

# Studies on the Circadian Variations of Body Temperature in Shift Workers

By

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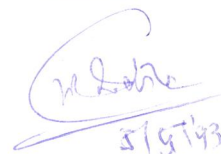
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A THESIS SUBMITTED TO THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE  
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# Introduction

## I. INTRODUCTION

Studies on the circadian variations in the physiology of shift workers may give more information about the fluctuations in the physiology of human subjects with special reference to their body temperature. This study could be done in correlation to the type of work, nature of work schedule and its environmental influence.

Much work has not been done regarding circadian variations of the body temperature in shift workers although other aspects like plasma, cholesterol and blood pressure in vegetarians have been undertaken in normal work schedule human subjects.

Industry, military and para-military agencies and the medical profession often work on a 24-hour basis. In an attempt at fair employment tactics, they routinely alternate their personnel between the day time and night time workshifts. At the onset of one of these changes, the employees are abruptly subjected to at least an 8-hour phase change from their normal working schedule. As far as their body temperature rhythms are concerned, this treatment can be transporting them to the day shift; after a sufficient number of days on the new schedule, their rhythms would be expected to shift appropriately.

This lack of adjustment apparently stems from two

facts; (i) most employees take atleast 2 days off work each week, during which they return to their old sleeping patterns so as to rejoin the rest of the world's social activities and (ii) as is especially true of nurses working in night shift, there are always opportunities for disrupting this altered pattern to join in the social life of the day-shift crowd at the expense of a little loss of sleep. These variations of the routine are sufficient to prevent the biological clock from completing a complete phase shift. Since these people's rhythms do not adjust, the performance of most night-shift crew is usually worse than on the day shift. In jobs that require little talent, effort, or concentration, the reduced efficiency is tolerable. In other jobs, where precision construction, a patient's life, or national security are involved, it is definitely worthwhile taking an employee's rhythm into account.

The external factors which influence the biological clock and to which adaptation can occur, are called zeitgebers. In the case of human beings social contact is probably important as a zeitgeber. A sudden shift of the zeitgebers phase, usually takes several periods for the organisms to become re-entrained and to again reach a constant, phase-angle difference. Experiments with human subjects have some peculiarities due to man's conscious judgement of conditions and his ability to change his phase-relationship to zeitgebers at will. When an individual takes up shift work he is exposed to a considerable phase shift. The difficulties of adaptation to this shift is largely dependent on the strength of the zeitgeber.

Rhythmicity is characteristic of nature. There is no component of nature that does not follow a particular rhythm. "Every component of the universe from an electron to a galaxy is continuously in motion and this movement cannot proceed for ever in the same direction sooner or later the movement must complete a cycle or stop and return in the opposite direction". (Cloudsley Thompson, J.L., 1973). Therefore a cyclic or rhythmic periodicity is characteristic of the systems in universe, both mechanical as well as biological organisms have been and are in constant interactions. With their environment and therefore with nature. Hence, it follows that as an evolutionary adaptation to life in a rhythmic environment most of their physiological as well as behavioural processes also come to follow a rhythmic pattern.

Rhythmicity is observed in human species too. To mention a few, the rapid oscillations in the muscles of heart, lungs, diurnal rhythm and so on. Life itself is a single rhythm or cycle encompassing several smaller rhythms of varying duration such as daily rhythms (Circadian), monthly rhythms and yearly rhythms (Circannual).

When the internal rhythms ("biological clocks") of men are disturbed, by shift work, the result is physiological disturbances like lowered performance. It would be natural to assume that external cues e.g. night/day alternations or changes in social life were triggering the

rhythmic physiological functions of the body. These in turn would then control the accuracy with which a mental task was solved. However, the problem is not that simple and one must abandon the hypothesis that the rhythmic body functions are only governed by factors outside the body. It turns out that many rhythms in the human body are internal or endogenous rhythms.

The term "Body temperature" refers to the temperature of the deeper structures (e.g. viscera, liver, brain); The skin usually has a lower temperature than the depths of the body. This provides a temperature gradient which leads to heat loss from the depths to the surface of the body and thence from the surface to the environment. In hot countries these temperature gradients may be reversed.

In mammals, the regulation of a relatively constant body temperature over a wide range of environmental conditions demands a complex interplay among all heat gain and heat loss mechanisms. Mechanisms in the defence against cold include (a) heat produced by muscular shivering, exercise or other exothermic biochemical reactions which elevate basal metabolic rate and (b) heat conserved by cutaneous vasoconstriction or by growth of hair or for leading to increase in peripheral insulation. Defence mechanisms against heat include (a) increase in heat loss by sweating, panting or salivation, as well as by a rise in extracellular fluid volume and in cutaneous blood flow, with attendant

increase in peripheral thermal conductance, and (b) lowering of metabolic heat production. In addition to these physiologic and metabolic adjustments, it is now generally recognized that behavioural thermo-regulation is of equal or of greater importance in defense against heat and cold in most mammals, especially in man.

Organisms consist of elaborately and precisely regulated exchanges of energy and materials between the self-sustaining chemical systems and the environment. Since temperature affects chemical reaction rates profoundly and because most organismic responses involve chemical transactions, it is evident that temperature is a major parameter in virtually all biological activities. It is evident that temperature is an indispensable factor in biology, and an examination of the human body temperature offers a biologist many insights. Body temperature has therefore been of interest to many workers. Hence, the present study is focussed towards the circadian variations of the body temperature in shift workers.

# Review of Literature

## II. REVIEW OF LITERATURE

### II. (i) CIRCADIAN RHYTHM IN BODY TEMPERATURE (HUMAN)

In the natural habitat, daily rhythms are strictly 24 hours in length; they are "locked", or "entrained", to this frequency mainly by the daily light-dark cycles generated by the rotation of the earth on its axis. When plants and animals are brought into the laboratory where light and temperature cycles are precluded (called constant conditions), the rhythms often persist, but the periods usually become slightly longer or shorter than 24 hours when it was eventually recognized that this change in period length almost always took place in organisms brought into the laboratory, the property was described with a name - it was called circadian (circa, about; diem, day - an), ie., rhythms about a day in length. Rhythmicity is characteristic of nature. (Thomas Hardy, 1970).

The terms "rhythm", "cycle" and "periodicity" have in the past, been applied somewhat indiscriminately to various recurring phenomena and events, (Kleitman, 1949). He has attempted to bring order from chaos by restricting "rhythm" to regularly recurring quantitative changes in some variable biological process, whether it takes place in a cell, tissue, organ, organism or population. He applies the term "cycle" to repetitive

series of events or to successive changes of state, either qualitative or quantitative in nature.

Rhythmic phenomena has been subdivided into two main categories (Park, 1940, 1941a). They are "Exogenous" rhythms that are direct responses to physical changes in the environment and those that do not persist when conditions are kept constant and "endogenous" rhythms which continue, at any rate for a time, under constant conditions. He suggests that the majority of species in their natural environment appear to show a combination of both types and such rhythms he designates "composite". He further subdivides "endogenous" rhythms into "inherent" (i.e. genetical) and "habitual" ones, but (Calhoun, 1944) considers all diurnal "endogenous" rhythms to be of the latter category. He claims, "the genetical determination of 24-hour periodicity has in no case been demonstrated.

Rhythmicity is observed in human species too. To mention a few, the rapid oscillations in the muscles of heart, lungs, diurnal rhythm of sleep activity, temperature rhythm and so on (Aschoff, 1965). Eosinophil content of blood, electrolyte content, melatonin content and excretion vary in a rhythmic pattern, circannual rhythm in the urinary excretion of 17 ketosteroids has been discovered by (Helberg et al, 1971) following 15 years of study in the Excretory pattern of a normal male.

Life itself is a single rhythm or cycle, encompassing several smaller rhythms of varying duration such as daily rhythms (Circadian); monthly rhythms and yearly rhythms (Circannual). Rhythmicity is a feature of many a biochemical process, physiological functions and behavioural aspects of living organisms. To cite a few examples of the latest additions, rhythm of change in the composition of blood occurs in man and other animals (Pitts, 1943) described a diurnal rhythm in the blood sugar in white rats.

**(a) TEMPERATURE AND PERFORMANCE RHYTHMS :**

That the human body does not maintain an even 98.6° F temperature, throughout the day. A regular 24-hour variation, has been known since the middle of the century. A British army physician (John Davy, 1858) was one of the first to describe such a rhythm after using himself as an experimental subject. He made observations on himself daily, for nearly 8 months, and found that the temperature vasculated normally from a low in the small hours of the morning to a high, usually in the late afternoon and early evening.

Repetitive studies during the next century verified Davy's early findings many times. Now it is common knowledge that the rhythm becomes first noticeable at an age of 4-5 weeks and, depending on age, describes

a curve, vasculating approximately between  $97.2^{\circ}$  and  $98.35^{\circ}\text{F}$ , during a 24-hour period. Consequently, an afternoon temperature of  $99^{\circ}\text{F}$  does not necessarily mean that one is slightly feverish, though it does if recorded on waking.

Human Body-temperature depends on the balance between heat production in internal tissues and heat loss from the skin. Therefore, it was only logical for many early human physiologists to explain the rhythmic change they observed-without resource to experimental verification-as an axiomatic consequence of muscular activity, digestion of food stuffs, and maintenance metabolism (all heat-producing process) during the waking hours, alternating with a lack of these and bed rest during the night. In one study, two men regulated their living schedules to 21-hour "days" and later 28-hour "days", each for 6 weeks, while trying to participate in university activities whenever the times of sleep and activity permitted. Between these 2 experiments, they lived normal 24-hour days for six weeks. One of the subjects, the younger of the two, easily adopted to both the 21 - and 28 - hour routines within a week's time. Curiously, as his day length increased, the mean amplitude of the temperature curve also increased from  $1.21^{\circ}$ , to  $1.66^{\circ}$ , to  $1.75^{\circ}\text{F}$  for the 21-, 24- and 28-hour days, respectively (John D. Palmer, 1976).

**(b) REGULATION OF BODY TEMPERATURE IN MAN**

Man is homeothermal, i.e., he maintains his body temperature constant despite the changes in his environmental temperature. The temperature of the organism as a whole, depends upon the rate of heat production and heat loss. It is clear therefore that the various organs must have different temperatures. The liver which lies deep in the body and gives off heat in large amounts, has the highest temperature in man ( $37.8^{\circ}$  to  $38^{\circ}\text{C}$ ) while the temperature of the skin is much lower ( $29.5^{\circ}$  to  $33.9^{\circ}\text{C}$ ) on areas covered by clothes. This indicates that the body temperature does not remain constant, but fluctuates during the day within  $0.5^{\circ}$  to  $0.7^{\circ}\text{C}$  reading highest between 16:00 and 18:00 hours and lowest between 3:00 and 4:00. The variations depend upon the way of life, rest and sleep. Sleep causes a fall in temperature.

The diurnal variations in individuals who work at night for long periods may therefore be the opposite of those mentioned above with a high external temperature. The skin vessels become dilated and warm blood flows to the skin, raising its temperature and so increasing radiation and heat convection. The most important heat regulating centre is a section inside the brain, located just above the pituitary gland, called 'the hypothalamus'. Some of the cells in 'the hypothalamus' control the production of heat in the body tissues while another group of cells controls heat loss. This control springs in response to the heat brought to the brain by the blood as well as to the nerve impulses from the temperature receptors in the skin.

A diurnal variation of 1.5 C may occur in any normal person. The possible extent of the "tolerated" diurnal variation is not always fully appreciated as it is very unusual to take records at frequent intervals, during the night, in normal persons. It is commonly at the inconvenient hours of 2-6 a.m. that the minimum temperatures are observable. As the mouth temperature rises, the pulse rate increases, and vice versa. The normal temperature rise during the day is due to increased heat production from muscular activity and metabolism of food. During sleep the body temperature falls, partly because of bodily inactivity but also because of less perfect temperature regulation. When a healthy man is kept in bed the normal type of diurnal temperature variation takes place, but the evening maximum is not so high.

A reversal of the ordinary daily routine, e.g., on going to night work, ultimately reverses the temperature curve. This does not occur during the first night, for at the hour of the usual minimum (e.g., 3 - 4 a.m.) there is an imperative desire to sleep. After a few days, acclimatization takes place and sleepiness passes off (Samson Wright, 1971).

The temperature regulating system consists of two major functional divisions; (a) a quick reacting system characterized as a neutral net with time constants of

seconds or minutes, and (b) a slowreacting neuroendocrine system with time constants of minutes or hours (Carlson, L.D. 1973). The two systems have important interactions, both centrally and peripherally, in subserving thermo-regulation. In the neural net, skin receptors for warmth and "coolth" (D. Mitchell, Bligh, J., Moore R. 1942) are projected by sensory fibers in the lateral spinal thalamic tract to synaptic relays in the reticular system of the medulla and thence to the posterolateral ventromedial nuclei of the thalamus. Projection to cortical areas presumably mediates conscious thermal sensations.

Thermal receptors exist also in the spinal cord (Hammel, Jessen, C., Simon, E. Iriki, M. 1971), veins (Hammel, H.T. 1968), and the abdominal viscera (Adair, E.R. 1971, Hammel, H.T. 1968, Rawson, R.O., Quick, K.P. 1972). Both surface and deep body receptors are presumed to connect functionally with the preoptic anterior and posterior hypothalamus thermoregulating centres. Although specific pathways have not been identified, the ascending noradrenergic tracts connecting the brain stem with the hypothalamus may transmit the thermal sensory input. (Ungerstedt, U. 1971).

### **(c) BIOLOGICAL CLOCKS AND SHIFT WORK**

The fact that people have internal clocks has long been subjectively appreciated but has received little serious study until recently. The most clear-cut rhythms are our daily cycles. In a number of studies on people

living under constant conditions in caves or in isolated bunkers, it has usually been found that the length of the free-running sleep-awake rhythm is longer than 24 hours, averaging 24 hours and 42 minutes. One man, even though he had his wristwatch, found it impossible to stay on the outside schedule.

Perhaps the most familiar and well studied circadian rhythm is that of body temperature. Certain physiological functions are linked to human circadian rhythms. For example, human teeth are least sensitive during the day. It is true - and not just a complaint of fathers and doctors - that more babies are born in the hours between midnight and 8.00 A.M. than at other times of the day. Temperature is lowest in the hours just before waking, gradually rising during the day until it reaches a peak, around 7.00 or 8.00 P.M. that is usually more than  $1^{\circ}$  F higher. Such daily temperature rhythms persist even when one has a fever. The rhythm, most closely correlated with temperature, is very slow. For each  $1^{\circ}$  F increase in body temperature, the heart beat rate increases by about ten beats per minute.

