures of absolute levels. They are useful

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in comparisons among individuals or longitudinally in the same subject. Examination of free urinary epinephrine and norepinephrine allows differentiation of the two cathecholmines as does analysis of some metabolites such as metanephrine and normetanephrine. The alternative, measuring other metabolites of epinephrine and norepinephrine in the urine, does not permit differentiation because the two are metabolized in to the same compounds, primarily vanillylmandelic acid (VMA) and methoxyhydroxyphenylglycol (MOPG). Assessments of these metabolic products provide good estimates of overall cathecholamine activity but do not permit evaluation of separate levels of epinephrine and norepinephrine.

2) Assays

There are two principle techniques used to measure level of cathecholamine in biological fluid, radioenzymatic assay (REA) and high pressure liquid chromatography (HPLC).

2.4.1.2 Cortisol

Stress can be assessment by cortisol in biological fluid such as serum, urine and salivary.

1) Plasma and urinary cortisol

The half life of cortisol in plasma is longer than catecholamines (about 70 minutes). This means that different timing issues become important. If researchers are interested in measuring circulating catecholmines and cortisol as a function of an acute stressor, baselines for catecholamines cannot be taken right after venipuncture because the SNS-stimulating effects of the venipuncture will affect catecholamines right away. As a result, researchers should wait until the effects of the needle stick have passed, perhaps 15-50 minutes afterward, before drawing blood for baseline catecholamines levels. However, effects of venipuncture on cosisol might not be evident for at least 10-15 minutes after venipuncture, so an immediate postdraw sample would provide a useful baseline for cortisol. Most of the excretory product of cortisol is in the form of metabolites such as 17,21-dihydroxy-20-ketone (17-OHCS) compound and 17-hydroxycorticoids (which constitue up to half of total cortisol secretion). However, these metabolites are conjugates with glucoronide or sulfate in unactive form. In many studies conclude that corticosterone are more useful than

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catecholamines because it has long half life and immediate response than catecholamines.

2) Salivary cortisol

Saliva sample is a one specimen to measure hormones level. Saliva samples can be obtained without stressful by venipuncture and do not require medical personal for data collection. Use of salivary cortisol measured offers the opportunity to assess hormone without ethical problems. One problem associated with salivary measures in stress research has been concern about flow rate.

3) Assays

Corticosteroids are usually assayed by radioimmunoassay (RIA) technique that use radioisotopes in immunological processes. These assays yield reliable determinations of cortisol in plasma, urine and saliva. This technique is relatively to use, is highly reliable, and has been validated extensively.

2.4.1.3 Endogenous Opioid Peptides (EOPs)

Endogenous opioid peptides (EOPs), such as betaendrophin, leu-encephalin, met-enkephalin and dynorphin, have been studied as determinants or mechanisms in stress-drug interaction, as factors in eating or smoking, or mechanisms of stress-induced immune system changes, but their functions in the periphery are not clear. How ever, there is evidence that EOPs increasing during stress. Measurement of EOPs can be extremely important in clinical studies in which cerebral spinal fluid samples are available, or in animal research in which brain tissue can be collected and analyzed.

1) Assays

Assays of EOPs is ordinarily done with radioimmunoassay (RIA) technique

2.4.1.4 Serotinin

Serotonin (5-HT) is found in chromaffin cells of the intestinal mucosa, in the bloodstream (e.g. in platelets), the central nervous system, and in the brain. Among its roles are actions in muscle contraction, feeding, sleep, mood, metabolism, and neuromodulations. Recent research has linked serotonergic activity with

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depression, premenstrual syndrome and eating disorders. Serotonin can assays by metabolites or assays of excreted unmetabolized 5-HT. Major metabolite of serotonin is melatonin.

1) Assays

Serotonin is usually assayed by radioenzymatic procedures. Conceptually, this assay is similar to the radioenzymatic assay (REA) for catecholamines and by HPLC.

2.4.1.5 Others Hormone

In addition to these chemicals, prolactin, thyroid hormone, growth factor, insulin, gonadal hormone, and other peptides show changes associated with stress. The meaning of changes in these compounds is not always clear.

Table 2-3. Show the comparison between advantage and disadvantage of cathecholmines, melatonin, and cortisol in blood, urine, and saliva samples and assays technique for each hormone.

Table 2-3. Comparison between advantage and disadvantage of cathecholmines, melatonin, and cortisol in blood, urine and saliva samples and assays technique.

Hormone	Blood	Urine	Saliva	Assays
Cathecho-lamines	Half life about 3 minutes.	The levels of free cathecholmines in urine were low. The metabolites of cathecholamines were in to the same compounds. Assessments of these metabolic products provide good estimates of overall cathecholamine activity but do not permit evaluation of separate levels of epinephrine and norepinephrine	-	HPLC

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Table 2-3. Comparison between advantage and disadvantage of cathecholmines, melatonin, and cortisol in blood, urine and saliva samples and assays technique. (continuted).

Hormone	Blood	Urine	Saliva	Assays
melatonin	Half life about 28.4 minutes. (47)	Measurement in metabolite shows correlation with blood.	About 30 % of plasma	Radio enzymatic or HPLC
cortisol	Half life about 70 minutes.	Measurement in metabolite shows correlation with blood.	Fluctuated by flow rate	RIA

In this study was measured stress by assessing cortisol excretion levels and questionnaire. The levels of cortisol will be accessed in worker's urine and analyzed by radioimmunoassay technique. This technique is reliable and validated. Accordingly Ursala T. et al. (36) determined of urinary free cortisol by HPLC. The HPLC method was compared with RIA and automated immunoassay method. The result obtain by HPLC are about half the quantities obtained by immunoassays (about 40%), and especially in the low range of values the correlations in poor.

2.5 Radioimmunoassay Technique (25,37,38)

In 1960, Yalow and Berson, reported a method for the quantitative measurement of insulin based on a new technique of competitive binding assay. This method has been widely applied as the radioimmunoassay (RIA). An analysis procedure was continuing develop for more reliable and validated.

2.5.1 Principle of Radioimmunoassay

Figure 2-8 shows a principle of radioimmunoassay technique. The principle of radioimmunoassay is as follow. First, fixed quantity of antibody that specific for the hormone to be measured is produced. Second, fixed quantity of antibody is (1) mixed with a quantity of fluid from the animal containing the hormone to by measured (antigen) and (2) mixed simultaneously with an appropriate amount of radiolabelled antigen.

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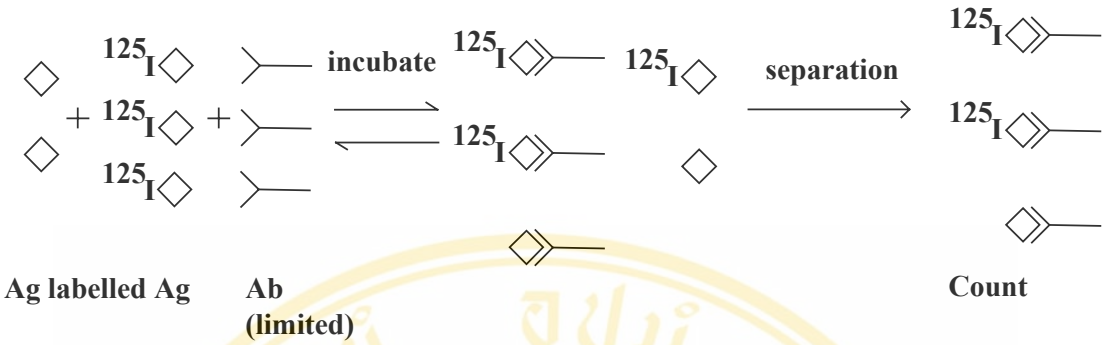

Figure 2-8. Principle of radioimmunoassay technique.

However, one specific condition must be met: There must be too little antibody to bind completely both the antigen and the radiolabelled antigen. Therefore, the antigen and the radiolabelled antigen are competing for the binding site of the antibody. In the process of competing, the quantity of each of the two hormones, antigen and radiolabelled antigen, that binds is proportional to its concentration in the assay fluid. Third, after binding has reached equilibrium, the antibody-hormone complex (bound) is separated from the remainder of the solution. Table 2-3 showed method for separated bound and free in radioimmunoassay techniques.

Table 2-4. Methods for separated bound and free in radioimmunoassay technique.

Type	Methods
1. Precipitation of the free	Dextran-coated charcoal system
2. Precipitation of the steroid-antibody complex	Double antibody
	Ammonium sulfate
	Polyethylene glycol
3. Solid phase	Antibody-coated polystyrene test tubes
	Polymerization of antibodies
	Antibodies covalently coupled to glass beads or magnetic particle

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The quantity of radiolabelled antigen bound in this complex is measured by radioactive counting techniques. If a large amount of radiolabelled antigen has bound with the antibody, it is clear that there was only a small amount of antigen to compete with the radiolabelled antigen, and therefore the concentration of antigen in the assayed was small. Conversely, if only a small amount of radiolabelled antigen has bound, it is clear that there was a large of antigen of competes of the binding sites. Fourth, to make the assay highly quantity, the radioimmunoassay procedure is performed also for "standard" solutions of untagged hormone, as show in Figure 2-9. By comparing the radioactive counts recorded from the "unknown" assay procedure with the standard curve, one can determine within an error of 10 to 15 per cent the concentrations of the hormone in the "unknown" assayed fluid. As little as billionths or even trillionths of a gram of hormone can often be assayed in this way.

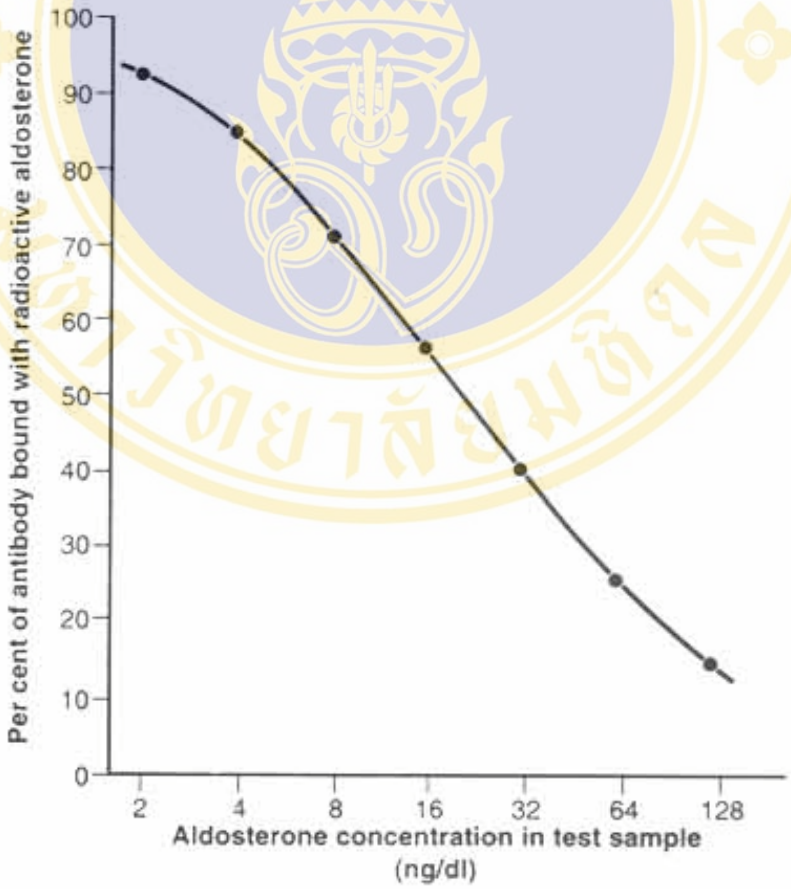

Figure 2-9. Standard curve for radioimmunoassay of aldosterone.

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2.5.2 Procedure for Analysis by Radioimmunoassay Technique

In RIA technique an analysis in each batch is contained:

2.5.2.1 Total Count (T): this tube contain tracer. The maximum total number of count obtained, equivalent to the amount of radioactivity added to each assay.

2.5.2.2 Non-Specific Binding(NSB): non-immunological binding of tracer to the precipitating reagent. Even in the absence of specific antiserum a small amount of tracer binds to the precipitating reagent; the NSB is the measure of this low binding.

2.5.2.3 Maximum Binding(BO): maximum amounts of the tracer that the antiserum can bind in the absence of free analyze.

2.5.2.4 Standard Tube: This tube contains tracer, antibody and series concentration of standard substances (5-6 levels).

2.5.2.5 Sample: This tube contains tracer, antibody and specimen for analyze.

2.5.3 Step for Analysis

Steps of analysis in RIA technique are contained 6 steps followings:

2.5.3.1 Purifying specimen before analyze. However, most of readymade solutions not use in this step.

2.5.3.2 Pipette solution

2.5.3.3 Incubated until equilibrium

2.5.3.4 Separate free and bound

2.5.3.5 Radioactive count in bound form

2.5.3.6 Calculation

2.6 Measurement of Kidney Function (48,49)

The amount of Blood urea nitrogen (BUN) and creatinine in the blood are equal to the amount excreted by the kidneys. The blood levels of BUN and creatinine remain unchanged unless there is sudden deterioration of renal function. If the kidneys are suddenly unable to function, BUN and creatinine increase daily. This condition is know as acute renal failure. Chronic renal failure is a condition distinguished by a gradual increase in BUN and creatinine over a long period of time.

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2.6.1 Blood urea nitrogen

Blood urea nitrogen (BUN) is the amount of nitrogen in the blood. It is produced when protein breaks down or is metabolized. The kidneys eliminate more than 90% of the BUN that body produces, so blood levels can indicate kidney function.

High BUN levels suggest impaired kidney function. This may be due to acute or chronic kidney disease. However, there are many things besides kidney disease that can affect BUN levels such as decreased blood flow to the kidneys as in congestive heart failure, shock, stress, recent heart attack or severe burns; conditions that cause obstruction of urine flow; or dehydration. Low BUN levels are not common and are not usually a cause for concern. They can be seen in severe liver disease liver or malnutrition but are not used to diagnose or monitor these conditions. Low BUN is also seen in normal pregnancy.

BUN levels increase with age and also with the amount of protein in that person diet. High-protein diets may cause abnormally high BUN levels. Very low-protein diets can cause abnormally low BUN. Lower BUN levels are also seen in infants and small children. The normal level of BUN is 10-15 mg/dl.

2.6.2 Creatinine

Creatinine is produced in muscles when a compound called creatine spontaneously breaks down. Creatine is part of the cycle that produces energy needed to contract the muscles and it is produced at a relatively constant rate. Almost all creatinine is excreted by the kidneys, so blood levels can indicate kidney function. Increased creatinine levels in the blood suggest diseases that affect kidney function. These can include:

1) glomerulonephritis
2) pyelonephritis
3) acute tubular necrosis
4) urinary tract obstruction
5) reduced blood flow to the kidney or complications of diabetes.

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Creatinine can also increase as a result of muscle injury. Low levels of creatinine are not common and are not usually a cause for concern. They can be due to lack of height, decreased muscle mass, and some severe liver disease. In general, creatinine levels will stay the same if eat behavior is normal. However, eating large amounts of meat may cause short-lived increases in blood creatinine levels. Taking creatine supplements may also increase creatinine. The normal level of creatinine is 0.5-2 mg/dl.

2.7 Literature Review

Weibel L.et al. (39) studied disturbances in hormonal profiles of night workers during their usual sleep and work times The endocrine profiles of night workers were compared to those of day-active subjects studied during their usual sleep-wake schedule. During usual day sleep, despite an adapted sleep structure, cortisol levels among night workers were abnormally. During usual work time, some hormonal disturbances persisted, in particular concerning cortisol and PRL.

Sluiter JK. et al. (40) find out what extent neuroendrocrine reactivity during work and neuroendrocrine recovery from work, and work characteristics, are related to subjective need for recovery and perceived health status. A result indicated that significant neuroendrocrine contributors were found for cortisol in reactivity during work and recovery immediately after work and recovery during the day off work, and for adrenaline in baseline level and recovery during the day off work.

Juergen H. et al. (41) determined the size of changed and the time point of those changes in biological rhythms during night shift and they associated tolerance. They showed a clear reversal of the circadian function for the total group after the fifth night. However, circadian function is changes in one worker. These subjects exhibited lower durations of and less consistency in recovery sleep across the following days after night work.

Hans Z. (42) studied workload and psychophysiological stress reactions in air traffic controllers. The questionnaire was introduced and saliva was collected before and after time during low and high traffic. The investigated working sessions showed that the airport control tower subjective rating correspond clearly to their cortisol

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response and the objective workload. Thus, worker complaints regarding excess can be seriously in the long run.

