A STUDY OF A PRACTICAL WORK - REST REGIMEN IN COLD STORAGE WORKERS AT - 15 CELSIUS

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Thesis

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A STUDY OF A PRACTICAL WORK - REST REGIMEN IN COLD STORAGE WORKERS AT -15 CELSIUS

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ABSTRACT

The objective of this study was to investigate the effect of differences of work - rest regimen on the physiological responses of eight workers in cold storage facilities (-15 Celsius). The measured parameters were the estimated body temperature, heart rate and subjective feeling of skin temperature. There were five work patterns of work - rest regimen, in which the duration of work and rest were equal. The five work-rest regimens were 20, 25,30, 35 and 40 minutes each.

The results showed that the difference of estimated body temperature and heart rate between working and resting and cold subjective feeling of skin of the all work patterns were significantly different ($P < 0.001$). The first work pattern, working and resting for 20 minutes, had the least difference of those physiological responses. This study suggests that working and resting for 20 minutes is the practical work-rest regimen for cold storage workers to prevent health problems and accidents.

KEY WORDS: COLD STORAGE WORKERS / ESTIMATED BODY TEMPERATURE / HEART RATE / WORK-REST REGIMEN

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การศึกษาระยะเวลาการปฏิบัติงานต่อระยะเวลาพักที่เหมาะสมในการปฏิบัติงานในห้องเย็นอุณหภูมิ -15 องศาเซลเซียล

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บทคัดย่อ

การศึกษานี้ได้ดำเนินการในคลังเก็บสินค้าสำเร็จรูปโรงงานผลิตไอศกรีม กรุงเทพมหานคร โดยทำการศึกษาผลการตอบสนองทางสรีระวิทยาของพนักงานที่เข้าปฏิบัติงานในห้องเย็นอุณหภูมิ -15 องศาเซลเซียล จำนวน 8 คน ตัวแปรที่ศึกษาประกอบด้วยอุณหภูมิร่างกายจากการคำนวณ ชีพจร และความรู้สึกเย็นที่ผิวหนัง การศึกษาได้ออกแบบแผนการปฏิบัติงาน 5 รูปแบบ โดยกำหนดให้ระยะเวลาการทำงานเท่ากับระยะเวลาพัก ซึ่งรูปแบบดังกล่าวประกอบไปด้วย 1) ระยะเวลาการทำงาน 20 นาที / ระยะเวลาพัก 20 นาที 2) ระยะเวลาการทำงาน 25 นาที / ระยะเวลาพัก 25 นาที 3) ระยะเวลาการทำงาน 30 นาที / ระยะเวลาพัก 30 นาที 4) ระยะเวลาการทำงาน 35 นาที / ระยะเวลาพัก 35นาที และ 5) ระยะเวลาการทำงาน 40 นาที / ระยะเวลาพัก 40 นาที

ผลการศึกษาพบว่า ทุกแผนการปฏิบัติงานส่งผลให้เกิดความแตกต่างของอุณหภูมิร่างกายจากการคำนวณ ชีพจร ก่อนและหลังการปฏิบัติงาน ตลอดจนความรู้สึกเย็นที่ผิวหนังของใบหน้า นิ้วมือ เท้า และลำตัว มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($P < 0.001$) โดยที่แผนการปฏิบัติงานที่ 1 ซึ่งมีระยะเวลาการปฏิบัติงานต่อระยะเวลาพัก เท่ากับ 20 นาที / 20 นาที มีความแตกต่างกันระหว่างข้อมูลทางสรีระวิทยาก่อนและหลังปฏิบัติงานน้อยที่สุด เมื่อเทียบกับแผนการปฏิบัติงานรูปแบบอื่น ดังนั้นแผนการปฏิบัติงานรูปแบบที่ 1 นี้จึงมีความเหมาะสมที่จะนำไปใช้เป็นแผนการปฏิบัติงานในห้องเย็นที่อุณหภูมิ – 15 องศาเซลเซียส เพื่อเป็นการป้องกันไม่ให้เกิดอันตรายต่อสุขภาพ และอุบัติเหตุจากการที่ต้องปฏิบัติงานในห้องเย็น

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CHAPTER I
INTRODUCTION

1.1 Background and Rationale

The cold storage industrial businesses in Thailand are grown rapidly each year. The characteristics of these businesses relate to and support many businesses, for example fishery, frozen foods, etc. There are approximately more than 530 factories of cold storages in Thailand. The capital is more than 21,530 millions baht. The report of BOI showed that there are 33,883 workers worked in the cold storage industries (13). This indicated that many workers have to work under extremely low temperature condition; the temperature is lower than normal temperature of 15.1–33.1 degree Celsius (14).

Most of cold storage industries in Thailand use ammonia as the refrigerant in refrigeration system. The average temperature is during (–15) – (–40) degree Celsius. The working temperature condition is much lower temperature than normal life temperature. Working in cold storage for long time affects workers' health. Controlling working procedures in the cold storage is necessary. It helps working safety.

Cold storage activities several temperature levels are operated in its cold storages, such as –15, –20 and –35 degree Celsius. Workers used to complain about their health conditions concerning cold effect problems, thermal pain and white fingers. The company implemented the mill operation guideline from headquarter, England. There are wind chill charts for working in cold condition in the factory. Even though the guidelines are suitable for several regions, it may not suitable for Thai workers. The study of suitable working time and resting time for Thai workers in the cold storage factories should be investigated. That may help contribute the healthy working places for any cold storage industries in Thailand.

1.2 Objective

To determine the practical work–rest regimen in cold storage at –15 Celsius.

1.3 Research Hypotheses

The difference work–rest regimen brings about the different effect to human body.

1.3.1 The difference of estimated body temperature when work – rest regiment has difference

1.3.2 The difference of heart rate when work – rest regiment has difference

1.4 Variable

1.4.1 Independent variables

1.41.1 Working time that work in cold store

(1) 20 minute

(2) 25 minute

(3) 30 minute

(4) 35 minute

(5) 40 minute

1.4.1.2 Rest time

(1) 20 minute

(2) 25 minute

(3) 30 minute

(4) 35 minute

(5) 40 minute

1.4.2 Dependent variable

1.4.2.1 Estimated mean body temperature

1.4.2.2 Heart rate

1.4.2.3 Cold feeling

1.4.3 Control variable

1.4.3.1 Personal

- Age 20 – 27 years
- Male workers
- Rest period before experiment
- Alcohol consumption

1.4.3.2 Environmental condition

- Temperature at –15 degree Celsius

1.4.3.3 Cold protective equipment

1.4.3.4 Task and work load

1.5 Scopes and Limitation of this Study

The subjects in this research were workers, who worked in Palletizes room, pallet location at the cold store department, Ice cream factory.

Period of data collection was from March to July 2002.

1.5.1 Data collection in the morning shift was performed during 07.00 a.m. – 03.00 p.m.

1.5.2 The subjects had to have at least three months experiences.

1.5.3 Data collection was not continued.

1.5.4 The duration of working and resting time must be equal.

1.6 Outcomes and Benefit

The results of this research would be served as the guideline for the suitable working time schedules in the cold storages with the minimum of health effects to workers.

1.7 Definition

Cold storage:	Palletizes room, Cold store department, Temperature –15 degree Celsius
Worker:	Palletizes worker in palletizes room, Cold storage, department, 24 workers.
Working time:	Time period that worker work in cold storage, set period 20, 25, 30, 35 and 40 minute.
Resting time:	Time period that worker rest in rest room. Set the period are 20, 25, 30, 35 and 40 minutes.
Estimated body temperature:	The result from the algebraic equation using the core temperature and the skin temperature; Body temperature = 0.33 (Skin temperature) + 0.67 (Estimate Core temperature) in normal condition that have average temperature in 37 degree Celsius.
Estimated core temperature:	Estimated temperature of body from skin and muscles. In the assumption, the skin temperature is lower than the real core temperature 0.6 degree Celsius.
Skin temperature:	Temperature at skin and muscle of body that can change from ambient condition. The measurement of skin (37) temperature followed as ISO 9886 and 8-Point method that measure at 1. Forehead 2. Right scapula 3. Left upper chest 4. Right arm- upper location 5. Left arm-lower location

6. Left hand
7. Left posterior thigh
8. Left calf.

CHAPTER II
LITERATURE REVIEW

2.1 Hazard from working in cold storage

Many hazards from working in the cold storage often happen. Slippery is one of them High humidity might be the cause of injuries in the cold storage (22). When high humidity air gets into the cold storage, the humidity will be transformed to be snowflake falling down on the floor (19). It will finally turn into ices covering the floor. That is the major cause of slippery. Some workers also have respiratory problems in the cold storage. Cold stress, one of the results from the acts of cold, causes whole body cooling, extremity cooling, convective cooling (skin), contact cooling and respiratory cooling (21). The severity of effects varies from discomfort to cold injuries. Furthermore some workers cannot adjust their body temperatures during working and resting period.

Figure 2-1 Working condition in cold storage -15 degree Celsius

2.2 Human temperature control

Human body temperature is always constant at 36.7 to 37.8 degree Celsius at all temperature (18) condition because body has temperature control system at brain. It is Hypothalamus. When any factors affect body temperature, hypothalamus will command for control mechanism in body for body temperature to be normal at 37 degree Celsius. Although body temperature tries to maintain a constant temperature, some changes will occur. For instances, there is a temperature variation of about 1-1.5 degrees during the course of a normal day, with the lowest temperature occurring between 12 and 8 O'clock in the morning. During heavy exercises, temperature may increase by up to 1 degree Celsius because of the increasing in the metabolism. The temperature is regulated by a series of feedback systems in the hypothalamus of the brain. In this area there are thermal sensors that detect the temperature of the arterial blood coming to the brain. The response of this center is modified by temperature sensors in the periphery or skin. There are sensors reaching both heat and cold. When the skin is cool, cold receptors will increase their firing. Heat receptors increase firing when skin temperature increase. There are two conditions of temperature changes in the environment.

2.2.1 The response to an upward variation in body temperature is the initiation of perspiration, which moves moisture from body tissues to the body surface. When the moisture reaches the surface it evaporates, carrying with it a quantity of heat. The explanation for a person becoming thirsty when exposed to a hot environment for a period of time is that fluids lost due to perspiration must be replaced.

2.2.2 The response to a downward variation in body temperature is shivering, which is the body's attempt to generate heat. Shivering is an involuntary contraction and expansion of muscle tissue occurring on a large scale. This muscle action creates heat through friction.

Except process in body, important thing that help in temperature control of body is cold protective cloth and other personal protective equipment example cold protective boot and glove. In present it was developed more efficiency than the past.

2.3 Temperature.

The body temperature is the difference between the amount of heat produced by body processes and the amount of heat lost to the external environment. For healthy young adults the average temperature is 36.5 to 37.5 degree Celsius (17), however, the range varies with the site of temperature measurement. The body temperature is normally kept constant in the core temperature, probably the temperature in the center of the brain. Practically this cannot be measured. Besides the core temperature is estimated from the measurement of rectal temperature, temperature in the ear channel, in the mouth, or under the arm. The average temperatures of oral, rectal and auxiliary are 37, 37.5 and 36.5 degree Celsius (7), respectively.

Body temperature

The body can be considered conceptually in two parts, a core and a skin. Mean body is the average temperature over the whole body.

Core temperature

These core tissues are maintained within a narrow range of temperatures by thermoregulation. A list of common sites is provided here mouth, ear canal, tympanum, esophagus, abdomen, rectum and urine (8).

Skin temperature

The temperature of the skin varies with external environmental conditions and the thermoregulatory state of the body. Skin temperature is often taken as the mean skin temperature over the body.

Normal Range of body temperature

There is considerable diurnal variation in body temperature in the normal person. Strenuous exercise can rise up to 38 or 39^{o} C (oral) and much higher to 40^{o} C (rectal). The usual range is at least = 1 ^{o}C.

Body temperature variations

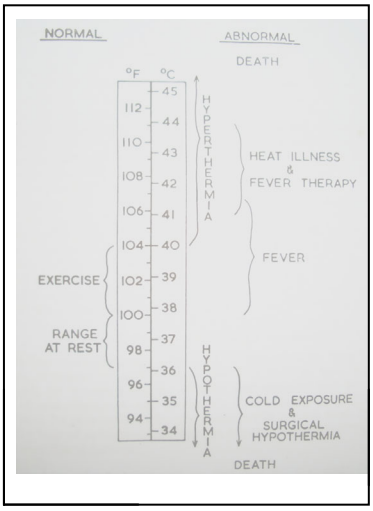


Figure 2-2 Variations in body temperature (Adapted from DuBois, 1948.)

The highest body temperature of the day is around 6 p.m. and lowest at around 4 a.m., producing a characteristic curve *pari passu* with oxygen usage, and probably reflects variation in the activity of voluntary and involuntary muscle. If the subjects are the night shift workers, or have abnormal time routine, most show a rapid inversion of the curve, the response being largely due to the new pattern of activity. However there is evidence in some subjects of an inherent 24-hour rhythm that persists (Lewis & Lobban, 1957).

2.4 Factors Effecting Body Temperature (5)

2.4.1 Age

Babies temperature control mechanisms are immature, and may respond drastically to changes in the environment, exposure to temperature extremes should be avoided. Temperature regulation is unstable until children reach puberty. Normal temperature ranges usually drop as individuals approach older adulthood. The oral temperature of 35 degree Celsius is not unusual for older adults in cold weather. Older adults are sensitive to temp. Extremes because of deterioration of control mechanisms

particularly poor vasomotor control, reduced amounts of subcutaneous tissue, reduced sweat gland activity, and reduced metabolism.

2.4.2 Exercise

Exercise cause the demand of increased blood supply, carbohydrate and fat breakdown for muscular activity. It increases metabolism that results the increasing of production and temperature.

2.4.3 Hormone Level

Generally women have greater fluctuations in body temperature than men. This is caused by hormonal variations during the menstrual cycle. During the menstrual cycle the temperature in some women drops about 0.6 C but at the ovulation time there is a distinct rise that is maintained over the next 14 days. When progesterone levels are low, the body temperature is slightly lower than baseline level, body temperature changes also occur in women during menopause. They may experience intense body heat and sweating lasting from 30 seconds to 5 minutes. This is due to the instability of the vasomotor controls.

2.4.4 Rhythm

Body temperature normally changes 0.5 degree Celsius to 1 degree Celsius during a 24-hour period. During the day it rises steadily till about 6 p.m. then declines to early morning levels. Temperature peaks at an earlier time of day in oldest adults.

2.4.5 Stress

Physical and emotional stress increases body temperature though hormonal and neural stimulation. Stress increases metabolism, which increases heat production.

2.4.6 Environment

Warm temperatures can increase body temperature and can cool it down as well. Infants and older adults are most likely to be affected by environment

In addition, there are many factors increasing danger from cold such as air movement, wetness, low activity and contact with cold objects. The medical

conditions especially those affecting circulation such as diabetes, heart disease and frostbite induce hazard from cold as well as some medications for example tranquilizers and beta-blockers. Those medications decrease vasoconstriction leading to the inefficiency to response to cope with the cold. Furthermore some agents such as alcohol, caffeine and nicotine can raise the risk to the cold. Alcohol impairs judgment and reduces shivering. Caffeine increases urine production and blood circulation; both lead to a loss of body heat. Nicotine decreases blood flow to the extremities.

Physiological responses to cold (6)

When the body becomes cold, vasoconstriction reduces blood flow to the skin and hence heat loss. Where there is a tendency for body temperature to fall, non-shivering thermogenesis will increase heat production. As the body temperature falls and termoegulates, shivering begins; there may also be some reaction type shivering due to psychological response and rate of fall in skin temperature due to sudden exposure.

Shivering is an effective method of increasing heat production. This will help maintain brain temperature.

The effectiveness of human thermoregulation in the cold is such that an environment which produces any fall in deep body temperature below about 36^{o}C can be regarded as severe and a fall below 35 ^{o}C potentially dangerous. These are very specialized conditions however, and under normal conditions environments must be extreme. There are also great individual differences in response. Violent shivering occurs in an attempt to maintain body temperature. If temperature begins to fall muscles become stiff and blood viscosity increases so movements become clumsy. There may be a clouding of consciousness a loss of sensory information and unconsciousness. There is a large individual variation but almost all persons will be unconscious at an internal body temperature of 30 – 31 ^{o}C, and at these levels and below there will be major risk of death due to ventricular fibrillation.

In cold conditions where vasoconstriction reduces blood flow and hence heat loss, there is an apparently anomalous reaction where at around 12 ^{o}C or below, depending upon rate of cooling, muscle and skin temperatures vasodilatation occurs.

2.5 Hypothermia

Hypothermia is a drop in the body's core temperature. Any drop below a body temperature of 98.6 Fahrenheit. Is considered the onset of hypothermia. Hypothermia is brought on by exposure to conditions that cause the body to loose heat faster than it can generate it. Cold, wind, and water are the three major contributing factors of hypothermia. A cold environment forces the body to work harder to maintain its temperature. Cold air, water, and snow all draw heat from the body. Wind causes heat loss due to convection. This effect is known as the 'wind chill'. Water, whether on the skin or on the clothes, greatly increases convectional heat loss and evaporative heat loss. A combination of water and wind can provide deadly heat loss due to evaporation and convection.

Therefore, while it is easy to see that sub-zero temperatures and poor clothing can quickly bring on hypothermia, it is important to realize that it can also be brought on by temperatures in the 50's coupled with some rain and light wind.

Symptoms

The effects of hypothermia range from the mild to the severe. Since the initial effects of hypothermia are mild, they often go unnoticed by the victim. As the body temperature drops and the effects become more severe, the victims thought processes are affected and one may still not realize what is happening. It is up to all the members of a backcountry group to keep a close eye on each other.

Impending Hypothermia:

Due to physiological, medical, environmental, or other factors the person's core temperature has decreased to 36 degrees Celsius. The person will increase activity in an attempt to warm up. The skin may become pale, numb and waxy. Muscles become tense, shivering may begin but can be overcome by activity. Fatigue and signs of weakness begin to show.

Mild Hypothermia:

The person has now become a victim of hypothermia. The core temperature has dropped to 35 - 34 degrees Celsius. Uncontrolled, intense shivering begins. The victim is still alert and able to help self, however movements become less coordinated and the coldness is creating some pain and discomfort.

Moderate Hypothermia:

The victim's core temperature has now dropped to 33 - 31 degrees Celsius. Shivering slows or stops, muscles begin to stiffen and mental confusion and apathy sets in. Speech becomes slow, vague and slurred, breathing becomes slower and shallow, and drowsiness and strange behavior may occur.

Severe Hypothermia:

Core temperature now below 31 degrees Celsius. Skin is cold, may be bluish- gray in color, eyes may be dilated. Victim is very weak, displays a marked lack of coordination, slurred speech, appears exhausted, may appear to be drunk, denies problem and may resist help. There is a gradual loss of consciousness. There may be little or no apparent breathing, victim may be very rigid, unconscious, and may appear dead.