Biological clocks are temperature independent, giving the same cyclic periods over a wide temperature range. This property is essential for a good clock but is uncommon in biological systems. Most metabolic reactions - like all chemical reactions - are doubled or tripled for

a temperature increase of 10 C. Even physical processes such as diffusion speed up as the temperature rises. If living clocks are indeed keeping time by a purely biological process, it must be one that uniquely compensates for temperature changes.

When the internal rhythms ("biological clocks") of man are disturbed, e.g. by shift work or jet flight across time zones, the result is physiological disturbances and lowered performance. Many rhythmic biological functions can easily be found and recorded. Everyone has experienced the rhythmic body temperature fluctuations from day to night. During the years 1912-1931, some 175000 meter readings were made by three-shift workers every hour of the day at gasworks in Sweden. The example given shows that it is important to study such daily fluctuations in man's behaviour for economic-industrial reasons. But a study is motivated also from medical points of view. It would be natural to assume that external cues, e.g. night/day alternations or changes in social life, were triggering the rhythmic physiological functions of the body. These in turn would have then had a control on the accuracy with which a mental task was solved. However, the problem is not that simple and one must abandon the hypothesis that the rhythmic body functions are only governed by factors outside the body. It turns out that many rhythms in the human body are internal or 'endogenous' rhythms. The rhythmic functions of the body are not only regulated by factors outside the body

but also continue under absolutely constant conditions. The activity and temperature rhythms in man, under free running conditions, show an average of 25.0 hours value ( $\pm 0.6$  hours) (R.Weaver,1971).

The expression "biological clocks" reminds us of the fact that rhythmic functions in biological organisms are used as time-measuring devices. The term is also suggestive from another point of view: the rhythmic functions of man which we can relatively and easily record are only the "hands" of the clocks - while the mechanisms of the "wheels" still remain unclarified. (E.Bunning,1973). A temperature rhythm with a period of 25 hours, under free running conditions, normally changes to exactly 24 hours when the subject lives in and is adjusted to the society with all its rigid 24 hour rhythms. This adaptation of the period of the biological clock to that of the external rhythm is 'entrainment'. The external factors that influence the biological clocks and to which adaptation can occur are called 'zeitgebers'. In the case of human beings, social contact is probably important as a zeitgeber. A sudden phase change of the Zeitgeber - a simple example would be if one changes day to night and vice versa - does not result in an immediate analogous phase change of the biological clock. On the contrary, it may take several days under which the

clock, and thus also the physiological functions which it governs, gradually adapt to the new conditons.

In shift work, the phase of the work period is altered with respect to the biological clock. Shift work involves great changes in the zeitgeber: the social situation, possibilities to watch TV etc. since the shift worker seldom wants to adjust completely to the reversed rhythm. When an individual takes up shift work he is exposed to a considerable phase shift. The night worker has to battle strongly opposing zeitgebers in the surrounding society and adaptation often proves difficult. If the change between day and night work occurs frequently (e.g. rotating shift work) and the process of adaptation has to be met several times each month, one could anticipate that the difficulties of adaptation to night shift will be higher than the permanent night worker.

Work on the night shift causes tendencies towards inversion of the body temperature rhythm of the worker (R.B. GIBSON, 1905, R.Weaver 1966). These results are, however, not undisputable and other authors (F.H. Bonjer 1960, J. Rutenfranz, 1970) have not obtained any inversion. Investigations which include other bodily functions than temperature are very sparse. (Conroy et al, 1970) showed that the 11 - hydroxycorticosteroid rhythm was phase shifted in continous night work, while workers on rotating shifts were no different from day workers. In some cases, therewas

no circadian variation at all. In another study, the same authors found that the excretion of potassium was lowest during sleep irrespective of work hours, while the diuresis was often higher during day sleep than during night sleep.

In short, it appears that the reaction of circadian rhythms to shift work is not one of inversion, but one of half-way inversion. (R.T. W.L. Conroy, A.L. Elliott & J.N. Mills 1970) (Burckhardt and Kayser, 1947) studied the rectal temperature in a 27 - year old microcephalic before and after inversion of the light - dark cycle in a well - isolated room. From this, it could be inferred that attempts to shift human circadian rhythms will be more successful, the better the subject is isolated from the social environment. This was already known to (Lindhard, 1917). He explains that earlier attempts to reverse the rhythm have failed because of insufficient isolation, and who clearly states: "one cannot disconnect the individual from society; so long as the latter follows a fixed rotation, the single individual will consciously or unconsciously, tend towards the same mode of life". It is for this reason that night-workers in their rhythms usually keep a phase-relationship to local time similar to that of day-workers, especially if they are off duty on week ends. If night work is done continuously without interruptions, at week ends, and if contacts with the social environment

are limited, the rhythm of body temperature can be shifted more drastically and may even be reversed, although with a smaller amplitude (Colquhoun et al, 1968 & 1969).

In view of the multiplicity of rhythms within the organism, and in view of the possibility of their mutual independence, one could also expect differences in the rigidity against shifting in different functions. According to (Perkoff et al., 1959) 5 days after an 8 - h delay of sleep time (onset of sleep shifted from midnight to 08<sup>00</sup>) various degrees of shifts are accomplished for serum Fe, plasma 17-OHCS and oral temperature. According to Lanuza and Marottoa, 1974, 7 days of a reversal sleep schedule does not seem to be enough to completely shift plasma cortisol, calcium and magnesium.

## **Materials and Methods**

### III. MATERIALS AND METHODS

#### III.1 CHOICE AND SELECTION OF SUBJECTS

Experiments with human subjects, compared to animal experiments, are complicated by the fact that man can willfully change his phase-relationship to the zeitgebers. Further, social zeitgebers are more relevant for a man than for animals and seem to play a dominant role in comparison to physical zeitgebers. His emotional vagaries easily and routinely disrupt normal physiological patterns; and it can be especially perplexing to an experimenter if a psychosomatic upset occurs in the middle of a long set of observations.

Selection of the shift worker could be justified by the following reasons.

When an individual takes up shift work he is exposed to a considerable phase shift. The difficulty of adaptation to this shift is largely dependent on the strength of the zeitgeber. As was mentioned, the night worker has to battle strongly, opposing zeitgebers in the surrounding society, and adaptation often proves difficult. If the change between day and night work occurs frequently (eg. rotating shift work) then the process of adaptation has to be met several times each month. One could anticipate that the difficulties of adaptation to night shift will be higher compared with that of the permanent night worker.



The body temperature rhythm was observed continuously for every one hour, whereas the biochemical parameters were observed only once, in the day and night shift schedule.

### **III.3 SITE OF MEASUREMENT**

For the study of rhythm, the temperature measured must represent the thermal state of the body. Since, measurement of rectal temperature over a few days is often restricted by the daily routine, and is also very inconvenient, especially when it is to be recorded with a clinical thermometer oral temperature has been recorded in this work. This is the best alternative for the rectal temperature.

### **III.4 THERMOMETER USED**

The mercury in glass clinical thermometer (Fahrenheit) was used and temperature was measured by placing the thermometer under the tongue. The thermometer was held in position for two minutes and the same thermometer was used throughout the experiment to minimize any instrumental error that may occur with change of thermometers. The thermometer was cleaned after every recording.

### III.5 TIME AND INTERVAL OF MEASUREMENT OF THE BODY TEMPERATURE

The body temperature readings were recorded for every one hour continuously for 24 hours for each of the groups namely the control and the experimental groups. The observation was carried on for a period of about 7 days for each group. The temperature readings were recorded from 06.00 A.M. of the first day to 06.00 A.M. of the next day which covers 24 hours a day, and completes one cycle. In order to observe even the slight oscillations, occurring each hour, the temperature was recorded for every one hour continuously for 24-hours. The start of the day shift was from 06.00 to 18.00 hours, whereas for night shift it was from 18.00 to 06.00 hours.

Graphs are drawn to depict the circadian rhythm by taking the mean value of all observations for a particular time (hourwise), and also daywise for the control and the experimental groups.

In the course of this study, an attempt was made to observe certain Biochemical Factors too and they are as follows.

### III. 6 BIOCHEMICAL ASPECTS

#### a) Blood Pressure

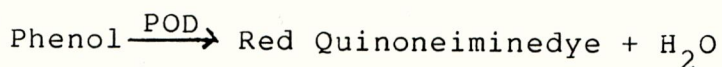
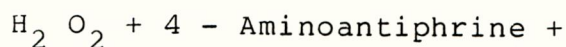
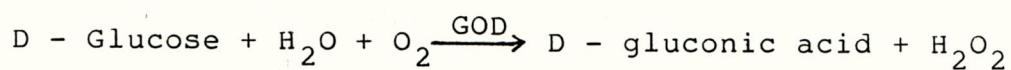
Blood pressure was always measured in (mm Hg) because the mercury manometer has been used as the standard reference for measuring blood pressure throughout the history of physiology and as the systolic and diastolic fluctuations occur too rapidly to be registered accurately by a mercury manometer.

#### b) Estimation of Glucose

##### (GOD/POD Method)

##### Principle

Glucose is oxidised by the enzyme glucose oxidase (GOD) to give D-gluconic acid and hydrogen peroxide. Hydrogen peroxide in presence of enzyme peroxidase (POD) oxidises phenol which combines with 4 - aminoantipyrine to produce a red colored quinoneimine dye. The intensity of the color developed is proportional to glucose concentration in the sample.



**c) Estimation of Serum Cholesterol Total****(Wybenga Pileggi Method)****Principle**

Both free and esterified cholesterol reacts with hot ethyl acetate and sulphuric acid in the presence of ferric iron to give a purple coloured complex. This is measured at 520- 540 nm. (Green Filter).

**d) Estimation of Haemoglobin****(Cyanmethemoglobin method)****Principle**

The blood haemoglobin is treated with Drabkin's solution. Ferricyanide from Drabkin's solution converts haemoglobin to methemoglobin which is further converted to cyanmethemoglobin by the action of cyanide. The cyanmethemoglobin has an absorbance which is proportional to the haemoglobin concentration.

**e) Estimation of Total Protein and Albumin****(Biuret and BCGDYE binding method)****Principle**

Proteins bound with copper ions in an alkaline medium of the Biuret Reagent and produce a purple coloured complex; its absorbance is proportional to the protein concentration. Albumin in buffered medium binds with

Bromocresol green (BCG) and produces a green colour whose absorbance is proportional to the Albumin concentration.

Globulins gm% was estimated by  
 Total Proteins in gm% - Albumin in gm%

#### f) Estimation of Bilirubin

(Modified Jendrassik & Grof Method)

##### Principle

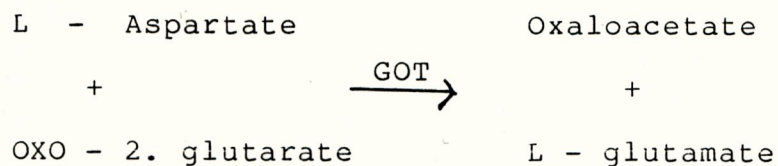
Bilirubin reacts with diazotized sulfanilic acid in acidic medium to form azobilirubin, a purple coloured complex substance whose absorbance is proportional to bilirubin concentration. Direct bilirubin being water soluble is allowed to react with diazotized sulfanilic acid in the absence of an activator, while for total bilirubin, (Direct & indirect) the diazotization is carried out in the presence of an activator.

#### g) Estimation of (ASAT) Aspartate Amino Transferase (SGOT)

(DNPH Method)

##### Principle

Aspartate aminotransferase catalyses the following reaction.



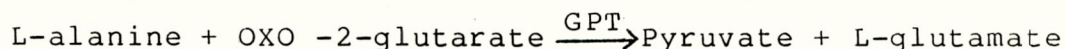
GOT activity is shown by the quantity of oxaloacetate formed. This keto acid may be assayed by the formation of 2, 4 - dinitrophenyl hydrazone which yields a brown colour in alkaline medium. The intensity of this colour is a function of the quantity of oxalo acetate formed, and thus the catalytic activity of aspartate aminotransferase.

#### **h) Estimation of (ALAT) Alanine Amino Transferase (SGPT)**

**(DNPH Method)**

##### **Principle**

Alanine aminotransferase catalyses the following reaction.



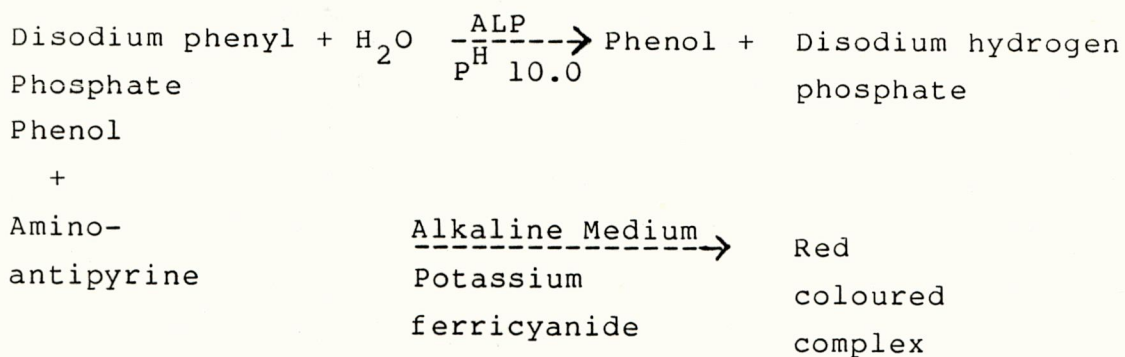
The GPT activity controls the quantity of pyruvate formed. This keto acid may be assayed by the formation of 2, 4 dinitrophenyl hydroazone which yields a brown colour in alkaline medium. The intensity of that colour is a function of the quantity of pyruvate formed and thus the catalytic activity of alanine aminotransferase.

#### **i) Estimation of Alkaline Phosphatase (ALP)**

**(Kind and Kings Method)**

Serum ALP hydrolyzes phenyl phosphate into phenol and disodium hydrogen phosphate at P<sup>H</sup> 10.0. The phenol so

formed reacts with 4 - aminoantipyrine in alkaline medium in presence of oxidising agent potassium ferricyanide to form red coloured complex whose absorbance is proportional to the enzyme activity.



#### j) Estimation of Urea in Urine

(DAM Method)

##### Principle

Urea reacts with DAM in an acidic medium to produce a colored complex. The color is intensified by using thiosemicarbazide and a cadmium salt. The intensity of the colour produced is proportional to urea concentration.

#### k) Estimation of Creatinine in Urine

(Alkaline Picrate Method)

##### Principle

In alkaline medium picric acid reacts with creatinine and produces a red colored complex, whose

absorbance is proportional to creatinine concentration. Picric acid reagent has a dual role, as a deproteinizing agent and as a reactant.

### III.7 STATISTICAL ANALYSIS

In the present study 't' test was used. Based on 't<sub>0</sub>' values, the difference between control and experimental are stated as significant or non-significant.