Neary JP. et al.(6) examined the relationship among resting cortisol levels measured in serum, saliva, overnight urine and 24 h urinary free cortisol samples. For determine an appropriate sample to monitoring recovery from the physiological stress imposed by exercise training. Cortisol was analysis by using solid phase radioimmunoassay. Level of cortisol in serum is 656.5+/-122.3 nmol x L(-1). In saliva is 41.9+/-12.3 nmol x L(-1), overnight urine is 72.0+/-19.5 nmol x L(-1) and 24 h urinary free cortisol is 170.8 +/-58.7 nmol x day(-1). Intraclass correlation coefficients (R) showed a high correlation between 24 h urinary free cortisol versus serum (R=0.99), saliva (R=0.97), and overnight (R=0.97), and between serum and saliva cortisol (r=0.99). In conclusion, the strong intraclass correlation coefficient between 24 h urinary free cortisol versus serum and saliva suggests that either sample can be used to monitor cortisol hormone during a recovery period from exercise training. Accordingly Kos-Kudla B. et al. (7) that evaluation of the usefulness of salivary and urinary cortisol levels and urinary cortisol metabolites in 24-hr urine was conducted using the correlation coefficient between the cortisol level in the salivary or urine and that in blood serum. The result indicated that high correlation between the serum and salivary cortisol level (r=0.817). The correlation coefficient between the serum and urinary cortisol level in basal conditions was 0.759, while that between the saliva and urinary level was 0.723. It was concluded that urine and saliva samples for the cortisol analysis may have many advantages due to its non-invasive nature.

Feldman JM. and Roche J. (43) studied the effect of contraceptives on adrenal function. Subjects are the women who receiving oral contraceptive and control group. They showed no difference of 17-hydroxycorticosteriod, 17-ketosteroid and urinary free cortisol in the two groups. The subjects who receive oral contraceptive had higher plasma cortisol concentrations than the controls. This finding is agreed with the studied of Fahl WE. and Rose .P. (44) that shown about contraceptive steroids caused increase in the corticosteroid sulfate but, urinary free cortisol was unchanged.

Wilk TJ. and Himing DA (45) evaluated of five serum cortisol kits regarding precision and accurancy. The kits are Amerlex (Amersham International), Corti-Shure (Nuclear Medical Laboratories), Gammacoat (Clinical Assays). Coat-A-Count and

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DPC-direct (Diagnostic Products Corperation). All kits showed good sensitivity and parallelism. Coat-A-Count and Gammacoat were technically the simplest assays while Corti-Shure and DPC direct kit had the best designed standard curves over the diagnotic range.

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CHAPTER III
MATERIALS AND METHODS

3.1 Study Design

The study design in this research was divided into 2 steps. Primary step was a cross-sectional design. In this step the workers participated for determining stress levels, health status, and perceived working condition levels. Secondary step will be a quasi-experiment one group design and selecting subjects by purposive sampling. In this step the workers participated for determining cortisol excretion and sleep quality. The general information of the workers, levels of stress, levels of perceived working condition and sleep quality was evaluated by questionnaires. Cortisol excretion rates were measured in workers' urine and analyzed using a radioimmunoassay.

3.2 Study Population

This study was performed in toy manufactory, Chachoengsao Province, Thailand. Ninety-five subjects were participated in primary step and 12 subjects were participated in secondary step. The subjects were performing the same job in the plastic injected department. The purpose of the study and experimental procedure was explained to the subjects. The characteristics of the subjects are shown below:

3.2.1 female shift workers

3.2.2 aged 20-35 years

3.2.3 minimum of 6 months experience in this job

3.2.4 normal kidney function test by measuring levels of creatinine and blood urea nitrogen (BUN).

3.2.5 not taking any of the following medications:

3.2.5.1 Ascorbic acid	3.2.5.2 Quinidine
3.2.5.3 Digoxin	3.2.5.4 Spironalactone
3.2.5.5 Cortisone	3.2.5.6 Chlorpromazine
3.2.5.7 Hydralzine	3.2.5.8 Colchicine

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3.2.5.9 Paraldehyde 3.2.5.10 Erythromycin

3.2.5.11 Quinine 3.2.5.12 Estrogen

3.2.5.13 Dexamethasone 3.2.5.14 Calcium gluconate

3.2.5.15 Reserpine 3.2.5.16 Corticosteroids

3.2.5.17 Phenothiazines 3.2.5.18 Oral contraceptives

3.2.6 working in the same conditions in both shifts.

3.2.7 no consumption of coffee, tea, alcohol, or soft drinks during the experimental periods.

3.2.8 no smoking during the experimental periods.

3.2.9 no menstruation during the experimental periods.

3.2.10 healthy workers

3.2.11 voluntary subjects

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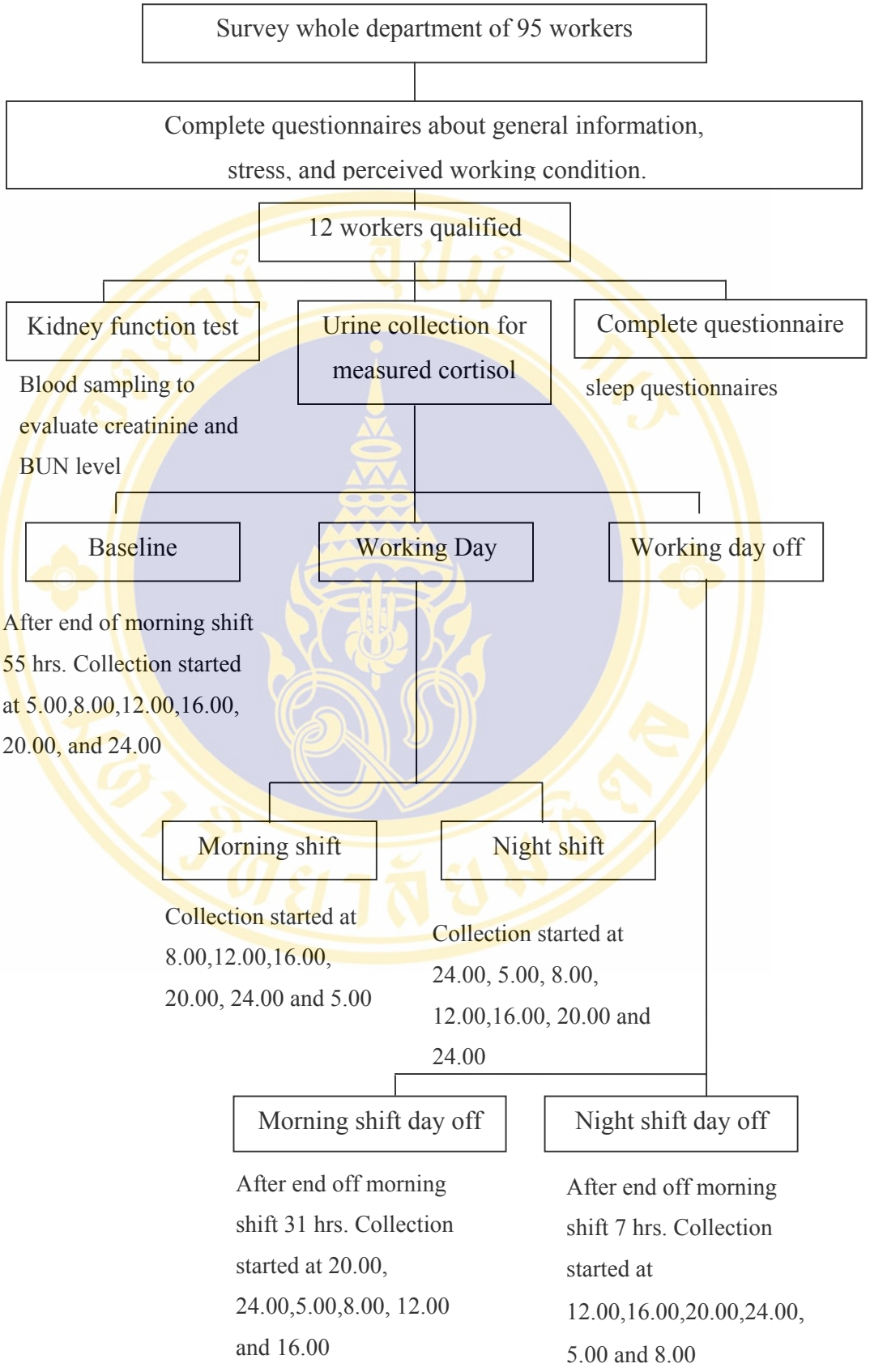

Figure 3-1. Study design

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3.3 Material and Method

3.3.1 Questionnaire

3.3.1.1 General Questionnaire

This questionnaire includes questions about age, weight and height, marital status, education level, shift work experience, smoking habits, caffeine consumption, alcohol consumption, medicine use, and health problems. Details about this questionnaire are given in Appendix A-1.

3.3.1.2 Stress Questionnaire (H.O.S)

The stress questionnaire contains 20 items. It covers physio-psychological health problems and psychosomatic symptoms associated with work-related stress, with a reliably coefficient of 0.77 (Cronbach's Alpha). Details about this questionnaire are given in Appendix A-2. Scoring of responses was based on a 1 to 3 scale (1= never, 2= sometimes, 3= frequently). The scale was interpreted using mean item scores which were divided into 3 levels:

Normal stress level = mean + 1SD.
Moderate stress level = between mean + 1SD. to mean + 2SD.
High stress level = mean + 2SD.

3.3.1.3 Perceived Working Conditions Questionnaire

This questionnaire consists of 33 items about work conditions scale and organization scale, with a reliably coefficient of 0.76 (Cronbach's Alpha). This questionnaire was certified as accurate in content and structure by a specialist, and was tested before starting the experiment. Details about this questionnaire are shown in Appendix A-3. Scoring of responses was based on a 1 to 3 scale (1= never, 2= sometime, 3= frequently). The scale was interpreted using summed scores and calculates in percentage, which were divided into 3 levels:

Normal level of perceived working condition = < 60 %
Moderate level of perceived working condition = 60-69 %
High level of perceived working condition = ≥ 70 %

3.3.1.4 Sleep Questionnaire

This questionnaire consists of 9 items about overall sleep quality, time of sleep, sleep disturbances, used of sleep medications and alcoholic beverages and daytime dysfunction over the last month. This questionnaire was adapted from the

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Pittburgh sleep quality index (PSQI), with a reliably coefficient of 0.83 (Cronbach's Alpha). Details about this questionnaire are shown in Appendix A-4. Scoring of responses was based on a 0 to 3 scale (0= never, 1= seldom, 2= sometimes 3= frequently). The scale was interpreted using summed scores which were divided 4 levels:

Very good = 0
Fairly good = 1-9
Fairly bad = 10-18
Very bad = 19-27

3.3.2 Cortisol Levels Measurement

3.3.2.1 Urine Collection

1) Volumetric urine container without preservative
2) Record form
3) Freezer: Mirage, Model FZ-269, -20 ^{o}C of temperature

3.3.2.2 Urine Extraction

1) Polypropylene tube with cap: Sarstedt, 75x12 mm., polypropylene
2) Dichloromethane: Merck, analytical grade, Lot No. K 91802650 312.
3) Micropipette: 500 μL
4) Pipette tip: Sarstedt
5) Glass pipette: 1 mL
6) Pasture pipette
7) Centrifuge: Hehich EBA 3S, type 2006, serial No. 66952
8) Rack
9) Stop clock
10) Tray

3.3.2.3 Radioimmunoassay

1) Coat-A-Count: Diagnostic Products Corporation, Lot No.: 1266 and 1068.
2) Plain tube: Sarstedt, 75x12 mm., polypropylene

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3) Micropipette: 25μL, 50 μL and 1,000 μL
4) Pipette tip: Sarstedt
5) Nitrogen and evaporator
6) Vortex: Vortex Genicz, model G-560E, serial No.# 2-77456
7) Thermostatic bath circulator: TRL-40SP
8) Thermometer
9) Absorbant paper
10) Rack
11) Gamma counter: Gammatec III, model 600B
12) Personal computer and software: Windows 98, GMS

3.3.3 Environmental Measurement

3.3.3.1 Light intensity: TES-1134 light meter, serial No. 4375.

3.3.3.2 WBGT heat stress index: Metrosonics hs-3700 Portable heat stress.

3.3.3.3 Sound level meter: Extech 407735, serial No. 95061584.

3.4 Data Collection

There were seven steps for data collection as follows:

3.4.1 Survey for General Data

3.4.1.1 Ninety-five female shift workers in the plastic injected department introduced to general questionnaire, stress questionnaire, and perceived working condition questionnaire clearly.

3.4.1.2 Data form 95 workers were collected and analyzed.

3.4.2 Qualification of the Subject

3.4.2.1 Twelve subjects met the qualifications required to undergo sampling. The purpose and experimental methods were clearly explained to the subjects, and they were asked to fill out consent forms.

3.4.2.2 Blood samples were collected to evaluate kidney function by measuring levels of creatinine and blood urea nitrogen (BUN). Blood samples were collected at 8.00 am.

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3.4.2.3 All subjects had normal kidney function tests and continued to collect urine samples.

3.4.2.4 Subjects completed the stress questionnaire, perceived working condition, and sleep quality index questionnaires on morning shift.

3.4.3 Urine Collection

Measurements of cortisol were performed at baseline, during working periods, and on working day off. The subjects were asked to collect 20 mL of all urine in these periods at 5.00, 8.00, 12.00, 16.00, 20.00, and 24.00 hr. All subjects were clearly informed about proper urine collecting techniques. All the times of urination were record urine volume and time periods that asked to collect urine, was kept in urine containers. All samples were collected in different containers. These 20-mL samples were kept frozen (-20 ^{o}C) until analysis. Consumption of coffee, tea, soft drink, alcohol, medicine and smoking was control for differences. Procedures for urine collections were as follows:

3.4.3.1 Baseline

Before starting urine collection in this period, subjects were required to have finished a morning shift and to have rested at least 55 hours. They also had to rest for eight hours the night before collection. The urine collection for the baseline period started at 5.00, 8.00, 12.00, 16.00, 20.00, and 24.00 hr.

3.4.3.2 Working day

Urine collections on working days were separated into two sections - morning shift and night shift. The urine collection for morning shift started at 8.00, 12.00, 16.00 20.00, 24.00, and 5.00 hr. The urine collection for night shift started at 24.00, 5.00, 8.00, 12.00, 16.00, and 20.00 hr. Urine was collected on each shift for three days: the first working day of the shift, the working day middle of the shift and the last working day of the shift.

3.4.3.3 Working day off

Urine collections on working day off were separated into two sections - morning shift day off and night shift day off. The urine samples for morning shift day off were collected 31 hrs after the end of the morning shift. and started at 20.00, 24.00, 5.00, 8.00, 12.00 and 16.00 hr. Urine collections for night shift day off were collected

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7 hrs after the end of the night shift, and started at 12.00, 16.00, 20.00, 24.00, 5.00, and 8.00 hr.

3.4.5 Environmental Data Collection

Environmental data were assessed for both morning shifts and night shifts. While collecting environmental data, general data about the workplace e.g. workload were recorded for additional information. Procedures for collections were as follows:

3.4.5.1 Light intensity was measured at the production lines and in the passageways. Data was collected at 8.00,13.00 and 24.00 hr.

3.4.5.2 WBGT heat stress index was measured near subjects' working areas. Data was collected at 8.00,13.00, 24.00, and 5.00 hr.

3.4.5.3 Noise levels were measured at 8.00 and 24 hr.

3.4.6 Preparation of Urine Samples

3.4.6.1 Label one polypropylene tube with cap for each urine sample.

3.4.6.2 Mixed well the urine container and pipet 500 μL of each urine sample into the tube.

3.4.6.3 Extraction: Add 1.0-mL dichloromethane to every tube.

3.4.6.4 Mix by gentle inversion for 5 to 10 minutes.

3.4.6.5 Centrifuge for 5 minutes at about 1500 g to separate the two phases.

3.4.6.6 Separate the two phases by Pasteur pipette; transfer lower phase into 75x12-mm polypropylene tube.

3.4.6.7 Evaporation: Transfer 50 μL of lower phase from step 3.4.6.6 into cortisol Ab-Coated Tubes.

3.4.6.8 Evaporate to complete dryness under a gentle stream of nitrogen at room temperature (15-28 ^{o}C).

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3.4.7 Radioimmunoassay Procedure

3.4.7.1 Plain tubes: Label four plain (uncoated) 75x12-mm polypropylene tubes "T" (total counts) and "NSB" (nonspecific binding) in duplicate.

Coated tubes: Label twelve Cortisol Ab-coated Tubes "A" (maximum binding) and "B" through "F" in duplicate. Label additional Cortisol Ab-Coated Tubes, also in duplicate, for control and samples.

3.4.7.2 Pipet 25 μL of the zero calibrator A into the "NSB" and "A" tubes, and also into each of the urine sample evaporation tubes. Pipet 25 μL of each remaining calibrator, control and sample into the prepared tubes. Pipet solution directly to the bottom.

3.4.7.3 Add 1.0 mL of cortisol to all tubes and vortex.

3.4.7.4 Incubate for 45 minutes at 37 ^{o}C.

3.4.7.5 Decant thoroughly, removing all visible moisture. Decant the contents of all tubes (except the T tubes) using a foam decanting rack, and allow them to drain for 2 or 3 minutes. Then strike the tubes sharply on absorbant paper to shake off all residual droplets.