Death from Hypothermia

- Breathing becomes erratic and very shallow
- Semi - conscious
- Cardiac arrhythmias develop; any sudden shock may set off Ventricular Fibrillation

2.6 Conditions Leading to Hypothermia

Many variables contribute to the development of hypothermia. Age, health, nutrition, body size, exhaustion, exposure, duration of exposure, wind, temperature, wetness, medication and intoxicants may decrease heat production, increase heat loss,

or interfere with thermostability. The temperature, which cause hypothesis in cold storage, is between -15 to -40 degree Celsius.

The healthy individual's compensatory responses to heat loss via conduction, convection, radiation, evaporation and respiration may be overwhelmed by exposure. Medications may interfere with thermoregulation. Acute or chronic central nervous system processes may decrease the efficiency of thermoregulation. Conduction means direct transfer of heat by contact with a cooler object - conduction of heat to the cooler object. Convection is the moving of cool air across the surface of the body, heat transferred to the cool air, warming it and cooling the body Radiation means heat radiated outward from the warm body to the cooler environment. Evaporation is the loss of heat through the process of removing water from the surface of the body through vaporization. Respiration is the inspired air raised to body temperature and then exhaled. Each of these causes of heat loss can play a large or small role in the development of hypothermia (30), depending on clothing, head cover, wind, weather, etc.

2.7 Physiological response (31)

The pulse is the palpable bounding of blood flow noted at various points on the body. It is an indicator of circulatory status. Circulation is the means by which cells receive nutrients and remove waste products of metabolism.

- Electrical impulses travel through heart muscle to stimulate cardiac contraction
- Approx 60 – 70 ml (Stroke Volume) of blood enters the aorta with each ventricular contraction
- With each Stroke Volume ejection, the walls of the aorta distend, creating a pulse wave
- When the pulse wave reaches a peripheral artery, it can be felt by palpating the artery lightly against underlying bone or muscle
- The number of pulsing sensations occurring in one min. Is the pulse rate.
- The volume of blood pumped by the heart during one min. Is the Cardiac Output, the product of heart rate and the ventricles stroke volume.

- The heart normally pumps 5000 ml of blood per minutes in an adult.
- Pulse rate x stroke Volume = Cardiac output E.g. 70 beats/min x 700 ml/beat = 4.9 L/min

2.7.1 Pulse sites

Any artery can be assessed for pulse rate, radial and carotid are easily palpated, and the carotid is best for quickly finding a pulse, especially if the condition of the brain as long as possible.

2.7.2 Normal Heart Rates.

Infants 120-160/min

Toddlers 90-140/min

Preschoolers 80-110/min

School Ages 75/100/min

Adolescent 60-90/min

Adult 60-100/min

2.7.3 Character of Pulse

Assessment of pulse includes measurement of the rate, rhythm, strength, and equality.

2.7.3.1 Rate

Factors influencing pulse rates

Exercise

Temperature – Fever, hypothermia

Emotions – acute pain, anxiety

Drugs –

Haemorrhage – Loss of blood

Posteral Changes – Lying, sitting or standing

Pulmonary conditions – Diseases causing poor oxygenation

Common abnormalities of rate include:

Tachycardia: Abnormally elevated heart rate, above 100 min in adults

Bradycardia: A slow rate, below 60/min in adults

2.7.3.2 Rhythm

Normally a regular interval occurs between each pulse or heart beat. An interval interrupted by an early or late beat, or a missed beat, indicates an abnormal rhythm or Dysrhymia

A dysrhymia threatens the hearts ability to provide adequate cardiac output, particularly if it occurs regularly.

2.7.3.3 Strength

The strength of the pulse reflects the volume of blood ejected against the arterial wall with each heart contraction and the condition of the arterial vascular system leading to the pulse site. Normally the pulse strength remains the same with each heart beat. Strength may be described as strong, weak, thready or bounding.

2.7.3.4 Equality

Pulses on both sides of the peripheral vascular system should be assessed, i.e. both radial pulses to compare the characteristics of each.

Disease processes may cause unequal strength or an absence eg. Thrombus (clot) formation.

The carotid pulse should never be measured simultaneously because excessive pressure may block blood supply to the brain.

2.8 Prevention and Control cold hazard in cold store

If workers are or may be exposed to conditions that could cause hypothermia or cold-related injury, a risk assessment should be performed to determine areas and tasks where the workers may be at risk. The potential for accidental exposure to cold conditions should be included in this assessment.

(1) Environmental Measures

(a) Temperature and wind conditions at the work location should be. known e.g. weather report on the radio, current weather office information.

(b) Steps should be taken to protect workers from wind (or indoors from drafts or forced air from air handling units). The combination of low temperatures and even moderate winds can quickly create dangerous working conditions. Table 2 clearly demonstrates the effects of temperature and wind speed.

(c) Ensure that heated rest areas such as a truck cab, tent or hut are

Table 2-1 Cooling power of wind on exposed flesh expressed as an equivalent chill temperature

Actual Temperature Reading (^{o}C)

Estimated Wind speed In kph	10	4	-1	-7	-12	-18	-23	-29	-34	-40	-46	-51
Equivalent Chill Temperature												
Calm	10	4	-1	-7	-12	-18	-23	-29	-34	-40	-46	-51
8	9	3	-3	-9	-14	-21	-26	-32	-34	-44	-49	-56
18	4	2	-9	-16	-23	-31	-36	-43	-50	-56	-64	-71
24	2	-6	-13	-21	-28	-38	-43	-50	-58	-65	-73	-80
32	0	-8	-16	-23	-32	-39	-47	-55	-63	-71	-79	-85
40	1	-9	-18	-26	-34	-42	-51	-59	-67	-76	-83	-92
48	-2	-11	-19	-28	-36	-44	-53	-62	-70	-78	-87	-96
56	-3	-12	-20	-29	-37	-46	-55	-63	-72	-81	-89	-98
64	-3	-12	-21	-29	-38	-47	-56	-65	-73	-82	-91	-100

Wind speeds Greater than 64 kph have little additional effect	Little Danger If exposure is for less than one hour and skin and clothing are dry. However, workers should be aware of a false sense of security.	Increasing Danger exposed flesh may freeze within one Minute	Great Danger Exposed flesh may freeze within 30 seconds

(From ACGIH 1999)

Table 2.2 Work/Warm-up Schedule for a 4-hour Shift and Moderate to Heavy Work Activity

Air Temperature °C –Sunny Sky	No noticeable wind		8 km/h wind (1.6 m/sec)		16 km/h wind (3.2 m/sec)		24 km/h wind (4.8 m/sec)		24 km/h wind (6.4 m/sec)	
	Max..Work Period (mins)	No of Breaks	Max.Work Period (mins)	No of Breaks	Max.Work Period (mins)	No of Breaks	Max.Work Period (mins)	No of Breaks	Max.Work Period (mins)	No of Breaks
-26 to -28	Normal	1	Normal	1	75	2	55	3	40	4
-26 to -28	Normal	1	75	2	55	3	40	4	30	5
-26 to -28	75	2	55	3	40	4	30	5	Emergency work only	
-26 to -28	55	3	40	4	30	5	Emergency work only			
-26 to -28	40	4	30	5	Emergency work only					
-26 to -28	30	5	Emergency work only							
-26 to -28	Emergency work only									

NOTES This schedule applies to any 4-hour work period with moderate to heavy work activity, and with warm-up breaks of 10 minutes and an extended lunch break, all in a warm location. For light to moderate work (little Physical movement), apply the schedule one step lower. For example, if The recommended maximum work period is 40 minutes on the above chart, For light work

If no means of measuring air movement is available, in an outside location The approximate air speed can be determined from the following:

Light flag movement	8 km/h
Flag fully extended	16 km/h
Raises sheets of newspaper	24 km/h
Blows drifting snow	32km/h

Table 2-2 presents a recommended schedule of maximum cold weather work periods that should be followed by a rest period. The table takes into account the combination of wind and temperature, and applies to moderate to heavy work activity. The notes at the bottom of the table explain how to adjust its recommendations for lighter work activity.

The cold stress threshold limit values (TLVs) presented in Table 2-2 are intended to protect workers from the severest effects of cold stress (hypothermia) and cold injury. Table 2-2 is based on exposure to cold working conditions under which it is believed that nearly all workers can be repeatedly exposed without adverse health effects.

(2) Work Practices

A schedule of regular rest breaks should be established to allow workers to worm up. These breaks should be not less than 10 minutes in length and should be taken in a heated area. Outer clothing should be removed to prevent overheating and sweating when in the heated area. Returning to cold work while damp or sweaty may result in rapid chilling. The following recommended work practices should be followed (adapted from ACGIH, 1999):

Recommendation for continuous work in the cold: (34)

(a) Heated warming shelters (tents, cabins, rest rooms etc.) should be provided. Workers should be encouraged to use these at regular intervals, the frequency of use depending on the severity of environmental exposure;

(b) When entering the heated shelter, outer and middle clothing layers (as necessary) should be removed to prevent overheating and to permit dampness to evaporate. A change of dry clothing may be necessary;

(c) Warm fluids should be consumed at the work site to provide energy, warmth, and replace fluids lost during work. Significant fluid loss can occur in the cold due to sensible and insensible sweating, breathing. And the extra energy requirements of working in the cold. Dehydration in the cold is a serious concern, increasing a worker's susceptibility to hypothermia; and

(d) The onset of severe shivering, the feeling of excessive fatigue, drowsiness, irritability or euphoria are indications for immediate return to the shelter.

The following additional precautions apply at colder temperatures:

(e) Workers should be under constant protective observation by a buddy or supervisor;

(f) Work rate should not be high enough to cause sweating. If heavy work must be performed, rest periods in heated shelters and the opportunity to change into dry clothing should be provided;

(g) New employee should not be performed, rest periods in heated shelters and the opportunity to change into dry clothing should be provided;

(h) Weight and bulkiness of clothing should be included in estimating

required work performance;

(i) Work should be arranged to minimize periods of standing or sitting still; and

(j) Workers should be appropriately trained as outlined in Section

(3) Personal Measures

(a) Diet

Workers have increased energy requirements when working in the cold. Consider adding additional wholesome foods to the diet such as pasta, potatoes, rice, dairy products, nuts, meat, herring, and salmon. Light snacks and warm fluids should be taken during rest breaks.

Alcohol must not be consumed when working in the cold. Alcohol produces a deceptive feeling of warmth but may contribute to dehydration and impair judgement.

(b) Dressing for the Cold

To stay worm in the cold,

(1) Clothes must be layered to manage moisture and keep dry,

(2) Insulating layers must trap air to stay warm, and

(3) The worker must be protected from the wind and weather.

To remain comfortable as weather and work conditions change, clothing layers should be added or removed, or ventilation openings in clothing opened or closed to remain comfortable. Clothing layers should be managed to remain comfortably warm.

Every effort must be made to avoid sweating and becoming damp. Clothing selections are normally made on the basis of staying warm while inactive. Consider the work to be performed and the weather conditions then have workers dress so that layers can be shed and they can still remain comfortably warm, if clothing layers do become damp and remain that way, workers should be prepared to

replace them before becoming chilled and hypothermic. If a worker is sweating, then their clothing is probably too warm for the conditions and tasks being performed.

The following approach of using three clothing layers- inner, middle and outer – is applicable to all situations. However, the recommended synthetic fabrics may not be appropriate for situations requiring clothing with fire resistant (FR) or anti-static properties. FR clothing next to the skin or an acceptable fire retardant material. The general practices described below should be followed, recognizing that the fabrics selected may be limited by specific, special work applications.

Inner Layer

The first layer of clothing should manage moisture by moving perspiration away from the skin to keep the worker dry and comfortable.

Avoid cotton, especially in long underwear and socks. Once cotton is wet, whether through perspiration, rain, or snow, it loses all insulating properties.

For long underwear, brands made of synthetic fibers (e.g. polyester, polypropylene, etc.), silk, or wool retain body heat when wet and wick perspiration to outer clothing layers for evaporation, leaving the body dry. Many types of long underwear are available in varying thicknesses or weights depending upon intended activity level and weather conditions. Select an appropriate style and thickness of long underwear.

Middle Layer

The second or middle layer (s) should trap warm air escaping from the body and hold it in open spaces within the layer (s) to keep the worker warm and insulated. Workers should wear several thin layers of clothing rather than one heavy garment. Layers can be added or removed, depending upon weather and activity level.

Select lightweight clothing that provides freedom of movement. Multiple middle layers give a worker the ability to tailor their need for warmth based on environmental temperature and activity level.

Look for middle layers that can be added or removed easily. Zippered neck openings and zippered leggings allow for ventilation. A down vest or jacket may be an appropriate middle layer.

Outer Layer

The outer layer should provide protection from wind, rain, sleet, snow and identified workplace hazards. It should also keep cold air and moisture from penetrating into the middle layer(s). Breathable fabrics may or may not be necessary. Windproof is a critical feature of an outer layer used in the cold outdoors.

Two-way zippered front openings can be used to regulate heat load and ventilate the body.

An outer layer having arm-pit zippers can be helpful in providing ventilation.

Windproof pants or “wind pants”, fully zippered from ankle to hip, can be added or removed without footwear having to be removed.

Jackets with hoods offer an additional layer of protection for the head. Newer hood designs provide unimpeded views and free movement.

Cotton twill made water and windproof may be an alternative.

The extremities must also be protected. The following suggestions apply to the hands, head and feet.

Handwear

Mittens keep hands warmer than gloves since fingers are together. With gloves, fingers are separated, losing heat from one another.

Have workers wear thin glove liners under gloves or mittens. Liners need not be removed when removing the gloves.

Removable glove and mitten liners can be replaced and dried when they become damp.

Windproof over mitts offer additional hand protection without adding significant bulk.

Figure 2-3 Cotton glove for cold protective equipment

Headwear

Up to 50 percent of body heat is lost through the head. A hat or other head protection must be worn in the cold.

Avoid cotton and use synthetic fabrics or wool instead.

Workers must use an appropriate hard hat liner to reduce heat loss when wearing a hard hat.

Select a hat appropriate for the weather conditions and activity level. Consider thickness, extent of head coverage (e.g. open faced or full balaclava, ear coverage, etc.), need for windproofness, effect on vision and hearing, and ability to fit into or over protective headwear if required.

A facemask and eye protection may be necessary under some circumstances.

Figure 2-4 Inner head cold protective equipment

Footwear

Warm, insulated safety footwear is essential. Boots should have thick soles for insulation while standing in snow or on cold concrete. Footwear selection should be based on the work being performed, the surfaces on which the worker will work, and the weather conditions to which the worker will normally be exposed. Tight-fitting boots reduce circulation and can make feet feel cold.

Footwear should be sized so that it will accommodate an extra layer(s) of socks. A synthetic sock liner worn beneath a synthetic blend or wool outer sock wicks moisture away from the skin, keeping feet drier and warmer.

Figure 2-5 Footwear for working in cold storage

(4) Worker Training

Worker should be instructed in health and safety procedures appropriate to the tasks and environment in which those tasks are performed, this instruction should also include:

(a) Proper rewarming procedures and appropriate first aid treatment;
(b) How to dress for the cold;
(c) Recognition of frostnip and frostbite; and
(d) Recognition of the signs and symptoms of impending hypothermia.

Special Precautions:

Exposure to vibration may increase a worker's susceptibility to cold injury because of the way that vibration can reduce circulation, particularly in the extremities.

Work performed in snow- or ice-covered terrain may require tinted safety eyewear and/or sunglasses with side shields. If there is a potential for eye hazards from blowing snow or ice crystals, special safety goggles should be worn. Workers in such situations should be prepared for white-out conditions, having a plan in place regarding movement and navigation under such conditions.

Alcohol must be avoided. It produces a deceptive feeling of warmth but can affect circulation, fluid balance, and judgement.

Limit the consumption of caffeine-containing beverages because they act as diuretics affecting hydration (35).

Workers with health conditions that affect normal body temperature regulation or impair circulation e.g. Raynaud's syndrome, diabetes, thrombophlebitis, etc. should take appropriate precautions when working in the cold (36).

Body parts that have sustained a frostnip or frostbite injury are sensitive to re-injury. Workers should be aware of this and limit opportunities for re-injury.

If loose or bulky clothing is worn, special care should be taken when working around moving equipment or machinery to prevent clothing entrapment.

Literature Review

Barbara Griefahn, et al. (1997) (1) studied the working in moderate cold and a possible risk to health. The report concerns a cross – sectional study in the food industry. The 1,213 workers in moderately cold climates (-5 to –15 ^{o}C) concern in this study. The study found for non – specific system, gastrointestinal complaints, and pains in the back and in the joints, rheumatic and bronchitis, complaints, colds, hearing problem and the systems of the white finger disease, the results support the hypothesis that moderate cold at the workplace constitutes a health risk.

This study concern about problem of white finger disease, the result supports the hypothesis that working in cold constitutes a health.

Sara Arphorn, et al. (1997) (2) studied the working condition of workers who were engaged in a fish storage plant in which a temperature of approximately –20 ^{o}c. Six mole workers aged from 26 – 44 year old participated in the study. They work in a fish storage refrigerator in which a temperature of approximately –20 ^{o}c was maintained. The result of this study suggest that improved protection of the whole body and extremities, as well as the longer resting periods, would decrease the negative effects due to cold exposure.

This study concern about improve protection of the whole body and extremities better than the longer resting periods, supports the hypothesis that the work pattern 1 and 2 that better than work pattern 3 , 4 and 5 because the work and rest period shorter than them.

Shin – ichi Sawada and Toshio Kobayashi (1998) (4) studied the thermal comfort, thermal sensation, and associated behavioral and Physiological responses during alternately repeated exposure to cold and warm environments. The young men aged 21 to 23 years, wearing only a T- shirt and shorts were exposed four times to a temperature of 5 ^{o}c for 15 minute, followed by 15 minute exposure to a temperature of 30 ^{o}c. The results suggest that subjective criteria such as thermal discomfort, cold sensation and behavioral motivation for seeking warmer condition during repeated cold exposure are sensitive and reliable.

Yumiko Nagai, et al. (1998) (5) studied the thermal responses of cold storage workers repeatedly exposed to severe cold. This study was carried out to ascertain the influence of different working temperature on thermal responses to severe cold. One group is composed of 8 cold storage workers who worked in severe cold environment. (-20 ^{o}c to –25 ^{o}c) for more than 4 years. Another group is 8 men working in ordinary thermal environment. The subjects were kept in severely cold room (25 ^{o}c) for 20 minute, then in a cool room (10 ^{o}c) for minute. This pattern was repeated three times. Rectal temperature was significantly higher for cold storage workers at the end of the experiments. Thermal discomforts of the cold storage workers were less severe at the second and the third exposure to severe cold. These results showed that because of they're past working in cold environment, the workers adapted well to their repeated exposure to cold.