FIG - 13: GLASS CLINICAL THERMOMETER GIVES GRADATIONS OF 4°F



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FIG - 14: MALE WORKER OF AN INDUSTRY WHILE TAKING BODY TEMPERATURE READINGS. NOTE THE INSERTION OF THE THERMOMETER INTO THE ORAL CAVITY AT ONE END, WHILE THE OTHER END OF THE THERMOMETER IS HELD BY THE EXPERIMENTER.



**FIG - 15:** FEMALE WORKER OF AN INDUSTRY WHILE TAKING THE BODY TEMPERATURE READINGS. NOTE THE RECORDING OF PULSE RATE BY THE EXPERIMENTER. 30



**FIG - 16:** MALE WORKER OF AN HOSPITAL WHILE TAKING THE BODY TEMPERATURE READINGS. NOTE THE GENTLE INSERTION OF THE THERMOMETER INTO THE ORAL CAVITY AT ONE END, WHILE THE OTHER END OF THE THERMOMETER IS HELD BY THE EXPERIMENTER.



FIG - 17: FEMALE WORKER OF AN HOSPITAL WHILE TAKING THE BODY TEMPERATURE READINGS BY THE EXPERIMENTER. 31



FIG - 18: MALE WORKER OF THE CONTROL GROUP WHILE TAKING THE BODY TEMPERATURE READINGS. NOTE THE RECORDING OF PULSE RATE BY THE EXPERIMENTER.



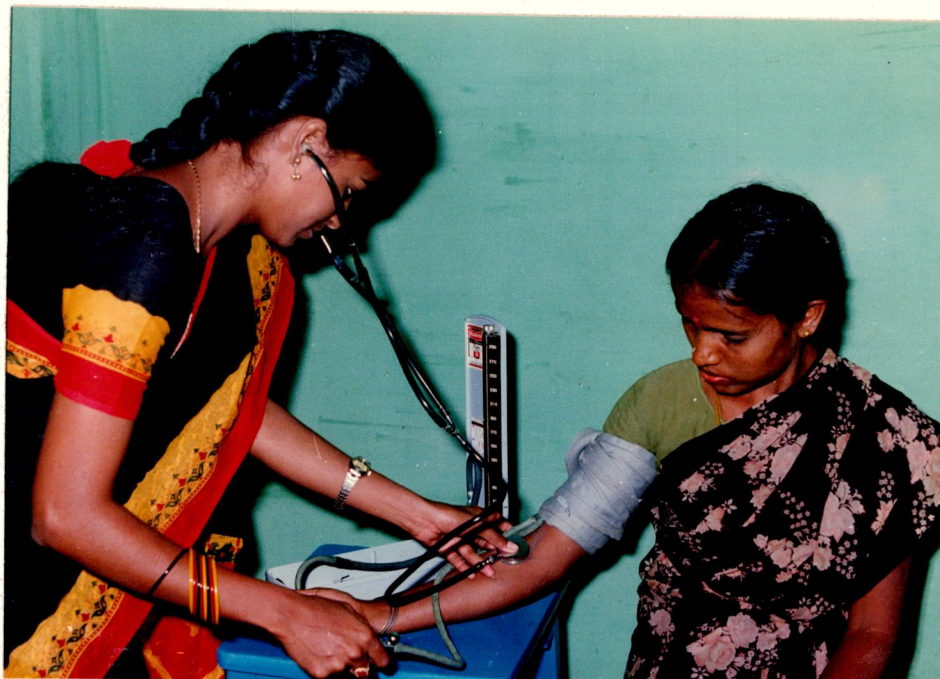
**FIG - 19:** OBSERVATION OF BODY TEMPERATURE READINGS ( OF AN HOSPITAL FEMALE ) IN A CLINICAL THERMOMETER BY THE EXPERIMENTER.



**FIG - 20:** MALE WORKER OF AN INDUSTRY WHILE OBSERVING THE BLOOD PRESSURE READINGS BY THE EXPERIMENTER.



**FIG - 21:** FEMALE WORKER OF AN INDUSTRY WHILE OBSERVING THE BLOOD PRESSURE READINGS BY THE EXPERIMENTER. **33**



**FIG - 22:** MALE WORKER OF AN INDUSTRY WHILE PRICKING THE FINGER TIP FOR BLOOD SAMPLE FOR BIO-CHEMICAL TEST BY THE EXPERIMENTER.

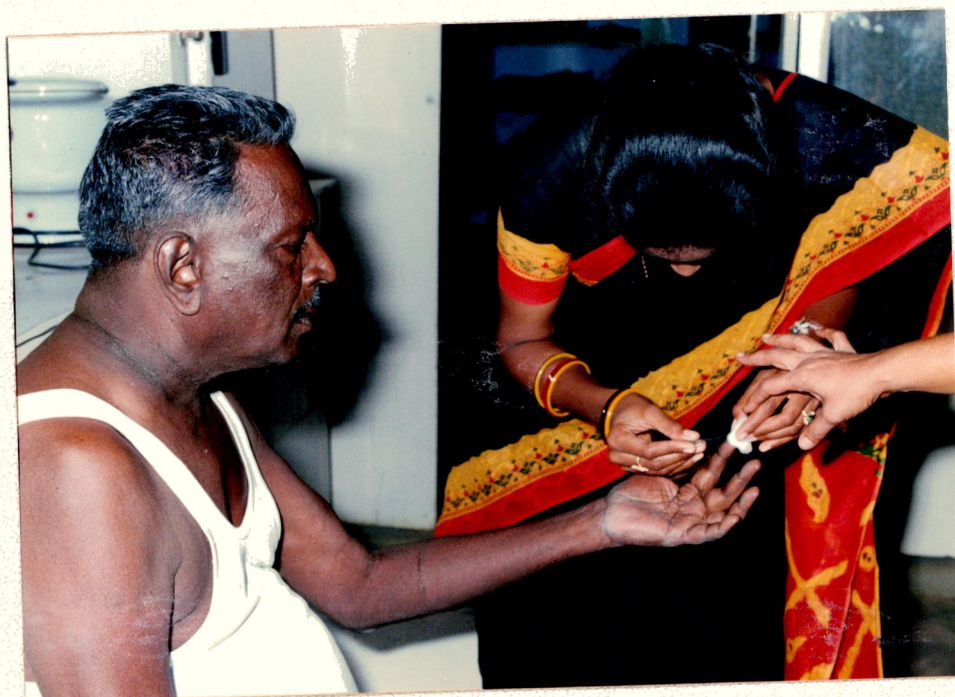


FIG - 23: FEMALE WORKER OF AN INDUSTRY WHILE PRICKING THE FINGER TIP FOR BLOOD SAMPLE BY THE EXPERIMENTER.



FIG - 24: MALE WORKER OF AN HOSPITAL WHILE GETTING READY TO TAKE BLOOD SAMPLE FROM FINGER TIP BY THE EXPERIMENTER.



FIG - 25: FEMALE WORKER OF AN HOSPITAL WHILE DRAWING BLOOD FROM THE VEIN BY THE EXPERIMENTER.



FIG - 26 BIO-CHEMICAL TESTS CARRIED OUT BY THE EXPERIMENTER.





FIG -27



FIG -28

## Results

#### IV. RESULTS

The body temperature rhythm which is the main parameter of the present study was observed in both control and Experimental Set of male and female workers under different work schedules. In order to find out the normal rhythmic pattern of the body temperature, male and female subjects of the age group 25-45 years were selected. A group of ten male and a group of ten female subjects were served as control (whose working time was a normal pattern of 7 hours i.e., 10 a.m. to 17 p.m.).

A group of ten male and a group of ten female subjects who were working in an industry were selected as experimental group - I. A group of ten male and a group of ten female subjects who were working in an Hospital were selected as experimental group - II. Their shift schedule consisted of 7 days on day shift followed by 2 free days, and 7 days on night shift in an industry and an Hospital. The duration of the day shift was 06.00 hours to 18.00 hours, which brings a total of 12 hours of working schedule. Similarly, the duration of the night shift was 18.00 to 06.00 hours which amounts to a total of 12 hours of working schedule both in the industry as well as in the hospital.

#### IV.1 The body temperature rhythm of control and experimental group of male shift workers of an industry (Day shift and night shift)

The body temperature was recorded for every one hour continuously for twenty four hours for 7 days both in the control as well as in the experimental group of male shift workers during day schedule and night schedule. The pattern of the body temperature rhythm in the control and the experimental group of male shift workers of an industry during day and night schedule (mean values) are shown in table - I, II, III & Fig. 1.

##### CONTROL GROUP

Table - I, Fig.1. shows that in control group, a minima of  $98.3 \pm 0.04^{\circ}\text{F}$  at 06.00 hours which is followed by a small rise of  $98.4 \pm 0.04^{\circ}\text{F}$  between 07.00 to 08.00 hours and reached a peak of  $98.7 \pm 0.03^{\circ}\text{F}$  between 12.00 hours and 13.00 hours. This is followed by a gradual decline of body temperature of  $98.5 \pm 0.03^{\circ}\text{F}$  between 14.00 to 17.00 hours and  $98.3 \pm 0.04^{\circ}\text{F}$  at 18.00 hours. Thus there is a rhythmic pattern of the body temperature found to occur in male subjects.

##### EXPERIMENTAL GROUP

###### DAY SHIFT

In male day shift workers the minima of body temperature starts with a value  $98.2 \pm 0.04^{\circ}\text{F}$  at 06.00 hours

which is followed by a small rise of  $98.6 \pm 0.5^{\circ}\text{F}$  at 11.00 hours and reached a highest peak of  $99.8 \pm 0.1^{\circ}\text{F}$  at 13.00 hours. This peak is followed by a gradual decline  $98.6 \pm 0.07^{\circ}\text{F}$  at 18.00 hours. Thus there is a rhythmic pattern of the body temperature found to occur in male day shift workers of an industry (Table - II & Fig.1).

#### **NIGHT SHIFT**

Male night shift workers of an industry exhibit a pattern of body temperature rhythm with a start of  $98.3 \pm 0.06^{\circ}\text{F}$  at 18.00 hours followed by a gradual increase of  $98.7 \pm 0.1^{\circ}\text{F}$  at 21.00 hours, and reached a highest peak of  $99.7 \pm 0.1^{\circ}\text{F}$  at 24.00 hours. This is followed by a gradual decline of body temperature of  $98.3 \pm 0.05^{\circ}\text{F}$  at 05.00 hours (Table - III & Fig.1).

The graph in Fig.1 reveals an overall elevation of body temperature rhythm in experimental group of day shift and night shift workers than that of the control.

This figure also reveals that the day shift male workers show a maximum of  $99.8 \pm 0.01^{\circ}\text{F}$  at 13.00 hours, and a minima of  $98.2 \pm 0.2^{\circ}\text{F}$  at 06.00 hours. Similarly the night shift male workers show a maxima of  $99.7 \pm 0.06^{\circ}\text{F}$  at 24.00 hours and the minima of  $98.3 \pm 0.06^{\circ}\text{F}$  at 05.00 hours. Thus

it is evident that the maxima of body temperature (i.e.,  $99.8 \pm 0.01^{\circ}\text{F}$ ) is significantly higher in day shift male and the minima of body temperature (i.e.,  $98.3 \pm 0.06^{\circ}\text{F}$ ) is higher in night shift male.

#### **IV.2 The body temperature rhythm in the control and experimental group of female shift workers (day & night) of an industry.**

The pattern of the body temperature rhythm in the control and experimental group of female shift workers of an industry both day shift and night shift (mean values) are shown in (Table - IV, V, VI, & Fig.2).

##### **CONTROL GROUP**

Table - IV, Fig.2 reveals that in control group, the graph starts with a temperature of  $98.4 \pm 0.06^{\circ}\text{F}$  at 06.00 hours and slowly reaches a higher value of  $98.7 \pm 0.04^{\circ}\text{F}$  between 12.00 hours and 13.00 hours and gradually decreases to a minimum of  $98.4 \pm 0.03^{\circ}\text{F}$  at 18.00 hours. This shows that the body temperature occur rhythmically in female control group.

##### **EXPERIMENTAL GROUP**

###### **DAY SHIFT**

Similarly in the day shift female workers the body temperature starts with a minima of  $98.0 \pm 0.06^{\circ}\text{F}$  at 06.00

hours and slowly increases and reaches a peak of  $99.6 \pm 0.1^{\circ}\text{F}$  at 12.00 hours. This is followed by a gradual decline of body temperature to  $98.6 \pm 0.05^{\circ}\text{F}$  at 18.00 hours (Table - V, & Fig.2).

#### **NIGHT SHIFT**

And also in the female night shifts workers the body temperature shows a rhythmic pattern. Table - VI, & Fig.2. shows that the temperature starts with a value of  $98.5 \pm 0.03^{\circ}\text{F}$  at 18.00 hours and slowly increases and reaches its peak of  $99.2 \pm 0.09^{\circ}\text{F}$  at 24.00 hours and gradually declines to a minimum of  $98.4 \pm 0.06^{\circ}\text{F}$  at 02.00 hours.

Fig.2 shows that the overall amplitude of body temperature rhythm in experimental group of day shift and night shift workers is higher and elevated than that of the control. And also this figure depicts that the female day shift workers shows the maxima of body temperature of  $99.6 \pm 0.1^{\circ}\text{F}$  at 12.00 hours and a minima of  $98.0 \pm 0.06^{\circ}\text{F}$  at 06.00 hours. Whereas the female night shift workers shows a maxima of  $99.2 \pm 0.09^{\circ}\text{F}$  at 24.00 hours and a minima of  $98.4 \pm 0.03^{\circ}\text{F}$  at 19.00 hours. This means that the maxima of body temperature is more (i.e.,  $99.6 \pm 0.1^{\circ}\text{F}$ ) in day shift female and the minima is more (i.e.,  $98.4 \pm 0.03^{\circ}\text{F}$ ) in night shift female.

#### **IV.3 Comparison of the body temperature rhythm of male and female day shift workers of an industry.**

Comparison of the body temperature rhythm in male and female day shift workers of an industry reveals that in male day shift workers the body temperature  $99.8 \pm 0.1^{\circ}\text{F}$  is significantly higher when compared to that of the female day shift workers. (Table - II, V & Fig. 3).