3.4.7.6 Count for 1 minute in a gamma counter.

3.4.7.7 Cortisol excretion rate: The Gamma counter reports data in units of count per minute (CPM). This data was then used by a personal computer to construct a standard curve from which concentrations were calculated in μg/dL. Cortisol concentrations were then transformed to ng/mL and multiplied by the volume of urine (mL) to obtain amount of ng unit. This amount was divided by the amount of time (minute) passed since prior of the urination, to obtain mean excretion rate for that period (ng/min).

3.5 Statistic Analysis

Analytical data were separated into 2 sections as follows:

3.5.1 Descriptive Statistics

This section includes data from the questionnaires from which frequency distributions were created and means and standard deviations were calculated.

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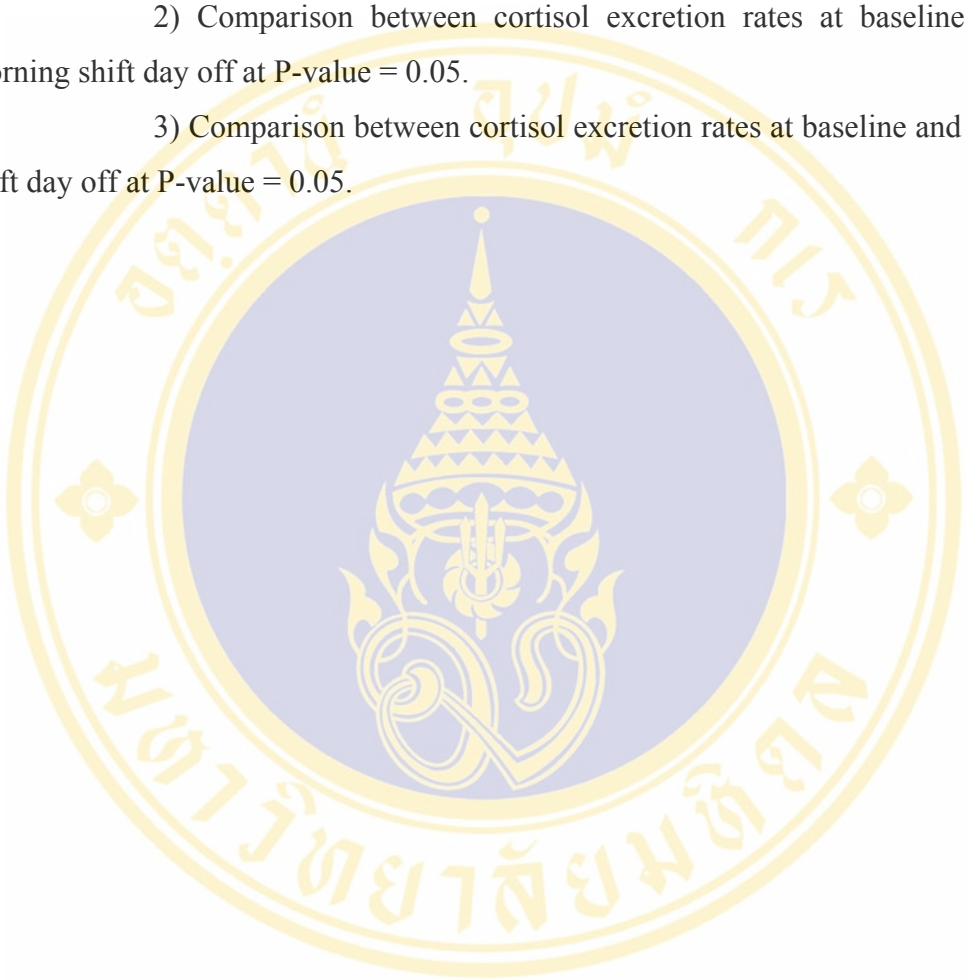
3.5.2 Inferential Statistics

3.5.2.1 Paired t-test and Wilcoxon Signed Ranks Test

1) Comparison between cortisol excretion rates during morning shift and night shift at P-value = 0.05.

2) Comparison between cortisol excretion rates at baseline and on morning shift day off at P-value = 0.05.

3) Comparison between cortisol excretion rates at baseline and on night shift day off at P-value = 0.05.



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CHAPTER IV
RESULTS

This study aimed to study stress levels and compare cortisol excretion rates in female shift workers who work on morning shifts and night shifts. The results were divided into seven parts as follows:

4.1 General characteristics of subjects

4.2 Stress levels

4.3 Perceived working condition levels

4.4 Working environment

4.5 Sleep quality index

4.6 Cortisol excretion rates

4.7 Comparison of cortisol excretion rates between morning shifts and night shifts, baseline and morning shifts day off, baseline and night shift days off.

4.1 General Characteristics of Subjects

Subjects were female shift workers in toy manufactory, Chachoengsao Province, Thailand. The average age of subjects was 26.13 years. The average weight and height were 51.98 kg and 156.95 cm, respectively. Sixty percent of subjects were single, and 58.95 % had completed secondary school. Of the 95 subjects, 50.53 % had shift work experience. Of the 95 subjects, 5.26 % smoke and 94.74 % did not smoke. The percentage of caffeine consumption and alcohol consumption was 70.53 %, and 23.16 %, respectively. Of 95 subjects, 30 subjects had health problems, 33.33 % had headaches and 16.68 % had peptic ulcers. The results are shown in Table 4-1.

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Table 4-1. The details of general characteristics of subjects, n=95

Items	No. of subjects	Percentage
1. Age (Year)		
≤ 24	43	45.26
25-29	24	25.26
30-34	17	17.90
≥ 35	11	11.58
mean = 26.13 years, SD. = 6.19		
2. Weight (Kg.)		
< 40	1	1.05
40-49	42	44.21
50-59	35	36.84
60-69	13	13.69
≥ 70	4	4.21
mean = 51.98 kg, SD. = 8.42		
3. Height (Cm.)		
145-149	4	4.21
150-154	24	25.26
155-159	33	34.74
160-164	20	21.05
≥ 165	14	14.74
mean = 156.95 cm, SD. = 5.74		
4. Marital status		
Single	57	60.00
Married	33	34.74
Divorce	1	1.05
Separated	1	1.05
Widow	3	3.16

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Table 4-1. The details of general characteristics of subjects, n=95 (continued)

Items	No. of subjects	Percentage
5. Education levels		
Primary school	28	29.47
Secondary school	56	58.95
Diploma	9	9.41
Bachelor degree	2	2.11
6. Shift work experience		
Yes	48	50.53
No	47	49.47
7. Smoking behavior		
Yes	5	5.26
No	90	94.74
8. Caffeine consumption		
Yes	22	70.53
No	28	29.47
9. Alcohol consumption		
Yes	22	23.16
No	73	76.84
10. Health problem		
No	65	68.42
Yes	30	31.58
Head ache	10	33.33
Peptic ulcer	5	16.68
Shoulders and arms pain	2	6.67
Back pain	1	3.33
Allergy	7	23.34
Hand tremor	1	3.33
Tachycardia	1	3.33
Hypotension	1	3.33
Diabetes	1	3.33

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Table 4-1. The details of general characteristics of subjects, n=95 (continued)

Items	No. of subjects	Percentage
Thyroids	1	3.33

4.2 Stress Levels

Table 4-2 shown the mean values, standard deviations, and stress level of the subjects. Scoring of responses was based on a 1 to 3 scale (1= never, 2= sometimes, 3= frequently). The scale was interpreted using mean item scores which were divided into 3 levels:

Normal stress level = mean + 1SD.
Moderate stress level = between mean + 1SD. to mean + 2SD.
High stress level = mean + 2SD.

The HOS score has a potential range between low and high stress of 20-60. Result from 95 subjects found mean stress score at 32.33 with SD 5.25. The cut off score of 37 was used to identify the normal stress level, 38-41 was used to identify the moderate stress level and 42 and above was used to identify the high stress level. Result from data analysis of stress level of the 95 subjects found that 75.79 % of the subjects had a normal stress level, 22.11 % had a moderate stress level and 2.10 % had a high stress level. Result from data analysis of 12 subjects found that 7 subjects had a normal stress level, 5 subjects had a moderate stress level.

Table 4-2. Mean values, standard deviations, and stress levels of the subjects, n=95 of population target and 12 of population samples

Items	Mean	level	Mean.	Level
	n = 95		n = 12	
Hand tremor severe enough to be annoying.	1.32	normal	1.53	normal
Sweating of hand and feet severe enough to be annoying.	1.56	normal	1.67	moderate
Rapid heart rate or tachycardia.	1.48	normal	1.50	normal
Exhaustion upon awakening and fatigue.	1.93	high	2.25	high
Presences of any sleep problems.	1.98	high	2.08	high

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Table 4-2. Mean values, standard deviations, and stress levels of the subjects, n=95 of population target and 12 of population samples (continued)

Items	Mean	level	Mean	Level
	n = 95		n = 12	
Having an abnormal digestion (e.g. stomachache, diarrhea).	1.76	high	1.83	high
Used to have nightmares.	1.64	moderate	1.50	normal
Used to sweat, cold body due to being frightened.	1.39	normal	1.41	normal
Feelings of pain in different organs with unknown causes.	1.81	high	1.91	high
Usually relax by use cigarette smoking, drug and alcohol.	1.20	normal	1.33	normal
Loss of appetite.	1.82	high	1.92	high
Work reflects to their health.	1.69	moderate	1.83	high
Fell no alert.	1.37	normal	1.58	normal
Feeling of dizziness.	1.94	high	1.83	high
When worried, used to loss or gain body weight.	1.77	high	2.17	high
Used to have dyspnea or difficulty in breathing without exercise.	1.56	normal	1.92	high
Thinking that themselves are strong and have the ability to work successfully.	1.62	normal	1.50	normal
Feel happy.	1.62	normal	1.62	normal
Thinking that in this world there is nothing of value for them.	1.44	normal	1.25	normal
Having health problem.	Number of subjects (percentage)			
Yes	30 (31.58)		0 (0.00)	
No	65 (68.42)		12 (100.00)	

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Table 4-2. Mean values, standard deviations, and stress levels of the subjects, n=95 of population target and 12 of population samples (continued)

Items	Mean level	Mean Level
	n = 95	n = 12
	Number of subjects (percentage)	
Stress levels		
Normal stress level	72 (75.29)	7 (58.33)
Moderate stress level	21 (22.11)	5 (41.67)
High stress level	2 (2.10)	-
Total	95 (100.00)	12 (100.00)

Table 4-2 shows the point-value frequencies of different signs, which reflect the levels of body tension of 95 subjects. The highest levels of body tension were found in the forms of sleep problems, feeling of dizziness, exhaustion upon awakening and fatigue, loss of appetite, feelings of pain in different organs with unknown causes, loss or gain of body weight due to anxiety, and digestive abnormalities. Moderate levels of body tension were found in the forms of anxiety that work was negatively affecting their health, and having nightmares. For the group of 12 subjects, high stress levels took in the forms of exhaustion upon awakening, loss or gain of body weight due to anxiety, sleep problems, loss of appetite, dyspnea, feelings pain in different organs with unknown causes, digestive abnormalities, anxiety that work was negatively affecting their health, and feeling of dizziness. Moderate levels took in the forms of sweating of hands and feet severe enough to be annoying.

From the stress questionnaire both groups found 7 items of high stress levels in common. These 7 items were as follows: exhaustion upon awakening and fatigue, sleep problems, digestive abnormalities, feelings pain in different organs with unknown causes, loss of appetite, feeling of dizziness, and loss or gain of body weight due to anxiety.

4.3 Perceived Working Condition Levels

Table 4-3 shows the mean values, standard deviations, and perceived working condition level of the subjects. Scoring of responses was based on a 1 to 3 scale

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(1= never, 2= sometimes, 3= frequently). The scale was interpreted using summed scores and calculates in percentage, which were divided into 3 levels:

Normal level of perceived working condition = < 60 %

Moderate level of perceived working condition = 60-69 %

High level of perceived working condition = ≥ 70 %

The perceived working condition score has a potential range between low and high level of 33-99. Result from 95 subjects found mean score at 62.99 with SD 8.41. The cut off score of 59 was used to identify the normal level, 60-69 was used to identify the moderate level and above 69 was used to identify the high level. Result from data analysis of perceived working condition level of 95 subjects found that 33.68 % of the subjects had a normal perceived working condition level. 48.42 % of the subjects had a moderate perceived working condition level and 17.90 % had a high perceived working condition level. Result from data analysis of 12 subjects found that 2 subjects had a normal perceived working condition level, 7 subjects had a moderate perceived working condition level, and 3 subjects had high perceived working condition level.

Table 4-3. Mean values, standard deviations, and perceived working condition level of the subjects, n=95 of population target and n=12 of population samples

Statement	Mean	level	Mean	Level
	n = 95		n = 12	
Work Environment	1.98	normal	2.08	normal
Work environment has a lot of loud noise.	2.48	high	2.75	high
My working environment heats till make me uncomfortable.	2.13	normal	2.17	normal
My working area has unsuitable lighting.	1.64	normal	1.75	normal
My working environment has bad ventilation.	1.86	normal	1.83	normal
I always work with a static posture through the working time.	2.04	normal	2.25	moderate
My work is repetitive and boring.	1.74	normal	1.75	normal

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Table 4-3. Mean values, standard deviations, and perceived working condition level of the subjects, n=95 of population target and n=12 of population samples (continued)

Statement	Mean	level	Mean	Level
	n = 95		n = 12	
Work characteristic and workload.	2.06	normal	2.12	normal
My work makes me exposed to hazardous chemical substance.	1.81	normal	1.92	normal
My work has a high risk of accident.	1.78	normal	1.75	normal
My work is overload, I do not have enough free time to do what others expect of me.	1.68	normal	1.50	normal
My work must complete with short time.	2.40	high	2.50	high
My work wants a careful on the job.	2.64	high	2.92	high
Shift work	1.95	normal	1.58	normal
I feel shift work system is not comfort enough.	1.90	normal	1.67	normal
I have enough time to take a break.	1.89	normal	1.50	normal
I have enough time and day off before next shift.	2.22	moderate	1.50	normal
After night shift I usually have some sleep disorders.	2.40	high	2.00	normal
I feel uncomfortable to commute during the shift work.	1.59	normal	1.50	normal
The shift work system gave some negative effect in my activities with family and society	1.68	normal	1.33	normal
Role and responsibility	1.71	normal	1.75	normal
I have high responsibility on my job.	2.49	high	2.83	high
My job lack opportunity and any chance to make a lot of decision making on my own personal initiative.	1.76	normal	1.83	normal

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Table 4-3. Mean values, standard deviations, and perceived working condition level of the subjects, n=95 of population target and n=12 of population samples (continued)

Statement	Mean	level	Mean	Level
	n = 95		n = 12	
My work is not interesting in me.	1.36	normal	1.25	normal
I feel my work is not important and prestigious.	1.21	normal	1.25	normal
I work in other job out of my responsibility.	1.53	normal	1.75	normal
My working job is suitable to my skill.	1.89	normal	1.58	normal
Relationship in organization	1.80	normal	1.43	normal
The relationship between my boss and me is good.	1.64	normal	1.50	normal
The relationship between my co-worker and me is good.	1.30	normal	1.17	normal
A work rotate is annoyed my work.	1.81	normal	1.92	normal
The colleagues have little cooperation while on the job.	1.74	normal	1.67	normal
I never have some free time to meet with my friends who work in other production units.	2.53	high	2.33	moderate
Organization and salary.	2.10	normal	2.12	normal
Administrative workers are interest and understand the worker.	2.10	normal	2.10	normal
Administrative workers are support when the workers have problem.	2.02	normal	2.00	normal
I need to develop my welfare service.	2.52	high	2.92	high
I fear layoffs and elimination of jobs in economic crisis.	2.10	normal	1.75	normal
I need to changes and consider a new job.	1.65	normal	1.83	normal

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Table 4-3. Mean values, standard deviations, and perceived working condition level of the subjects, n=95 of population target and n=12 of population samples (continued)

Statement	Mean level n = 95	Mean Level n = 12
perceived working condition levels	Number of subjects	
Low perceived working condition level	32 (33.68)	2 (16.67)
Moderate perceived working condition level	46 (48.42)	7 (58.33)
High perceived working condition level	17 (17.90)	3 (25.00)
Total	95 (100.00)	12 (100.00)

Table 4-3 shows the points-value frequencies for perceived working conditions, an assessment of working problems and their relationship with the mental health of the 95 subjects. Items contributing most to workers' characterizations of working conditions as high level were the need to be careful on the job, never having free time to meet friends in other production units, lack of welfare services, high responsibility on the job, loud work environment, the work need to complete their in a short amount of time, and sleep disorders commonly occurring after night shifts. Items contributing most to workers' characterizations of working conditions as moderate level were lack of enough time off before next shift. For the group of 12 subjects, items contributing most to workers' characterizations of working conditions as high level were the need to be careful on the job, lack of welfare services, high responsibility on the job, loud work environment, and the work need to complete their in a short amount of time. Items contributing most to workers' characterizations of working conditions as moderate level were the work need to complete their in a short amount of time, and never having free time to meet friends in other production units.