This study supports the thesis about reason that the all subjects in this thesis had experience in cold storage less than 6 month.

Suphoj Kanachai (2000) (12) studied the comparison of the recovery time of core temperature and skin temperature at finger, hand, skin, neck, scapula and toe of workers working in cold storage by using forced warm air and not using forced warm air. The result of this study showed that the core temperature and skin temperature at hand, finger, skin, neck, scapula and toe in the forced warm air group could recover more quickly than that of the group without using forced warm air. Moreover, the result revealed significant differences in heart rate between the group with forced warm air and group without forced warm air.

This result of study showed about core temperature, skin temperature and heart rate significant difference between the group with forced warm air and group without farced warm air.

Ornchulee Chantra (2000) (10) studied the comparison of clothing insulation between two kinds of cold – protective gloves was performed in this study and the physiological responses such as finger skin temperature, mean skin temperature, estimated core temperature , heart rate , blood pressure , psychophysical

rating ballots and subject's feeling of frozen food workers were determined. The results of the study illustrated that worker's finger skin temperature. Mean skin temperature, estimated core temperature and heart rate were significantly different between ordinary and new- designed cold protective gloves during four work periods. There were no significant differences in blood pressure.

The result of this study showed the worker's finger skin temperature, mean skin temperature, estimated core temperature and heart rate were significantly different between old and new designed cold protective gloves.

Orawich Kangsuk (1999) (7) studied the effect of two kinds of clothing on the thermophysiological responses of cannery workers and to determine the subjective feelings of the workers during work in cold store. Fire healthy makes working in the conned food industry were selected as the subjects. These subjects under event eight continuous hours of exercise were testing. The work schedules were designed as 45 minutes work and 15 minutes rest. Each subject was tested for firework days of wearing each type of clothing giving total exposure time for all subjects of 50 days. The results of this study revealed that worker's care temperature and heart rate did not differ significantly between coated and uncoated ensemble during any work periods.

CHAPTER III
MATERIALS AND METHODS

3.1 Study Design

This study design was a quasi-experimental study. The subjects were selected by purposive sampling method. The general information of the workers and their levels of cold stress were collected by questionnaires. The measurement of body temperature and heart rate were performed periodically. Five work patterns were selected for this study. First work pattern was working 20-minutes/ rest 20 minutes. Second one was working 25 minutes/rest 25 minutes. Third one was working 30 minutes/rest 30 minutes. Forth one and the fifth one were 35/35 and 40/40 respectively.

3.2 Study Population

This study was performed in cold store department of ice cream manufactory in Bangkok Thailand. There were 24 workers in the department; only eight of them participated in this study. They had the same job responsibility and workload in the palletized room. The purpose of the study and the experimental procedure were clearly explained to the subjects. The characteristics of the subjects are shown bellows:

3.2.1 Working in the morning shift, during 07.00 a.m. to 03.00 p.m.

3.2.2 Aged between 20-30 years

3.2.3 Healthy well being before work

3.2.4 Having minimum of three month experiences in this job

3.2.5 No consumption of alcohol for 12 hours prior to the collecting data and during the experimental periods.

3.3 Materials and Methods

3.3.1 Questionnaire

3.3.1.1 General Questionnaire

The questionnaire included questions about age, weight and height, alcohol consumption, health problems and working experiences. Details of this questionnaire were given in Appendix A-1.

3.3.1.2 Cold stress Questionnaire

The cold stress questionnaire contained three items. Details of this questionnaire were given in Appendix A-2

3.3.2 Environmental data measurement

3.3.2.1 Control room chart

3.3.2.2 Thermometer

3.3.3 Physiological measurement

3.3.3.1 Skin temperature: PAYNGER MX4, High performance Infrared Thermometer

3.3.3.2 Sphygmomanometer

3.3.3.3 Estimate core temperature: Thermometer

3.3.4 Stopwatch

3.3.5 Data collection form

3.4 Data Collection

There were four steps for data collection as follows:

3.4.1 Survey for General Data

3.4.1.1 Eight workers in the cold store department were clearly introduced to general questionnaire, cold stress questionnaire, and perceived working condition questionnaire.

3.4.1.2 Data from eight workers were collected and analyzed.

3.4.2 Collection Period

The data collection started in March and ended in July 2002. It was collected from eight subjects, who participated throughout the experiment. It was done for five times in every three week as follows:

Table 3-1 The collection period

Work Pattern	Working / rest time	Subject no.	Date
1	20 mins. / 20 mins.	1 – 4	29 May 2002
		5 - 8	1 June 2002
2	25 mins. / 25 mins.	1 – 4	19 June 2002
		5 - 8	22 June 2002
3	30 mins. / 30 mins.	1 – 4	10 July 2002
		5 - 8	13 July 2002
4	35 mins. / 35 mins.	1 – 4	31 July 2002
		5 - 8	3 August 2002
5	40 mins. / 40 mins.	1 – 4	21 August 2002
		5 - 8	24 August 2002

3.4.3 Working System during the study

3.4.3.1 The subjects were divided into two groups. The first group was subject number 1 to 4 and another group was subject number 5 to 8.

3.4.3.2 The first group performed the experiment on Wednesday while the data from the second group was taken on Saturday.

3.4.3.3 Each subject did the experiment 5 minutes apart from each other and performed in chronological order from 1 to 4 or from 5 to 8.

3.4.3.4 Physiological parameters were measured before their shift working.

3.4.3.5 Performed the work schedule

3.4.3.6 Promptly measuring the subjects' biological responses after they left the cold storage.

(1) Core temperature measurement

(2) Skin temperature measurement

(3) Heart rate measurement

3.4.3.7 The steps 3.4.3.5 to 3.4.3.7 were repeated five times.

3.4.4 Estimate Core Temperature Collection

There were five steps for the estimate core temperature collection.

3.4.4.1 Taking the thermometer out of the alcohol basin

3.4.4.2 Catching upper area of thermometer and fling it to dry

3.4.4.3 Insert it under the tongue of subject and leave it there for 3 minute

3.4.4.4 Taking it out and read the scale

3.4.4.5 Recording data in the data collection table

3.4.5 Skin Temperature Collection

The researcher performed skin temperature collection. The temperature had to be measured at 6 inches away from subjects' skin. Moreover, the measurement of each subjects had to be performed at the same location in the control 25 degree Celsius room. There were five steps for the skin temperature collection.

3.4.5.1 Setting the sensitivity of the instrument: RAYNGER MX4, at 3 second.

3.4.5.2 Collecting the data by using infrared light to the 8 landmarks on body as follows in data collection table

3.4.5.3 Recording the data

3.4.5.4 Calculating the skin temperature by using the following formula

$$Ts = Ts1(0.07) + Ts2(0.175) + Ts3(0.175) + Ts4(0.07) + Ts5(0.07) + Ts6(0.05) + Ts7(0.19) + Ts8(0.20)$$

When TS = Mean skin temperature
Ts1 = Skin temperature at Forehead
Ts2 = Skin temperature at Right Scapula Chest
Ts3 = Skin temperature at Left Upper Chest
Ts4 = Skin temperature at right Arm-Upper location
Ts5 = Skin temperature at Left Arm-Lower location
Ts6 = Skin temperature at Left Hand
Ts7 = Skin temperature at Left Posterior Thigh
Ts8 = Skin temperature at Left Posterior Calf

3.4.6 Heart Rate Collection

The heart rate in this study was measured by palpation at the left wrist. The measurement was performed both before and after the working schedules. There was only one nurse operating that task

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 distribution were created; means and standard deviation were calculated.

3.5.2 Inferential Statistic

3.5.2.1 Non – parametric test

1) Comparison between difference estimated body temperature before work and rest five work pattern at P-value = 0.05

2) Comparison between difference heart rate before work and rest five work pattern at P-value = 0.05

CHAPTER IV
RESULTS

This study aimed to compare the differences between the physiological cold stress of subjects before and after work period in difference working and resting schedules. Eight workers participated in this study.

This chapter is divided into three parts that are general characteristics of subjects, mean body temperature and heart rate.

4.1 General Characteristics of Subjects

Subjects were palletizes workers in ice cream manufactory located in Bangkok, Thailand. The average age of subjects was 22.37 years. The average weight and height were 63.62 kilograms and 171.62 centimeters. The average experience of work was 16.88 months. The results were shown in table 4.1

Table 4-1 The details of general characteristics of subjects

	Age (years)	**Weight (kg.)**	**Height (cm.)**	**BMI ($kg./m^2$)**	**Experience of Work (month)**
Mean	22.37	63.62	171.62	21.62	16.87
SD	2.45	4.37	5.37	1.57	12.70

N = 8

4.2 The Body Mass index of workers

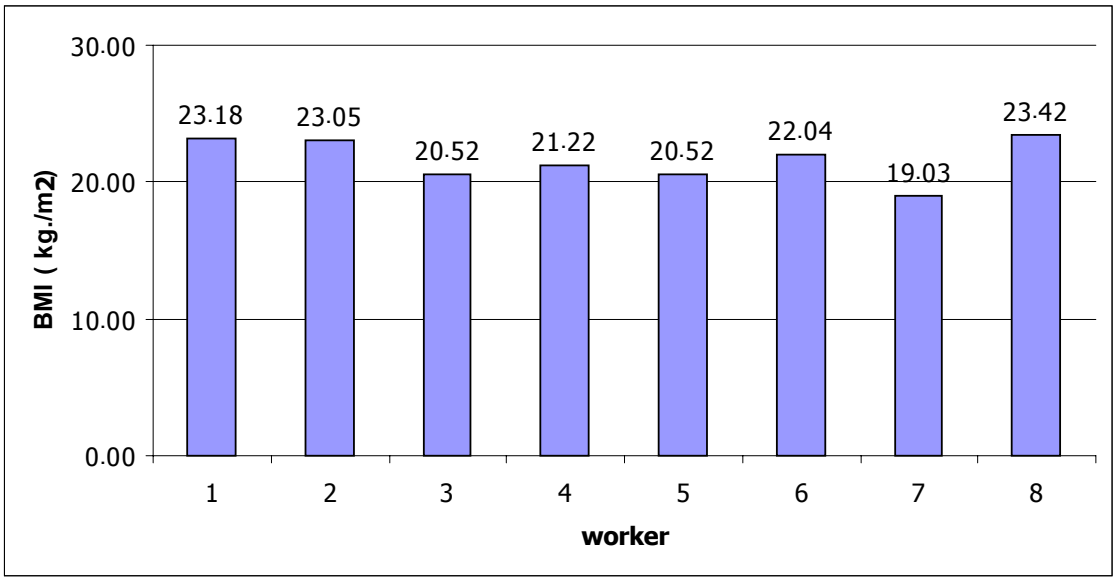


Figure 4-1 The Body Mass Index of workers.

The BMI of all workers was shown in figure 4.5. The minimum BMI of the worker was 19.03 kg. /m^2, which defined as mild starvation. The maximum BMI found in this study was 23.42 kg. /m^2. The average of BMI of these workers was 21.62 kg. /m^2. The table 4-2 showed significantly difference of BMI.

Table 4-2 Body Mass Index of eight workers

	t	df	P- value
BMI	38.98	7	< 0.001

The data showed that the weight and height of workers had no effect to subjective feeling of cold in this study.

4.3 Estimate mean body temperature (^{0}C)

The mean body temperature in this study could be calculated by using the formula: Estimate mean body temperature = 0.33 (Mean skin temperature) + 0.67 (Estimated core temperature)

Table 4-3 The summary of the difference of mean body temperature (^{0}C) between before and after work periods observing from all experiment periods.

	Work period						
Working time/rest time	1	2	3	4	5	Total	Average
20/20 minute	0.64	1.01	0.64	0.65	0.75	3.69	0.74
25/25 minute	0.84	0.85	0.95	1.20	1.08	4.91	0.98
30/30 minute	1.43	1.34	1.44	1.81	1.41	7.13	1.43
35/35 minute	1.28	1.30	1.15	1.50	1.23	6.45	1.29
40/40 minute	1.49	1.36	1.33	1.50	1.65	7.33	1.47
Total	5.66	5.86	5.20	6.66	6.11	29.50	

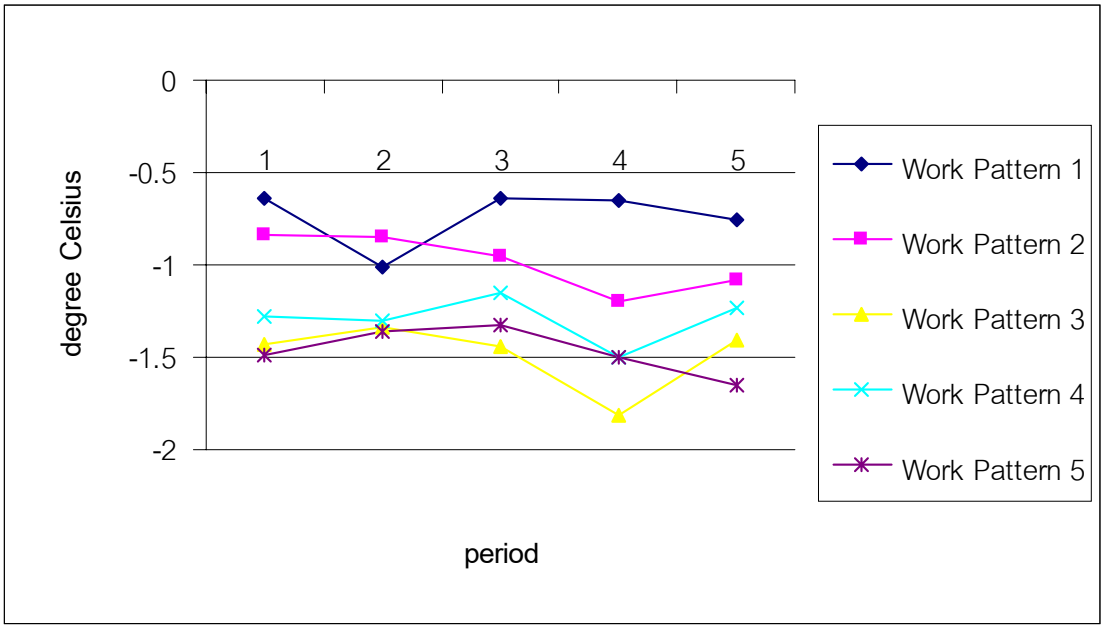


Figure 4-2 The summary of the difference of means body temperature (^{0}C) between before and after work periods observing from all experiment periods.

The reading from figure 4-2 stated that:

Work pattern 1, the first and the third periods revealed the least differences of the mean temperature that was 0.64 degree Celsius. Meanwhile, the second period showed the most differences, which was 1.01 degree Celsius.

Work pattern 2, the first periods showed the least differences of the mean temperature which was 0.84 degree Celsius, while the fourth period demonstrated the most differences which was 1.20 degree Celsius.

Work pattern 3, the first periods illustrated the least differences of the mean temperature, which was 1.14 degree Celsius. The forth period showed the most differences, which was 1.81 degree Celsius.

Work pattern 4, the third periods showed the least differences of the mean temperature, which was 1.15 degree Celsius. In the meantime, the second period depicted the most differences, which was 1.50 degree Celsius.

Work pattern 5, the third periods illustrated the least differences of the mean temperature, which was 1.33 degree Celsius. The second period showed the most differences, which was 1.65 degree Celsius.

Most of the work patterns showed the lowest means body temperature at the forth period. Five work patterns were significantly different. ($P < 0.001$)

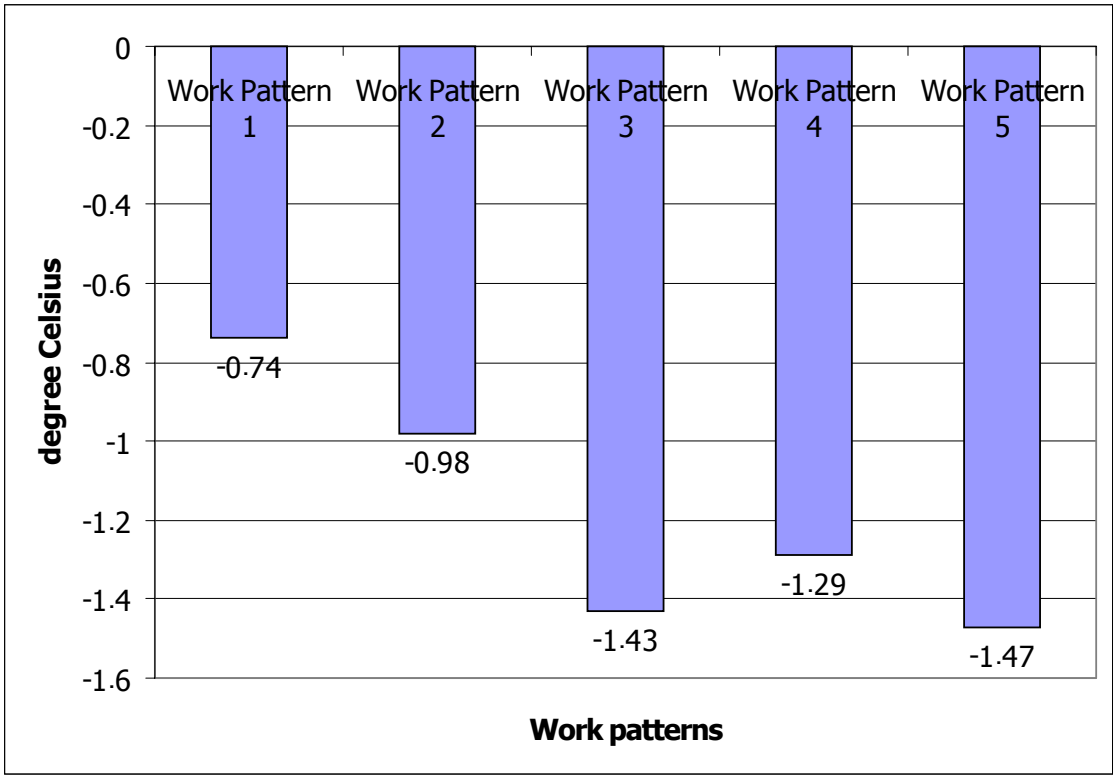


Figure 4-3 The summaries of the difference of mean body temperature (^{0}C) between before and after work periods monitoring from all periods.

Figure 4-3 showed that the first work pattern had minimum difference of mean temperature before and after work period, 0.74^0C and maximum difference was the fifth work pattern (1.47^0C). The first and the second work pattern had difference of mean temperature less than 1^0C and another model had difference more than 1.29^0C.

4.4 Heart rate

The heart rate in this study was measured by the palpation at the left wrist. The measurement was performed both before and after the working schedules. There was only one nurse operating that task.

Table 4-4 The summary of the difference heart rate between before and after five working periods.