#### **IV.4 Comparison of the body temperature rhythm of male and female night shift workers of an industry.**

Comparison of the body temperature rhythm of male and female night shift workers of an industry shows a higher elevation of body temperature of  $99.7 \pm 0.1^{\circ}\text{F}$  at 24.00 hours which is the peak body temperature in male night shift workers and it is higher than that of the female night shift workers who shows a peak body temperature of only  $99.2 \pm 0.09^{\circ}\text{F}$  at 24.00 hours. Thus there is a higher amplitude of body temperature in male night shift workers than that of the female night shift workers of an industry. This clearly indicates that the body temperature varies in a rhythmic pattern according to work schedule. (Table - III, VI & Fig. 4)

#### **IV.5 24 hour average (daywise) of body temperature of male and female shift workers of an industry.**

Every day average (24 hour average) of the body temperature of the male and female day shift and night shift workers of an industry were compared with that of the control. Every one hour readings, recorded continuously for 24 hours, were pooled and computed for each day and

expressed as average. It could be noticed that in both day and night shiftt male and female workers, everyday average of body temperature is distinctly higher than that of the resective control group, as shown in the table XI, XII, XIII, XIV, XV & Fig.5. From this figure it is evident that there is a significant increase in the 24 hour average of body temperature of experimental groups, compared to that of the control group.

#### **IV.6 Pattern of the body temperature rhythm in the control and experimental group of male shift workers of an hospital.**

##### **EXPERIMENTAL GROUP**

##### **DAY SHIFT**

Table - VII & Fig.6. shows the day shift male workers of an hospital. This shows that the body temperature start with the minimum value of  $98.2 \pm 0.08^{\circ}\text{F}$  at 06.00 hours and slightly increase and reaches a value of  $98.6 \pm 0.03^{\circ}\text{F}$  at 11.00 hours which is followed by a gradual increase and reaches a peak body temperature of  $99.4 \pm 0.05^{\circ}\text{F}$  at 12.00 hours. This is followed by a gradual decline to a minimum of  $98.5 \pm 0.04^{\circ}\text{F}$  at 16.00 hours and finally declines to a minimum of  $98.4 \pm 0.03^{\circ}\text{F}$  at 17.00 hours. Thus the body temperature exhibits a rhythmic pattern in male day shift workers of an hospital.

##### **NIGHT SHIFT**

The body temperature pattern of male workers of an hospital during night shift is shown in Table - VIII, & Fig.6. It shows a minimum value of  $98.5 \pm 0.05^{\circ}\text{F}$  at 18.00 hours and gradually increases a higher value of  $99.1 \pm 0.1^{\circ}\text{F}$

at 24.00 hours and reaches the peak value of  $99.2 \pm 0.08^{\circ}\text{F}$  at 01.00 hours and declines gradually to a minimum value of  $98.4 \pm 0.03^{\circ}\text{F}$  at 05.00 hours.

Table-I, VII, VIII & Fig.6 shows the pattern of body temperature rhythm in male shift workers (day & night) of an hospital. It could be noted that the overall amplitude of body temperature rhythm which is significantly higher in day shift & night shift male workers of an hospital when compared to that of the control group of male. One could observe that the maxima of body temperatures is  $99.4 \pm 0.05^{\circ}\text{F}$  at 12.00 hours in day shift male and  $99.2 \pm 0.08^{\circ}\text{F}$  at 01.00 hours in night shift male whereas the minima of body temperature  $98.2 \pm 0.08^{\circ}\text{F}$  at 06.00 hours in day shift male and  $98.4 \pm 0.06^{\circ}\text{F}$  at 19.00 hours in night shift male. This reveals that the maxima of body temperature (i.e.,  $99.4^{\circ}\text{F}$ ) is more in day shift male and minima of body temperature (i.e.,  $98.4^{\circ}\text{F}$ ) is more in night shift male.

**IV.7 Pattern of the body temperature rhythm in the control and experimental group of female shift workers of an hospital.**

#### **EXPERIMENTAL GROUP**

##### **DAY SHIFT**

As in table IX & Fig.7. the day shift workers of the female in the hospital shows a minimum value of 97.9

$\pm 0.07^{\circ}\text{F}$  at 06.00 hours which is followed by a slight increase of  $98.6 \pm 0.02^{\circ}\text{F}$  at 11.00 hours and gradually increased and reaches a maximum of peak of  $100 \pm 0.06^{\circ}\text{F}$  at 12.00 hours and then it follows a slight decrease of  $99.6 \pm 0.05^{\circ}\text{F}$  at 13.00 hours and reaches a minimum decline of  $98.5 \pm 0.03^{\circ}\text{F}$  at 13.00 hours. This depicts that the body temperature shows the rhythmic variation at every one hour interval.

### NIGHT SHIFT

The body temperature pattern of female night shift workers of an hospital shows the minimum value of  $98.4 \pm 0.04^{\circ}\text{F}$  at 18.00 hours and slightly increases to  $98.8 \pm 0.04^{\circ}\text{F}$  at 22.00 hours and reaches a highest peak of  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hours. This is followed by a gradual decline to a minimum of  $98.3 \pm 0.06^{\circ}\text{F}$  at 05.00 hours. (Table X & Fig.7)

Fig.7 shows the body temperature rhythm of day and night shift female workers of an hospital and control group. It is obvious that there is higher elevation of body temperature in day and night shift workers which is significantly more when compared to that of the control. This shows the peak body temperature of  $100 \pm 0.06^{\circ}\text{F}$  in day shift female workers at 12.00 hours which is more when compared to that of the peak body temperature of night shift female workers which is  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hours.

#### **IV.8. Comparison of the body temperature rhythm of male and female day shift workers of an hospital.**

Table VII IX & Fig.8 shows the pattern of the body temperature rhythm of male and female day shift workers of an hospital. Observe the peak temperature in female day shift workers which is  $100.0 \pm 0.06^{\circ}\text{F}$  at 12.00 hours. This is more when compared to that of the male day shift workers where the peak temperature is  $99.4 \pm 0.05^{\circ}\text{F}$  at 12.00 hours. This brings a difference of body temperature of  $0.06^{\circ}\text{F}$  between female and male day shift workers of an hospital. Thus it proves that the female day shift workers of an hospital shows the higher elevation of body temperature than that of the male day shift workers.

#### **IV.9. Comparison of the body temperature rhythm of male and female night shift workers of an hospital.**

The pattern of the body temperature rhythm of male and female night shift workers of an hospital reveals the maximum body temperature of  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hours by female night shift workers which appears to be more when compared to that of male night shift workers. In male night shift workers the maximum temperature is only  $99.2 \pm 0.08^{\circ}\text{F}$ . A significant difference of  $0.5^{\circ}\text{F}$  of body temperature is exhibited between female and male night shift workers (Table - VIII, X & fig.9).

**NIGHT SHIFT:**

In female night shift workers of an hospital the overall average of body temperature is  $98.5 \pm 0.03^{\circ}\text{F}$  which is significantly higher when compared to that of the control group ( $98.4 \pm 0.02^{\circ}\text{F}$ ) as well as with that of an industry ( $98.4 \pm 0.02^{\circ}\text{F}$ ).

**INDUSTRY**

From this it is evident that the overall average of body temperature of male day shift ( $98.6 \pm 0.02^{\circ}\text{F}$ ) and night shift ( $98.5 \pm 0.05^{\circ}\text{F}$ ) workers are significantly more when compared to that of the female day shift ( $98.5 \pm 0.07^{\circ}\text{F}$ ) and night shift workers ( $98.4 \pm 0.02^{\circ}\text{F}$ ) whereas comparison of the overall average of body temperature of male day shift ( $98.6 \pm 0.02^{\circ}\text{F}$ ) and night shift workers ( $98.5 \pm 0.05^{\circ}\text{F}$ ) shows a significant increase in the day shift.

**HOSPITAL**

The overall average of body temperature of female day shift workers ( $98.6 \pm 0.02^{\circ}\text{F}$ ) and night shift workers ( $98.5 \pm 0.03^{\circ}\text{F}$ ) are significantly higher when compared to that

of the overall average of the body temperature of male day shift workers ( $98.5 \pm 0.02^{\circ}\text{F}$ ) and night shift workers ( $98.4 \pm 0.05^{\circ}\text{F}$ ). Amongst the day shift workers and the night shift workers of female, the overall average of body temperature of day shift workers ( $98.6 \pm 0.02^{\circ}\text{F}$ ) is significantly more when compared to that of the night shift workers ( $98.5 \pm 0.03^{\circ}\text{F}$ ).

From the above results, it is seen that there is a circadian rhythmic pattern of the body temperature existing both in control as well as in experimental workers. But the experimental group shows an elevation of body temperature pattern when compared to that of the control group, which might be due to the nature of work schedule, type of work and influence of environmental factors.

#### IV.13. BIOCHEMICAL TESTS:

On various parameters the biochemical tests were analysed for the control group as well as for the experimental group of day shift and night shift workers of an industry and hospital. But there were no marked significant change was observed between the day shift and night shift of the experimental group of industry and hospital workers. (Table - XXII)

TABLE - I

## HOURWISE/DAYWISE BODY TEMPERATURE READINGS • CONTROL GROUP • MALE

Days	A.M										P.M										A.M				
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	
1	98.4	98.5	98.5	98.6	98.5	98.6	99.0	98.8	98.6	98.4	98.5	98.4	98.4	98.5	98.5	98.5	98.5	98.5	98.8	98.6	98.5	98.4	98.6	98.5	
	±0.01	±0.04	±0.1	±0.03	±0.06	±0.06	±0.07	±0.01	±0.6	±0.01	±0.3	±0.01	±0.03	±0.01	±0.03	±0.01	±0.3	±0.0	±0.01	±0.03	±0.01	±0.3	±0.5	±0.01	
2	98.3	98.5	98.6	98.7	98.4	98.5	98.7	98.8	98.6	98.5	98.4	98.5	98.4	98.5	98.4	98.4	98.4	98.5	98.6	98.5	98.4	98.5	98.4	98.4	
	±0.03	±0.01	±0.03	±0.7	±0.09	±0.04	±0.01	±0.03	±0.5	±0.1	±0.01	±0.03	±0.02	±0.01	±0.01	±0.03	±0.5	±0.1	±0.03	±0.4	±0.02	±0.01	±0.03	±0.3	
3	98.5	98.3	98.7	98.5	98.6	98.4	98.7	98.6	98.4	98.6	98.4	98.4	98.5	98.3	98.4	98.5	98.3	98.4	98.7	98.4	98.3	98.3	98.5	98.3	
	±0.06	±0.3	±0.09	±0.01	±0.1	±0.3	±0.06	±0.6	±0.01	±0.02	±0.06	±0.2	±0.6	±0.06	±0.03	±0.02	±0.07	±0.05	±0.01	±0.01	±0.01	±0.03	±0.02	±0.01	
4	98.4	98.2	98.4	98.4	98.5	98.5	98.8	98.7	98.5	98.4	98.4	98.6	98.3	98.4	98.3	98.3	98.5	98.5	98.6	98.5	98.5	98.2	98.3	98.4	
	±0.05	±0.03	±0.2	±0.6	±0.0	±0.0	±0.5	±0.01	±0.3	±0.01	±0.01	±0.0	±0.3	±0.06	±0.01	±0.0	±0.3	±0.7	±0.03	±0.3	±0.6	±0.01	±0.03	±0.4	
5	98.2	98.3	98.6	98.6	98.4	98.4	98.7	98.7	98.4	98.5	98.4	98.6	98.4	98.4	98.4	98.2	98.4	98.4	98.5	98.4	98.4	98.1	98.4	98.3	
	±0.02	±0.01	±0.2	±0.3	±0.7	±0.03	±0.3	±0.0	±0.01	±0.03	±0.3	±0.6	±0.1	±0.4	±0.6	±0.4	±0.0	±0.01	±0.1	±0.01	±0.01	±0.3	±0.0	±0.01	
6	98.5	98.4	98.7	98.7	98.7	98.5	98.7	98.6	98.4	98.4	98.4	98.5	98.5	98.3	98.2	98.3	98.0	98.3	98.3	98.7	98.4	98.3	98.3	98.1	
	±0.03	±0.7	±0.05	±0.0	±0.06	±0.01	±0.01	±0.4	±0.5	±0.03	±0.01	±0.5	±0.3	±0.3	±0.01	±0.1	±0.6	±0.01	±0.3	±0.02	±0.03	±0.01	±0.03	±0.04	
7	98.3	98.5	98.4	98.4	98.6	98.4	98.5	98.7	98.4	98.6	98.6	98.5	98.2	98.3	98.4	98.2	98.2	98.2	98.6	98.3	98.2	98.3	98.2	98.2	
	±0.1	±0.07	±0.1	±0.3	±0.3	±0.2	±0.01	±0.5	±0.6	±0.3	±0.03	±0.01	±0.5	±0.6	±0.5	±0.0	±0.01	±0.3	±0.01	±0.03	±0.02	±0.03	±0.01	±0.02	
MEAN	98.3	98.4	98.4	98.5	98.5	98.5	98.7	98.7	98.5	98.5	98.5	98.5	98.3	98.4	98.4	98.3	98.4	98.4	98.6	98.4	98.3	98.2	98.4	98.3	
	±0.04	±0.04	±0.07	±0.05	±0.04	±0.03	±0.05	±0.03	±0.04	±0.03	±0.03	±0.02	±0.04	±0.04	±0.02	±0.06	±0.04	±0.04	±0.03	±0.03	±0.04	±0.06	±0.05	±0.05	

Mean S.D. are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 male control group.