From the perceived working condition questionnaire, both groups found 5 items in common that contributed to their perception working conditions as high level. These 5 items were as follows: loud work environment, the work need to complete their in a short amount of time, the need to be careful on the job, high responsibility on the job, and lack of welfare services.

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4.4 Working Environment

Working area of this section was on 1 st floor, with two doors exit. This room had general ventilation and local ventilation was use to improved working conditions. The results of working condition shown as follows:

4.4.1 Light intensity

4.4.2 WBGT heat stress index

4.4.3 Noise level

4.4.1 Light Intensity

In Thailand, The Ministry of Interior has the notification of occupational criteria for light intensity. The recommended level is 200 lux for the production line in this job and 50 lux for passageway, respectively. Light intensity was measured at 8.00 hr. on morning shift and 24.00 hr. on night shift. The light intensity was measured on production lines and in passageways. The light intensity on production lines ranged from 373.10 lux to 441.60 lux in morning shift and 268.26 lux to 346.57 lux in night shift. The light intensity in passageways ranged from 148.38 lux to 190.62 lux in morning shift and 134.54 lux to 172.21 lux in night shift.

The measured level was higher than the standard level issued in the notification of The Ministry of Interior as related to Environment Condition (Light intensity). The results were shown in Table 4-4.

Table 4-4. Light intensity (lux) on production lines and in passageways

Time (hr.)	Min	Max	n	Thai recommended
production lines				
8.00	373.10	441.60	17	200.00
24.00	268.26	346.57	17	200.00
passageways				
8.00	148.38	190.62	8	50.00
24.00	134.54	172.21	8	50.00

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4.4.2 WBGT Heat Stress Index

The standard of ACGIH and NIOSH for determine heat stress is Wet bulb glove temperature (WBGT) index. Type of this work was classified as light workload. Therefore, the permissible heat exposure thresholds limit value for light workload which continuous work is 30 ^{o}C. In Thailand, The Ministry of Industrial has the notification of occupational criteria for heat stress. The recommended level for this job is 34.00 ^{o}C. From Table 4-5, WBGT heat stress indexes were measured at 8.00 hr. to 13.00 hr. on morning shift and at 24.00 hr. to 5.00 hr. on night shift. The results on morning shift ranged from 27.79 ^{o}C to 28.34 ^{o}C. The results on night shift ranged from 27.78 ^{o}C to 28.15 ^{o}C. The measured level was lower than the standard level issued in the notification of The Ministry of Industry at related to Environment Condition (Heat) and ACGIH standard. The results were shown in Table 4-5.

Table 4-5. Wet bulb glob temperature (WBGT) heat stress index (^{o}C) at the workplace

Time (hr.)	Min	Max	n	Thai recommended	ACGIH standard
Morning shift					
8.00	27.79	28.34	6	34.00	30.00
Night shift					
24.00	27.78	28.15	6	34.00	30.00

4.4.3 Noise Levels

In this section, noise level was classified as continuous noise. In Thailand, The Ministry of Interior has the notification of occupational criteria for this job and OSHA standard for 8 hours working was 90 dB. Noise levels were measured at 8.00 hr. on morning shift and 24.00 hr. on night shift. The noise level on morning shift varied from 80.00 dB. to 86.50 dB. The noise level on night shift varied from 81.80 dB. to 88.40 dB. The measured level was lower than the standard level issued in the notification of The Ministry of Interior at related to Environment Condition (Noise). The results were shown in Table 4-6.

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Table 4-6. Noise levels (dB) at the workplace

Time (hr.)	Min	Max	n	Thai recommended
Morning shift				
8.00	80.00	86.50	12	90.00
Night shift				
24.00	81.80	88.40	12	90.00

The light intensity was higher than the notification of The Ministry of Interior at related to Environment Condition (Light intensity). WBGT heat stress index was lower than the notification of The Ministry of Industry at related to Environment Condition (Heat). Noise level was lower than the notification of The Ministry of Interior at related to Environment Condition (Noise). Table 4-7 shown working conditions between morning shift and night shift. There was significant difference of light intensity between morning and night shift (P-value = 0.001). There was no significant difference of WBGT heat stress index and noise level between morning and night shift, respectively.

Table 4-7. Working conditions between morning shift and night.

Working condition	n	df	t	P-value
Light intensity at production line	17	16	-2.019	0.001*
Light intensity at passageway	8	7	1.483	0.182
WBGT heat stress index	6	5	0.598	0.576
Noise level	12	11	-1.725	0.112

* = Significant difference

4.5 Sleep Quality Index

Sleep questionnaire was introduced to 12 female shift workers who were qualified. Table 4-8 shown the sleep characteristic, the mean value and the percentage of the subjects. Scoring of response was based on a 0 to 3 scale (0= never, 1= seldom, 2= sometimes 3= frequently). The scale interpreted by sum scores that the way in which divided 4 levels as:

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Very good = 0
Fairly good = 1-9
Fairly bad = 10-18
Very bad = 19-27

The results shown that 7 subjects had a fairly good sleep quality, 5 subjects had fairly bad sleep quality. When no night shift 4 subjects had sleep duration less than 6 hours per night and 8 subjects had sleep duration more than 6 hours per night.

Table 4-8. The sleep characteristic of subjects, the mean values, standard deviations, and the percentage of the subjects. (n=12)

statement	number	percentage	Mean (SD.)
Sleep hours per night (when you have no night shift)			1 (1.48)
< 6 hrs.	4	33.33	
> 6 hrs.	8	66.67	
Difficulty maintaining sleep			1.92 (0.79)
Cannot get to sleep within 30 minutes			2.33 (0.89)
Wake up in the middle of the night			3.00 (0.85)
Early morning awakening			2.25 (0.75)
Daytime drowsiness			2.08 (0.51)
Sleep medication use			1.42 (0.51)
Alcoholic beverage use			1.25 (0.45)
Trouble at work			1.92 (0.94)
Sleep quality			
Fairly good	7	58.30	
Fairly bad	5	41.70	

Table 4-8 shows the points-value frequency of sleep quality found that the first 3 items with bad sleep quality. The most frequent was wake up in the middle of the night with a point-value of 3.00. The second was couldn't get to sleep within 30 minutes with a point-value of 2.33. The last was awakening in the early morning with a point-value of 2.25.

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4.6 Cortisol Excretion Rate

Urine collection procedure for measured cortisol excretion rates was introduced to 12 female shift workers. All of these workers do not take medicine or beverage consumption that affected to cortisol excretion during experimental periods. They had no menstruation during urine collection periods. Urines were collected at 5.00, 8.00, 12.00, 16.00, 20.00, and 24.00 hr. for baseline, morning shift, night shift, morning shift day off, and night shift day off. The results were divided into three parts as follows:

4.6.1 Cortisol excretion rates at baseline

4.6.2 Cortisol excretion rates of morning and night shifts

4.6.3 Cortisol excretion rates of morning shift day off and night shift day off

4.6.1 Cortisol Excretion Rates at Baseline

Cortisol excretion rate at baseline was highest at 8.00 hr. with mean 84.22 ng/min at range between 41.84 ng/min to 126.60 ng/min. And then declined to lowest at 24.00 hr. with mean 26.17 ng/min at range between 11.08 ng/min to 41.26 ng/min. The details were shown in Table 4-9. The profile of baseline cortisol was shown in Figure 4-1.

Table 4-9. Rate of cortisol excretion (ng/min) at baseline and sample time (n=12)

Time (hr.)	Rate of cortisol excretion (ng/min)		
	min-max	mean	SD.
5.00	16.15-51.23	33.69	27.60
8.00	41.84-126.60	84.22 ^{H}	66.70
12.00	22.99-84.17	53.58	48.14
16.00	35.45-79.09	57.27	34.33
20.00	15.29-54.44	34.86	30.80
24.00	11.08-41.26	26.17 ^{L}	23.74

H = Highest

L = Lowest

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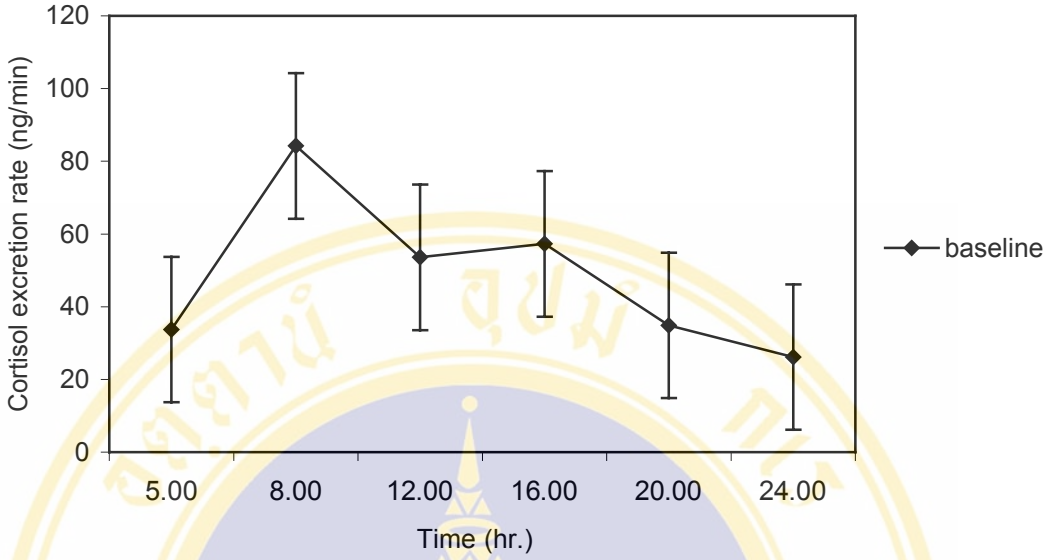

Figure 4-1. The profile of cortisol excretion rates (ng/min) at baseline

4.6.2 Cortisol Excretion Rates of Morning and Night Shift

4.6.2.1 Cortisol excretion rates of the first working day of morning and night shift

Cortisol excretion rates of the first working day of morning shift was highest at 8.00 hr. with mean 85.44 ng/min at range between 42.86 ng/min to 128.02 ng/min. And then declined to lowest at 20.00 hr. with mean 26.17 ng/min at range between 17.07 ng/min to 35.27 ng/min.

Cortisol excretion rates of the first working day of night shift was highest at 20.00 hr. with mean 76.22 ng/min at range between 32.70 ng/min to 119.75 ng/min. And then declined to lowest at 24.00 hr. with mean 30.01 ng/min at range between 17.09 ng/min to 42.94 ng/min. The details were shown in Table 4-10. The profile of cortisol excretion rates of the first working day of morning and night shift cortisol was shown in Figure 4-2.

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Table 4-10. Rate of cortisol excretion (ng/min) of the first working day for morning shift and night shift, and sample time (n=12)

Time (hr.)	Rate of cortisol excretion (ng/min)					
	Morning shift			Night shift		
	min-max	mean	SD.	min-max	mean	SD.
5.00	25.83-87.04	56.44	48.16	17.79-64.06	40.93	36.41
8.00	42.86-128.02	85.44 [H]	67.02	26.34-94.24	60.29	53.43
12.00	32.25-53.13	42.69	16.43	37.36-107.24	72.30	55.00
16.00	34.92-66.16	50.54	24.58	30.55-44.56	37.56	11.02
20.00	17.07-35.27	26.17 [L]	14.33	32.70-119.75	76.22 [H]	68.50
24.00	34.46-79.28	56.87	35.27	17.09-42.94	30.01 [L]	20.34

H = Highest

L = Lowest

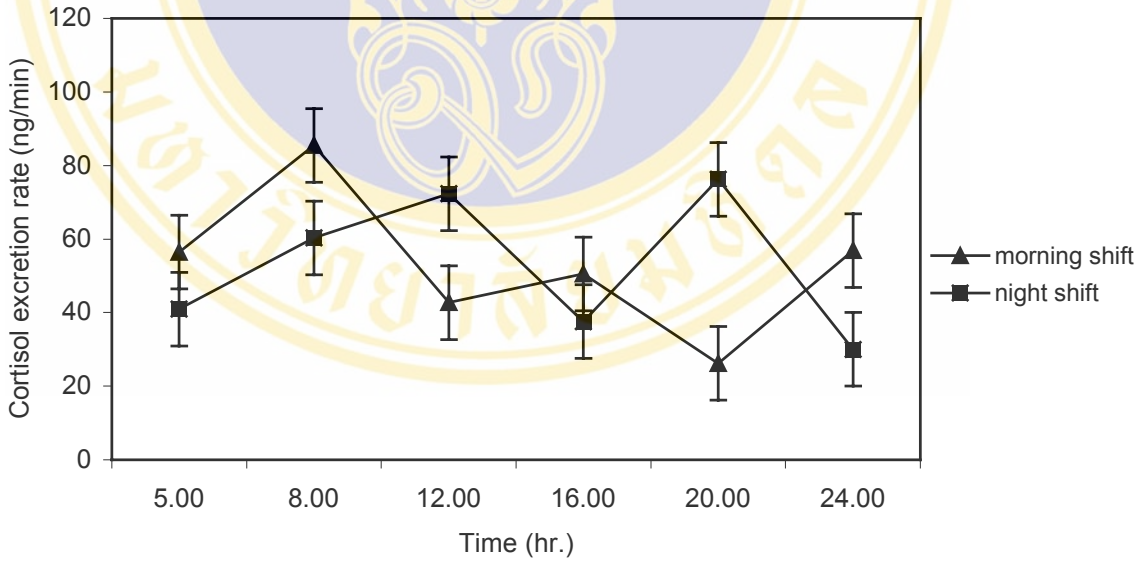

Figure 4-2. The profile of cortisol excretion rates of first working day of morning and night shift.

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4.6.2.2 Cortisol excretion rates of the working day middle of the shift of morning and night shift

Cortisol excretion rates of the working day middle of the shift of morning shift was highest at 8.00 hr. with mean 88.42 ng/min at range between 67.11 ng/min to 109.73 ng/min. And then declined to lowest at 20.00 hr. with mean 28.79 ng/min at range between 18.95 ng/min to 38.63 ng/min.

Cortisol excretion rates of the working day middle of the shift of night shift was highest at 8.00 hr. with mean 83.02 ng/min at range between 35.70 ng/min to 130.34 ng/min. And then declined to lowest at 24.00 hr. with mean 32.32 ng/min at range between 18.23 ng/min to 46.40 ng/min. The details were shown in Table 4-11. The profile of cortisol excretion rates of working day between shift of morning and night shift was shown in Figure 4-3.

Table 4-11.Rate of cortisol excretion (ng/min) of the working day middle of the shift for morning shift and night shift, and sample time (n=12)

Time (hr.)	Rate of cortisol excretion (ng/min)					
	Morning shift			Night shift		
	min-max	mean	SD.	min-max	mean	SD.
5.00	32.60-74.55	53.57	33.01	20.68-52.16	36.42	24.78
8.00	67.11-109.73	88.42 [H]	33.55	35.70-130.34	83.02 [H]	74.48
12.00	41.08-74.88	57.98	26.59	31.27-80.10	55.69	38.42
16.00	42.61-67.54	50.08	19.61	29.71-116.36	73.04	68.18
20.00	18.95-38.63	28.79 [L]	15.49	24.25-95.93	60.09	56.41
24.00	21.82-48.54	35.18	21.03	18.23-46.40	32.32 [L]	22.17

H = Highest

L = Lowest

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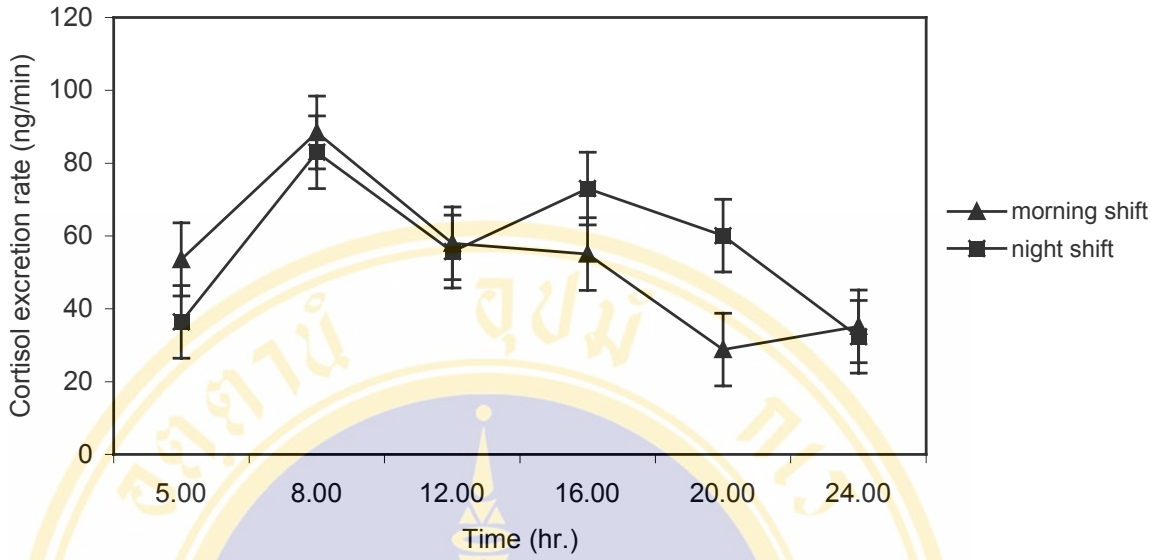

Figure 4-3. The profile of cortisol excretion rates of working day middle of the shift for morning and night shift

4.6.2.3 Cortisol excretion rates of the last working day of morning and night shift

Cortisol excretion rates of the last working day of morning shift was highest at 8.00 hr. with mean 97.48 ng/min at range between 60.32 ng/min to 134.65 ng/min. And then declined to lowest at 20.00 hr. with mean 30.04 ng/min at range between 22.30 ng/min to 37.78 ng/min.