	Work period						
Working time/rest time	1	2	3	4	5	Total	Average
20/20 minute	-1.25	0.75	2.25	2.25	0.5	4.5	0.9
25/25 minute	2.5	2	3	1	1	9.5	1.9
30/30 minute	8.75	13.5	9.5	7.25	4.75	43.75	8.75
35/35 minute	4	6.25	6.75	11	8	36	7.2
40/40 minute	3.5	4.25	-0.25	3	3.5	14	2.8
Total	17.5	26.75	21.25	24.5	17.75		

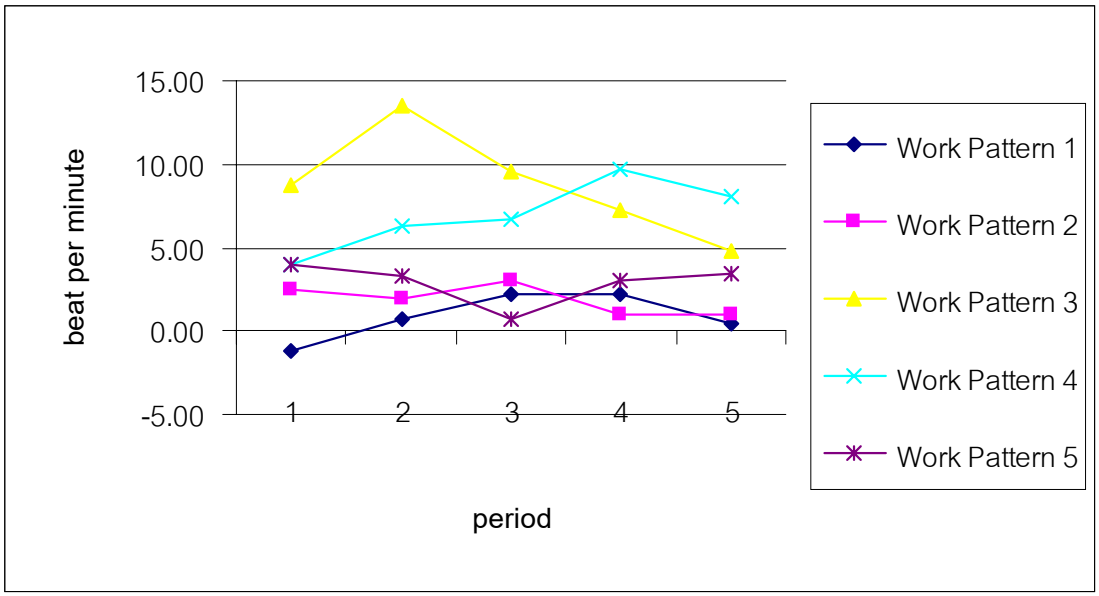


Figure 4-4 The summary of the difference heart rate between before and after five working periods.

Figure 4-4 illustrated as follows:

Work pattern 1 revealed that the minimum difference of heart rate between before and after work period was at the first period (-1.25 beats per minute) and maximum was at the third and the forth periods (2.25 beats per minute)

Work pattern 2,the period that had minimum difference of heart rate between before and after work period minimum are the forth and the fifth period (1 beat per minute) and the third period showed the maximum difference (3 beat per minute)

Work pattern 3, the fifth period demonstrated the minimum difference of heart rate between before and after work period minimum is the fifth period (4.75 beat per minute) while maximum difference was at the second period (13.5 beat per minute)

Work pattern 4, the minimum difference of heart rate between before and after work period was pointed out at the first period (4 beat per minute) and maximum one was showed at the fourth period (11 beat per minute)

Work pattern 5, the period that displayed the minimum difference of heart rate between before and after work period minimum is the third period (-0.25 beat per minute) meanwhile the maximum one was at the second period (4.25 beat per minute)

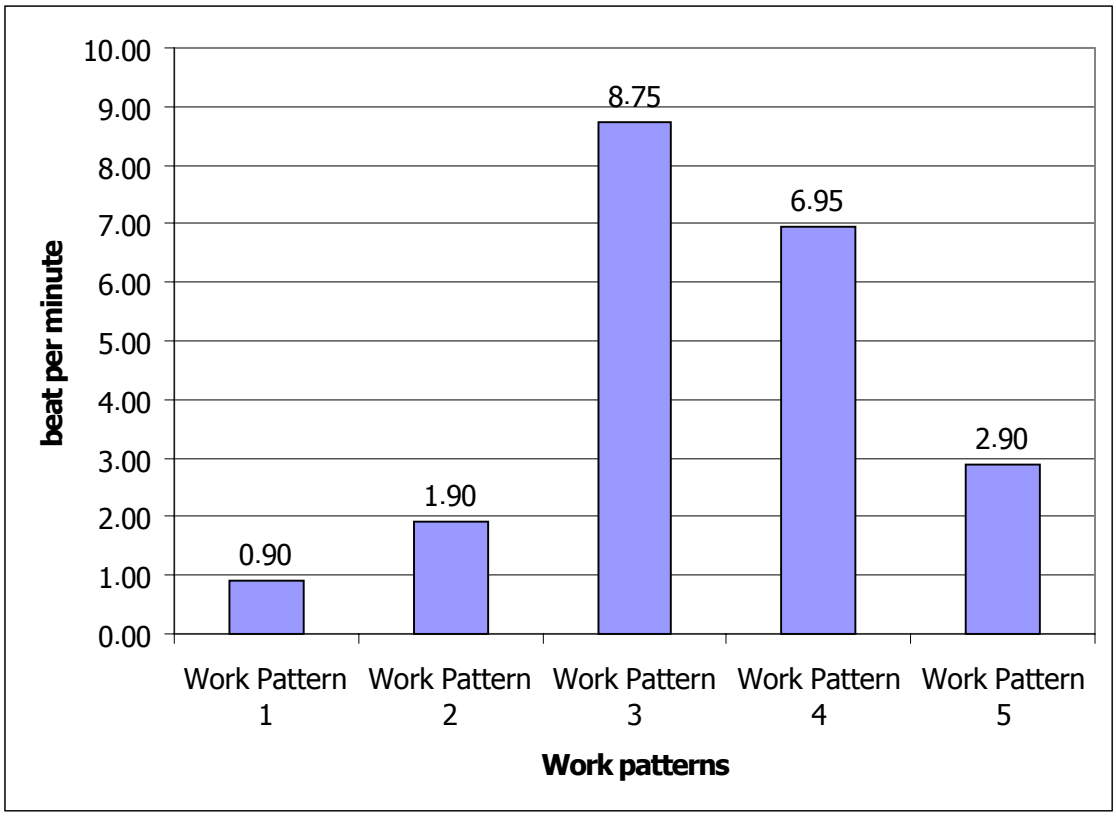


Figure 4-5 The summary of the difference heart rate between before and after five working periods.

Figure 4-5 the work pattern that showed the minimum difference of heart rate before and after work period was the first period (0.9 beat per minute) and maximum one was the third period (8.75 beat per minute). The first and the second had difference of mean temperature less than 2 beats per minute and another work pattern had a difference more than 2.8 beats per minute. Five work patterns were significantly different. (P value< 0.001)

4.5 Subjective feeling of the skin temperature

Cold stress on the skin

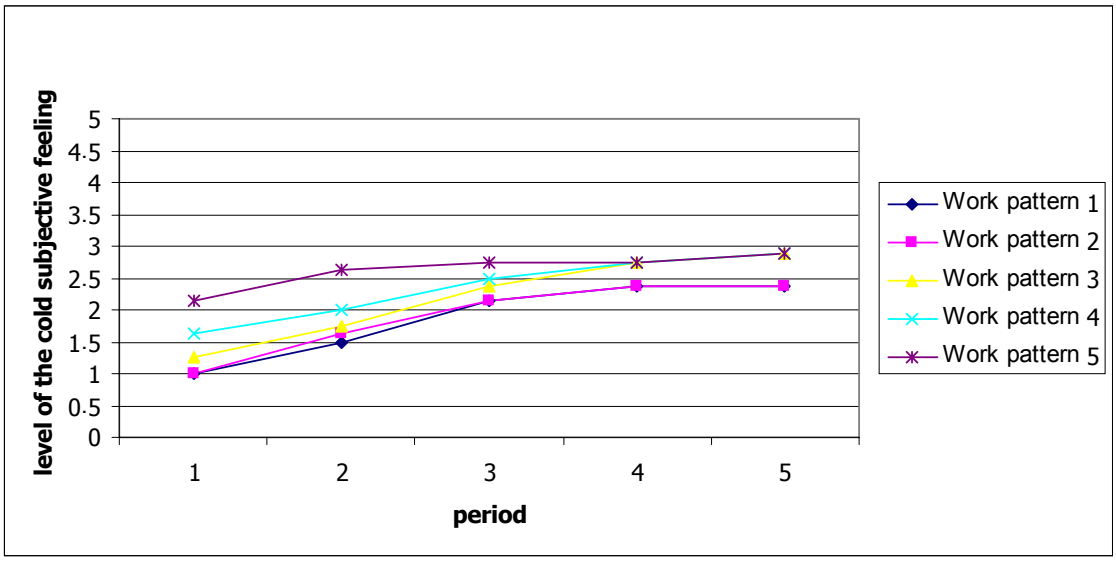


Figure 4-6 The subjective feeling on body

Figure 4-6 showed that the cold stress on body tended to increase in the second period and stable at the third period

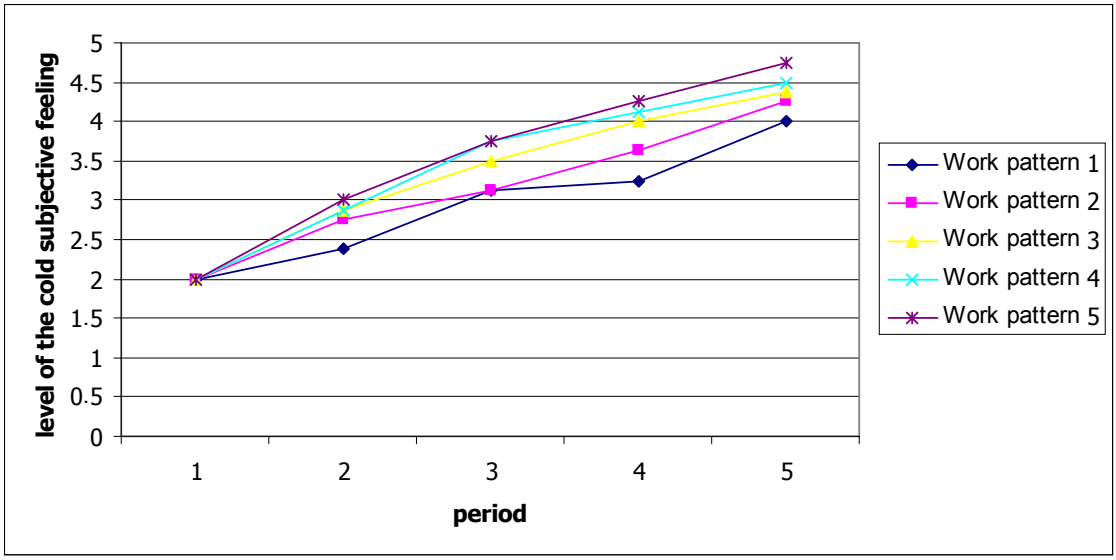


Figure 4-7 The subjective feeling on face

Figure 4-7 showed that the cold stress on face was likely to increase starting from the second period until the fifth period.

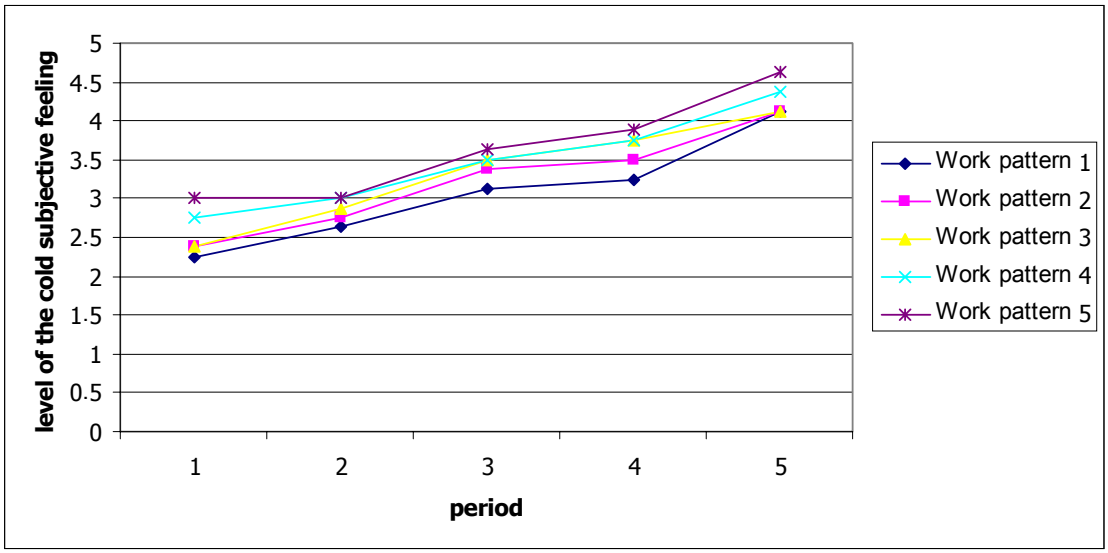


Figure 4-8 The subjective feeling on finger

Figure 4-8 showed that the cold stress on the finger started increasing from the second period on.

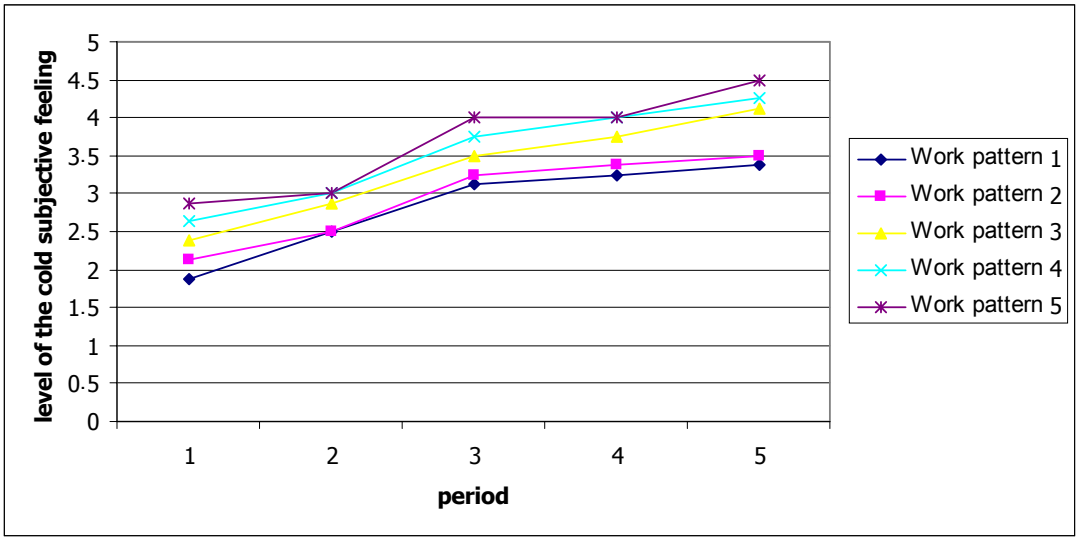


Figure 4-9 The subjective feeling on feet

Figure 4-9 the reading revealed that the shown cold stress on the feet was likely to increase starting from the second period until the fifth period.

4.6 The Mean body temperature from five work patterns before contacting the cold at – 15 degree Celsius in cold storage

Table 4-5 The Mean body temperatures before contact the cold at – 15 degree Celsius in cold storage in work pattern.

	Mean body temperature at period (degree Celsius)					
	1	2	3	4	5	Average
Work pattern 1	36.39	36.29	36.19	36.08	36.15	36.22
Work pattern 2	35.83	35.90	36.14	36.14	36.26	36.05
Work pattern 3	36.01	35.95	36.09	36.54	36.38	36.19
Work pattern 4	35.89	35.85	36.04	36.18	36.00	35.99
Work pattern 5	36.11	35.91	36.03	36.05	36.25	36.07

Table 4-6 The Mean body temperature before contact the cold at – 15 degree Celsius in cold storage in work pattern

	Chi-Square	df	P-value
Mean body temp.	6.25	4	0.181

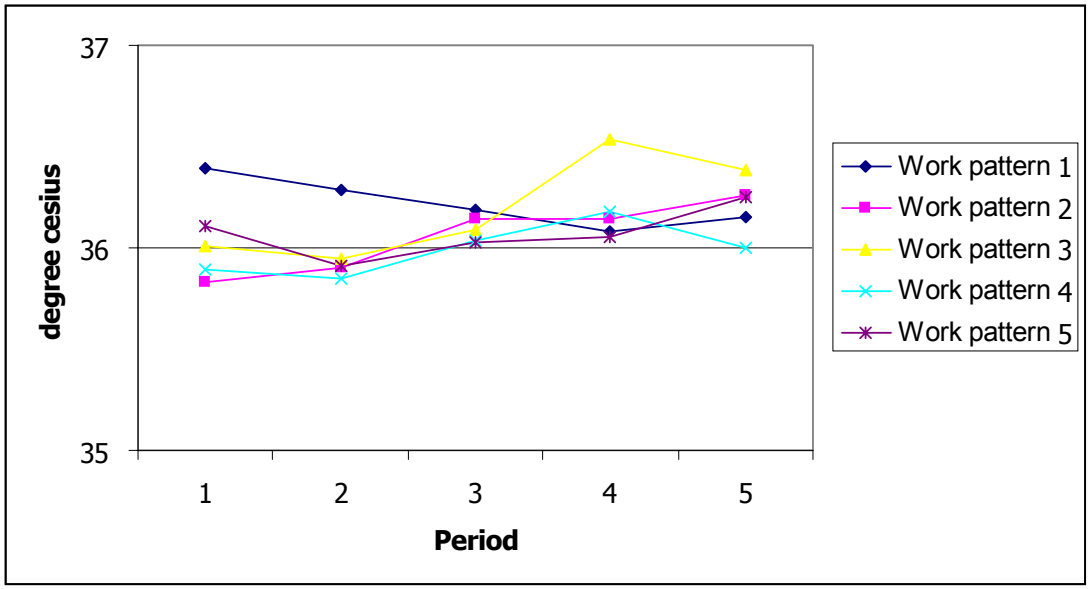


Figure 4-10 The Mean body temperature from five work patterns before contacting the cold at – 15 degree Celsius in cold storage

From figure 4-9 The Mean body temperatures before contact the cold at – 15 degree Celsius in cold storage shown the workers can return to same temperature

CHAPTER V
DISCUSSION

This study aimed to determine whether the difference working patterns affect the physiological response to cold stress or not. Those responses were the estimated body temperature and heart rate. Meanwhile the subjective feeling of skin temperature was monitored before and after work period of the practical work – rest regimen in cold store at –15 Celsius as well. The working patterns were working 20 minutes/ rest 20 minutes, working 25 minutes/rest 25 minutes, working 30 minutes/ rest 30 minutes, working 35 minutes/rest 35 minutes and working 40 minutes/ rest 40 minutes.