TABLE • II

HOURWISE/DAYWISE BODY TEMPERATURE READINGS • EXPERIMENTAL GROUP • I • INDUSTRY • DAY SHIFT • MALE

Days	A.M										P.M										A.M				
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	
1	98.2	98.3	98.4	98.4	98.6	98.5	99.5	100	99.9	98.6	98.6	98.7	98.6	98.4	98.6	98.5	98.6	98.7	98.9	99.2	98.6	98.4	98.3	97.2	
	±0.1	±0.04	±0.01	±0.06	±0.01	±0.06	±0.05	±0.06	±0.06	±0.3	±0.01	±0.03	±0.01	±0.01	±0.2	±0.03	±0.01	±0.03	±0.04	±0.01	±0.03	±0.3	±0.04	±0.05	
2	98.2	98.3	98.5	98.00	98.5	98.7	99.0	99.9	100.1	98.7	98.8	98.8	98.8	98.5	98.7	98.5	98.6	98.8	99.0	98.8	98.5	98.3	98.2	98.3	
	±0.03	±0.01	±0.1	±0.06	±0.01	±0.01	±0.07	±0.04	±0.03	±0.08	±0.03	±0.01	±0.03	±0.01	±0.1	±0.1	±0.03	±0.01	±0.01	±0.03	±0.01	±0.01	±0.05	±0.04	
3	98.0	98.4	98.4	98.3	98.4	98.7	99.1	98.9	99.6	98.6	98.9	98.8	99.0	98.5	98.5	98.5	98.7	98.6	99.3	99.0	98.4	98.3	98.4	98.0	
	±0.01	±0.06	±0.09	±0.01	±0.03	±0.03	±0.7	±0.03	±0.01	±0.06	±0.3	±0.04	±0.1	±0.03	±0.03	±0.3	±0.01	±0.04	±0.05	±0.1	±0.3	±0.03	±0.04	±0.03	
4	98.1	98.2	98.3	98.2	98.5	98.8	99.3	100.1	99.5	98.5	99.0	98.6	98.7	98.5	98.4	98.6	98.7	98.6	98.6	98.9	98.6	98.2	98.3	98.1	
	±0.04	±0.05	±0.07	±0.07	±0.01	±0.01	±0.06	±0.06	±0.03	±0.03	±0.06	±0.4	±0.3	±0.01	±0.1	±0.03	±0.03	±0.05	±0.06	±0.03	±0.1	±0.04	±0.03	±0.01	
5	98.3	98.3	98.4	98.4	98.5	98.6	98.8	99.8	99.6	98.4	98.7	98.6	98.6	98.5	98.4	98.4	98.8	98.7	98.7	98.6	98.5	98.4	98.0	98.3	
	±0.06	±0.01	±0.05	±0.01	±0.06	±0.04	±0.01	±0.07	±0.04	±0.1	±0.03	±0.01	±0.2	±0.03	±0.03	±0.06	±0.3	±0.01	±0.04	±0.03	±0.01	±0.04	±0.03	±0.1	
6	98.1	98.2	98.4	98.2	98.6	98.5	99.2	99.9	99.5	98.4	98.5	98.5	98.5	98.6	98.5	98.4	98.7	98.5	99.1	98.7	98.6	98.0	98.2	98.5	
	±0.01	±0.03	±0.01	±0.03	±0.01	±0.01	±0.03	±0.04	±0.06	±0.01	±0.1	±0.03	±0.1	±0.01	±0.01	±0.0	±0.3	±0.03	±0.01	±0.01	±0.03	±0.04	±0.01	±0.4	
7	98.2	98.4	98.5	98.5	98.4	98.4	99.4	100.2	99.4	98.8	98.4	98.4	98.6	98.6	98.5	98.4	98.6	98.6	99.0	98.5	98.7	98.2	98.3	98.4	
	±0.03	±0.01	±0.03	±0.1	±0.03	±0.07	±0.1	±0.03	±0.01	±0.01	±0.0	±0.05	±0.3	±0.3	±0.03	±0.3	±0.3	±0.04	±0.03	±0.01	±0.3	±0.04	±0.04	±0.5	
MEAN	98.2	98.3	98.4	98.3	98.5	98.6	99.2	99.8	99.6	98.6	98.7	98.7	98.6	98.5	98.5	98.4	98.7	98.6	98.9	98.8	98.6	98.3	98.2	98.3	
	±0.04	±0.03	±0.02	±0.05	±0.03	±0.05	±0.03	±0.1	±0.09	±0.05	±0.07	±0.06	±0.07	±0.03	±0.03	±0.04	±0.03	±0.04	±0.08	±0.08	±0.03	±0.05	±0.04	±0.1	

DAY SHIFT

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 male experimental group day shift industry workers

HOURWISE/DAYWISE BODY TEMPERATURE READINGS • EXPERIMENTAL GROUP • I • NIGHT SHIFT • MALE

Days	A.M										P.M										A.M				
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	
1	98.4	98.3	98.3	98.2	98.4	98.8	98.6	98.8	98.4	98.6	98.6	98.3	98.4	98.7	98.6	98.9	98.5	99.2	99.6	99.7	98.6	99.1	98.5	98.3	
	±0.3	±0.03	±0.06	±0.06	±0.01	±0.03	±0.01	±0.01	±0.03	±0.01	±0.04	±0.08	±0.06	±0.03	±0.01	±0.06	±0.01	±0.01	±0.04	±0.0	±0.04	±0.06	±0.4	±0.06	
2	98.3	98.2	98.4	98.4	98.5	98.6	98.7	98.6	98.4	98.4	99.0	98.2	98.5	98.4	98.5	99.2	98.5	99.6	99.8	99.7	98.7	98.5	98.6	98.6	
	±0.07	±0.04	±0.01	±0.07	±0.06	±0.06	±0.07	±0.04	±0.03	±0.01	±0.1	±0.3	±0.06	±0.3	±0.4	±0.2	±0.3	±3.01	±0.02	±0.03	±0.01	±0.3	±0.03	±0.07	
3	98.0	98.3	98.3	98.3	98.4	98.4	98.8	98.5	98.7	98.5	98.8	98.4	98.4	98.4	98.6	98.7	98.4	99.8	99.6	99.6	98.4	99.0	98.6	98.3	
	±0.01	±0.1	±0.3	±0.06	±0.03	±0.3	±0.09	±0.01	±0.06	±0.05	±0.01	±0.03	±0.4	±0.3	±0.1	±0.03	±0.06	±0.6	±0.07	±0.06	±0.03	±0.06	±0.1	±0.05	
4	98.4	98.1	98.4	98.4	98.4	98.6	99.0	98.8	98.6	98.6	98.7	98.3	98.3	98.5	98.5	98.6	98.4	98.7	99.5	99.8	98.6	98.7	98.4	98.2	
	±0.06	±0.03	±0.1	±0.3	±0.3	±0.03	±0.01	±0.01	±0.04	±0.5	±0.03	±0.03	±0.06	±0.3	±0.1	±0.1	±0.1	±0.03	±0.01	±0.02	±0.3	±0.1	±0.1	±0.3	
5	98.1	98.3	98.3	98.4	98.6	98.5	98.7	99.7	99.7	98.5	98.9	98.2	98.2	98.6	98.5	98.8	98.4	99.0	99.6	99.3	98.5	98.6	98.5	98.4	
	±0.01	±0.01	±0.04	±0.01	±0.01	±0.01	±0.03	±0.01	±0.0	±0.01	±0.3	±0.03	±0.01	±0.02	±0.02	±0.03	±0.02	±0.1	±0.06	±0.3	±0.0	±0.09	±0.03	±0.06	
6	98.1	98.2	98.2	98.5	98.5	98.7	98.6	98.6	98.8	98.6	98.5	98.4	98.0	98.6	98.4	98.9	98.6	99.3	100.2	99.9	98.4	98.5	98.4	98.3	
	±0.07	±0.03	±0.1	±0.06	±0.06	±0.01	±0.03	±0.02	±0.03	±0.07	±0.06	±0.06	±0.07	±0.03	±0.1	±0.1	±0.1	±0.03	±0.1	±0.03	±0.01	±0.07	±0.03	±0.05	
7	97.2	98.2	98.3	98.6	98.4	98.6	98.5	98.8	98.6	98.5	98.4	98.3	98.1	98.4	98.4	98.0	98.6	99.2	100.1	100	98.8	98.6	98.5	98.2	
	±0.03	±0.05	±0.03	±0.7	±0.06	±0.3	±0.07	±0.01	±0.03	±0.3	±0.3	±0.3	±0.01	±0.03	±0.03	±0.03	±0.1	±0.01	±0.03	±0.01	±0.03	±0.1	±0.06	±0.3	
MEAN	98.1	98.2	98.3	98.4	98.5	98.6	98.7	98.7	98.6	98.5	98.7	98.3	98.3	98.5	98.5	98.7	98.5	99.2	99.7	99.7	98.6	98.7	98.5	98.3	
	±0.1	±0.03	±0.02	±0.04	±0.03	±0.04	±0.05	±0.04	±0.05	±0.03	±0.08	±0.03	±0.06	±0.04	±0.03	±0.01	±0.03	±0.1	±0.1	±0.08	±0.05	±0.08	±0.03	±0.05	

NIGHT SHIFT

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 male experimental group-Night shift industry workers

TABLE • IV

HOURWISE/DAYWISE BODY TEMPERATURE READINGS • CONTROL GROUP • FEMALE

Days	A.M										P.M										A.M				
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	
1	98.4	98.4	98.5	98.4	98.5	98.5	98.6	98.7	98.6	98.5	98.4	98.4	98.4	98.2	98.4	98.5	98.4	98.5	98.6	99.4	98.6	98.3	98.3	98.6	
	±0.1	±0.01	±0.02	±0.06	±0.01	±0.01	±0.02	±0.03	±0.05	±0.4	±0.03	±0.01	±0.03	±0.01	±0.3	±0.3	±0.01	±0.6	±0.3	±0.01	±0.01	±0.01	±0.04	±0.05	
2	98.2	98.4	98.5	98.4	98.5	98.5	98.6	98.7	98.4	98.4	98.4	98.4	98.5	98.3	98.4	98.4	98.4	98.5	98.4	98.4	98.7	98.2	98.5	98.5	
	±0.2	±0.3	±0.01	±0.02	±0.06	±0.02	±0.04	±0.5	±0.05	±0.06	±0.01	±0.5	±0.01	±0.0	±0.03	±0.01	±0.03	±0.01	±0.06	±0.05	±0.01	±0.01	±0.06	±0.7	
3	98.5	98.3	98.5	98.4	98.5	98.6	98.6	98.7	98.7	98.2	98.4	98.5	98.5	98.2	98.3	98.4	98.4	98.5	98.4	98.3	98.5	98.4	98.5	98.4	
	±0.01	±0.03	±0.0	±0.03	±0.02	±0.06	±0.03	±0.01	±0.06	±0.07	±0.06	±0.01	±0.3	±0.4	±0.01	±0.03	±0.01	±0.2	±0.03	±0.0	±0.7	±0.0	±0.07	±0.02	
4	98.3	98.4	98.6	98.4	98.5	98.6	98.8	98.6	98.6	98.4	98.4	98.6	98.4	98.2	98.2	98.2	98.4	98.6	98.4	98.2	98.3	98.4	98.4	98.3	
	±0.04	±0.5	±0.3	±0.5	±0.02	±0.09	±0.06	±0.6	±0.03	±0.01	±0.03	±0.03	±0.01	±0.03	±0.04	±0.3	±0.06	±0.01	±0.5	±0.01	±0.6	±0.01	±0.06	±0.0	
5	98.4	98.4	98.4	98.4	98.7	98.8	98.8	98.5	98.7	98.6	98.4	98.6	98.4	98.4	98.2	98.0	98.2	98.4	98.2	98.4	98.2	98.4	98.4	98.2	
	±0.3	±0.02	±0.07	±0.01	±0.06	±0.1	±0.4	±0.07	±0.4	±0.6	±0.03	±0.2	±0.5	±0.07	±0.3	±0.01	±0.6	±0.0	±0.4	±0.02	±0.02	±0.04	±0.3	±0.1	
6	98.6	98.5	98.7	98.4	98.6	98.7	98.8	98.8	98.8	98.7	98.4	98.6	98.6	98.3	98.0	98.3	98.2	98.4	98.2	98.2	98.4	98.2	98.3	98.4	
	±0.01	±0.0	±0.5	±0.01	±0.01	±0.1	±0.01	±0.03	±0.03	±0.05	±0.0	±0.1	±0.01	±0.06	±0.01	±0.01	±0.02	±0.04	±0.01	±0.3	±0.02	±0.2	±0.01	±0.7	
7	98.7	98.4	98.4	98.4	98.6	98.5	98.8	98.7	98.8	98.5	98.2	98.5	98.4	98.3	98.2	98.3	98.2	98.4	98.2	98.5	98.4	98.2	98.3	98.5	
	±0.0	±0.03	±0.02	±0.6	±0.2	±0.05	±0.03	±0.01	±0.5	±0.3	±0.01	±0.03	±0.1	±0.4	±0.03	±0.06	±0.02	±0.01	±0.1	±0.01	±0.03	±0.02	±0.0	±0.01	
MEAN	98.4	98.4	98.5	98.4	98.5	98.6	93.7	98.7	98.6	98.5	98.4	98.5	98.4	98.3	98.2	98.3	98.3	98.5	98.3	98.3	98.4	98.3	98.4	98.4	
	±0.06	±0.02	±0.04	±0.0	±0.03	±0.04	±0.04	±0.04	±0.05	±0.06	±0.02	±0.03	±0.03	±0.03	±0.05	±0.06	±0.03	±0.03	±0.06	±0.04	±0.06	±0.04	±0.03	±0.05	

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 female control group

HOURLY/DAILY BODY TEMPERATURE READINGS • EXPERIMENTAL GROUP • I • INDUSTRY • DAY SHIFT • FEMALE

Days	A.M.										P.M.													
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5
1	98.2	98.3	98.4	98.4	98.5	98.7	100.1	99.6	98.5	98.4	98.7	98.5	98.8	98.6	98.5	98.7	98.6	98.8	99.0	98.8	98.4	98.5	98.5	98.4
	±0.3	±0.01	±0.01	±0.03	±0.2	±0.3	±0.01	±0.03	±0.01	±0.3	±0.01	±0.01	±0.02	±0.04	±0.01	±0.3	±0.01	±0.01	±0.01	±0.03	±0.01	±0.01	±0.03	±0.01
2	97.8	98.2	98.4	98.5	98.5	98.7	99.8	98.8	98.7	98.5	98.6	98.4	98.7	98.5	98.6	98.6	98.5	98.6	98.6	98.6	98.4	98.5	98.4	98.3
	±0.2	±0.06	±0.3	±0.06	±0.3	±0.01	±0.02	±0.01	±0.6	±0.02	±0.02	±0.6	±0.01	±0.03	±0.6	±0.01	±0.03	±0.03	±0.03	±0.03	±0.01	±0.02	±0.03	±0.2
3	98.0	98.2	98.3	98.4	98.4	98.5	100	99.6	98.8	98.5	98.5	98.6	98.4	98.4	98.5	98.6	98.5	98.6	98.5	98.6	98.5	98.4	98.4	98.3
	±0.04	±0.07	±0.0	±0.01	±0.01	±0.03	±0.01	±0.3	±0.0	±0.01	±0.01	±0.3	±0.01	±0.3	±0.02	±0.3	±0.01	±0.01	±0.01	±0.02	±0.01	±0.02	±0.1	±0.01
4	98.1	98.1	98.2	98.3	98.5	98.5	99.2	98.6	98.6	98.4	98.4	98.3	98.6	98.5	98.5	98.5	98.4	98.5	98.6	98.7	98.3	98.4	98.2	98.3
	±0.01	±0.7	±0.01	±0.04	±0.0	±0.02	±0.03	±0.02	±0.01	±0.01	±0.06	±0.01	±0.03	±0.01	±0.01	±0.01	±0.04	±0.06	±0.02	±0.01	±0.03	±0.01	±0.3	±0.03
5	98.3	98.0	98.4	98.2	98.4	98.5	99.6	98.9	98.5	98.5	98.4	98.5	98.5	98.4	98.3	98.6	98.5	98.7	98.8	98.5	98.3	98.3	98.3	98.0
	±0.5	±0.09	±0.6	±0.3	±0.05	±0.03	±0.03	±0.01	±0.03	±0.3	±0.01	±0.02	±0.01	±0.3	±0.02	±0.02	±0.3	±0.01	±0.1	±0.01	±0.3	±0.3	±0.03	±0.5
6	98.2	98.1	98.2	98.1	98.5	98.4	99.3	99.3	98.4	98.6	98.4	98.4	98.5	98.5	98.6	98.5	98.5	98.6	99.0	98.4	98.4	98.5	98.4	98.1
	±0.3	±0.4	±0.05	±0.01	±0.01	±0.01	±0.01	±0.02	±0.01	±0.03	±0.01	±0.5	±0.01	±0.4	±0.1	±0.02	±0.03	±0.01	±0.03	±0.3	±0.01	±0.02	±0.01	±0.02
7	98.0	98.2	98.1	98.0	98.4	98.6	99.5	99.0	98.4	98.5	98.5	98.5	98.6	98.7	98.5	98.5	98.4	98.5	98.9	98.7	98.4	98.4	98.5	98.2
	±0.04	±0.3	±0.01	±0.03	±0.03	±0.01	±0.3	±0.03	±0.4	±0.01	±0.03	±0.01	±0.01	±0.0	±0.4	±0.01	±0.02	±0.3	±0.01	±0.1	±0.3	±0.01	±0.1	±0.01
MEAN	98.0	98.2	98.3	98.4	98.5	98.6	99.6	99.1	98.6	98.5	98.5	98.4	98.6	98.5	98.4	98.6	98.5	98.6	98.8	98.6	98.3	98.4	98.4	98.2
	±0.06	±0.04	±0.04	±0.09	±0.02	±0.04	±0.1	±0.1	±0.04	±0.02	±0.04	±0.04	±0.05	±0.04	±0.05	±0.03	±0.02	±0.04	±0.07	±0.05	±0.03	±0.03	±0.03	±0.04

DAY SHIFT

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 female experimental group - day shift industry workers.