Cortisol excretion rates of the last working day of night shift was highest at 8.00 hr. with mean 104.37 ng/min at range between 54.17 ng/min to 154.57 ng/min. And then declined to lowest at 20.00 hr. with mean 37.93 ng/min at range between 17.46 ng/min to 58.41 ng/min. The details were shown in Table 4-12. The profile of cortisol excretion rates of the last working day for morning and night shift was shown in Figure 4-4.

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Table 4-12. Rate of cortisol excretion (ng/min) of the last working day for morning shift and night shift, and sample time (n=12)

Time (hr.)	Rate of cortisol excretion (ng/min)					
	Morning shift			Night shift		
	min-max	mean	SD.	min-max	mean	SD.
5.00	30.55-66.74	48.65	28.48	22.15-56.59	39.37	27.10
8.00	60.32-134.65	97.48 [H]	58.50	54.17-154.57	104.37[H]	79.01
12.00	28.38-87.44	57.91	46.47	29.60-64.73	47.17	27.64
16.00	34.92-67.83	51.38	25.90	31.00-74.64	52.82	34.34
20.00	22.30-37.78	30.04 [L]	12.18	17.46-58.41	37.93 [L]	32.22
24.00	15.58-51.19	33.39	28.02	33.73-75.26	54.49	32.68

H = Highest

L = Lowest

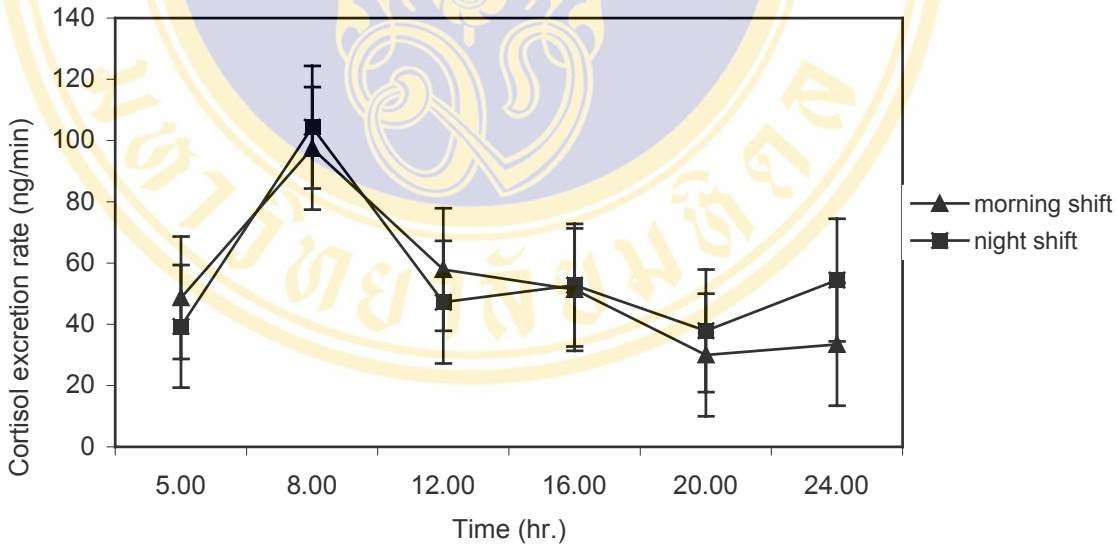

Figure 4-4. The profile of cortisol excretion rates of the last working day for morning and night shift

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4.6.3 Cortisol Excretion Rates of Morning Shift Day off and Night Shift Day off

Cortisol excretion rate of morning shift day off was highest at 8.00 hr. with mean 167.48 ng/min at range between 102.22 ng/min to 232.74 ng/min. And then declined to lowest at 24.00 hr. with mean 32.26 ng/min at range between 15.91 ng/min to 48.61 ng/min.

Cortisol excretion rate of night shift day off was highest at 8.00 hr. with mean 116.67 ng/min at range between 64.57 ng/min to 168.76 ng/min. And then declined to lowest at 16.00 hr. with mean 57.24 ng/min at range between 32.48 ng/min to 82.01 ng/min. The details were shown in Table 4-13. The profile of morning shift day off and night shift day off cortisol was shown in Figure 4-5.

Table 4-13. Rate of Cortisol excretion (ng/min) of morning shift day off and night shift day off, and sample time (n=12)

Time (hr.)	Rate of cortisol excretion (ng/min)					
	Morning shift day off			Night shift day off		
	min-max	mean	SD.	min-max	mean	SD.
5.00	28.93-107.99	68.46	62.21	33.67-105.10	69.38	56.25
8.00	102.22-232.74	167.48[H]	102.71	64.57-168.76	116.67[H]	82.00
12.00	59.74-154.69	107.22	74.72	33.40-96.09	64.74	49.34
16.00	45.31-103.19	74.25	45.54	32.48-82.01	57.24 [L]	38.98
20.00	23.77-51.68	37.72	21.96	28.63-89.18	58.91	47.65
24.00	15.91-48.61	32.26 [L]	25.73	27.90-90.46	59.18	49.22

H = Highest

L = Lowest

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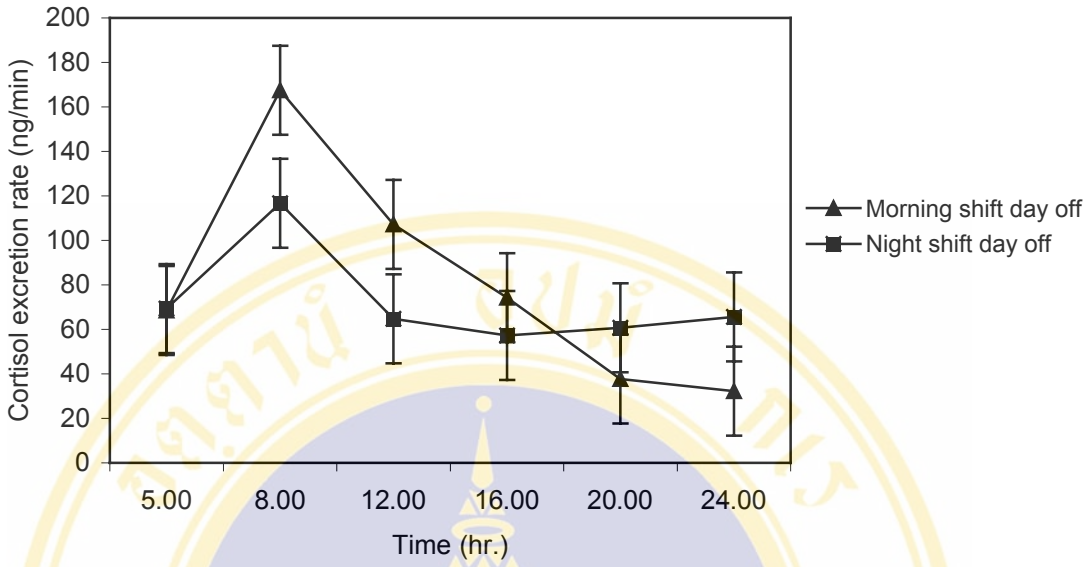

Figure 4-5. Cortisol excretion rates (ng/min) of morning shift day off and night shift day off

4.7 Comparison of cortisol excretion rates between morning shifts and night shifts, baseline and morning shift day off, baseline and night shift day off.

4.7.1 Comparison of cortisol excretion rates between morning shifts and night shifts

The comparison of cortisol excretion rates between morning shifts and night shifts were tested by Wilcoxon Signed Ranks Test. The details were shown in Table 4-14. The results shown that the cortisol excretion rates of morning shift was significantly lower than night shift at 20.00 hr. (P-value = 0.008). Figure 4-6 shown the comparison of cortisol excretion rates between morning shift and night shift.

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Table 4-14. The comparison of cortisol excretion rates between morning shifts and night shifts were tested by Wilcoxon Signed Ranks Test.

Time (hr.)	mean	SD.	n	Z-test	P-value
5.00					
morning shift	52.88	36.57	36	-1.728	0.084
night shift	38.91	29.05	36		
8.00					
morning shift	90.45	53.55	36	-1.021	0.307
night shift	82.56	70.25	36		
12.00					
morning shift	52.86	32.23	36	-0.204	0.838
night shift	58.38	42.03	36		
16.00					
morning shift	52.33	22.93	36	-0.770	0.441
night shift	54.47	45.69	36		
20.00					
morning shift	28.33	13.75	36	-2.639	0.008 *
night shift	58.08	55.27	36		
24.00					
morning shift	41.81	29.90	36	-0.353	0.724
night shift	38.94	27.30	36		

* Significant difference

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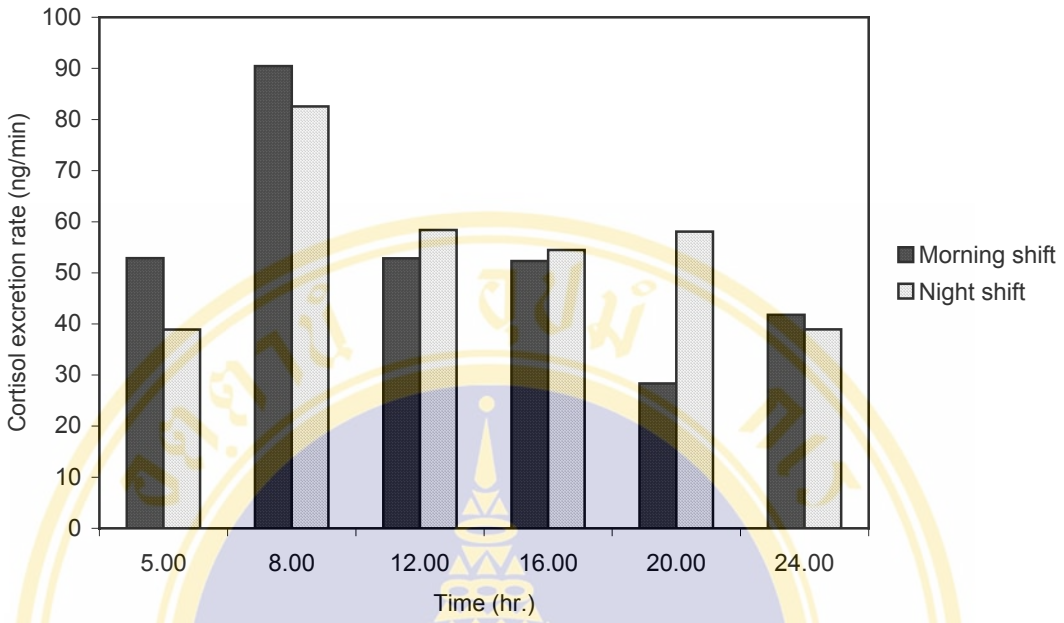

Figure 4-6. Comparison of cortisol excretion rates between morning shift and night shift.

4.7.2 Comparison of cortisol excretion rates between baseline and morning shift day off

The comparison of cortisol excretion rates between baseline and morning shift day off were tested by Paired t-test and Wilcoxon Signed Ranks Test. The details were shown in Table 4-15. The results shown that the cortisol excretion rates at baseline was significantly lower than morning shift day off at 8.00 hr. (P-value = 0.010). Figure 4-7 shown the comparison of cortisol excretion rates between baseline and morning shift day off.

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Table 4-15. The comparison of cortisol excretion rates between baseline and morning shift day off were tested by Paired t-test and Wilcoxon Signed Ranks Test.

Time (hr.)	mean	SD.	n	t-test (Z test)[w]	P-value
5.00					
baseline	33.69	27.60	12	(-1.883)	0.600
morning shift day off	68.46	62.21	12		
8.00					
baseline	84.22	66.70	12	(-2.589)	0.010*
morning shift day off	167.48	102.71	12		
12.00					
baseline	53.58	48.14	12	(-1.961)	0.500
morning shift day off	107.22	74.72	12		
16.00					
baseline	57.27	34.33	12	-1.075	0.305
morning shift day off	74.25	45.54	12		
20.00					
baseline	34.86	30.80	12	-0.257	0.802
morning shift day off	37.72	21.96	12		
24.00					
baseline	26.17	23.74	12	(0.863)	0.388
morning shift day off	32.26	25.73	12		

w = Tested by Wilcoxon Signed Ranks Test.

* = Significant difference

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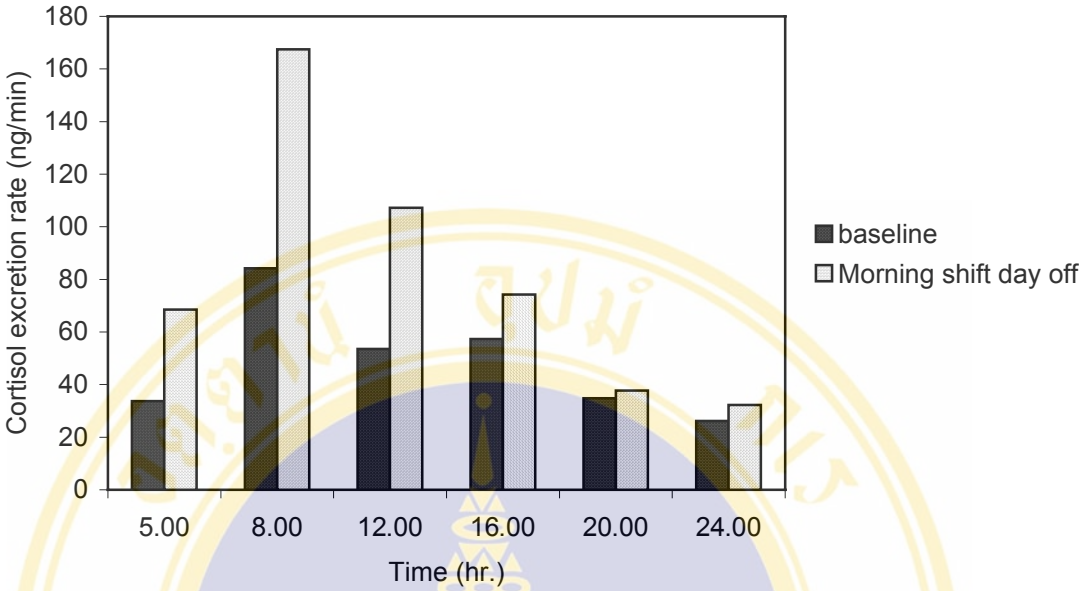

Figure 4-7. Comparison of cortisol excretion rates between baseline and morning shift day off.

4.7.3 Comparison of cortisol excretion rates between baseline and and night shift day off

The comparison of cortisol excretion rates between baseline and night shift day off were tested by Paired t-test and Wilcoxon Signed Ranks Test. The details were shown in Table 4-16. The results shown that the cortisol excretion rate of baseline was significantly lower than night shift day off at 5.00 hr. and 24.00 hr. (P-value = 0.034 and 0.034, respectively). Figure 4-8 shown the comparison of cortisol excretion rates between baseline and night shift day off.

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Table 4-16. The comparison of cortisol excretion rates between baseline and night shift day off were tested by Paired t-test and Wilcoxon Signed Ranks Test.

Time (hr.)	mean	SD.	n	t-test (Z test)[w]	P-value
5.00					
baseline	33.69	27.60	12	(-2.118)	0.034*
night shift day off	69.38	56.25	12		
8.00					
baseline	84.22	66.70	12	(1.098)	0.272
night shift day off	116.67	82.00	12		
12.00					
baseline	53.58	48.14	12	(0.471)	0.638
night shift day off	64.74	49.34	12		
16.00					
baseline	57.27	34.33	12	0.002	0.999
night shift day off	57.24	38.98	12		
20.00					
baseline	34.86	30.80	12	(-1.647)	0.099
night shift day off	58.91	47.65	12		
24.00					
baseline	26.17	25.74	12	(-2.118)	0.034*
night shift day off	59.18	49.22	12		

w = Tested by Wilcoxon Signed Ranks Test.