Discussion was divided into parts as follows:

5.1 Discussion of study design

5.2 Discussion of study result

5.1 Discussion of study design

The study design in this research was a quasi-experimental study. The subjects were selected by purposive sampling method. The general information of the workers and their level of cold stress were collected by questionnaires. The measurement of body temperature and heart rate were performed periodically.

The questionnaire of the subjective feeling and cold stress feeling was introduced in this study. The details of questionnaire were related to cold feeling on body, face, finger and feet. Eight workers in the cold store department were clearly introduced to general questionnaire, cold stress questionnaire, and perceived working condition questionnaire.

In order to minimize the personal error the heart rate and estimate core temperature were investigated by only one nurse and the skin temperature measurement was performed by the researcher. The thermometer was hold approximately 6 inches from subjects' skin. Moreover, the measurement of each

subjects had to be performed at the same location with control temperature 25 degree Celsius room.

For physiological measurement each subjects did the experiment for 5 minutes apart from each and performed in chronological order and immediately after they left the cold store. They had the same job responsibility and workload in the palletized room.

5.2 Discussion of study result

5.2.1 General characteristic of workers

General information such as age, weight, height, experience of work and body mass index was shown in Table 4.1. It showed that all subjects were in middle age. They had an average work experience of 16.88 months. They have already been acclimatized to cold longer than 6 months. The average of Body Mass Index of workers was 21.62 kg/m^2, which was defined by the WHO Expert Committee on Physical Status as the normal weight range.

5.2.2 Comparison of the difference of the estimated body temperature between before working and resting schedule

Comparison of the estimate body temperature between before working schedule was shown in Table 4-3 and Figure 4-3 Work pattern 1, the first and the third periods revealed the least differences of the mean temperature, which was 0.64 degree Celsius. Meanwhile, the second period showed the most differences, which were 1.01 degree Celsius.

Work pattern 2, the first periods showed the least differences of the mean temperature which was 0.84 degree Celsius, while the fourth period demonstrated the most differences which was 1.20 degree Celsius.

Work pattern 3, the first periods illustrated the least differences of the mean temperature, which was 1.14 degree Celsius. The forth period showed the most differences, which was 1.81 degree Celsius.

Work pattern 4, the third periods showed the least differences of the mean temperature, which was 1.15 degree Celsius. In the meantime, the second period depicted the most differences, which were 1.50 degree Celsius.

Work pattern 5, the third periods illustrated the least differences of the mean temperature, which was 1.33 degree Celsius. The second period showed the most differences, which was 1.65 degree Celsius.

Most of the work patterns showed the lowest means body temperature at the forth period. Five work patterns were significantly different. ($p < 0.001$) From the result, the first work pattern had the least difference of mean body temperature between the works and rests therefore it could be the most practical work pattern for working in cold store at -15 degree Celsius. This work pattern could make less difficulty for the body to bring the homeostasis than other patterns. It also showed that the temperature during working in the cold storage was higher than other patterns. It could demonstrate that there was no serious case of any type of hypothermia. The test of mean body temperature of all patterns and all periods of work before expose the cold at – 15 degree Celsius in cold storage was performed. It was found that they were not significant difference at $p < 0.05$. It meant that the mean body temperature can return to same level before working. This could reflect that there was no accumulation effect from cold. The recorded temperature from subjects revealed the temperature from exposed working conditions. The study was clearly shown that the work pattern 5 caused lowest temperature, 35.99 degree Celsius. It was not classified as severe hypothermia but the cold feeling on skin at finger may effect working task in cold storage. It might be the risk for mild hypothermia as well. Hypothermia is divided into two types. Primary hypothermia occurs when the body's heat-balancing mechanisms are working properly but are subjected to extreme cold, whereas secondary hypothermia affects people whose heat-balancing mechanisms are impaired in some way and cannot respond adequately to moderate or perhaps even mild cold. Primary hypothermia typically involves exposure to cold air or immersion in cold water. The cold air variety usually takes at least several hours to develop, but immersion hypothermia will occur within about an hour of entering the water, since water draws heat away from the body much faster than air does. Secondary hypothermia is often a threat to the elderly, who may be on medications or suffering from illness that affect

their ability to conserve heat. The research suggested as well that shivering and blood vessel narrowing. Therefore the care to protect cold should be much taken into consideration. However, the signs and symptoms of hypothermia follow a typical course, though the body temperature at which they occur vary person-to-person depending on age, health and other factors.

5.2.3 Comparison of heart rate between before working and resting schedule

Comparison of heart rate between before work and rest was shown in Table 4-4 and Figure 4-5. Five work patterns were significantly different. ($p < 0.001$) From the result, the first work pattern had the difference heart rate between the works and rests the lowest; it was the most practical work pattern for work in cold store at -15 degree Celsius. In term of the heart rate changes, it could be confirmed that this pattern may be practical work pattern for working in cold storage. Hypothermia is typical effect from cold. Once hypothermia begins, the blood vessel near skin may dilate, causing further heat loss, which may result in further induction in deep body temperature. It is well known that circulatory and ventilatory function may be compromised in hypothermia. Heart rate, respiration rate, and blood pressure rise during the first stages of hypothermia, which was found in this study, but fall once the 32.2 degree Celsius mark is passed. Below 30 degree Celsius most victims are comatose, and below 27.8 degree Celsius the heart's rhythm becomes dangerously disordered.

5.2.4 Subjective feeling of the skin temperature

The result showed that the subjective feeling of the skin temperature increases upon the working hour. For the subjective feeling of the body showed that it was increased in the second period of work and maintained stable at the third period. The feeling of cold at finger and face started at the earlier stage of work when compare the other parts of the body. This finding agreed with Sara et al. They showed that the feeling of cold at the extremities begun first among cold storage workers. The reason might from the principle that the body attempt to maintain stable core temperature, therefore other parts of the body might be affected by low temperature. Another reason

might be the efficiency of the existing protective clothing. The quality of the protective clothing should be considered; meanwhile working dexterity must be taken into account. The warning indicator to prevent cold stress might be feeling cold at the extremity. When the body especially the finger becomes cold, the cold injury can occur. Frostbite and frostnip occurred when contacted the cold temperature such that tissue fluid freezes. It could cause the severe accident. Coordination, for instance may begin to suffer as soon as body temperature reaches 35 degree Celsius. The early signs of hypothermia also include cold and pale skin and intense shivering. As body temperature continues to fall, speech becomes slurred, the muscles go rigid, and the victim becomes disoriented and experiences eyesight problem. Other harmful consequences include dehydration as well as liver and kidney failure. The impact of hypothermia on the nervous system often becomes apparent quite early. The response to a downward variation in body temperature is shivering, which is the body's attempt to generate heat. Shivering is an involuntary contraction and expansion of muscle tissue occurring on a large scale. This muscle action creates heat through friction.

CHAPTER VI
CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study was designed to determine the effect of the differences of five working patterns in the cold storage. 8 subjects in palletizes room participated this study. The difference of estimated core temperature and heart rate were monitored. The feeling of cold at body, finger, face and feet were interviewed in those subjects. It was found that the first work pattern, which was 20 min. working and 20 min. resting, caused the lowest difference of the estimated body temperature and heart rate when compared them before working and during resting time. Therefore, it should be suggested that the first work pattern was the most practical work-rest regimen for working in cold storage –15 degree Celsius under the convention that the working duration and resting duration were equal. This was strongly confirmed by the subjective feeling of temperature. The first work pattern showed the delay subjective feeling for many parts of the body. Feeling of cold at the finger occurred earlier than other parts such as face, feet, and body.

6.2 Recommendations for the future studies

6.2.1 The comparison of these parameters from the workers in day-shift and night-shift should be conducted.

6.2.2 Some other parameters such as hormones which are essential to maintain the physiological function should be monitored especially in female workers, who have to work in the cold conditions.

6.3 Recommendations for the factory

6.3.1 The factory should consider adjusting working system of 20 / 20 minute for working and resting in cold storage workplace (at -15 C)

6.3.2 The fingers usually feel cold first. The risk of frostbite also increases. Therefore, the employer or contractor should provide heated warm-up shelters at the workplace

6.3.3 The health examination particularly the cardiological functions for the cold storage worker should be performed in the future for the chronic exposure evaluation.

REFERENCES

1. Barbara Griefahn, et al. Working in Moderate Cold: A Possible Risk to Health. Journal of Occupational Health. ; 1997 : 39 : 36-44.
2. S. Arphorn, et al. A study on workers exposed to cold stress in a food – processing factory in Thailand. Proceedings of the fifth southeast Asian Ergonomics Society Conference on Human Factors Vision – Care for the Future ; 1997 : 146-150.
3. S. Arphorn, et al. Effect of cold exposure on workers in a food – processing factory in Thailand. Proceedings of Second International Conference on Human-Environment System ; 1988 : 267-282.
4. Shin – ichi Sawada, et al. Thermal comfort, Thermal sensation, and associated behavioral and physiological responses during alternately repeated exposure to cold and warm environments. Proceeding of Second International Conference on Human-Environment System 1998: 279-270.
5. Yumiko Nagai, et al. Thermal response of cold storage workers repeatedly exposed to severe cold. Proceeding of Second International Conference on Human-Environment System 1998: 227-230.
6. Masatoshi Tanaka, et al. Cold Storage Work and Environment. Research perspectives in Occupational Health and Ergonomics in Asia and other Countries; 1991: 325-329.
7. Borut Likar and Pavel Poredos. Measurement of Surface Body Temperature and changes in Skin Temperature in Disorders of Arterial Blood Supply to the limbs. Available from: http://www.trnovo.kclj.si/mikrocirk/likar.html
8. Suzanne Browne, et al. Accurate measurement of body temperature in the neonate. Journal of neonatal nursing. 2000 ; 6 (5) : 165 – 168.
9. True V-M Measuring the skin temperature in agricultural work : University of Helsinki. Available from: http://www. Helsinki fi.

10. Ornchulee Chantra. The comparative study on the ordinary and the new designed cold – protective gloves among frozen flood workers. Mahidol University : 2000.
11. Orawich Kongsuk. The effectiveness of protective clothing to reduce cold strain in canned food workers. Mahidol University : 1999.
12. Suphoj Kangchai. Physiological recovery from working in cold storage. Mahidol University : 1997.
13. สำนักงานเศรษฐกิจอุตสาหกรรมและสำนักงานปลัดกระทรวงอุตสาหกรรม. ฐานข้อมูล/จำนวนโรงงานตามประเภทอุตสาหกรรม. กระทรวงอุตสาหกรรม. 2542.
14. กรมอุตุนิยมวิทยา. สถิติอุณภูมิ ณ. สถานีอุตุนิยมวิทยา. 2543.
15. Joan Elma Rahm, Library of congress Cataloging in Publication data. Keeping Worm, Keeping Cool ; 1983.
16. Genium Publishing corp. Material Safety Data Sheet Collection. Revision E.3/98.
17. Ramon J. Ceron. Department of Industrial Engineer. University of Wisconsin. Hand Skin Temperature Variations for Work in Moderately Cold Environment and The Effectiveness of Periodic Rewarming. 1995.
18. Robert H. Starky, Former Chairman. Heating and Cooling for man in industry. 2nd edition. 1995.
19. National Center for Environment Health. Extreme Cold A Prevention Guide to Promote Your Personal Health and Safety. U.s. Department of Health and Human Services. 1996.
20. J.L Parkinson. Hazard and precautions in the use of ammonia as a refrigerant. Unilever Safety Service. 1982.
21. M.R.M. Gehemiau. The Safe Management of Ammonia Refrigeration Systems. Unilever Research & Engineering Division. 1994.
22. Occupational Safety & Health Administration. Protection Workers in Cold Environments. OSHA Fact Sheets. 1998.
23. Jeanne Mager Stellman. Encyclopedias of Occupational Health and Safety. 4th edition. Vol 2.

24. The American Conference of Governmental Industrial Hygienists. Threshold Limit Values of Chemical Substance And Physic; Agents Biological Indices. 1999 : 159-161.
25. Eric L. Noji. The Public Health Consequences of Disasters. National Center for Environmental Health Centers for Disease Control and Prevention. 1997 : 270-286.
26. Robert L. Harris. Patty's Industrial Hygiene. 5th Edition; 2000 : 2 : 822-825.
27. Sue-Ellen smith. Bachelor of Nursing – Introduction to Practice' st Year – skill Lecture. Available from: http://www.readgum.bendigo.latrode.edu. OK/N obrien/CONUSSKI.htm
28. The Alberta Human Resources and Employment. Workplace Health and Safety. General Safety November 1999.
Available from: http://www.whs.gov.ab.ca.
29. Goldsmith. R. Encyclopedia of Occupational Health and Safety. Vol 1 ; A-K : 319-320.
30. Rick Curtis. Outdoor Action Guide to Hypothermia and Cold Weather Injuries. Available from: http://www.princeton.edu.
31. B.R. Mackenna. Illustrated Physiology. Institute of Physiology. University of Glosgow. 1990 : 105.
32. Barbara A. Plog. Fundamentals of Industrial Hygiene 3 th. National Safety : 259-265.
33. P.T. Hardcastle. Musculoskeletal skin module lecture material. Department of Biomedical Sciences. The University of Shefficld. 1996.
34. Industry Wide Labor - Management Safety Committee. Safety Bulletin# 34 Guidelines for Working in Extreme Cold Temperature Conditions. Available from: http://www.comeraguild.com/safety/s-34 htm.
35. Southeast Michigan Coalition on Occupational Safety and Health. Cold Stress : when is it dangerous to be cold?
Available from: http://www.semcosh. org/cold%20 stess.htm.
36. Peter J Baxter, et al. Hunter's diseases of Occupations. 9th edition. 2000 : 325-333.
37. ISO. Evaluation of Thetnal Strain by Physiology Measurement (ISO 9886). 1992.

APPENDIX

General Questionnaire (A-1)

Name . . . . .Sur name . . .. Age. . . . . .

Date. . . . . Time...... . . . .

Working experience. . . . .

Height . . . . .c.m. Weight . . . . k.g

Alcohol consumption before work . . . . no. . . . . .yes…………..

Health problems . . . .

แบบสอบถามข้อมูลทั่วไป **(A-1)**

ชื่อ . . . . .นามสกุล . . .. อายุ. . . . . . ปี.

วันที่. . . . . เวลา.... . . . .

ประสบการณ์การทำงาน. . . . .

ความสูง . . . . .ซ.ม. น้ำหนัก . . . . ก.ก.

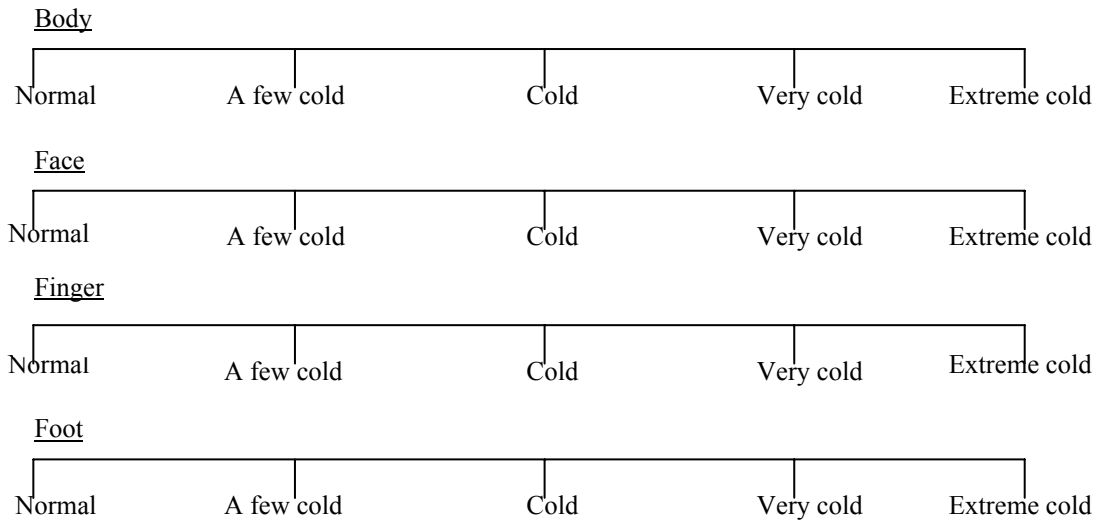
มีการดื่มเครื่องดื่มแอลกอฮอล์ก่อนเข้าทำงาน . . . . ไม่ดื่ม . . . . .ดื่ม

ปัญหาด้านสุขภาพปัจจุบัน . . . .

Cold Stress Questionnaire (A-2)

Name . . . . .Sur name . . . . Age……....
Date. . . . . Time..... . . . . ……...
Working experience. . . . . .

Cold Feeling



แบบสอบถามความเค้นจากความเย็น

ชื่อ . . . . นามสกุล. . . . . .อายุ. . . . . .

วันที่. . . . . .เวลา..... . . . . . .

ประสบการณ์การทำงาน. . . . . .