TABLE # VI

HOURWISE/DAYWISE BODY TEMPERATURE READINGS # EXPERIMENTAL GROUP # I # INDUSTRY # NIGHT SHIFT # FEMALE

Days	A.M							P.M							A.M									
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5
1	97.9	98.3	98.3	98.2	98.4	98.7	98.7	98.4	98.3	98.4	98.5	98.8	98.6	98.5	98.4	98.4	98.3	98.6	98.0	99.8	98.6	98.5	98.6	98.5
	±0.01	±0.01	±0.0	±0.03	±0.04	±0.04	±0.2	±0.01	±0.5	±0.01	±0.04	±0.01	±0.1	±0.3	±0.04	±0.01	±0.01	±0.01	±0.3	±0.01	±0.3	±0.04	±0.03	±0.07
2	97.8	98.1	98.2	98.1	98.5	98.7	98.7	98.5	98.3	98.4	98.4	98.4	98.7	98.6	98.4	98.6	98.3	98.6	99.0	98.6	98.4	98.3	98.6	98.4
	±0.02	±0.04	±0.06	±0.06	±0.0	±0.03	±0.3	±0.03	±0.03	±0.03	±0.07	±0.05	±0.3	±0.01	±0.03	±0.02	±0.3	±0.3	±0.02	±0.03	±0.01	±0.07	±0.01	±0.06
3	98.1	97.9	98.4	98.3	98.4	98.6	98.7	98.7	98.4	98.3	98.3	98.3	98.6	98.4	98.4	98.5	98.5	98.8	99.1	98.7	98.3	98.5	98.5	98.4
	±0.3	±0.01	±0.04	±0.03	±0.02	±0.1	±0.04	±0.6	±0.04	±0.01	±0.02	±0.05	±0.07	±0.02	±0.02	±0.1	±0.1	±0.1	±0.03	±0.03	±0.5	±0.06	±0.06	±0.05
4	98.3	98.3	98.1	98.3	98.4	98.5	98.6	98.4	98.5	98.3	98.2	98.4	98.5	98.5	98.5	98.5	98.6	98.5	99.4	98.4	98.5	98.6	98.4	98.5
	±0.05	±0.02	±0.03	±0.01	±0.08	±0.2	±0.01	±0.03	±0.05	±0.06	±0.1	±0.2	±0.03	±0.01	±0.04	±0.3	±0.3	±0.01	±0.3	±0.1	±0.06	±0.05	±0.07	±0.04
5	98.1	98.2	98.0	98.4	98.5	98.5	98.6	98.5	98.5	98.5	98.4	98.2	98.5	98.4	98.5	98.6	98.5	98.7	98.6	98.5	98.6	98.2	98.5	98.3
	±0.01	±0.03	±0.05	±0.04	±0.03	±0.03	±0.03	±0.01	±0.1	±0.3	±0.03	±0.03	±0.01	±0.03	±0.2	±0.03	±0.03	±0.02	±0.02	±0.03	±0.3	±0.04	±0.05	±0.05
6	98.2	98.1	98.2	98.2	98.4	98.4	98.5	98.4	98.4	98.5	98.3	98.1	98.6	98.5	98.3	98.6	98.5	98.6	98.9	98.6	98.6	98.3	98.3	98.3
	±0.07	±0.04	±0.04	±0.6	±0.04	±0.7	±0.07	±0.3	±0.01	±0.3	±0.3	±0.1	±0.06	±0.01	±0.01	±0.01	±0.1	±0.2	±0.1	±0.3	±0.04	±0.3	±0.06	±0.01
7	98.3	98.2	98.3	98.0	98.6	98.6	98.5	98.5	98.3	98.3	98.4	98.4	98.5	98.4	98.5	98.5	98.7	98.5	99.5	98.5	98.7	98.5	98.6	98.5
	±0.01	±0.01	±0.01	±0.07	±0.05	±0.01	±0.06	±0.1	±0.03	±0.2	±0.01	±0.3	±0.01	±0.06	±0.3	±0.06	±0.3	±0.01	±0.3	±0.2	±0.4	±0.03	±0.07	±0.0
MEAN	98.1	98.2	98.2	98.2	98.4	98.5	98.6	98.4	98.3	98.3	98.3	98.3	98.5	98.4	98.4	98.5	98.4	98.6	99.2	98.6	98.4	98.5	98.5	98.4
	±0.06	±0.05	±0.06	±0.04	±0.03	±0.03	±0.03	±0.05	±0.04	±0.04	±0.02	±0.09	±0.03	±0.03	±0.02	±0.02	±0.06	±0.03	±0.09	±0.04	±0.06	±0.07	±0.04	±0.03

NIGHT SHIFT

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for female control group

TABLE # VII

HOURWISE/DAYWISE BODY TEMPERATURE READINGS # EXPERIMENTAL GROUP # II # HOSPITAL # DAY SHIFT # MALE

Days	A.M							P.M							A.M									
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5
1	97.9	98.4	98.5	98.6	98.7	98.6	99.6	99.1	98.8	98.6	98.4	98.5	98.5	98.6	98.5	98.4	98.4	98.5	98.1	99.9	98.5	98.4	98.5	98.4
	±0.04	±0.06	±0.06	±0.1	±0.04	±0.3	±0.01	±0.04	±0.3	±0.04	±0.01	±0.03	±0.01	±0.02	±0.01	±0.03	±0.04	±0.01	±0.03	±0.04	±0.05	±0.06	±0.01	±0.03
2	98.4	98.4	98.4	98.4	98.6	98.7	99.5	98.9	98.7	98.7	98.3	98.4	98.4	98.5	98.6	98.4	98.3	98.6	98.6	98.8	98.6	98.3	98.6	98.3
	±0.05	±0.06	±0.01	±0.3	±0.1	±0.01	±0.02	±0.01	±0.04	±0.06	±0.05	±0.01	±0.06	±0.05	±0.3	±0.07	±0.06	±0.09	±0.04	±0.3	±0.1	±0.2	±0.2	±0.01
3	98.4	98.4	98.3	98.5	98.5	98.6	99.4	98.8	98.6	98.5	98.5	98.6	98.6	98.6	98.5	98.5	98.5	98.6	98.5	98.4	98.5	98.5	98.5	98.5
	±0.03	±0.05	±0.3	±0.06	±0.01	±0.05	±0.03	±0.04	±0.03	±0.04	±0.05	±0.06	±0.06	±0.07	±0.4	±0.05	±0.3	±0.01	±0.03	±0.1	±0.01	±0.04	±0.05	±0.06
4	98.3	98.5	98.4	98.5	98.4	98.5	99.2	98.9	98.7	98.4	98.6	98.4	98.5	98.4	98.3	98.5	98.5	98.7	98.7	98.8	98.6	98.4	98.3	98.4
	±0.3	±0.06	±0.05	±0.01	±0.3	±0.4	±0.5	±0.07	±0.06	±0.04	±0.06	±0.05	±0.01	±0.3	±0.4	±0.05	±0.1	±0.04	±0.3	±0.01	±0.1	±0.05	±0.04	±0.3
5	98.2	98.3	98.5	98.4	98.3	98.4	99.4	98.8	98.8	98.5	98.6	98.3	98.4	98.3	98.4	98.6	98.4	98.5	98.6	98.7	98.5	98.5	98.4	98.3
	±0.1	±0.0	±0.06	±0.07	±0.04	±0.3	±0.2	±0.1	±0.01	±0.03	±0.4	±0.06	±0.5	±0.07	±0.07	±0.05	±0.06	±0.04	±0.3	±0.05	±0.4	±0.04	±0.06	±0.07
6	98.5	98.4	98.4	98.5	98.4	98.6	99.2	98.7	98.7	98.4	98.5	98.5	98.5	98.4	98.3	98.5	98.4	98.5	98.6	98.6	98.6	98.4	98.5	98.4
	±0.05	±0.6	±0.07	±0.06	±0.08	±0.6	±0.1	±0.3	±0.1	±0.2	±0.01	±0.03	±0.5	±0.06	±0.07	±0.06	±0.07	±0.6	±0.6	±0.5	±0.4	±0.05	±0.04	±0.03
7	98.0	98.4	98.4	98.4	98.5	98.5	99.3	98.8	98.8	98.5	98.4	98.4	98.4	98.4	98.4	98.5	98.5	98.6	98.8	98.6	98.5	98.5	98.4	98.4
	±0.06	±0.05	±0.3	±0.0	±0.06	±0.01	±0.01	±0.02	±0.03	±0.03	±0.4	±0.4	±0.4	±0.05	±0.06	±0.06	±0.7	±0.3	±0.3	±0.1	±0.2	±0.1	±0.2	±0.0
MEAN	98.2	98.4	98.4	98.5	98.5	98.6	99.4	98.9	98.8	98.5	98.5	98.4	98.4	98.5	98.4	98.5	98.4	98.6	98.7	98.7	98.5	98.4	98.5	98.4
	±0.08	±0.02	±0.03	±0.03	±0.04	±0.03	±0.05	±0.04	±0.03	±0.03	±0.04	±0.03	±0.02	±0.04	±0.04	±0.03	±0.02	±0.03	±0.07	±0.04	±0.03	±0.03	±0.03	±0.02

DAY SHIFT

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for male experimental group = day shift Hospital workers.

TABLE • X

HOURWISE/DAYWISE BODY TEMPERATURE READINGS • EXPERIMENTAL GROUP • II • HOSPITAL NIGHT SHIFT • FEMALE

Days	A.M							P.M							A.M										
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	
1	98.1	98.1	98.3	98.4	98.5	98.7	99	98.9	98.6	98.4	98.5	98.6	98.4	98.6	98.4	98.5	98.3	98.5	99.8	99.6	98.8	98.6	98.5	98.4	
	±0.01	±0.3	±0.04	±0.05	±0.01	±0.03	±0.1	±0.1	±0.1	±0.02	±0.04	±0.0	±0.1	±0.04	±0.06	±0.1	±0.2	±0.2	±0.01	±0.03	±0.04	±0.05	±0.06	±0.01	
2	97.8	97.9	98.4	98.5	98.6	98.6	98.8	98.8	98.5	98.5	98.4	98.5	98.3	98.5	98.5	98.3	98.4	98.6	99.6	99	98.9	98.5	98.4	98.5	
	±0.06	±0.05	±0.04	±0.03	±0.01	±0.03	±0.05	±0.03	±0.5	±0.06	±0.07	±0.06	±0.03	±0.01	±0.04	±0.5	±0.01	±0.01	±0.04	±0.03	±0.1	±0.03	±0.05	±0.06	
3	97.6	98.0	98.3	98.4	98.5	98.5	98.6	99.1	98.4	98.3	98.3	98.4	98.5	98.4	98.6	98.2	98.5	98.7	99.9	99.2	98.9	98.7	98.4	98.4	
	±0.03	±0.03	±0.05	±0.04	±0.03	±0.01	±0.03	±0.03	±0.01	±0.07	±0.06	±0.06	±0.03	±0.1	±0.03	±0.01	±0.01	±0.03	±0.05	±0.01	±0.01	±0.01	±0.01	±0.07	
4	97.5	98.3	98.5	98.5	98.4	98.4	99.1	98.7	98.3	98.6	98.4	98.4	98.6	98.3	98.4	98.4	98.6	98.6	99.8	99.4	98.8	98.6	98.5	98.5	
	±0.04	±0.01	±0.01	±0.01	±0.01	±0.03	±0.01	±0.3	±0.01	±0.7	±0.06	±0.07	±0.01	±0.01	±0.3	±0.03	±0.03	±0.1	±0.04	±0.03	±0.04	±0.04	±0.06	±0.01	
5	97.9	98.1	98.4	98.4	98.5	98.4	98.7	98.6	98.6	98.4	98.5	98.5	98.5	98.2	98.3	98.0	98.5	98.5	99.7	99.2	98.7	98.4	98.4	98.3	
	±0.05	±0.03	±0.06	±0.03	±0.05	±0.01	±0.03	±0.01	±0.04	±0.1	±0.1	±0.03	±0.5	±0.03	±0.1	±0.01	±0.01	±0.03	±0.06	±0.01	±0.06	±0.06	±0.04	±0.03	
6	97.7	98.3	98.3	98.3	98.2	98.5	98.9	98.5	98.5	98.4	98.6	98.6	98.4	98.4	98.4	98.5	98.4	98.5	99.6	99.3	98.6	98.5	98.5	98.2	
	±0.06	±0.01	±0.07	±0.01	±0.06	±0.6	±0.01	±0.03	±0.05	±0.02	±0.3	±0.06	±0.01	±0.01	±0.01	±0.04	±0.3	±0.01	±0.06	±0.03	±0.03	±0.03	±0.01	±0.02	
7	98.1	98.1	98.2	98.2	98.3	98.4	98.5	98.4	98.7	98.5	98.3	98.4	98.3	98.4	98.3	98.4	98.5	98.4	99.5	99.1	98.7	98.5	98.4	98.0	
	±0.01	±0.05	±0.06	±0.01	±0.06	±0.7	±0.03	±0.1	±0.06	±0.3	±0.01	±0.3	±0.0	±0.03	±0.03	±0.06	±0.03	±0.03	±0.01	±0.04	±0.01	±0.01	±0.02	±0.03	
MEAN	97.8	98.1	98.3	98.4	98.5	98.5	98.8	98.7	98.5	98.6	98.6	98.5	98.4	98.5	98.4	98.3	98.8	98.5	99.7	99.3	98.8	98.5	98.4	98.3	
	±0.08	±0.05	±0.04	±0.04	±0.06	±0.04	±0.08	±0.08	±0.04	±0.04	±0.04	±0.04	±0.03	±0.04	±0.05	±0.04	±0.06	±0.04	±0.04	±0.05	±0.08	±0.04	±0.04	±0.02	±0.06

NIGHT SHIFT

Mean S.E. are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 female experimental group - Night shift Hospital workers.