* = Significant difference

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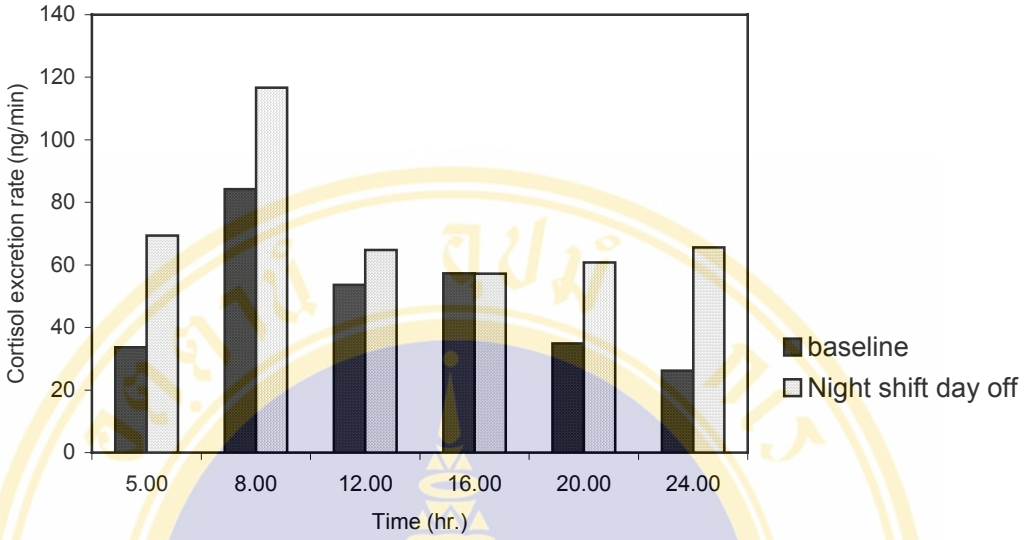

Figure 4-8. Comparison of cortisol excretion rates between baseline and night shift day off.

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CHAPTER V
DISCUSSION

This study aimed to study stress levels and compare cortisol excretion rates in female shift workers who work morning shifts and night shifts The cortisol excretion were measured in 12 female shift workers by selecting specific samples, who met the qualifications required to undergo sampling. In this study was decided to measured cortisol during work as well as after work to investigated cortisol excretion rates. Discussion was divided into two parts as follows:

5.1 Discussion of study design

5.2 Discussion of study results

5.1 Discussion of Study Design

The study design in this research was divided into 2 steps. Primary step was a cross-sectional design. In this step the workers participated for determining stress levels, health status, and perceived working condition levels. Secondary step will be a quasi-experiment one group design and selecting subjects by purposive sampling. This study was measured cortisol excretion rates on morning and night shift and after work that affect circadian rhythm and mental stress to workers. The error of data collection and analysis in this study was cause from the random error and the systematic error. Therefore, this research was controlled in order to recheck the quality. The researcher also tried to reduce and error in this study.

5.1.1 Questionnaire and error

Questionnaire that used in this study was stress questionnaire, perceived working condition questionnaire, and sleep quality index questionnaire. The details of each questionnaire were as follows:

Stress questionnaire (H.O.S.): This questionnaire was covers physio-psychological health problems or psychosomatic symptoms associated with work-related stress, with a reliably coefficient of 0.77 (Cronbach’s Alpha).

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Sleep quality questionnaire: This questionnaire was about overall sleep quality, time of sleep, sleep disturbances, use of sleep medication and alcoholic beverages and daytime dysfunction over the last month. This questionnaire was adapted from the Pittburgh sleep quality index (PSQI), with a reliably coefficient of 0.83 (Cronbach's Alpha).

Perceived working condition questionnaire: This questionnaire was present in work conditions scale and organization scale, with reliably coefficient of 0.76 (Cronbach's Alpha). This questionnaire was certified as accurate in content and structure by specialist, and was tested before starting the experiment.

An error from these instruments might occurred if subjects misunderstand the questions. To reduce an error the researcher clearly described the objective of the study and question to the subjects before starting the experiment.

5.1.2 Urine Collection and Transportation

This study was designed to collect urine at 5.00, 8.00, 12.00, 16.00, 20.00, and 24.00 hr. Before starting the experiment, the researcher was clearly described the protocol of urine collection to the subjects. The subjects received a manual that contained details about urine collection. Potential errors from urine collection might be result from:

5.1.2.1 The subjects urinated at the incorrect time: An error from urinating at the incorrect time while working might result from the subjects not being able to the bathroom at the time of collection because their work had to be continued. To reduce errors, the subjects and supervisors of the production lines worked together in order to permit the subjects to go to the bathroom at the time of collection. An error from urinating at the incorrect time during time off might be caused by the subjects falling asleep and forgetting the time. Since, all the subjects lived in a factory dormitory, at the time of collection, the subjects and the assistant were called each other to get up and collect urine at that time. Furthermore, both the researcher and the assistant were always observed the urine containers for each subject at every hour that collection was scheduled.

5.1.2.2 The subjects don't have urinated at the time of collection: To reduce an error before starting experiment the subjects were trained to urinate at the time of collection about two days.

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5.1.2.3 Urine transportation: Duration from the factory to the freezer was 1.5 hrs. During transportation urine containers were kept in ice pack for reduce urine degenerated, after that immediately kept in the freezer at –20 ^{o}C.

5.1.3 Laboratory analysis and interpretation

Before conducting the study, the well knows and accurate method was selected to measured cortisol. This study was measured cortisol by radioimmunoassay technique. Accordingly Ursala T. et al. (37) compared urinary free cortisol between HPLC and RIA method. The result obtained by HPLC are about half the quantities obtained by immunoassays (about 40 %), and especially in the low range of values the correlations in poor. An error might be cause from:

5.1.3.1 Instrument error

Coat-A-Count Cortisol was a radioimmunoassay designed for the qualitative measurement of cortisol in serum and urine. It was use for clinical assessment of adrenal status. An error from Coat-A-Count might be cause from a different of Coat-A-Count in each batch because in this study was used Coat-A-Count total 2 batch. Batch different might be reducing an accuracy of analysis. Nerveless, before starting analysis the Coat-A-Count will be construct control chart and standard curve in each batch. Other error that can occur was in a step of calculated cortisol concentration by standard curve. To reduce personal error from step of calculated concentration, standard curve and cortisol concentrate were constructed and calculated by computer program instead of manual method.

5.1.3.2 Systemic error

This error might be occurred by researcher during performing radioimmunoassay procedure, which includes samples pipeting and the incubation time in room temperature. Researcher operated the laboratory investigated from 8.00-17.00 hr., therefore the incubation time of samples were different by room temperature of each day. To reduce an error the researcher always starts laboratory at same time, same room, and same room temperature in every day.

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5.1.3.3 Personal error

The error could occur from the researcher: insufficient training and poor skill of the researcher also caused the inaccurate data. To reduce this error the researcher was training by the technician and laboratory was performed by only one operator in order to reduce the personal error.

5.2 Discussion of Study Results

5.2.1 Physical health status and stress situation in female shift workers

General information and physical health status in 6 months ago were shown in Table 4-1. Of 95 subjects, 30 subjects had health problems, 33.33 % had headaches and 16.68 % had peptic ulcers. and someone have a hand tremor during work time. All of these health problems were cause from stress (14). The results from stress questionnaire of 95 subjects found that 75.79 % of the subjects had a normal stress level, 22.11 % had a moderate stress level and 2.10 % had a high stress level. Result from data analysis of 12 subjects found that 7 subjects had a normal stress level, 5 subjects had a moderate stress level. The subjects in high stress level groups were highly risk to physical and mental health problem.

From the stress questionnaire both groups found 7 items of high stress levels in common. These 7 items were as follows: exhaustion upon awakening and fatigue, sleep problems, digestive abnormalities, feelings pain in different organs with unknown causes, loss of appetite, feeling of dizziness, and loss or gain of body weight due to anxiety. From this result indicated that shift work was associated with sleep disturbance. The reason for the difficulty in sleeping during day was be cause of circadian rhythm. Accordingly, most of shift works research found that sleep problem was one of the major problems associated with shift work (17,18).

Result from data analysis of perceived working condition level of 95 subjects found that 33.68 % of the subjects had a normal level. 48.42 % of the subjects had a moderate level and 17.90 % had a high level. Result from data analysis of 12 subjects found that 2 subjects had a normal level, 7 subjects had a moderate level, and 3 subjects had high level.

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From the perceived working condition questionnaire, both groups found 5 items in common that contributed to their perception working conditions as high level. These 5 items were as follows: loud work environment, the work need to complete their in a short amount of time, the need to be careful on the job, high responsibility on the job, and lack of welfare services.

From Table 4-8 that shown the results about sleeps quality of 12 subjects. This study found that 7 subjects had a fairly good sleep quality. Five subjects had fairly bad sleep quality. The result found the first 3 items with bad sleep quality. The first was wake up in the middle of the night. The second was couldn't get to sleep within 30 minutes. The third was in the early morning was awakening. The sleep pattern could be disturbed because the workers had difficulty in sleep, and night workers have less sleeping hours. From a result shown that when they work in night shift they were sleep less than 6 hrs per day. The disruption of both the quality and the quantity of the normal sleep are inevitable in shift work particularly in night workers. The daytime sleep has seldom as refreshing as sleep at night. The problem was greater if there was not a quite, dark, comfortable place to sleep. When the workers returns home in the morning may still find sleep impossible or less refreshing. This problem occurs because circadian rhythms are no longer synchronized.

5.2.2 Cortisol Excretion Rates

In this study the subjects were decided to measure cortisol during work and after work to investigate the cortisol excretion rates changed. The discussions were divided in five parts as follows:

5.2.2.1 Comparison of profile between typical cortisol profile and in this study.

The results of baseline cortisol excretion were shown in Table 4-9 and Figure 4-1. Peak concentration of cortisol is normally reached in the early morning (24, 25, 26). Accordingly, this study found that cortisol excretion rate at baseline was highest at 8.00 hr. and then declined to lowest at 24.00 hr. From this results indicated that these workers had corresponded profile with the typical profile. Even though these workers were work in shift work that disturbance circadian rhythm but, if they had

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sufficient resting and enough sleep the profile of them were corresponded with the typical profile.

The cortisol excretion rates in this study were differing from other study, such as a study of Sluiter JK. et al. (7) that evaluated in male coach drivers' by measuring urinary cortisol and analyst by HPLC method. The results found the peak concentrations of cortisol were highest at 11.00 hr. and cortisol excretion rates were lower than in this study. The different onset time and excretion rate of the results may due to different from sex and frequency sample collection. Accordance with Loraine JA. et al. (47) that conducted the comparison the cortisol in male and female. The results found that cortisol concentrations in female were significantly higher than male in the same aged.

5.2.2.2 Cortisol excretion rates on morning and night shifts

The mean cortisol excretion rates on morning and night shifts for three days are shown in Tables 4-10, 4-11, and 4-12. The results show that there seems to be an accumulation of cortisol excretes from the first to the third day that it was measured. These results imply that the subjects have accumulated stress during both shifts. The main factor that causes this phenomenon might be work characteristics such as shift work or workload. In the night shift profiles of cortisol levels on the first working day, levels differed from the other days. These results indicate that the workers could not adapt their physiology on the first working day and because they were sleeping during the daytime on night shift working day, their circadian rhythms were highly disturbed on these days.

Humans are diurnal creatures accustomed to being asleep at night and awake and active during the day. Measuring cortisol is one method of analyzing circadian rhythms. The peak concentration of cortisol is early in the morning and lowest around 24.00 hr. This hormone is secreted to increase blood sugar levels to sustain energy and raise blood pressure for helping individuals stay alert and active during working time. So in night shift workers the cortisol excretion should be high at working time. Nevertheless, in this study it was found that cortisol excretion in night shift workers was lowest at 24.00 hr. This result indicates that their bodies were not ready to work at night. Previous study has shown that light is one factor that accelerates cortisol excretion (23). In this study it was found that light intensity on night shifts was

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significantly lower than on morning shift (P-value = 0.001). This result suggests that factory could improve the light intensity for night shift workers to help them stay alert during nighttime.

5.2.2.3 Comparison between cortisol excretion rate on morning shifts and night shifts

The comparison between cortisol excretion rates on morning shifts and night shifts were shown in Table 4-14 and Figure 4-6. The results show that the cortisol excretion rates on night shift were significantly higher than morning shift at 20.00 hr. (P-value = 0.008). These results indicated that the evening is for social life, and night time is for sleeping, The night shift workers might be suffer from additional stress caused by missing important parts of their social life. In addition, the workers were sleep before going to night work at this time it could be disturbed sleep pattern and interfere the circadian rhythm of these subjects.

5.2.2.4 Comparison between cortisol excretion rates at baseline and morning shift day off

Comparison between cortisol excretion rates at baseline and morning shift day off was shown in Table 4-15 and Figure 4-7. The results show that the cortisol excretion rates of morning shift day off was significantly higher than baseline at 8.00 hr (P-value=0.010). These result shown that their hormone not returns to baseline on day off. In addition, the overall mean excretions of cortisol on morning shift day off were higher than baseline. A hypothetical explanation for this finding is that the workers need prolong rest on their day off. It is hypothesised that starting work repeatedly in a state of fatigue debt requires extra exertion which in the long run could have adverse effects on health.

5.2.2.5 Comparison between cortisol excretion rates of baseline and night shift day off

Comparison between cortisol excretion rates at baseline and night shift day off was shown in Table 4-16 and Figure 4-8. The results show that the cortisol excretion rates of night shift day off were significantly higher than baseline at 5.00 and 24.00 hr (P-value = 0.034 and 0.034, respectively). In normally cortisol level were lowest at 24.00 hr. and slowly increased highest at 8.00 hr. From this study shown that cortisol level of morning shift day off at 24.00 hr. and 5.00 hr. were not return to baseline

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indicated that the subjects can not accommodate their physiologist. So, the physiology was not recovery in that time.

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CHAPTER VI
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study was designed to determine the stress levels and profiles of cortisol excretion rates in female shift workers by assessing cortisol excretion rates in urine and stress levels using a stress questionnaire. Overall the general health status of shift workers was good, though 33.33% had headaches, and 16.68% had peptic ulcers. Shift workers were found to sleep more than 6 hrs. if they did not work a night shift. The environmental data on the workplace well within the laws established by The Ministry of Interior and The Ministry of Industry as related to Environmental Conditions. The results of this study were as follows:

6.1.1 Results of Questionnaires

6.1.1.1 Results of stress levels in female shift workers

Results from stress questionnaire of 95 subjects found that 75.79 % of the subjects had a normal stress level, 22.11 % had a moderate stress level and 2.10 % had a high stress level. Result from data analysis of 12 subjects found that 7 subjects had a normal stress level, 5 subjects had a moderate stress level.

From the stress questionnaire both groups found 7 items of high stress levels in common. These 7 items were as follows: exhaustion upon awakening and fatigue, sleep problems, digestive abnormalities, feelings pain in different organs with unknown causes, loss of appetite, feeling of dizziness, and loss or gain of body weight due to anxiety.

6.1.1.2 Results of perceived working condition questionnaire

Result from data analysis of perceived working condition level of 95 subjects found that 33.68 % of the subjects had a normal level. 48.42 % of the subjects had a moderate level and 17.90 % had a high level. Result from data analysis of 12

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subjects found that 2 subjects had a normal level, 7 subjects had a moderate level, and 3 subjects had high level.

From the perceived working condition questionnaire, both groups found 5 items in common that contributed to their perception working conditions as high level. These 5 items were as follows: loud work environment, the work need to complete their in a short amount of time, the need to be careful on the job, high responsibility on the job, and lack of welfare services.

6.1.1.3 Results of sleep quality questionnaire

This study found that 7 subjects had a fairly good sleep quality, 5 subjects had fairly bad sleep quality. When no night shift 4 subjects had sleep duration less than 6 hours per night and 8 subjects had sleep duration more than 6 hours per night. This study found that the first 3 items with bad sleep quality. The first was wake up in the middle of the night. The second was couldn't get to sleep within 30 minutes. The last was awakening in the early morning.

6.1.2 Results of Cortisol Excretion Rates

6.1.2.1 Profile of cortisol

This study found that cortisol excretion rates at baseline were highest at 8.00 hr. and then declined to their lowest levels at 24.00 hr. The study found that the cortisol levels of the subjects corresponded well with the typical cortisol profile. Even though these workers carried out shift work that disturbed circadian rhythms if they had sufficient rest and enough sleep, their profile corresponded well with the typical profile.

6.1.2.2 Comparison of cortisol excretion rates between morning shift and night shift

The cortisol excretion rates on night shift were significantly higher than morning shift at 20.00 hr. (P-value = 0.008).

6.1.2.3 Comparison of cortisol excretion rates between baseline and morning shift day off

The cortisol excretion rates on morning shift day off were significantly higher than baseline at 8.00 hr (P-value=0.010).