ความรู้สึกหนาว

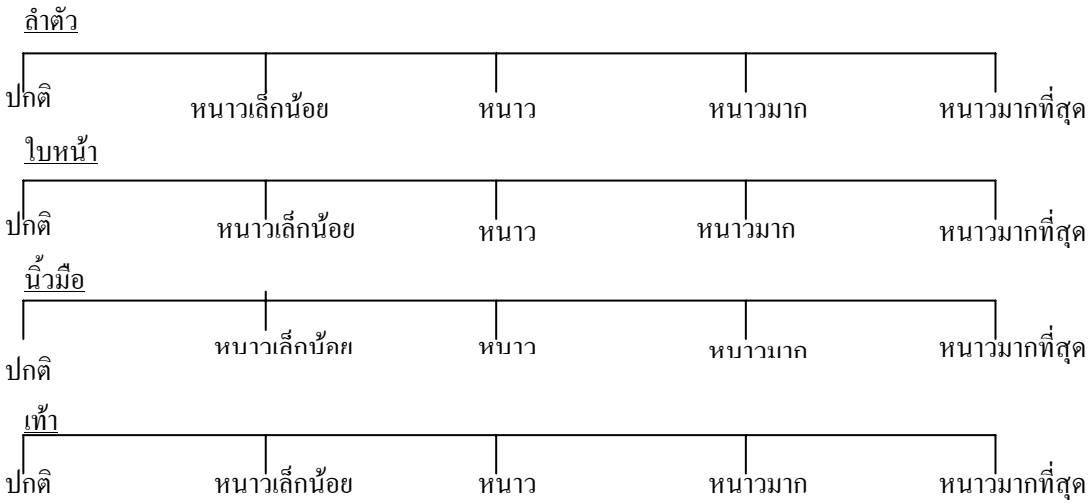


Table B-1 Physiological data

Name - Surname A Date 29/05/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.4	34.5	33.6	32.4	33.9	33.3	34.3	33.9	33.8	33.6	36.1	76
	After Work	07.40	36.2	33.9	33.4	32.0	34.5	31.9	33.4	31.1	30.2	32.1	35.5	70
2	Before Work	08.00	36.2	33.8	33.7	32.7	33.8	34.5	35.1	33.2	32.5	33.3	35.9	70
	After Work	08.20	36.0	31.0	31.8	31.7	33.4	32.9	31.7	31.4	30.2	31.5	35.2	70
3	Before Work	08.40	36.2	34.7	33.0	31.3	33.9	33.8	35.0	33.9	32.7	33.2	35.9	74
	After Work	09.00	36.1	35.2	32.8	29.9	33.9	33.8	32.5	32.0	30.1	31.9	35.4	70
4	Before Work	09.20	36.2	35.7	33.1	33.0	34.7	34.6	34.5	32.4	33.1	33.4	36.0	70
	After Work	09.40	36.1	32.0	30.8	30.2	33.9	33.6	33.2	31.4	29.7	31.2	35.2	70
5	Before Work	10.00	36.1	35.7	34.3	32.7	34.3	34.4	33.7	34.4	32.4	33.7	36.0	70
	After Work	10.20	36.0	29.8	30.7	30.5	33.8	33.6	31.3	31.0	29.9	30.9	35.0	70

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-2 Physiological data

Name - Surname B Date 29/05/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.7	35.8	35.9	34.5	34.8	34.6	33.9	34.2	34.1	34.7	36.7	70
	After Work	07.40	36.7	32.7	34.8	32.2	32.2	33.5	32.8	31.8	30.7	32.4	36.0	70
2	Before Work	08.00	36.7	35.7	36.3	36.0	34.1	33.9	34.2	34.6	33.2	34.8	36.8	68
	After Work	08.20	35.8	28.8	33.8	31.2	33.6	32.9	30.1	32.3	31.3	31.9	35.2	70
3	Before Work	08.40	36.6	35.7	34.4	35.6	33.9	33.4	33.5	34.1	33.1	34.2	36.5	68
	After Work	09.00	36.6	32.4	34.3	32.8	34.1	33.9	29.9	31.6	30.4	32.3	35.9	70
4	Before Work	09.20	36.5	35.4	35.4	35.1	34.2	34.1	33.4	33.4	31.1	31.9	35.7	70
	After Work	09.40	36.0	30.6	33.4	32.7	33.3	33.1	29.5	30.5	29.5	31.5	35.2	70
5	Before Work	10.00	36.1	35.4	35.1	34.5	33.9	33.9	31.4	32.7	32.0	33.6	35.9	70
	After Work	10.20	36.0	30.7	33.6	33.4	33.2	33.0	28.5	30.4	30.4	31.8	35.3	68

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-3 Physiological data

Name - Surname C Date 29/05/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.2	35.4	35.6	35.4	35.3	35.1	33.3	34.4	33.8	34.8	36.4	76
	After Work	07.40	36.1	31.7	34.6	34.5	34.2	33.4	30.2	32.5	32.2	33.2	35.8	76
2	Before Work	08.00	36.2	35.3	35.4	35.2	34.4	34.2	33.3	34.0	33.5	34.5	36.3	76
	After Work	08.20	36.1	31.6	34.1	34.5	33.1	33.1	29.4	31.7	31.3	32.6	35.6	70
3	Before Work	08.40	36.2	35.7	35.4	35.2	34.8	34.1	32.7	33.2	32.7	34.2	36.2	70
	After Work	09.00	36.1	32.5	33.7	32.2	34.8	33.3	30.0	31.9	30.8	32.3	35.5	76
4	Before Work	09.20	36.2	35.1	35.1	34.7	35.0	34.8	33.3	32.1	31.9	33.7	36.0	78
	After Work	09.40	36.0	31.6	33.2	33.1	33.5	33.4	31.4	30.5	29.8	31.8	35.3	76
5	Before Work	10.00	36.2	34.8	34.8	34.5	34.5	34.4	30.7	33.2	32.0	33.6	36.0	78
	After Work	10.20	36.0	30.0	34.2	33.4	34.1	33.9	28.1	31.1	30.3	32.1	35.4	70

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-4 Physiological data

Name - Surname D Date 29/05/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.9	35.5	31.9	32.2	33.6	33.4	33.4	32.6	32.2	32.7	36.2	80
	After Work	07.40	36.5	29.5	31.0	30.8	33.6	31.6	33.4	30.1	29.8	30.8	35.3	80
2	Before Work	08.00	36.3	34.4	34.3	33.4	34.3	33.9	33.7	32.4	31.5	33.2	35.9	80
	After Work	08.20	35.2	31.7	32.0	29.8	33.2	33.1	32.7	31.7	30.3	31.4	34.6	78
3	Before Work	08.40	36.3	35.4	34.4	32.4	34.2	34.1	34.0	32.4	31.9	33.2	35.9	78
	After Work	09.00	36.2	29.2	31.8	31.1	32.6	31.9	33.2	31.5	29.6	31.1	35.2	80
4	Before Work	09.20	36.2	35.1	33.8	31.9	34.2	34.1	33.2	32.4	31.9	32.9	35.8	80
	After Work	09.40	36.0	29.5	31.9	31.3	31.6	31.9	32.3	30.0	29.4	30.8	34.9	80
5	Before Work	10.00	36.1	35.3	34.1	32.5	34.5	34.3	33.8	32.4	31.7	33.1	35.8	80
	After Work	10.20	36.0	28.9	31.6	31.3	32.2	31.1	33.1	29.4	28.7	30.4	34.8	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-5 Physiological data

Name - Surname E Date 01/06/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.9	36.7	36.6	36.3	36.1	34.1	32.6	34.4	34.4	35.3	37.0	80
	After Work	07.40	36.9	31.5	35.0	34.1	34.3	33.4	27.0	33.0	32.6	33.2	36.3	86
2	Before Work	08.00	36.8	36.0	36.5	35.9	35.2	33.7	30.7	33.8	33.7	34.7	36.8	86
	After Work	08.20	36.8	29.2	34.0	34.2	33.6	33.4	27.3	32.6	32.1	32.6	36.1	76
3	Before Work	08.40	37.1	36.1	36.0	36.2	35.6	33.5	32.0	34.0	33.3	34.7	37.0	66
	After Work	09.00	36.9	31.4	34.1	34.1	34.1	33.3	27.0	32.3	32.2	32.8	36.2	80
4	Before Work	09.20	37.3	35.9	35.5	35.6	35.1	33.1	30.3	34.1	33.8	34.5	37.0	84
	After Work	09.40	37.2	31.5	33.9	34.4	34.1	33.6	28.4	32.5	32.2	32.9	36.5	82
5	Before Work	10.00	37.2	36.4	34.9	35.3	35.2	34.0	30.7	33.8	33.7	34.4	36.9	78
	After Work	10.20	37.0	30.0	35.9	33.8	33.5	32.9	27.0	32.6	32.2	32.9	36.3	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-6 Physiological data

Name - Surname F Date 01/06/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.0	35.2	33.2	34.0	34.1	33.5	32.8	32.8	32.8	33.4	35.8	76
	After Work	07.40	36.0	33.4	33.1	32.3	33.9	33.5	30.1	30.4	30.2	31.8	35.3	70
2	Before Work	08.00	35.9	35.4	33.9	33.8	33.7	33.2	32.3	32.5	32.2	33.2	35.7	66
	After Work	08.20	35.0	33.7	32.9	32.1	32.4	32.2	30.7	30.5	30.2	31.6	34.6	72
3	Before Work	08.40	35.5	35.2	34.2	33.7	33.5	33.0	32.5	32.1	32.4	33.2	35.4	76
	After Work	09.00	35.0	35.5	32.4	31.9	32.4	32.5	29.3	30.4	30.2	31.6	34.5	72
4	Before Work	09.20	35.7	35.4	34.4	33.5	33.6	33.2	31.6	32.5	32.9	33.4	35.6	72
	After Work	09.40	35.0	33.9	32.9	32.6	32.9	33.0	29.3	31.4	30.1	31.9	34.6	78
5	Before Work	10.00	35.7	35.5	33.9	34.9	34.0	33.5	32.2	32.0	32.9	33.5	35.7	72
	After Work	10.20	35.0	34.1	32.4	32.9	32.8	32.9	27.9	31.0	30.0	31.7	34.6	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-7 Physiological data

Name - Surname G Date 01/06/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.7	33.8	32.9	33.8	33.9	32.8	33.8	34.1	33.5	33.6	36.3	80
	After Work	07.40	36.5	30.2	31.1	31.8	33.6	31.0	31.0	31.4	31.1	31.4	35.5	80
2	Before Work	08.00	36.7	35.5	33.2	33.8	33.8	32.6	33.4	33.3	32.0	33.3	36.2	76
	After Work	08.20	36.4	30.5	31.7	32.7	33.7	31.8	31.0	31.6	31.4	31.8	35.6	89
3	Before Work	08.40	36.5	33.6	32.0	34.3	34.3	33.0	33.2	32.1	32.3	32.9	36.0	80
	After Work	09.00	36.2	32.2	33.0	33.8	34.0	32.0	30.8	31.9	31.5	32.5	35.6	78
4	Before Work	09.20	36.4	35.6	34.5	34.4	34.2	33.6	32.8	32.2	32.0	33.5	36.1	80
	After Work	09.40	36.3	34.0	32.0	33.3	33.4	32.4	31.9	31.9	30.9	32.2	35.6	90
5	Before Work	10.00	36.7	35.6	34.3	33.8	34.2	33.7	33.4	32.7	31.9	33.4	36.3	80
	After Work	10.20	36.5	31.4	31.9	32.3	34.1	33.1	31.5	32.1	31.5	32.1	35.7	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-8 Physiological data

Name - Surname H Date 01/06/02

Working Time/Rest Time 20 / 20 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.20	36.7	36.1	35.0	34.3	34.9	34.1	34.5	34.0	33.7	34.4	36.6	70
	After Work	07.40	36.5	32.7	34.8	33.0	35.0	34.7	31.8	33.8	33.5	33.7	36.3	66
2	Before Work	08.00	36.9	36.6	35.1	34.2	34.8	34.1	32.4	34.2	33.9	34.4	36.7	68
	After Work	08.20	35.0	32.9	35.3	33.8	35.2	34.6	32.3	33.6	33.6	34.0	35.3	80
3	Before Work	08.40	36.7	35.4	35.1	34.3	35.3	34.1	33.1	34.5	33.6	34.4	36.6	70
	After Work	09.00	35.9	33.4	35.6	34.1	35.4	35.3	33.3	34.4	34.0	34.5	36.1	76
4	Before Work	09.20	36.5	36.2	34.9	34.4	34.9	34.8	34.0	32.9	32.8	34.1	36.4	72
	After Work	09.40	36.0	33.9	35.2	34.7	35.1	34.9	33.7	33.6	33.5	34.3	36.1	78
5	Before Work	10.00	36.7	36.3	35.0	34.8	34.9	34.9	34.3	34.1	33.0	34.4	36.6	70
	After Work	10.20	36.0	33.3	35.2	34.4	35.6	35.3	32.3	33.5	33.4	34.1	36.1	78

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-9 Physiological data

Name - Surname A Date 19/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	36.1	31.5	32.4	30.0	34.0	32.2	33.0	34.4	33.7	32.7	35.6	80
	After Work	07.50	35.8	29.2	31.6	30.4	34.8	33.8	32.4	30.7	30.3	31.2	35.0	74
2	Before Work	08.15	35.9	35.4	34.1	33.2	34.7	33.4	34.7	33.9	33.6	33.9	35.9	78
	After Work	08.40	35.0	31.6	31.6	31.0	34.0	33.2	31.4	30.8	30.5	31.4	34.5	80
3	Before Work	09.05	36.7	35.2	33.9	33.0	34.4	34.1	34.2	33.5	33.1	33.7	36.4	72
	After Work	09.30	36.5	29.8	32.0	30.9	34.8	33.0	32.3	31.2	30.4	31.5	35.5	80
4	Before Work	09.55	36.7	35.5	30.5	32.6	34.3	34.1	34.1	33.9	33.5	33.2	36.2	62
	After Work	10.20	35.0	30.3	32.9	31.2	35.0	33.6	32.1	31.1	30.3	31.7	34.6	72
5	Before Work	13.55	36.7	35.8	35.4	33.5	34.6	34.1	34.0	33.3	34.2	34.2	36.6	76
	After Work	14.20	35.0	29.6	32.7	31.8	34.9	34.0	32.3	31.1	30.2	31.7	34.6	78

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-10 Physiological data

Name - Surname B Date 19/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	35.8	33.7	34.1	33.0	33.5	32.8	32.7	32.2	31.7	32.8	35.5	64
	After Work	07.50	36.2	27.1	33.7	32.9	33.4	33.2	29.3	30.4	29.6	31.4	35.3	70
2	Before Work	08.15	36.7	34.6	34.6	34.5	34.2	33.4	32.1	32.1	32.7	33.5	36.3	70
	After Work	08.40	35.0	29.3	34.5	33.0	34.2	33.5	27.6	29.7	29.4	31.5	34.5	76
3	Before Work	09.05	36.0	35.1	34.9	34.3	34.1	33.1	31.3	33.0	32.4	33.6	35.9	66
	After Work	09.30	36.0	28.0	34.4	32.2	33.4	33.7	27.9	31.0	30.0	31.6	35.2	76
4	Before Work	09.55	36.0	35.1	35.1	34.5	34.2	33.4	29.3	32.0	31.9	33.3	35.8	78
	After Work	10.20	35.0	34.8	34.7	33.7	35.6	34.8	27.0	30.7	30.3	32.6	34.9	76
5	Before Work	13.55	36.7	34.7	34.7	34.4	34.0	33.5	32.7	32.9	32.9	33.7	36.4	80
	After Work	14.20	35.6	33.8	33.4	33.0	33.3	33.1	29.4	30.1	29.3	31.7	35.0	78

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-11 Physiological data

Name - Surname C Date 19/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	35.8	32.7	33.6	34.1	34.1	33.1	29.9	32.9	32.7	33.1	35.6	70
	After Work	07.50	35.9	30.1	35.3	34.5	34.5	34.1	18.2	31.2	30.9	35.3	35.3	76
2	Before Work	08.15	35.6	34.8	34.6	34.5	34.6	33.1	31.9	32.3	32.3	35.6	35.6	74
	After Work	08.40	35.0	27.8	34.9	34.5	35.1	34.4	25.8	32.2	31.5	34.9	34.9	78
3	Before Work	09.05	35.8	35.0	35.5	34.8	34.2	33.3	31.3	32.7	32.3	35.8	35.8	76
	After Work	09.30	35.0	29.0	35.7	34.9	34.5	34.3	27.3	31.9	31.1	35.0	35.0	80
4	Before Work	09.55	36.0	35.6	35.4	35.1	34.9	33.3	30.1	32.4	32.6	35.9	35.9	70
	After Work	10.20	35.0	28.3	35.4	34.4	35.2	34.9	29.7	32.0	31.6	35.0	35.0	70
5	Before Work	13.55	36.0	35.6	35.1	35.4	35.4	34.5	33.5	32.7	32.8	36.1	36.1	70
	After Work	14.20	35.2	28.9	35.9	35.4	35.4	35.1	26.7	32.3	31.3	35.1	35.2	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B12 Physiological data

Name - Surname D Date 99/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	36.9	34.5	32.1	31.4	32.9	33.2	33.1	32.0	31.0	32.1	36.0	78
	After Work	07.50	35.8	29.2	31.6	30.6	31.3	31.4	29.5	29.1	29.0	30.1	34.6	76
2	Before Work	08.15	35.9	35.1	33.4	32.7	32.8	33.0	31.9	32.5	31.9	32.8	35.5	80
	After Work	08.40	35.0	33.0	32.5	31.0	31.2	31.9	30.7	30.6	29.7	31.1	34.4	80
3	Before Work	09.05	36.2	35.3	34.3	33.6	33.8	34.0	32.7	34.2	34.1	34.1	36.2	80
	After Work	09.30	36.0	32.9	32.4	31.7	31.6	31.7	31.6	31.0	30.9	31.6	35.2	80
4	Before Work	09.55	36.7	33.4	32.4	32.0	33.2	33.0	33.1	32.3	32.3	32.5	36.0	78
	After Work	10.20	35.0	27.0	30.1	26.9	31.9	31.9	30.8	30.0	30.0	29.6	33.9	80
5	Before Work	13.55	36.0	34.5	33.5	32.3	35.0	34.7	33.7	32.9	33.0	33.3	35.8	80
	After Work	14.20	35.0	30.5	31.3	31.3	31.4	31.4	30.4	30.5	30.6	30.9	34.3	82

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-13 Physiological data

Name - Surname E Date 22/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	36.1	34.4	33.0	33.9	33.9	33.5	33.8	33.5	33.4	33.6	35.9	72
	After Work	07.50	35.4	27.6	33.2	32.0	33.9	33.4	26.1	32.6	32.5	32.1	35.0	74
2	Before Work	08.15	36.2	34.5	33.5	33.7	34.7	32.9	34.3	33.4	33.4	33.6	36.0	80
	After Work	08.40	36.0	30.1	32.3	32.1	33.6	33.4	27.7	32.5	31.5	31.9	35.3	80
3	Before Work	09.05	36.4	34.2	33.9	34.1	34.5	34.0	34.3	34.1	33.1	33.9	36.2	80
	After Work	09.30	35.8	30.8	33.4	32.4	34.3	34.0	29.0	32.8	32.3	32.6	35.4	70
4	Before Work	09.55	36.3	34.3	34.3	34.3	34.8	33.9	34.0	33.7	33.4	34.0	36.2	80
	After Work	10.20	35.8	33.4	33.7	32.7	34.2	34.5	27.4	33.2	33.1	33.1	35.6	70
5	Before Work	13.55	36.0	35.3	35.1	34.6	35.6	34.3	33.5	34.1	34.5	34.6	36.2	80
	After Work	14.20	35.8	33.1	33.1	32.7	33.4	33.2	28.3	33.1	33.0	32.8	35.5	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-14 Physiological data