TABLE - XI

COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS  
OF THE CONTROL GROUP OF MALE

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	t' <sub>o</sub> VALUE	P' VALUE (t' <sub>0.05</sub> = 1.960)
1.	98.5 $\pm$ 0.03	-	-	-
2.	98.4 $\pm$ 0.03	1 and 2	2.248	* 1.960
3.	98.4 $\pm$ 0.02	1 and 3	2.301	* 1.960
4.	98.4 $\pm$ 0.02	1 and 4	2.358	* 1.960
5.	98.4 $\pm$ 0.02	1 and 5	2.352	* 1.960
6.	98.4 $\pm$ 0.04	1 and 6	1.867	N.S
7.	98.3 $\pm$ 0.03	1 and 7	3.898	* 1.960

Twenty four Observations Each:

Mean  $\pm$  S.E are calculated for the body temperature readings observed for every one hour Continuous  
7 days for 10 Male control group.

\* Significant at 5% Level

N.S - Not Significant

TABLE - XII

COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL GROUP  
OF MALE - INDUSTRY WORKERS - DAY SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	$t'_o$ VALUE	P' VALUE ( $t_{0.05} = 1.960$ )
1.	98.7 $\pm$ 0.1	-	-	-
2.	98.6 $\pm$ 0.06	1 and 2	1.020	N.S
3.	98.6 $\pm$ 0.06	1 and 3	0.882	N.S
4.	98.6 $\pm$ 0.09	1 and 4	0.743	N.S
5.	98.5 $\pm$ 0.04	1 and 5	1.949	N.S
6.	98.5 $\pm$ 0.07	1 and 6	1.669	N.S
7.	98.5 $\pm$ 0.08	1 and 7	1.603	N.S

Twenty Four Observations each :

N.S - Not Significant

Mean  $\pm$  S.E readings are calculated for every one hour recording continuously for 7 days for 10 Male Experimental Group - I.

TABLE - XIII  
 COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL GROUP  
 OF MALE-INDUSTRY WORKERS - NIGHT SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	t <sub>o</sub> ' VALUE	P' VALUE (t <sub>0.05</sub> = 1.960)
1.	98.5 $\pm$ 0.09	-	-	-
2.	98.6 $\pm$ 0.08	1 and 2	0.793	N.S
3.	98.6 $\pm$ 0.07	1 and 3	0.837	N.S
4.	98.6 $\pm$ 0.07	1 and 4	0.841	N.S
5.	98.5 $\pm$ 0.08	1 and 5	-	-
6.	98.5 $\pm$ 0.1	1 and 6	-	-
7.	98.5 $\pm$ 0.1	1 and 7	-	-

Twenty Four Observations each :

N.S - Not Significant

Mean  $\pm$  S.E readings are calculated for every one hour recording continuously for 7 days for  
 10 Male Experimental Group - I

TABLE XIV  
 COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS  
 OF THE CONTROL GROUP OF FEMALE

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	t' VALUE t' <sub>0</sub>	P' VALUE (t' <sub>0.05</sub> = 1.960)
1.	98.5 $\pm$ 0.02	-	-	-
2.	98.4 $\pm$ 0.02	1 and 2	2.768	*1.960
3.	98.4 $\pm$ 0.02	1 and 3	2.625	*1.960
4.	98.4 $\pm$ 0.03	1 and 4	2.407	*1.960
5.	98.4 $\pm$ 0.03	1 and 5	2.188	*1.960
6.	98.4 $\pm$ 0.04	1 and 6	1.873	N.S
7.	98.4 $\pm$ 0.03	1 and 7	2.171	*1.960

Twenty Four Observations each:

\* Significant at 5% level  
 N.S. - Not Significant

Mean  $\pm$  S.E. are calculated for the body temperature reading observed  
 for every one hour continuously for 7 days for 10 Male control Group.

TABLE - XV  
 COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL  
 GROUP OF FEMALE - INDUSTRY WORKERS - DAY SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	' $t_0$ ' VALUE	'P' VALUE ( $t_{0.05} = 1.960$ )
1.	98.6 $\pm$ 0.08	-	-	-
2.	98.5 $\pm$ 0.06	1 and 2	0.954	N.S
3.	98.5 $\pm$ 0.1	1 and 3	0.757	N.S
4.	98.5 $\pm$ 0.04	1 and 4	1.030	N.S
5.	98.5 $\pm$ 0.04	1 and 5	1.048	N.S
6.	98.5 $\pm$ 0.05	1 and 6	0.972	N.S
7.	98.5 $\pm$ 0.05	1 and 7	1.015	N.S

Twenty Four Observations Each:

N.S. - Not Significant

Mean  $\pm$  S.E readings are calculated for every one hour recording continuously for 7 days for 10 Female experimental group - I.

TABLE - XVI

COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL  
GROUP OF FEMALE - INDUSTRY WORKERS - NIGHT SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	't' <sub>0</sub> VALUE	P' VALUE (t <sub>0.05</sub> = 1.960 )
1.	98.6 $\pm$ 0.03	-	-	-
2.	98.5 $\pm$ 0.04	1 and 2	1.491	N.S
3.	98.5 $\pm$ 0.04	1 and 3	1.390	N.S
4.	98.5 $\pm$ 0.02	1 and 4	1.466	N.S
5.	98.5 $\pm$ 0.05	1 and 5	1.296	N.S
6.	98.5 $\pm$ 0.02	1 and 6	1.373	N.S
7.	98.5 $\pm$ 0.03	1 and 7	1.214	N.S

Twenty Four Observation Each :

N.S - Not Significant

Mean  $\pm$  S.E. readings are calculated for every one hour recording continuously for 7 days for 10 female experimental group - I.

TABLE - XVII

## COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL GROUP OF MALE - HOSPITAL - DAY SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	't' <sub>0</sub> VALUE	P' VALUE (t <sub>0.05</sub> = 1.960)
1.	98.6 $\pm$ 0.06	-	-	-
2.	98.5 $\pm$ 0.05	1 and 2	1.165	N.S
3.	98.6 $\pm$ 0.05	1 and 3	-	-
4.	98.5 $\pm$ 0.04	1 and 4	1.254	N.S
5.	98.5 $\pm$ 0.04	1 and 5	1.193	N.S
6.	98.5 $\pm$ 0.03	1 and 6	1.316	N.S
7.	98.5 $\pm$ 0.04	1 and 7	1.258	N.S

Twenty Four Observations Each:

N.S - Not Significant

Mean  $\pm$  S.E are calculated for the body temperature readings observed for every one hour continuously for 10 male experimental group - II

TABLE - XVIII

COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL GROUP OF MALE - HOSPITAL WORKERS - NIGHT SHIFT

DAYS	MEAN $\pm$ S.E.(°F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	't <sub>0</sub> ' VALUE	P' VALUE (t <sub>0.05</sub> = 1.960)
1.	98.6 $\pm$ 0.05	-	-	-
2.	98.5 $\pm$ 0.05	1 and 2	1.277	N.S
3.	98.5 $\pm$ 0.05	1 and 3	1.296	N.S
4.	98.5 $\pm$ 0.05	1 and 4	1.189	N.S
5.	98.5 $\pm$ 0.05	1 and 5	-	-
6.	98.5 $\pm$ 0.06	1 and 6	1.150	N.S
7.	98.5 $\pm$ 0.05	1 and 7	1.401	N.S

Twenty Four Observations Each :

N.S - Not Significant

Mean  $\pm$  S.E are calculated for the body temperature readings observed for every one hour continuously for 7 days for 10 male experimental group - II

TABLE -XIX

COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL  
GROUP OF FEMALE - HOSPITAL WORKERS - DAY SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	't' <sub>o</sub> VALUE	P' VALUE ( $t_{0.05} = 1.960$ ) =
1.	98.6 $\pm$ 0.09	-	-	-
2.	98.6 $\pm$ 0.08	1 and 2	-	-
3.	98.6 $\pm$ 0.09	1 and 3	0.737	N.S
4.	98.6 $\pm$ 0.09	1 and 4	-	-
5.	98.5 $\pm$ 0.09	1 and 5	0.722	N.S
6.	98.6 $\pm$ 0.1	1 and 6	-	-
7.	98.5 $\pm$ 0.1	1 and 7	0.760	N.S

Twenty Four Observations Each:

N.S - Not Significant

Mean  $\pm$  S.E readings are calculated for every one hour recording continuously for 7 days for 10 female experimental group - II.

TABLE - XX

COMPARISON OF EVERYDAY BODY TEMPERATURE READINGS OF THE EXPERIMENTAL  
GROUP OF FEMALE - HOSPITAL WORKERS - NIGHT SHIFT

DAYS	MEAN $\pm$ S.E ( $^{\circ}$ F)	COMPARISON BETWEEN SUBSEQUENT DAYS AND FIRST DAY	't' <sub>0</sub> VALUE	P' VALUE (t <sub>0.05</sub> = 1.960)
1.	98.6 $\pm$ 0.06	-	-	-
2.	98.5 $\pm$ 0.06	1 and 2	1.003	N.S
3.	98.5 $\pm$ 0.08	1 and 3	0.899	N.S
4.	98.5 $\pm$ 0.08	1 and 4	0.894	N.S
5.	98.5 $\pm$ 0.07	1 and 5	1.015	N.S
6.	98.5 $\pm$ 0.07	1 and 6	0.980	N.S
7.	98.5 $\pm$ 0.06	1 and 7	1.116	N.S

Twenty Four Observations Each

N.S - Not Significant

Mean  $\pm$  S.E readings are calculated for every one hour recording continuously for 7 days for 10 female experimental group - II.

TABLE - XXI

COMPARISON OF THE OVERALL BODY TEMPERATURE OF  
CONTROL AND EXPERIMENTAL GROUP

S.No	WORK SCHEDULE	MEAN $\pm$ S.E( $\pm$ F)	't' <sub>0</sub> VALUE	P' VALUE (t <sub>0.05</sub> = 1.960)
I	CONTROL MALE	98.4 $\pm$ 0.02	-	-
A.	<u>INDUSTRY</u>			
(1)	DAY SHIFT MALE	98.6 $\pm$ 0.02	5.293	* 1.960
(2)	NIGHT SHIFT MALE	98.5 $\pm$ 0.05	1.527	N.S
B.	<u>HOSPITAL</u>			
(1)	DAY SHIFT MALE	98.5 $\pm$ 0.02	3.243	* 1.960
(2)	NIGHT SHIFT MALE	98.4 $\pm$ 0.05	0.501	N.S
II	CONTROL FEMALE	98.4 $\pm$ 0.01	-	-
A.	<u>INDUSTRY</u>			
(1)	DAY SHIFT FEMALE	98.5 $\pm$ 0.07	1.247	N.S
(2)	NIGHT SHIFT FEMALE	98.4 $\pm$ 0.02	1.621	N.S
B.	<u>HOSPITAL</u>			
(1)	DAY SHIFT FEMALE	98.6 $\pm$ 0.02	6.485	* 1.960
(2)	NIGHT SHIFT FEMALE	98.5 $\pm$ 0.03	2.462	* 1.960

\* - Significant at 5 % level, N.S - Not Significant

TABULATION OF BIOCHEMICAL TESTS - OVERALL AVERAGE

Sl No.	Work Schedule	Blood pressure (mm Hg)	Blood Suger Random (mgs%)	Blood Cholesterol (mgs%)	Haemoglobin (gms%)	Total Protein (gms%)	Albumin (gms%)	Globulin (gms%)	Liver Function Test			Urine Urea (mgs%)	Urine creatinine (mgs%)	
									Bilirubin (mgs%)	SGOT I.U/Lt.	SGPT I.U/Lt.			Serum Alkaline Phosphatase (K.A/100 ml)
I	CONTROL MALE	120=80	140	190	10	6.6	5.0	1.6	0.7	8.0	9.0	4.1	1,500	120
A	<u>INDUSTRY</u>													
1.	DAY SHIFT MALE	110=70	136	205	11	6.0	3.3	2.7	0.8	7.0	15.0	6.0	1,300	110
2.	NIGHT SHIFT MALE	110=70	136	205	11	6.0	3.3	2.7	0.8	7.0	15.0	6.0	1,300	110
B.	<u>HOSPITAL</u>													
1.	DAY SHIFT MALE	115=85	120	200	12	5.6	4.0	1.6	0.4	15.0	12.0	8.0	1,200	100
2.	NIGHT SHIFT MALE	115=85	120	200	12	5.6	4.0	1.6	0.4	15.0	12.0	8.0	1,200	100
II.	CONTROL FEMALE	125=75	118	180	9.8	6.5	4.2	2.3	0.4	12.0	11.0	9.2	1,350	115
A.	<u>INDUSTRY</u>													
1.	DAY SHIFT FEMALE	105=80	130	175	10	6.6	5.0	1.6	0.7	8.0	9.0	4.0	1,400	125
2.	NIGHT SHIFT FEMALE	105=80	130	175	10	6.6	5.0	1.6	0.7	8.0	9.0	4.0	1,400	125
B.	<u>HOSPITAL</u>													
1.	DAY SHIFT FEMALE	130=70	125	170	13	7.6	4.6	3.0	0.2	10	8.0	9.0	1,100	100
2.	NIGHT SHIFT FEMALE	130=70	125	170	13	7.6	4.6	3.0	0.2	10	8.0	9.0	1,100	100