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6.1.2.4 Comparison of cortisol excretion rates between baseline and and night shift day off

The cortisol excretion rates on night shift day off were significantly higher than at baseline at 5.00 and 24.00 hr (P-value = 0.034 and 0.034, respectively).

6.2 Recommendations for Future Studies

6.2.1 Future studies should increase the number of subjects and compare cortisol excretion rates between shift and non-shift workers.

6.2.2 Future studies should compare cortisol profiles between morning and evening shifts to determine differences in cortisol excretion rates.

6.2.3 Future studies should focus on the relationships between sleep problems, cortisol excretion rates, and health complaints.

6.2.4 Future studies should compare cortisol excretion rates between work day off and short brake during the shift.

6.2.5 Cortisol excretion rates should be measured in first working day of shift for determining stress in shift workers.

6.2.6 The factory should improve working conditions such as levels of noise and light intensity.

6.2.7 During the morning shift day off and night shift day off the rates of cortisol excretion did not return to baseline values, which seems to indicate an incomplete recovery. The researcher recommends that workers should rest longer on workday off and should have at least two days off after these kinds of this work.

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APPENDIX A

1. General Questionnaire (A-1)
2. Health Opinion Survey Test (A-2)
3. Perceived Working Condition (A-3)
4. Sleep Quality Questionnaire (A-4)

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General Questionnaire (A-1)

Please indicate in □ or choose the best answer to the following questions.

1. Name -lastname……Age……..years……months
2. Weigh……..Kilograms high……centimeter.
3. Marital Status
   □ 1. Single □ 2. Married □ 3. Divorce
   □ 4. Separated □ 5. Widow
4. Education level
   □ 1. Pratom 4 □ 2. Protom 6 □ 3. Matayom 3
   □ 4. Matayom 6 □ 5. Bachelor degree □ 6. Not of above……
5. Have you ever done shift work?
   □ 1. No
   □ 2.Yes; if yes how long did you work?…….years…….month
   Type of job…….
6. Are you smoker? □ 1. No
   □ 2. Yes; if yes in the present □ No □ yes
7. Do you drink tea or coffee? □ 1. No
   □ 2. Yes; if yes in the present □ No □ yes
8. Do you drink alcohol? □ 1. No
   □ 2. Yes; if yes in the present □ No □ yes
9. Do you have any health problem?……..
10. Do you take any medicine?……

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แบบสอบถามข้อมูลทั่วไป

กรุณาเขียนเครื่องหมาย / ลงใน ☐ ที่ถูกต้องกับคุณมากที่สุด

1. ชื่อ-สกุล……อายุ……ปี……เดือน
2. น้ำหนัก……กิโลกรัม ส่วนสูง……เซนติเมตร
3. สถานภาพ

   ☐ 1. โสด ☐ 2. สมรส ☐ 3. หย่า ☐ 4. แยก ☐ 5. ม่าย
4. ระดับการศึกษาสูงสุดที่จบ (ระบุ)…….

   ☐ 1. ประถมศึกษา 4 ☐ 2. ประถมศึกษา 6 ☐ 3. มัธยมศึกษา 3

   ☐ 4. มัธยมศึกษา 6 ☐ 5. ปริญญาตรี ☐ 6. อื่น ๆ ระบุ…….
5. คุณเคยทำงานกะมาก่อนหรือไม่

   ☐ 1. ไม่เคย

   ☐ 2. เคย ทำงานกะมานาน……ปี……..เดือน ลักษณะงาน……
6. คุณเคยสูบบุหรี่หรือไม่ ☐ 1. ไม่เคยสูบ

   ☐ 2. เคยสูบ ปัจจุบันสูบหรือไม่ ☐ สูบ ☐ ไม่สูบ
7. คุณเคยดื่มชาหรือกาแฟหรือไม่ ☐ 1. ไม่เคยดื่ม

   ☐ 2. เคยดื่ม ปัจจุบันดื่มหรือไม่ ☐ ดื่ม ☐ ไม่ดื่ม
8. คุณเคยดื่มแอลกอฮอร์หรือไม่ ☐ 1. ไม่เคยดื่ม

   ☐ 2. เคยดื่ม ปัจจุบันดื่มหรือไม่ ☐ ดื่ม ☐ ไม่ดื่ม
9. คุณมีโรคประจำตัวอะไรบ้าง……
10. คุณรับประทานยาอะไรเป็นประจำ……..

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Stress Questionnaire (A-2)

Health Opinion Survey Test (H.O.S)

Explanation: Please indicates in □ or chooses the best answer to the following questions.

Frequently = 4 or more times a month
Sometimes = 3-4 times per month
Never = 1-2 times or never per month

Statement	Frequently	Sometimes	Never
1. Whether hand tremor make you any annoyance or not?			
2. Do you have any sweating from hand and foot?			
3. Is your heart rate to fast or tachycadia?			
4. After wake up in the morning do you feel don't want do Anything?			
5. Do you have any sleep problem?			
6. Do you have an abnormal digestion? (e.g. stomachache, diarrhea)			
7. Do you have nightmares?			
8. Do you have cold sweat when you frightened?			
9. Did you feel pain in the different organ with unknown causes?			
10. Do you usually relax by use cigarette smoking, drug and Alcohol?			
11. Do you loss appetite?			

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Statement	Frequently	Sometimes	Never
12. Have you illness effect on your health?			
13. Do you fell no alert?			
14. Do you often feel dizzy ?			
15. Do you have lost or gain body weight when you worry?			
16. Do you have dyspnea or difficulty in breathing though you have not exercise?			
17. Do you think you are strong and have the ability to work successfully?			
18. Do you feel happy?			
19. Do you feel depress?			

20.Do you have health problem? □ 1. Yes……□ 2. No

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แบบสำรวจความเครียดจากการทำงาน

คำชี้แจง กรุณาเขียนเครื่องหมาย / ลงในช่องที่ตรงกับความรู้สึกหรืออาการของคุณในช่วง 6 เดือนที่ผ่าน

เคยบ่อย ๆ หมายถึง มีความรู้สึกหรือมีอาการ 4 ครั้งหรือมากกว่าต่อเดือน

เคย หมายถึง มีความรู้สึกหรือมีอาการ 3-4 ครั้งต่อเดือน

ไม่เคยเลย หมายถึง มีความรู้สึกหรือมีอาการ 1-2 ครั้งต่อเดือนหรือไม่เคยมีเลย

สภาวะ	เคยบ่อยๆ	เคยบางครั้ง	ไม่เคยเลย
1. มือของคุณสั่นจนทำให้คุณรำคาญบ้างหรือไม่			
2. มือและเท้าของคุณมีเหงื่อออกจนทำให้คุณรู้สึกรำคาญบ่อยหรือไม่			
3. ขณะอยู่เฉย ๆ ก็รู้สึกว่าใจสั่นหรือใจเต้นเร็วผิดปกติบ้างหรือไม่			
4. เมื่อคุณตื่นนอนตอนเช้า คุณรู้สึกละเหี่ยท้อแท้บ้างหรือไม่			
5. คุณมีปัญหาเกี่ยวกับการนอนไม่หลับ หรือหลับๆ ตื่นๆ บ้างหรือไม่			
6. คุณมีระบบการย่อยที่ผิดปกติ เช่น ปวดท้อง ท้องเสีย บ่อยหรือไม่			
7. คุณมีฝันร้ายหรือไม่			
8. คุณมีเหงื่อออก ตัวเย็น เพราะตกใจบ้างหรือไม่			
9. คุณเคยมีอาการปวดตามส่วนต่าง ๆ ของร่างกายโดยไม่ทราบสาเหตุบ้างหรือไม่			
10. คุณผ่อนคลายด้วยการสูบบุหรี่, ใช้ยา หรือดื่มแอลกอฮอร์บ้างหรือไม่			
11. คุณเบื่ออาหารบ้างหรือไม่			
12. การเจ็บป่วยเคยมีผลกระทบต่อผลการทำงานของคุณบ้างหรือไม่			
13. คุณเคยอยู่เฉย ๆ โดยไม่มีความกระตือรือร้นหรือไม่			
14. คุณรู้สึกมึนงงหรือเวียนศีรษะบ่อยหรือไม่			
15. เมื่อคุณมีความกังวล น้ำหนักตัวของคุณจะมีการเปลี่ยนแปลงหรือไม่			
16. คุณรู้สึกหายใจลำบากหรือมีอาการหอบเหนื่อย แม้ไม่ได้ออกกำลังกายบ้างหรือไม่			
17. คุณคิดว่าคุณมีความแข็งแรงหรือมีความสามารถเพียงพอที่จะทำกิจกรรมต่าง ๆ ให้สำเร็จลุล่วงได้			
18. คุณรู้สึกสบายใจ			
19. คุณคิดว่าในโลกนี้ไม่มีสิ่งใดมีค่าเลย			

20. ขณะนี้คุณมีปัญหาเกี่ยวกับสุขภาพหรือไม่ 1. ☐ มี ระบุ..... 2. ☐ ไม่มี

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Perceived Working Condition (A-3)

Explanation: Please indicates in □ or chooses the best answer to the following questions.

Frequently = 4 or more times a month
Sometimes = 3-4 times per month
Never = 1-2 times or never per month

Statement	Frequently	Sometimes	Never
Work Environment			
1. Work environment has a lot of loud noise.			
2. My working environment heats till make me uncomfortable.			
3. My working area has unsuitable lighting.			
4. My working environment has bad ventilation.			
5. I always work with a static posture through the working time.			
6. My work is repetitive and boring.			
Work characteristic and workload.			
7. My work make me exposed to hazardous chemical substance.			
8. My work have a high risk of accident.			
9. My work is overload, I do not have enough free time to do what others expect of me.			
10. My work must compete with short time.			

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Statement	Frequently	Sometimes	Never
11. My work wants a careful on the job.			
Shift work			
12. I feel shift work system is not comfort enough.			
13. I have enough time to take a break.			
14. I have enough time and day off before next shift.			
15. After night shift I usually have some sleep disorders.			
16. I feel uncomfortable to commute during the shift work.			
17. The shift work system gave some negative effect in my activities with family and society			
Role and responsibility			
18. I have high responsibility on my job.			
19. My job lack opportunity and any chance to make a lot of decision making on my own personal initiative.			
20. My work is not interesting in me.			
21. I feel my work is not important and prestigious.			
22. I work in other job out of my responsibility			
23. My working job is suitable to my skill.			
Relationship in organization			
24. The relationship between me and my boss on good.			
25. The relationship between me and my co-worker is good.			

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Statement	Frequently	Sometimes	Never
26. A work rotate is annoyed my work.			
27. The colleagues have little cooperation while on the job.			
28. I never have some free time to meet with my friends who work in other production units.			
Organization and salary.			
29. Administrative workers are interest and understand the worker.			
30. Administrative workers are support when the worker have problem.			
31. I need to develop my welfare service.			
32. I fear layoffs and elimination of jobs in economic crisis.			
33. I need to changes and consider a new job.			

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แบบสอบถามสภาวะในการทำงาน

คำชี้แจง กรุณาเขียนเครื่องหมาย / ลงในช่องที่ตรงกับความรู้สึกหรืออาการของคุณมากที่สุด

บ่อยมาก หมายถึง มีความรู้สึกหรือมีอาการ 4 ครั้งหรือมากกว่าต่อเดือน

บางครั้ง หมายถึง มีความรู้สึกหรือมีอาการ 3-4 ครั้งต่อเดือน

ไม่เคย หมายถึง มีความรู้สึกหรือมีอาการ 1-2 ครั้งต่อเดือนหรือไม่เคยมีเลย

สภาวะ	บ่อยมาก	บางครั้ง	ไม่เคย
สิ่งแวดล้อมในการทำงาน			
1. คุณรู้สึกว่าสิ่งแวดล้อมในการทำงานของคุณมีเสียงดัง			
2. สิ่งแวดล้อมในการทำงานของคุณมีความร้อนจนทำให้คุณรู้สึกไม่สบาย			
3. บริเวณพื้นที่ทำงานของคุณมีแสงสว่างไม่เหมาะสม			
4. สิ่งแวดล้อมในการทำงานของคุณมีระบบระบายอากาศไม่ดี			
5. งานของคุณต้องอยู่ท่าทางเดิม ๆ ตลอดเวลาทำงาน			
6. งานของคุณมีความซ้ำซากและน่าเบื่อหน่าย			
ลักษณะงานและภาระงาน			
7. งานของคุณทำให้คุณสัมผัสกับสารเคมีอันตราย			
8. งานของคุณมีความเสี่ยงต่ออุบัติเหตุสูง			
9. งานคุณหนักมากจนไม่มีเวลาว่างพอที่จะทำสิ่งที่คิดไว้			
10. งานของคุณต้องแข่งกับเวลา			
11. งานของคุณเป็นงานที่ต้องการความละเอียดรอบคอบ			
ระบบงานกะ			
12. คุณรู้สึกว่าระบบงานกะทำให้เกิดความไม่สะดวกสบาย			
13. คุณมีช่วงเวลาพักที่เพียงพอในระหว่างเข้างานกะ			
14. คุณมีเวลาและวันพักเพียงพอก่อนที่จะเริ่มงานในกะต่อไป			
15. หลังจากทำงานกะกลางคืนคุณมักจะมีปัญหาเกี่ยวกับการนอนหลับ			
16. คุณรู้สึกลำบากในการเดินทางไปทำงานกะ			
17. ระบบงานกะส่งผลกระทบต่อกิจกรรมที่คุณมีต่อครอบครัวและสังคม			
บทบาทและความรับผิดชอบ			
18. งานของคุณต้องมีความรับผิดชอบสูง			
19. งานของคุณทำให้คุณขาดโอกาสในการตัดสินใจด้วยตนเอง			
20. งานของคุณไม่มีความน่าสนใจเพียงพอสำหรับคุณ			
21. คุณรู้สึกว่างานของคุณไม่มีความสำคัญและไม่เป็นที่เคารพนับถือ			
22. คุณต้องทำงานนอกเหนือหน้าที่รับผิดชอบ			
23. คุณคิดว่าคุณมีความเหมาะสมกับงาน			

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สภาวะ	บ่อยมาก	บางครั้ง	ไม่เคย
ความสัมพันธ์ระหว่างบุคคลในองค์กร			
24. คุณมีความสัมพันธ์ที่ดีกับหัวหน้างาน			
25. คุณมีความสัมพันธ์ที่ดีกับเพื่อนร่วมงาน			
26. การสับเปลี่ยนตำแหน่งงาน รบกวนการทำงานของคุณ			
27. ขณะทำงานมีการร่วมมือจากเพื่อนร่วมงานน้อย			
28. คุณไม่มีเวลาว่างพอที่จะพบปะกับเพื่อนพนักงานแผนกอื่น			
ลักษณะองค์กร, เงินเดือน, สวัสดิการ และความมั่นคง			
29. ผู้บริหารมีความสนใจและเข้าใจพนักงาน			
30. ผู้บริหารให้ความช่วยเหลือพนักงานเมื่อมีปัญหา			
31. คุณมีความต้องการให้มีการปรับปรุงด้านสวัสดิการ			
32. คุณกลัวการถูกไล่ออกจากภาวะวิกฤติทางเศรษฐกิจ			
33. คุณมีความต้องการเปลี่ยนงานใหม่			

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Sleep Quality Questionnaire (A-4)

Explanation : Please indicates in □ or chooses the best answer to the following questions.

Frequently = 3 or more times a week
Sometimes = one or twice a week
Seldom = less than once a week
Never = Not during the last month

Statement	Frequently	Sometimes	Seldom	Never
1. How often have you difficulty maintaining sleep				
2. How often have you cannot get to sleep within 30 minutes?				
3. How often have you wake up in the middle of the night?				
4. How often have you wake up in the early morning and had difficulty in getting back to sleep?				
5. How often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
6. How often have you taken medicine to help you sleep?				
7. How often have you used alcoholic beverage to help you sleep?				

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Statement	Frequently	Sometimes	Seldom	Never
8. Have you had any trouble at work due to drowsiness?				

9. How many hours of sleep did you get in the night?

□ 1. Less than 6 hours.

□ 2. More than 6 hours.