Name - Surname F Date 22/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	35.9	34.6	32.6	33.9	33.9	33.8	33.2	33.5	33.1	33.4	35.8	72
	After Work	07.50	35.4	32.5	31.9	32.5	33.9	33.9	29.2	34.4	30.3	32.3	35.1	82
2	Before Work	08.15	35.9	35.0	33.7	34.3	34.1	33.8	32.7	32.9	32.5	33.5	35.8	76
	After Work	08.40	36.2	32.8	31.6	32.8	33.6	33.1	29.1	31.2	31.0	31.8	35.4	76
3	Before Work	09.05	35.9	35.1	33.5	34.3	34.2	33.3	31.9	32.8	32.4	33.4	35.7	70
	After Work	09.30	35.0	32.0	31.0	31.9	33.9	34.1	34.1	31.7	30.9	31.9	34.7	78
4	Before Work	09.55	36.2	35.6	32.7	34.3	34.6	34.1	33.7	33.0	32.8	33.5	36.0	76
	After Work	10.20	35.5	33.6	32.9	33.3	33.9	34.2	28.0	31.7	31.0	32.3	35.1	80
5	Before Work	13.55	36.3	35.5	33.9	34.5	34.4	34.2	33.4	33.9	33.6	34.1	36.2	78
	After Work	14.20	36.0	33.1	33.1	33.1	33.1	34.5	31.0	30.5	29.8	32.0	35.4	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-15 Physiological data

Name - Surname G Date 22/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	36.2	35.0	33.3	34.0	33.9	33.3	33.6	32.7	32.6	33.3	35.9	76
	After Work	07.50	35.0	28.8	30.2	29.6	32.4	31.1	31.9	30.8	30.7	30.5	34.2	80
2	Before Work	08.15	36.2	34.9	30.7	32.3	34.4	33.0	33.1	33.8	32.8	32.8	35.8	78
	After Work	08.40	36.0	27.7	31.6	32.3	33.8	32.4	30.5	32.8	31.5	31.8	35.3	80
3	Before Work	09.05	36.3	35.2	32.2	34.2	34.2	33.1	33.1	33.5	33.1	33.4	36.0	72
	After Work	09.30	35.0	30.7	31.9	33.0	34.0	32.4	29.8	32.5	31.2	32.1	34.7	70
4	Before Work	09.55	36.2	35.6	32.4	35.4	34.6	33.4	34.4	33.4	32.7	33.7	36.1	76
	After Work	10.20	35.0	37.5	31.0	31.5	33.5	32.3	31.2	30.2	30.8	30.8	34.3	80
5	Before Work	13.55	36.3	35.8	32.9	35.7	34.6	33.6	33.6	33.4	32.6	33.8	36.2	80
	After Work	14.20	36.2	29.0	33.6	34.5	34.4	32.2	30.4	32.4	31.3	32.5	35.7	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-16 Physiological data

Name - Surname H Date 22/06/02

Working Time/Rest Time 25 / 25 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.25	36.4	34.8	34.4	33.4	34.5	34.3	33.3	34.1	33.9	34.0	36.3	78
	After Work	07.50	35.3	31.9	34.4	32.2	35.2	33.9	31.6	34.0	33.9	33.5	35.4	80
2	Before Work	08.15	36.5	35.1	33.5	33.7	34.9	34.2	34.2	33.9	33.3	33.9	36.3	80
	After Work	08.40	36.3	31.9	34.8	33.0	35.6	34.5	32.2	33.2	33.0	33.5	36.1	82
3	Before Work	09.05	37.2	35.3	34.4	34.2	34.8	33.9	32.6	34.1	33.8	34.2	36.9	80
	After Work	09.30	35.9	32.8	33.7	33.1	35.4	34.6	32.7	33.9	32.9	33.5	35.8	86
4	Before Work	09.55	37.2	36.0	34.3	35.1	35.6	34.6	33.7	34.1	33.3	34.4	36.9	80
	After Work	10.20	36.2	32.9	34.5	33.6	35.6	35.0	32.7	33.6	33.1	33.8	36.1	80
5	Before Work	13.55	36.7	35.6	35.7	34.3	34.7	34.7	34.2	34.3	33.4	34.5	36.6	80
	After Work	14.20	35.7	32.4	34.8	32.7	35.8	34.8	32.1	34.5	34.3	34.0	35.8	82

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-17 Physiological data

Name - Surname A Date 05/10/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.1	34.6	33.3	32.7	33.9	33.4	33.6	34.1	33.2	33.5	35.9	78
	After Work	08.00	35.0	27.6	31.7	30.1	33.4	31.9	30.3	29.8	29.4	30.4	34.1	80
2	Before Work	08.30	36.2	34.4	32.0	32.3	33.6	33.2	33.6	33.4	33.4	33.0	35.8	72
	After Work	09.00	35.0	28.4	30.7	29.2	33.5	31.0	30.8	31.0	30.7	30.6	34.2	92
3	Before Work	09.30	36.4	30.9	32.7	30.6	34.0	32.5	33.5	31.8	31.6	31.9	35.6	68
	After Work	10.00	35.0	29.8	31.8	30.2	34.3	32.3	31.8	30.5	30.4	31.1	34.4	90
4	Before Work	12.30	36.8	34.9	33.6	33.4	34.9	34.3	35.1	33.0	32.5	33.5	36.4	70
	After Work	13.00	35.0	28.7	30.3	29.2	33.0	31.2	31.2	31.3	29.6	30.3	34.1	80
5	Before Work	13.30	36.8	35.0	35.5	33.1	34.5	35.3	34.3	34.3	31.1	33.8	36.5	78
	After Work	14.00	35.0	31.1	32.4	33.7	34.5	32.7	32.1	32.0	31.3	32.4	34.8	86

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-18 Physiological data

Name - Surname B Date 05/10/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.4	33.6	34.1	32.8	33.4	33.1	33.9	33.5	33.4	33.5	36.1	70
	After Work	08.00	35.4	30.8	34.3	31.6	33.9	32.4	29.8	32.0	31.1	32.1	35.0	80
2	Before Work	08.30	36.4	34.8	34.8	34.2	33.9	32.3	34.2	33.7	33.6	34.0	36.3	66
	After Work	09.00	35.0	31.6	34.3	32.3	34.0	32.2	28.8	29.9	29.8	31.6	34.5	88
3	Before Work	09.30	36.8	35.1	33.8	33.6	34.3	33.9	33.9	34.3	33.4	33.9	36.5	74
	After Work	10.00	36.1	33.5	35.1	33.1	34.5	33.0	29.9	30.8	30.8	32.5	35.6	82
4	Before Work	12.30	36.7	33.8	33.2	32.6	34.3	34.7	34.8	34.2	34.0	33.7	36.4	78
	After Work	13.00	35.0	33.4	34.7	32.2	34.8	33.2	32.1	30.4	30.3	32.2	34.8	86
5	Before Work	13.30	36.7	35.1	35.1	34.4	33.9	34.3	33.5	34.2	34.3	34.4	36.6	80
	After Work	14.00	36.0	32.2	34.9	33.1	34.8	33.1	30.5	30.2	30.1	32.2	35.4	86

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-19 Physiological data

Name - Surname C Date 05/10/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.4	34.3	32.7	32.6	33.1	32.8	34.0	34.1	33.1	33.2	36.0	70
	After Work	08.00	35.0	29.6	34.5	32.2	34.7	33.3	29.2	32.1	31.8	32.4	34.8	80
2	Before Work	08.30	35.3	32.2	34.4	34.3	33.6	33.4	32.7	32.9	32.6	33.4	35.3	72
	After Work	09.00	35.0	23.9	33.5	31.9	35.1	31.3	28.3	32.4	32.5	31.8	34.6	92
3	Before Work	09.30	36.6	35.2	34.5	34.5	33.5	33.1	33.3	32.7	32.7	33.6	36.3	84
	After Work	10.00	35.0	27.0	34.1	33.3	34.1	33.1	28.9	32.0	31.6	32.2	34 8	90
4	Before Work	12.30	36.6	34.9	33.5	33.4	34.2	33.7	34.3	33.6	33.4	33.7	36.3	82
	After Work	13.00	35.0	32.1	34.5	33.6	35.1	33.1	28.5	32.3	32.1	32.9	35.0	92
5	Before Work	13.30	36.8	35.3	34.8	34.8	35.0	33.8	33.5	33.0	32.4	33.9	36.5	86
	After Work	14.00	36.0	29.2	34.2	33.4	33.6	32.3	27.8	31.3	31.2	32.1	35.4	90

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-20 Physiological data

Name - Surname D Date 05/10/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.3	33.9	32.3	33.4	33.3	32.4	32.0	34.0	33.2	33.2	35.9	74
	After Work	08.00	35.0	27.6	29.3	27.6	30.3	28.9	31.3	32.0	31.5	30.0	34.0	80
2	Before Work	08.30	36.2	34.2	32.4	32.0	32.9	32.8	23.1	31.9	31.6	31.8	35.4	70
	After Work	09.00	35.0	26.8	29.6	29.2	30.5	28.9	29.5	31.1	30.7	29.8	34.0	90
3	Before Work	09.30	36.8	33.9	30.8	31.0	32.9	31.1	31.1	33.0	32.2	31.9	35.9	74
	After Work	10.00	35.4	28.3	30.7	30.2	31.6	30.6	29.0	29.9	29.9	30.1	34.3	90
4	Before Work	12.30	36.7	33.3	32.4	31.5	32.5	32.6	33.7	34.0	33.1	32.8	36.1	80
	After Work	13.00	35.0	28.9	28.6	29.5	30.4	29.8	33.5	31.0	30.1	30.0	34.0	94
5	Before Work	13.30	36.8	33.9	31.9	32.1	33.4	32.7	32.9	33.2	33.0	32.8	36.1	86
	After Work	14.00	36.3	32.4	32.1	33.6	33.1	31.9	31.7	29.5	30.8	31.7	35.4	90

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-21 Physiological data

Name - Surname E Date 13/07/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.8	35.1	33.6	35.2	34.1	33.6	32.7	32.3	34.6	33.9	36.5	66
	After Work	08.00	35.0	31.0	33.3	33.3	33.4	33.9	27.0	32.4	32.1	32.5	34.8	96
2	Before Work	08.30	36.8	35.7	34.5	35.4	34.9	34.0	31.6	34.6	34.5	34.6	36.7	80
	After Work	09.00	35.6	28.5	32.9	33.1	32.6	32.9	24.1	33.0	32.4	32.1	35.1	90
3	Before Work	09.30	36.8	35.7	34.7	35.2	34.9	33.6	31.6	34.0	33.9	34.3	36.7	76
	After Work	10.00	35.0	32.4	33.0	34.3	33.9	33.3	27.5	33.2	32.6	33.0	35.0	82
4	Before Work	12.30	36.8	36.0	36.3	36.0	35.7	35.4	34.9	34.5	34.2	35.3	37.0	80
	After Work	13.00	35.2	27.7	33.7	33.5	33.2	33.1	27.0	32.1	32.2	32.2	34.9	96
5	Before Work	13.30	36.4	35.7	35.1	36.0	35.0	33.2	32.5	33.8	33.6	34.5	36.4	66
	After Work	14.00	35.0	28.8	32.7	33.6	32.9	33.4	23.7	33.0	32.3	32.2	34.7	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-22 Physiological data

Name - Surname F Date 13/07/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.2	34.7	32.7	33.9	33.3	33.6	33 2	32.5	32.4	33.1	35.8	76
	After Work	08.00	35.0	33.7	32.8	32.5	32.5	32.9	27.6	32.0	31.3	32.1	34.7	80
2	Before Work	08.30	35.8	35.0	34.5	34.3	33.5	33.1	33.1	33.1	32.8	33.7	35.8	76
	After Work	09.00	35.0	34.3	32.0	31.9	34.2	34.2	30.7	29.8	29.7	31.5	34.5	80
3	Before Work	09.30	35.6	35.0	32.6	34.0	34.1	34.0	31.1	32.9	32.6	33.2	35.5	76
	After Work	10.00	35.2	33.1	32.5	32.8	33.4	32.9	31.1	30.9	30.8	32.0	34.8	86
4	Before Work	12.30	37.0	35.0	33.9	34.8	34.3	34.4	33.9	34.1	33.4	34.1	36.7	80
	After Work	13.00	35.0	34.5	32.6	33.3	33.3	33.7	28.7	31.4	30.1	32.1	34.7	76
5	Before Work	13.30	36.6	35.4	33.4	35.1	34.3	34.2	32.7	33.6	33.6	34.0	36.4	80
	After Work	14.00	35.0	32.7	32.4	33.2	32.7	32.9	26.4	30.0	29.9	31.4	34.5	82

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-23 Physiological data

Name - Surname G Date 13/07/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	36.8	35.2	32.3	34.7	33.4	32.7	32.2	32.9	32.8	33.2	36.3	80
	After Work	08.00	35.0	28.4	32.4	32.9	34.1	32.7	28.9	31.2	30.9	31.6	34.6	86
2	Before Work	08.30	36.7	35.4	34.9	34.9	34.3	32.9	33.2	32.8	32.7	33.8	36.4	80
	After Work	09.00	35.0	29.5	33.1	32.7	33.9	32.6	28.9	32.4	31.7	32.2	34.7	82
3	Before Work	09.30	36.7	35.1	33.5	34.6	33.6	33.1	29.6	33.2	33.1	33.5	36.3	80
	After Work	10.00	35.4	29.9	33.4	33.0	33.9	32.2	29.8	32.2	32.0	32.3	35.1	80
4	Before Work	12.30	37.2	34.3	34.3	34.9	34.2	34.1	33.6	34.0	33.9	34.2	36.9	86
	After Work	13.00	35.5	28.3	33.7	33.9	33.7	32.2	29.0	32.1	31.1	32.2	35.1	86
5	Before Work	13.30	36.7	35.3	34.3	35.2	33.6	32.6	31.8	32.3	32.2	33.4	36.3	80
	After Work	14.00	35.0	27.3	32.0	32.7	33.1	32.7	27.0	30.0	29.8	30.8	34.3	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-24 Physiological data

Name - Surname H Date 13/07/02

Working Time/Rest Time 30 / 30 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.30	35.8	34.6	33.4	33.5	34.2	33.6	33.8	30.3	34.3	33.2	35.6	78
	After Work	08.00	35.0	29.5	32.3	30.8	33.9	32.7	27.6	33.3	33.2	2.1	34.7	80
2	Before Work	08.30	36.0	34.5	32.7	32.8	33.8	32.8	32.8	34.8	34.7	33.7	35.9	76
	After Work	09.00	35.0	31.3	34.3	32.9	35.0	34.0	33.2	34.4	34.3	33.8	35.3	86
3	Before Work	09.30	35.8	35.1	34.8	33.9	34.6	33.8	34.5	33.5	33.4	34.0	35.9	72
	After Work	10.00	35.4	31.8	34.7	33.9	35.2	34.2	33.9	34.0	33.9	34.0	35.6	80
4	Before Work	12.30	36.8	35.1	34.4	33.8	35.2	34.3	35.1	32.4	33.6	33.9	36.5	76
	After Work	13.00	35.0	31.0	35.2	33.0	34.3	34.0	33.4	33.6	33.4	33.6	35.2	80
5	Before Work	13.30	36.0	35.2	34.6	34.1	34.9	34.3	33.8	34.7	34.8	34.6	36.2	80
	After Work	14.00	35.0	31.2	34.8	32.1	35.0	34.2	32.8	34.0	33.8	33.6	35.2	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-25 Physiological data

Name - Surname A Date 31/07/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	35.6	34.3	32.9	32.8	33.8	33.6	33.4	32.3	32.2	32.9	35.4	88
	After Work	08.10	35.0	31.3	31.6	28.9	33.9	33.6	32.2	30.9	29.2	30.8	34.3	72
2	Before Work	08.45	36.2	35.4	32.8	32.7	34.7	34.5	34.5	32.3	32.2	33.1	35.8	86
	After Work	09.20	35.0	31.6	31.5	30.8	33.9	33.3	30.7	29.9	29.8	31.0	34.3	90
3	Before Work	09.55	36.5	35.9	33.4	32.3	34.0	33.7	33.5	32.0	31.2	32.7	35.9	88
	After Work	10.30	35.0	31.6	30.9	29.8	33.9	31.6	27.9	30.0	29.2	30.4	34.1	92
4	Before Work	11.05	36.4	35.2	33.3	33.7	34.0	33.3	33.2	33.8	33.5	33.7	36.2	68
	After Work	11.40	35.0	30.9	30.8	28.9	33.6	31.7	27.7	30.1	29.5	30.2	34.1	86
5	Before Work	12.15	35.8	35.2	33.5	33.4	34.0	33.6	33.2	32.5	32.3	33.2	35.6	70
	After Work	12.50	34.9	31.0	31.1	27.7	33.8	32.7	26.3	29.9	29.9	30.1	34.0	90

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-26 Physiological data

Name - Surname B Date 31/07/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.0	34.3	34.2	33.1	33.1	32.7	33.1	33.3	33.2	33.4	35.8	76
	After Work	08.10	35.3	28.1	33.6	33.5	34.3	31.2	30.7	31.3	31.3	32.0	34.9	80
2	Before Work	08.45	36.0	35.0	34.9	34.4	34.3	34.3	34.7	33.0	32.7	33.9	36.0	76
	After Work	09.20	35.0	39.6	34.3	33.9	33.9	33.6	31.9	31.0	30.8	32.4	34.8	86
3	Before Work	09.55	36.2	34.6	34.5	34.2	33.9	33.6	32.9	33.2	32.1	33.5	36.0	76
	After Work	10.30	36.0	29.5	33.0	32.8	34.0	31.8	26.9	30.6	30.5	31.4	35.2	80
4	Before Work	11.05	36.2	34.5	33.4	34.0	34.3	33.8	33.0	33.1	32.1	33.3	35.9	60
	After Work	11.40	36.0	30.1	33.8	33.5	34.2	33.4	26.3	30.6	30.7	31.9	35.3	90
5	Before Work	12.15	36.4	34.3	34.3	34.1	33.6	32.3	32.5	33.2	32.7	33.5	36.1	80
	After Work	12.50	36.0	29.3	34.2	33.6	34.0	30.9	37.8	30.5	30.4	31.7	35.3	90

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-27 Physiological data

Name - Surname C Date 31/07/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.0	34.0	33.9	33.7	33.0	33.1	33.2	33.1	32.2	33.2	35.8	68
	After Work	08.10	35.0	27.0	33.3	33.2	33.1	33.0	26.9	30.5	30.5	31.4	34.5	76
2	Before Work	08.45	35.7	34.5	34.4	33.8	34.1	33.7	31.9	32.7	32.4	33.4	35.6	72
	After Work	09.20	35.0	28.9	33.0	32.7	32.2	32.1	26.9	31.0	30.3	31.3	34.5	76
3	Before Work	09.55	36.5	34.6	34.6	34.4	33.7	33.4	30.4	32.3	32.1	33.3	36.1	78
	After Work	10.30	35.5	28.6	33.3	33.3	34.3	34.3	25.6	32.1	31.4	32.1	35.1	80
4	Before Work	11.05	36.5	35.1	31.2	34.8	34.7	34.0	33.4	33.1	32.9	33.4	36.1	76
	After Work	11.40	35.0	29.2	33.1	32.6	33.7	32.4	25.9	30.9	30.8	31.5	34.5	80
5	Before Work	12.15	36.2	33.5	34.2	34.4	34.5	33.7	30.9	33.2	32.5	33.5	36.0	78
	After Work	12.50	35.8	27.2	33.2	33.0	34.1	33.6	24.4	30.0	29.8	31.1	34.9	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-28 Physiological data