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แบบสอบถามเกี่ยวกับการนอน

คำชี้แจง กรุณาเขียนเครื่องหมาย / ลงในช่องที่ตรงกับความรู้สึกหรืออาการของคุณมากที่สุด

ไม่เลย	หมายถึง	ไม่เคยเลยหรือเพียงครั้งเดียว
นาน ๆ ครั้ง	หมายถึง	1 ครั้งต่อสัปดาห์หรือน้อยกว่า
บ่อย	หมายถึง	2-4 ครั้งต่อสัปดาห์
บ่อยมาก	หมายถึง	5 ครั้งต่อสัปดาห์หรือมากกว่า

อาการ	บ่อยมาก	บ่อย	นานๆครั้ง	ไม่เลย
1. ท่านคิดว่าท่านนอนหลับได้เพียงพอหรือไม่				
2.ท่านไม่สามารถนอนหลับลงได้ภายใน 30นาที บ่อยเพียงใด				
3. ท่านรู้สึกตัวบ่อยเพียงใดในขณะนอนหลับเวลากลางคืน				
4. ท่านตื่นเช้ากว่าปกติและไม่สามารถนอนหลับต่อได้อีกบ่อยเพียงใด				
5.ท่านรู้สึกงัวเงียในระหว่างขับรถ, รับประทานอาหาร, ทำกิจกรรมใน สังคมต่าง ๆ บ่อยเพียงใด				
6.ท่านทานยาเพื่อช่วยให้ท่านนอนหลับบ่อยเพียงใด				
7. ท่านดื่มเครื่องดื่มที่มีแอลกอฮอร์เพื่อช่วยให้ท่านนอนหลับบ่อยเพียงใด				
8. ท่านเคยมีปัญหาในการทำงานเนื่องจากง่วงเหงาหาวนอนหรือไม่				

9. เมื่อท่านไม่ได้ทำงานกะดึก ท่านนอนหลับในเวลากลางคืนเฉลี่ยวันละกี่ชั่วโมง

☐ น้อยกว่า 6 ชั่วโมง ☐ มากกว่า 6 ชั่วโมง

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APPENDIX B

Cortisol excretion rates of female shift workers

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Cortisol excretion rates of 12 female shift workers (Appendix B)

Table B-1. Cortisol excretion rates of baseline

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	13.00	24.58	26.83	22.21	11.25	12.21
2	21.73	59.53	15.54	57.50	6.13	1.77
3	31.98	10.39	141.25	39.29	25.50	11.70
4	40.50	239.86	88.49	107.50	48.18	30.42
5	115.93	66.61	70.96	68.17	83.81	75.00
6	17.84	77.56	31.73	20.88	15.04	10.73
7	29.83	60.11	14.06	52.60	54.27	30.42
8	31.07	80.00	25.13	19.81	15.50	12.50
9	19.80	40.25	41.15	61.90	30.08	16.42
10	13.27	71.11	27.63	60.25	17.44	6.83
11	27.13	86.76	12.88	43.67	10.48	38.10
12	42.23	193.89	147.33	133.50	100.67	67.96
Mean	33.69	84.22	53.58	57.27	34.86	26.17
SD.	27.60	66.70	48.14	34.33	30.80	23.74

Table B-2. Cortisol excretion rates of the first working day of morning shift

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	14.17	38.91	47.83	28.04	14.54	7.50
2	14.45	126.76	29.74	45.34	34.33	7.29
3	186.29	46.64	54.60	27.53	30.31	94.50
4	62.72	43.96	56.32	72.00	50.51	45.13
5	25.90	50.86	61.73	59.85	25.13	30.90
6	21.00	69.77	18.83	103.40	5.75	25.83
7	64.70	214.89	70.13	75.04	27.75	110.17
8	77.67	62.45	33.70	57.67	19.08	49.25
9	33.35	31.11	42.08	47.50	43.29	97.42
10	24.77	35.22	27.19	15.40	40.71	74.17
11	71.15	220.00	47.83	37.21	15.21	56.00
12	81.08	84.71	22.29	37.50	7.44	84.29
Mean	56.44	85.44	42.69	50.54	26.17	56.87
SD.	48.16	67.02	16.43	24.58	14.33	35.27

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Table B-3. Cortisol excretion rates of working day middle of shift of morning shift

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	20.95	80.67	43.25	48.50	6.33	20.21
2	31.14	84.08	124.48	54.83	30.25	6.71
3	101.00	59.97	30.80	37.13	58.18	59.75
4	13.77	49.62	56.13	70.40	44.01	40.50
5	21.37	66.91	82.29	71.33	47.34	26.73
6	28.90	63.12	46.27	28.25	19.90	16.43
7	83.88	143.33	43.42	52.38	17.88	25.88
8	92.17	46.75	36.35	38.69	27.50	36.00
9	22.25	113.89	76.33	94.42	38.38	24.35
10	77.50	92.72	65.19	77.33	26.21	78.50
11	80.47	128.33	57.83	37.67	14.63	26.88
12	69.50	131.67	33.44	50.00	14.88	60.21
Mean	53.57	88.42	57.98	50.08	28.79	35.18
SD.	33.01	33.55	26.59	19.61	15.49	21.03

Table B-4. Cortisol excretion rates of the last working day of morning shift

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	14.10	114.22	64.56	28.25	47.48	3.21
2	23.46	96.75	67.29	48.11	32.00	5.46
3	63.68	49.27	54.54	31.80	27.79	17.71
4	15.91	57.78	19.44	21.94	29.25	56.53
5	63.67	99.50	38.69	35.92	45.13	20.23
6	16.27	88.00	26.19	63.16	9.75	26.03
7	65.00	247.56	191.25	108.13	37.17	98.13
8	54.27	58.40	45.06	56.67	17.78	50.75
9	69.47	60.58	29.50	78.33	43.63	23.48
10	28.27	39.78	24.71	35.79	30.71	60.88
11	65.35	92.67	86.13	32.17	13.33	9.50
12	104.30	165.33	47.58	76.27	26.44	28.75
Mean	48.65	97.48	57.91	51.38	30.04	33.39
SD.	28.48	58.50	46.47	25.90	12.18	28.02

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Table B-5. Cortisol excretion rates of the first working day of night shift

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	42.17	53.53	137.88	38.79	126.85	19.23
2	26.40	13.03	25.81	39.23	95.00	9.86
3	37.53	12.42	55.89	26.25	77.62	31.80
4	42.24	59.80	111.50	57.55	34.56	52.03
5	58.43	66.44	67.08	24.35	81.02	30.42
6	128.00	202.00	128.41	47.08	63.63	33.50
7	5.38	71.58	22.63	33.67	42.63	7.15
8	17.50	107.25	31.27	52.75	23.69	25.13
9	5.48	46.33	34.25	37.94	76.17	22.57
10	9.40	9.33	27.06	23.63	17.67	10.44
11	88.75	61.29	186.67	41.19	11.71	38.25
12	29.87	20.50	39.13	28.25	264.13	79.77
Mean	40.93	60.29	72.30	37.56	76.22	30.01
SD.	36.41	53.43	55.00	11.02	68.50	20.34

Table B-6. Cortisol excretion rates of working day middle of shift of night shift

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	40.00	35.11	35.95	143.06	100.64	29.90
2	45.33	45.50	26.98	72.50	96.65	76.46
3	47.73	38.58	44.85	34.25	206.13	36.24
4	92.40	65.72	156.00	139.10	31.76	38.38
5	18.82	174.44	82.08	72.60	56.92	31.25
6	63.27	272.08	94.13	237.95	81.42	70.06
7	5.77	93.94	41.71	21.88	48.85	17.19
8	36.00	56.47	40.00	21.25	12.25	32.60
9	26.77	118.92	50.98	43.33	23.83	8.00
10	1.43	8.89	13.88	23.04	9.96	3.52
11	26.43	52.50	37.67	7.25	5.00	14.50
12	33.10	34.09	44.00	60.25	47.69	29.75
Mean	36.42	83.02	55.69	73.04	60.09	32.32
SD.	24.78	74.48	38.42	68.18	56.41	22.17

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Table B-7. Cortisol excretion rates of the last working day of night shift

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	71.93	39.89	52.35	80.94	86.13	35.90
2	9.73	11.44	22.60	16.60	30.85	9.44
3	20.57	25.07	25.92	122.93	99.44	72.53
4	48.00	126.12	97.71	86.25	32.94	75.31
5	50.43	32.17	65.75	51.53	43.43	14.04
6	56.10	205.42	95.43	35.79	62.65	22.08
7	11.30	99.11	29.54	15.00	12.54	52.33
8	29.94	224.78	26.38	49.00	11.40	45.00
9	23.33	212.22	62.88	88.33	9.13	104.94
10	2.18	29.17	20.96	20.13	6.33	108.13
11	87.25	99.63	37.06	29.34	4.67	43.06
12	61.69	147.39	29.42	38.00	55.71	71.17
Mean	39.37	104.37	47.17	52.82	37.93	54.49
SD.	27.10	79.01	27.64	34.34	32.22	32.68

Table B-8. Cortisol excretion rates of morning shift day off

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	4.90	48.13	60.94	35.50	11.25	4.38
2	36.21	129.94	56.85	57.50	26.46	5.25
3	49.83	395.00	253.50	154.95	25.71	20.40
4	33.00	201.72	185.58	161.06	85.75	62.07
5	15.17	164.08	19.23	26.08	22.06	23.98
6	57.07	212.41	140.38	86.00	31.33	61.58
7	47.17	120.67	105.58	113.33	18.96	89.27
8	78.42	221.80	61.21	63.33	72.17	23.17
9	108.33	25.22	209.69	60.29	50.69	14.92
10	17.23	79.83	103.50	45.42	34.88	19.63
11	186.00	136.67	44.75	44.25	40.13	34.58
12	188.20	274.31	45.38	43.33	33.30	27.92
Mean	68.46	167.48	107.22	74.25	37.72	32.26
SD.	62.21	102.71	74.72	45.54	21.96	25.73

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Table B-9. Cortisol excretion rates of night shift day off

No.	Rate of cortisol excretion (ng/min)					
	Time (hr.)					
	05.00	08.00	12.00	16.00	20.00	24.00
1	25.20	106.67	32.29	87.63	27.17	37.31
2	45.15	269.87	102.56	35.66	147.92	38.77
3	38.72	19.00	10.35	52.25	119.87	38.02
4	50.89	69.56	74.86	64.60	76.95	49.06
5	26.19	92.06	113.43	71.90	21.88	44.96
6	121.53	71.00	99.94	152.25	81.99	165.38
7	185.62	283.56	172.00	63.42	62.42	106.00
8	63.78	132.20	26.92	16.38	4.92	5.75
9	9.87	115.44	30.65	42.67	28.19	7.25
10	21.05	47.33	21.42	22.75	18.17	15.94
11	148.13	63.22	68.25	5.52	10.93	118.75
12	96.47	130.08	24.25	71.90	106.50	83.00
Mean	69.38	116.67	64.74	57.24	58.91	59.18
SD.	56.25	82.00	49.34	38.98	47.65	49.22

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Appendix C
Working Environment

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Working environment (Appendix C)

Table C-1. WBGT heat stress index (^{o}C)

No.	WBGT heat stress index (^{o}C)	
	Time (hr.)	
	8.00	24.00
1	28.10	28.10
2	27.80	27.90
3	27.80	28.20
4	28.20	27.90
5	28.00	28.00
6	28.50	27.70
Mean	28.07	27.97
SD.	0.26	0.17

Table C-2. Noise level (dB)

No.	Sound level (dB)	
	Time (hr.)	
	8.00	24.00
1	80.00	81.80
2	83.70	84.50
3	83.50	83.00
4	86.50	84.40
5	82.00	88.40
6	80.30	84.00
7	82.40	85.50
8	84.50	83.50
9	86.50	83.50
10	81.80	88.20
11	84.50	85.40
12	83.00	84.50
Mean	83.22	84.72
SD.	2.09	1.95

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Table C-3. Light intensity at production lines (Lux)

No.	Light intensity (Lux)	
	Time (hr.)	
	8.00	24.00
1	316.00	266.00
2	328.00	285.00
3	323.00	495.00
4	378.00	298.00
5	380.00	272.00
6	346.00	201.00
7	414.00	358.00
8	467.00	221.00
9	442.00	205.00
10	471.00	336.00
11	362.00	297.00
12	521.00	288.00
13	483.00	369.00
14	340.00	363.00
15	480.00	471.00
16	400.00	267.00
17	474.00	288.00
Mean	407.35	307.41
SD.	66.61	76.15

Table C-4. Light intensity at passageways (Lux)

No.	Light intensity (Lux)	
	Time (hr.)	
	8.00	24.00
1	133.00	121.00
2	203.00	140.00
3	165.00	167.00
4	174.00	122.00
5	186.00	161.00
6	138.00	168.00
7	195.00	178.00
8	162.00	170.00
Mean	169.50	153.37
SD.	25.26	22.52

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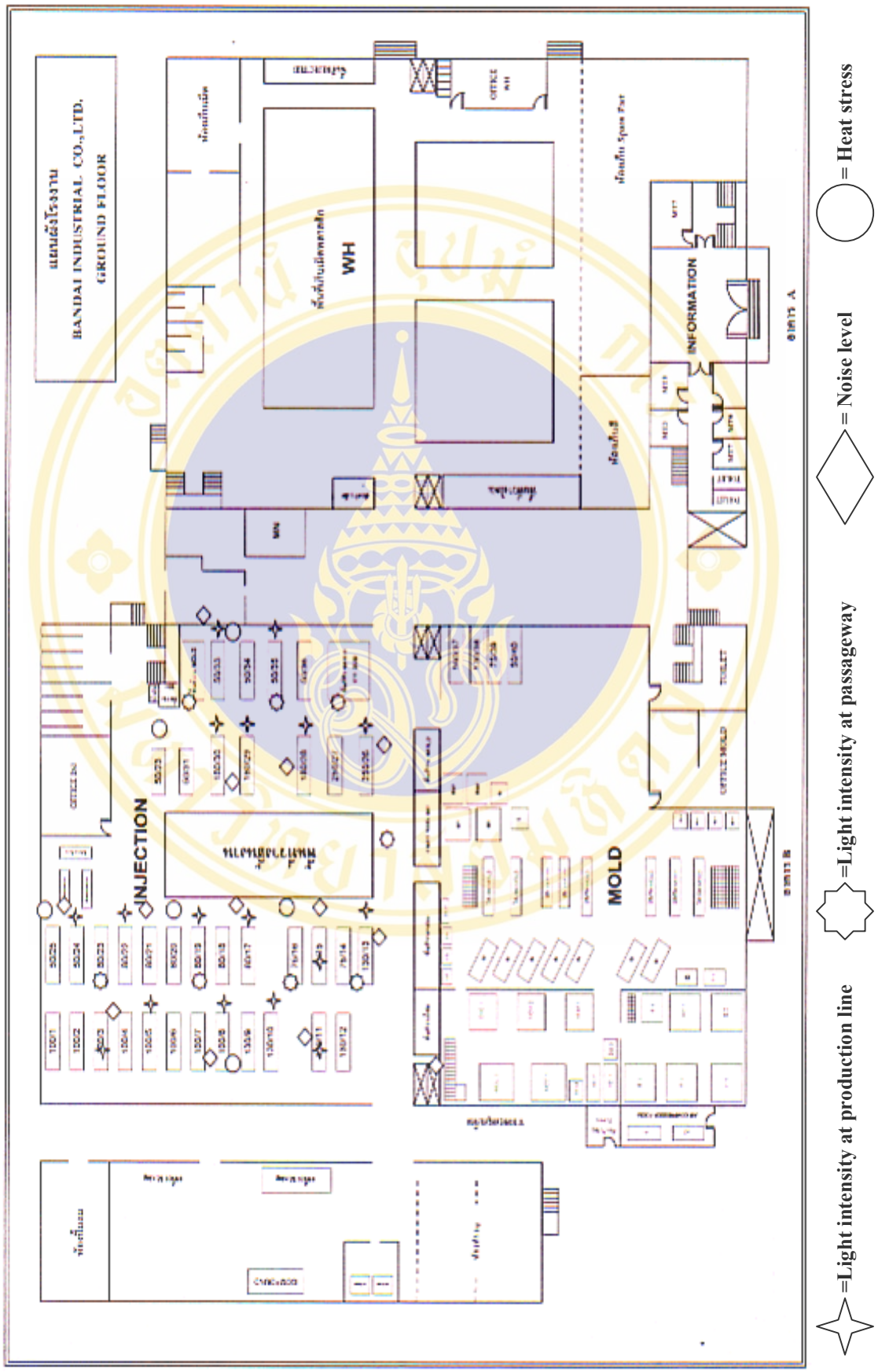

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APPENDIX D
FIGURES

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Figure D-1. Coat-A-Count cortisol kit

Figure D-2. Coat-A-Count tube

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Figure D-3. Gamma counter

Figure D-4. Foam rack

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Figure D-5. Centrifuge

Figure D-6. Vortex

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Figure D-7. Micropipett

Figure D-8. Urine container

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APPENDIX E

Documentary Proof of Ethical Clearance

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No. 169/2003

Documentary Proof of Ethical Clearance

The Committee on Human Rights Related to

Human Experimentation

Mahidol University, Bangkok

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Title of Project: A Study of Cortisol Level Changes and Stress in Female Shift Workers

Principal Investigator: Miss Amorn Upakaew

Name of Institution: Faculty of Public Health

Approved by the Committee on Human Rights Related to Human Experimentation

Signature of Chairman: _____

(Professor Dr. Srisin Khusmith)

Signature of Head of Institute: _____

(Professor Dr. Pornchai Matangkasombut)

Date of Approval: 24 SEP 2003

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