Name - Surname D Date 31/07/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.9	34.0	33.6	31.9	33.3	33.3	32.7	32.0	31.9	32.6	36.2	76
	After Work	08.10	35.3	30.6	30.7	27.2	32.1	31.9	32.2	29.2	29.0	29.7	34.1	80
2	Before Work	08.45	36.4	34.9	31.9	31.7	33.8	33.7	33.3	31.9	31.6	32.3	35.7	76
	After Work	09.20	35.0	31.7	31.3	28.4	32.3	32.2	30.1	29.9	28.8	30.1	34.1	86
3	Before Work	09.55	36.4	34.5	32.2	31.8	33.5	30.0	32.4	31.8	31.6	32.0	35.6	80
	After Work	10.30	36.0	31.4	31.1	27.6	31.6	30.2	28.3	29.0	28.6	29.4	34.5	86
4	Before Work	11.05	37.2	34.7	33.6	32.1	34.0	33.7	33.1	33.0	32.5	33.1	36.5	72
	After Work	11.40	35.6	31.1	31.1	30.5	31.4	30.6	31.2	29.1	28.3	30.0	34.4	88
5	Before Work	12.15	36.5	35.4	35.1	34.4	34.2	34.3	33.4	33.2	32.4	33.9	36.3	80
	After Work	12.50	36.0	32.1	31.9	29.1	30.4	30.3	29.9	31.3	31.1	30.8	35.0	94

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-29 Physiological data

Name - Surname E Date 03/08/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.0	34.3	33.9	33.9	33.8	33.4	33.3	34.0	33.8	33.9	36.0	70
	After Work	08.10	35.0	31.0	31.8	31.9	32.9	32.8	27.7	32.7	32.5	32.0	34.7	78
2	Before Work	08.45	35.6	35.0	34.1	34.0	34.3	33.8	33.5	32.9	32.8	33.6	35.6	68
	After Work	09.20	35.0	30.4	32.9	33.1	33.4	32.0	28.5	32.7	32.4	32.5	34.8	86
3	Before Work	09.55	36.2	34.1	34.0	34.2	34.2	33.8	34.0	33.2	33.1	33.7	36.0	72
	After Work	10.30	36.0	29.9	30.9	32.9	32.9	33.0	27.7	32.0	31.8	31.7	35.2	80
4	Before Work	11.05	35.8	35.2	34.7	34.9	34.9	34.3	33.5	34.4	34.4	34.7	36.1	70
	After Work	11.40	35.4	30.3	32.8	32.9	33.0	32.8	28.4	31.7	31.6	32.0	34.9	72
5	Before Work	12.15	36.2	34.4	34.3	34.5	34.5	34.1	33.9	34.1	34.1	34.2	36.2	72
	After Work	12.50	35.0	29.0	31.8	33.5	33.0	32.9	27.0	31.5	31.5	31.7	34.6	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-30 Physiological data

Name - Surname F Date 03/08/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.0	34.3	32.5	32.9	32.8	32.6	32.0	32.2	32.0	32.5	35.5	66
	After Work	08.10	35.0	31.7	31.7	32.1	32.3	32.3	27.9	33.0	32.5	32.1	34.7	70
2	Before Work	08.45	36.2	35.1	34.3	33.9	33.8	32.2	30.3	33.6	33.5	33.6	36.0	68
	After Work	09.20	35.0	32.6	31.8	32.1	33.2	32.9	26.6	30.4	30.3	31.3	34.4	72
3	Before Work	09.55	36.4	34.7	34.1	34.3	34.0	33.5	33.0	32.5	32.5	33.4	36.1	68
	After Work	10.30	36.2	32.3	32.1	32.2	32.4	32.9	26.2	30.2	30.0	31.1	35.2	80
4	Before Work	11.05	36.6	34.7	33.1	34.1	34.0	33.6	33.0	33.9	33.7	33.8	36.3	70
	After Work	11.40	35.0	32.3	32.2	32.3	32.1	31.1	23.3	30.7	30.3	31.0	34.4	72
5	Before Work	12.15	35.5	35.1	34.0	34.3	32.2	33.2	32.1	32.8	32.5	33.3	35.5	66
	After Work	12.50	35.1	33.1	32.4	32.9	33.1	32.1	26.6	32.0	31.8	32.1	34.8	74

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-31 Physiological data

Name - Surname G Date 03/08/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.8	34.2	33.4	34.1	34.0	33.2	32.6	34.3	34.0	33.9	36.5	70
	After Work	08.10	35.0	29.3	32.4	34.3	34.6	32.0	31.1	32.4	32.2	32.5	34.9	80
2	Before Work	08.45	37.1	35.3	33.9	34.5	34.2	33.4	33.2	33.6	33.5	33.9	36.7	78
	After Work	09.20	35.2	30.2	31.2	32.9	33.3	33.1	29.5	33.2	32.0	32.0	34.8	82
3	Before Work	09.55	37.2	34.3	33.2	34.3	34.2	33.5	33.4	31.5	31.4	32.9	36.4	76
	After Work	10.30	35.0	27.6	31.9	32.6	33.5	32.8	28.8	32.2	32.0	31.8	34.6	84
4	Before Work	11.05	37.1	35.1	34.0	34.2	34.0	31.9	33.1	32.6	32.2	33.3	36.5	80
	After Work	11.40	35.2	29.7	32.0	33.0	32.8	31.9	29.4	31.9	31.7	31.9	34.8	82
5	Before Work	12.15	36.7	35.4	34.8	35.5	34.7	33.6	32.7	32.8	32.8	34.0	36.5	80
	After Work	12.50	35.4	30.0	31.6	33.6	33.4	32.4	27.3	31.1	30.9	31.6	34.8	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-32 Physiological data

Name - Surname H Date 03/08/02

Working Time/Rest Time 35 / 35 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.35	36.0	34.3	34.5	33.4	34.1	33.6	33.0	33.5	33.1	33.7	35.9	76
	After Work	08.10	35.0	32.3	32.5	31.4	34.5	33.8	28.4	32.9	32.7	32.4	34.8	86
2	Before Work	08.45	35.4	34.5	34.1	33.7	34.4	34.3	32.4	30.9	33.9	33.4	35.4	80
	After Work	09.20	35.0	31.7	32.7	31.6	33.8	33.4	26.2	32.7	32.5	32.2	34.7	76
3	Before Work	09.55	36.6	35.0	31.3	33.6	33.8	33.4	32.6	34.3	34.2	33.5	36.2	70
	After Work	10.30	35.8	31.0	31.7	31.6	34.6	34.1	28.8	31.9	31.7	31.9	35.2	80
4	Before Work	11.05	36.0	33.9	33.8	32.9	33.4	32.6	30.6	34.2	34.1	33.5	35.8	76
	After Work	11.40	35.0	32.4	33.4	32.4	35.0	33.9	28.5	33.0	32.7	32.8	35.0	80
5	Before Work	12.15	35.5	34.4	35.1	34.6	34.2	34.0	33.2	34.2	33.8	34.3	35.8	70
	After Work	12.50	35.0	32.2	32.5	32.4	34.4	33.9	30.6	31.8	31.7	32.3	34.8	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-33 Physiological data

Name - Surname A Date 21/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	36.6	35.4	34.4	34.1	35.5	33.5	34.8	32.8	32.5	33.8	36.3	76
	After Work	08.20	35.2	32.5	32.1	31.6	33.1	32.4	31.5	28.6	28.0	30.6	34.4	80
2	Before Work	09.00	36.0	34.6	34.4	33.5	33.8	32.7	32.9	33.7	33.6	33.7	35.9	70
	After Work	09.40	35.0	31.9	32.0	31.6	33.0	32.3	31.6	31.0	30.7	31.5	34.5	74
3	Before Work	10.20	36..2	35.3	35.1	34.1	33.1	33.3	33.5	32.7	32.7	33.7	36.0	72
	After Work	11.00	35.0	32.4	31.9	31.7	32.5	32.7	30.5	28.9	28.8	30.7	34.3	76
4	Before Work	11.40	36.4	35.5	34.9	33.9	33.4	33.4	33.7	32.3	32.2	33.5	36.1	70
	After Work	12.20	35.3	32.2	31.8	31.8	32.5	32.2	26.7	28.8	28.6	30.4	34.4	78
5	Before Work	13.00	36.7	35.4	35.5	35.1	34.4	34.1	33.9	34.6	34.2	34.7	36.7	80
	After Work	13.40	35.0	32.0	31.8	31.4	31.1	31.6	26.2	29.2	29.2	30.4	34.1	82

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-34 Physiological data

Name - Surname B Date 21/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	36.6	35.1	34.4	33.8	33.3	32.9	31.9	33.6	33.2	33.6	36.3	76
	After Work	08.20	35.2	33.4	32.9	32.3	32.6	32.2	28.7	28.4	28.1	30.7	34.4	80
2	Before Work	09.00	36.0	35.2	35.3	34.8	34.1	33.8	32.9	31.1	32.6	33.6	35.9	76
	After Work	09.40	35.0	30.8	33.3	32.0	34.1	33.3	30.0	29.1	28.4	31.0	34.4	78
3	Before Work	10.20	36.4	35.8	35.5	34.5	34.1	34.0	33.4	33.2	32.6	34.0	36.3	80
	After Work	11.00	35.4	28.7	33.5	32.8	32.3	32.1	30.2	29.5	28.8	31.0	34.6	76
4	Before Work	11.40	36.4	35.2	34.3	33.7	33.8	33.4	32.2	32.9	32.3	33.4	36.1	78
	After Work	12.20	35.2	31.9	32.6	32.6	32.4	32.4	26.6	29.0	28.0	30.6	34.4	78
5	Before Work	13.00	36.3	35.8	35.3	34.4	34.1	35.5	32.7	32.5	32.4	33.9	36.2	70
	After Work	13.40	35.2	31.2	33.0	32.7	32.2	31.2	23.3	28.9	28.9	30.6	34.4	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-35 Physiological data

Name - Surname C Date 21/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	35.7	34.4	34.1	34.0	33.7	33.5	33.0	32.5	32.4	33.3	35.6	80
	After Work	08.20	35.0	29.2	34.4	33.5	35.2	34.5	26.9	30.7	30.5	32.1	34.7	86
2	Before Work	09.00	36.2	35.1	32.0	32.9	33.8	33.7	34.0	33.4	33.0	33.2	35.9	72
	After Work	09.40	34.7	29.0	34.3	33.5	34.6	34.1	27.6	29.9	29.8	31.7	34.4	80
3	Before Work	10.20	36.0	34.6	33.6	34.3	34.3	33.8	32.8	32.4	31.6	33.2	35.7	70
	After Work	11.00	34.5	25.3	34.8	34.3	34.7	33.8	25.6	31.0	30.0	31.8	34.3	70
4	Before Work	11.40	36.0	34.9	34.1	34.0	34.4	34.1	33.3	33.5	33.0	33.8	35.9	76
	After Work	12.20	34.0	28.2	34.5	33.9	33.5	33.2	26.0	30.7	30.3	31.7	33.9	78
5	Before Work	13.00	36.0	34.9	35.0	34.9	34.0	33.0	32.2	32.1	31.2	33.3	35.8	76
	After Work	13.40	35.0	26.7	34.9	34.9	33.3	32.4	26.0	31.2	30.9	32.1	34.7	78

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-36 Physiological data

Name - Surname D Date 21/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	36.7	34.6	31.8	31.7	33.8	33.4	32.8	30.4	33.4	32.3	35.9	80
	After Work	08.20	35.0	29.0	30.4	29.4	32.1	30.5	29.0	28.1	27.9	29.2	33.8	82
2	Before Work	09.00	36.4	33.8	30.0	31.6	33.8	33.6	33.2	32.0	31.4	31.9	35.6	78
	After Work	09.40	34.7	27.1	30.3	28.3	31.8	29.7	28.7	27.9	27.2	28.6	33.4	80
3	Before Work	10.20	36.4	34.3	32.6	31.5	33.5	32.9	32.5	32.2	31.8	32.4	35.7	80
	After Work	11.00	35.4	29.7	31.3	30.8	31.4	30.5	29.5	31.3	30.0	30.7	34.5	76
4	Before Work	11.40	36.7	34.0	33.1	32.0	33.6	32.5	31.7	32.5	32.0	32.6	36.0	80
	After Work	12.20	35.2	28.3	31.3	29.3	31.4	31.2	31.3	29.9	28.4	29.9	34.1	80
5	Before Work	13.00	36.8	34.8	32.9	32.6	33.2	33.6	33.2	31.1	30.6	32.3	36.0	76
	After Work	13.40	35.2	28.7	31.6	30.8	30.6	26.9	27.6	30.1	28.9	29.8	34.1	80

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-37 Physiological data

Name - Surname E Date 24/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	36.5	34.9	34.7	34.2	34.0	33.9	33.2	34.6	34.0	34.3	36.4	78
	After Work	08.20	35.0	30.3	33.5	34.3	34.4	34.6	30.6	34.1	33.5	33.5	35.2	80
2	Before Work	09.00	36.6	34.6	33.9	34.1	34.3	35.4	34.7	35.0	33.9	34.4	36.5	70
	After Work	09.40	35.3	28.2	33.3	33.7	34.3	34.1	27.8	33.9	33.6	33.0	35.2	80
3	Before Work	10.20	36.0	35.4	33.5	33.8	34.4	34.0	33.2	34.1	33.7	33.9	36.0	78
	After Work	11.00	35.5	27.7	34.0	33.6	34.4	34.2	27.8	33.8	33.0	33.0	35.0	82
4	Before Work	11.40	36.0	34.4	33.9	33.6	34.0	34.3	33.5	33.8	33.1	33.7	35.9	70
	After Work	12.20	35.5	32.6	33.0	33.4	34.0	33.9	27.7	33.2	32.5	32.8	35.3	76
5	Before Work	13.00	36.6	33.4	33.8	34.6	34.6	34.4	33.3	34.3	33.8	34.1	36.4	66
	After Work	13.40	35.0	31.6	33.4	33.3	34.7	34.3	27.9	33.6	33.3	33.2	35.1	76

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-38 Physiological data

Name - Surname F Date 24/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	36.3	34.5	33.2	34.1	33.6	33.7	33.9	34.0	33.4	33.7	36.1	66
	After Work	08.20	35.0	31.6	31.6	33.8	33.5	33.5	28.4	31.2	30.4	31.8	34.6	70
2	Before Work	09.00	35.6	35.0	31.0	34.6	34.1	33.7	30.9	33.2	32.5	33.0	35.4	68
	After Work	09.40	35.0	32.6	31.8	33.1	33.3	33.0	26.4	30.1	29.7	31.3	34.4	72
3	Before Work	10.20	36.0	35.0	33.3	34.7	34.5	33.4	30.2	33.1	32.4	33.4	35.8	68
	After Work	11.00	35.0	31.9	32.4	33.2	33.4	33.2	26.9	31.0	30.6	31.7	34.6	70
4	Before Work	11.40	36.7	35.4	33.6	34.2	34.4	33.9	33.5	34.1	33.1	33.9	36.4	70
	After Work	12.20	35.0	32.9	32.6	32.9	33.4	33.2	27.8	30.8	30.7	31.8	34.6	72
5	Before Work	13.00	37.0	35.1	34.1	34.6	34.7	34.1	33.5	34.0	33.4	34.1	36.7	66
	After Work	13.40	35.0	34.1	33.9	33.7	33.8	33.4	28.5	31.2	21.1	30.5	34.2	70

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-39 Physiological data

Name - Surname G Date 24/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	37.2	33.9	33.7	34.3	33.6	32.9	32.9	33.8	33.6	33.7	36.7	70
	After Work	08.20	35.4	27.5	31.8	32.8	32.5	32.5	29.3	32.1	31.6	31.7	34.8	76
2	Before Work	09.00	36.5	35.5	34.9	34.5	33.5	33.4	33.3	33.0	32.0	33.6	36.2	78
	After Work	09.40	35.5	30.8	33.5	33.4	33.6	33.2	30.3	31.6	31.2	32.3	35.1	76
3	Before Work	10.20	36.9	35.1	34.5	33.9	33.5	32.9	32.5	32.0	31.3	33.0	36.3	76
	After Work	11.00	35.0	27.7	33.3	33.5	33.6	33.4	30.6	31.5	30.9	32.0	34.7	80
4	Before Work	11.40	36.7	35.4	34.3	34.4	33.7	32.7	32.7	33.0	32.4	33.5	36.3	76
	After Work	12.20	35.0	30.5	33.3	33.4	33.5	33.1	28.6	31.1	30.3	31.9	34.6	78
5	Before Work	13.00	37.0	34.5	35.0	34.6	33.4	32.4	32.1	33.2	32.6	33.6	36.6	70
	After Work	13.40	35.0	32.1	35.0	34.8	34.6	34.2	30.5	33.2	32.3	33.6	35.2	72

Temperature (degree Celsius)
Heart rate (beat / minute)

Table B-40 Physiological data

Name - Surname H Date 24/08/02

Working Time/Rest Time 40 / 40 Minute

Period	Time During	Time	Estimate Core Temperature	Skin Temperature									Estimated Body temp	Heart rate
				1	2	3	4	5	6	7	8	Mean		
1	Before Work	07.40	35.4	34.1	33.9	33.6	33.6	33.8	34.0	34.0	34.0	33.9	35.6	76
	After Work	08.20	35.0	31.4	34.4	33.7	33.8	34.3	31.1	33.2	33.0	33.3	35.1	80
2	Before Work	09.00	36.0	35.1	34.3	33.8	33.9	33.8	33.4	34.3	34.2	34.1	36.1	78
	After Work	09.40	35.0	33.1	33.9	34.0	33.9	34.2	31.3	34.0	33.1	33.6	35.2	76
3	Before Work	10.20	36.2	35.1	34.2	33.7	33.7	33.5	33.6	33.8	33.6	33.9	36.1	70
	After Work	11.00	35.0	33.9	34.8	34.3	34.8	34.8	29.1	33.9	33.7	34.0	35.3	70
4	Before Work	11.40	35.5	35.1	34.9	34.3	33.8	33.8	33.1	34.1	33.2	34.1	35.7	72
	After Work	12.20	35.0	32.8	35.1	33.4	34.6	34.5	31.0	33.0	32.4	33.4	35.1	76
5	Before Work	13.00	35.7	35.1	34.2	33.7	33.9	34.0	32.7	32.6	32.0	33.3	35.6	78
	After Work	13.40	35.0	33.7	34.8	34.0	34.4	34.7	32.3	32.0	32.0	33.3	35.1	76

Temperature (degree Celsius)
Heart rate (beat / minute)

BIOGRAPHY

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