PATTEFN OF THE BODY TEMPERATURE RHYTHM IN THE CONTROL GROUP AND EXPERIMENTAL GROUP OF MALE SHIFT WORKERS - INDUSTRY

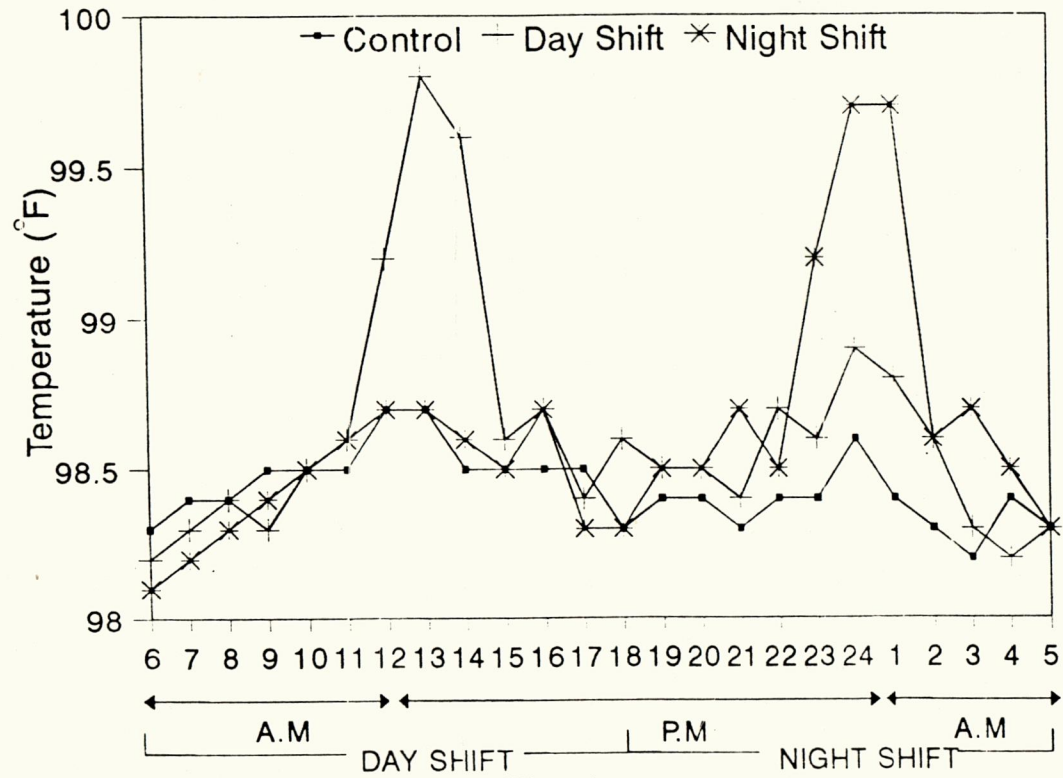


Fig-1

PATTERN OF THE BODY TEMPERATURE RHYTHM IN THE CONTROL GROUP AND EXPERIMENTAL GROUP OF FEMALE SHIFT WORKERS - INDUSTRY

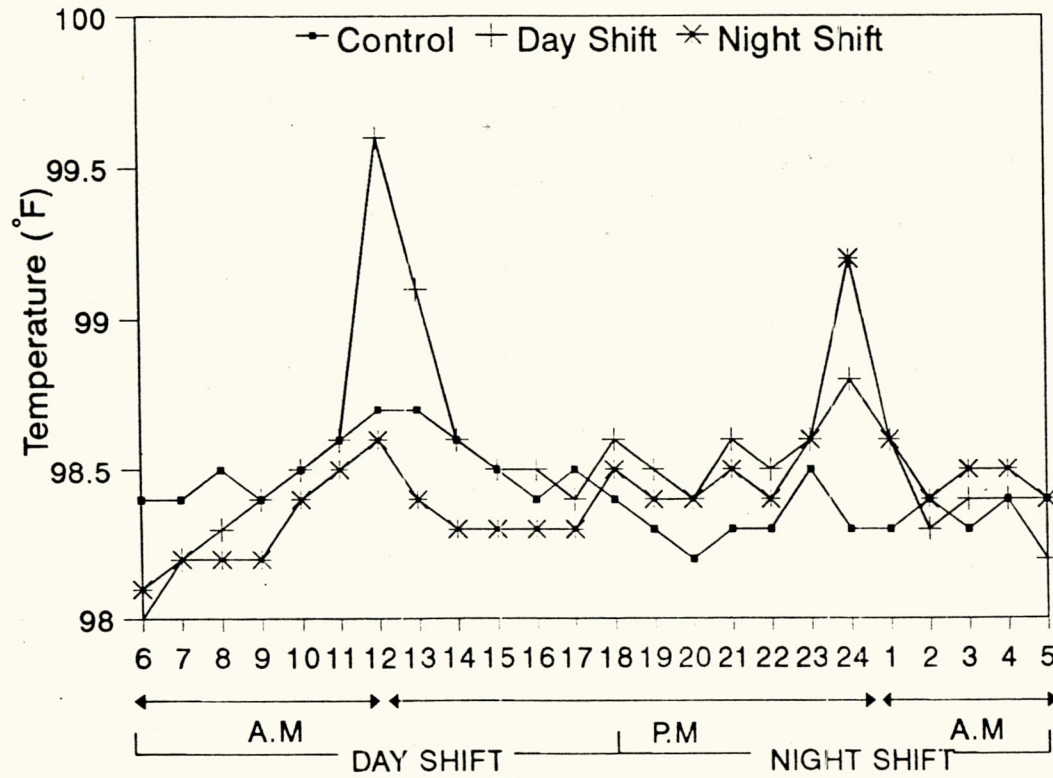


Fig-2

COMPARISON OF THE BODY TEMPERATURE RHYTHM OF  
MALE AND FEMALE DAY SHIFT WORKERS - INDUSTRY

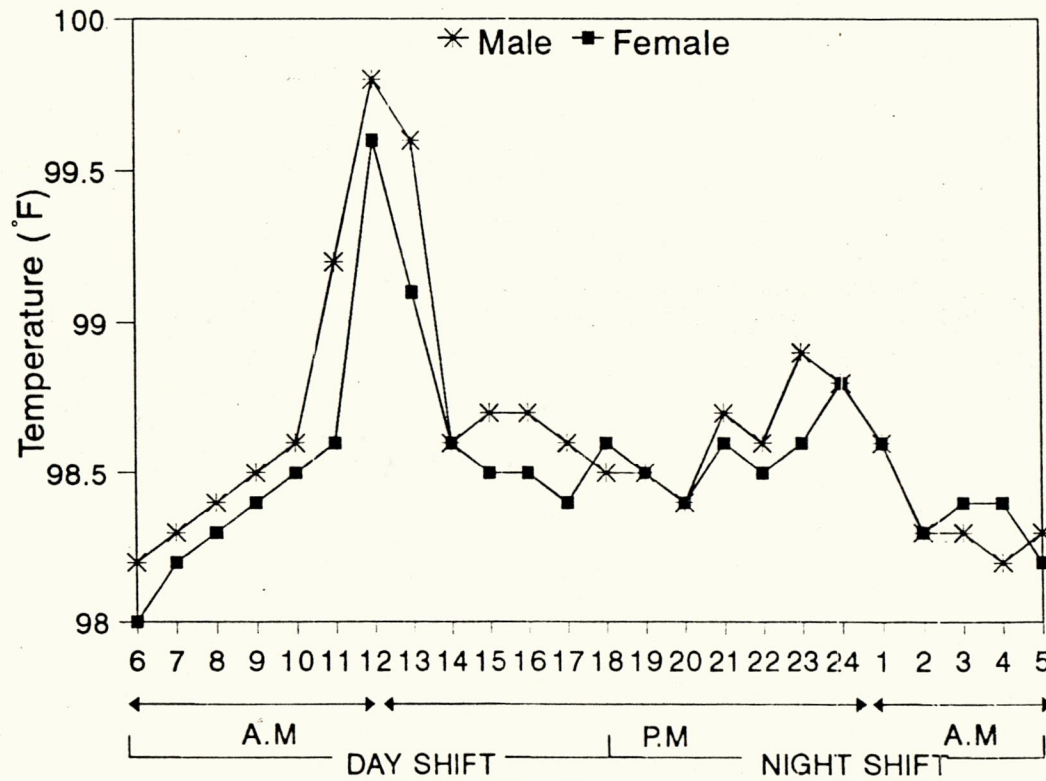


Fig-3

### COMPARISON OF THE BODY TEMPERATURE RHYTHM OF MALE AND FEMALE NIGHT SHIFT WORKERS - INDUSTRY

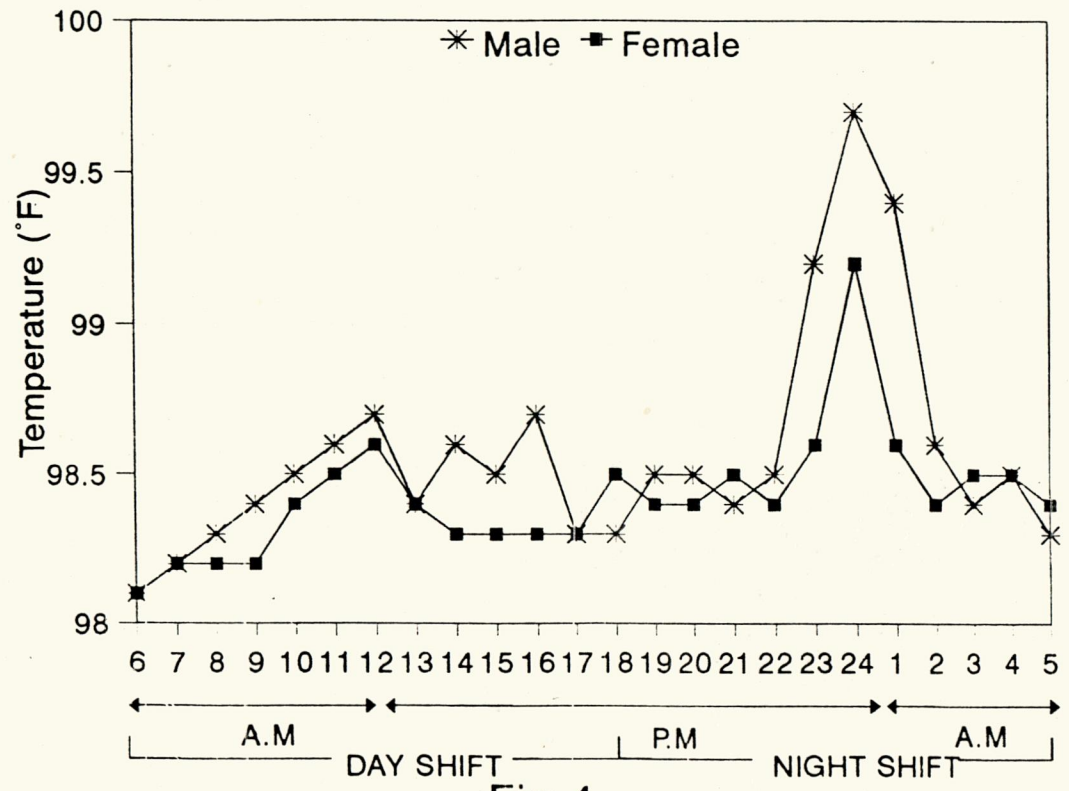


Fig-4

### COMPARISON OF THE BODY TEMPERATURE RHYTHM OF MALE AND FEMALE NIGHT SHIFT WORKERS - INDUSTRY

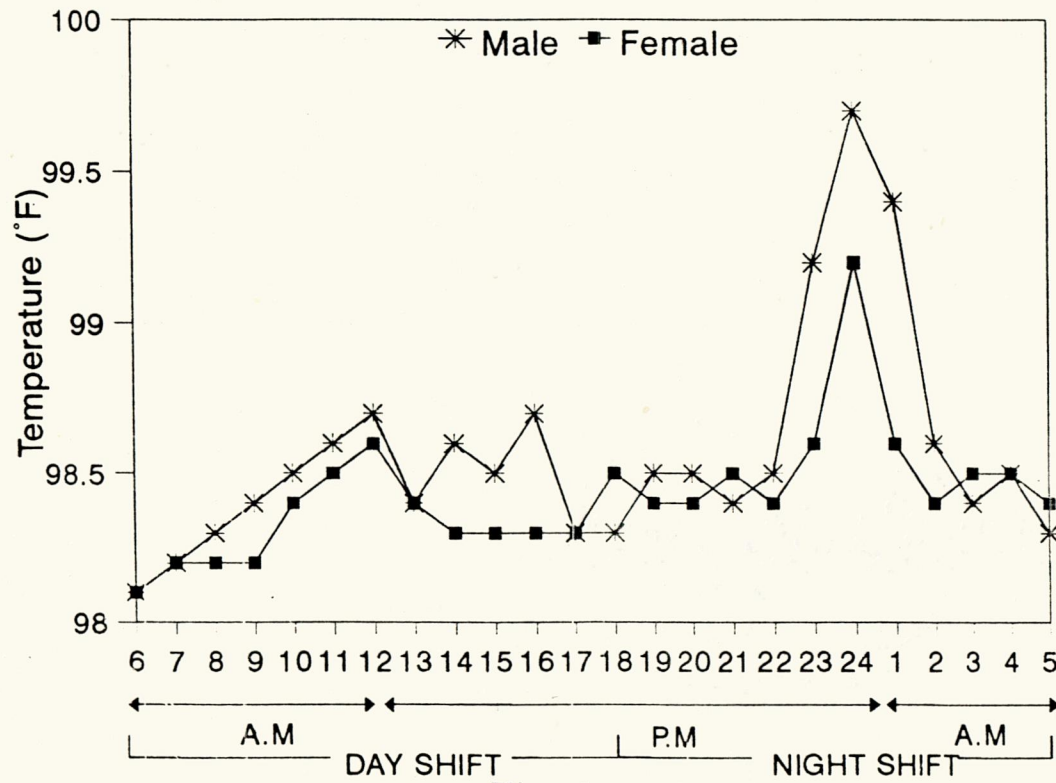


Fig-4

**Fig - 6 PATTERN OF THE BODY TEMPERATURE RHYTHM IN THE CONTROL GROUP AND EXPERIMENTAL GROUP OF MALE SHIFT WORKERS (Day and Night) - HOSPITAL**

Figure shows the pattern of body temperature rhythm in male shift workers (day & night) of an Hospital. Note that the overall amplitude of body temperature rhythm which is significantly higher in day and night shift male workers of an hospital. When compared to that of the control group of male. observe that the maxima of body temperature is  $99.4 \pm 0.05^{\circ}\text{F}$  at 12.00 hours in day shift male and  $99.2 \pm 0.08^{\circ}\text{F}$  at 01.00 hours in night shift male. Whereas the minima of body temperature is  $98.2 \pm 0.08^{\circ}\text{F}$  at 06.00 hours in day shift male and  $98.4 \pm 0.06^{\circ}\text{F}$  at 19.00 hours in night shift male. This shows that the maxima of body temperature (i.e.  $99.4^{\circ}\text{F}$ ) is more in day shift male and minima of body temperature (i.e.  $98.4^{\circ}\text{F}$ ) is more in night shift male.

BODY TEMPERATURE PATTERN OF MALE AND FEMALE-  
 DAYWISE AVERAGE - INDUSTRY

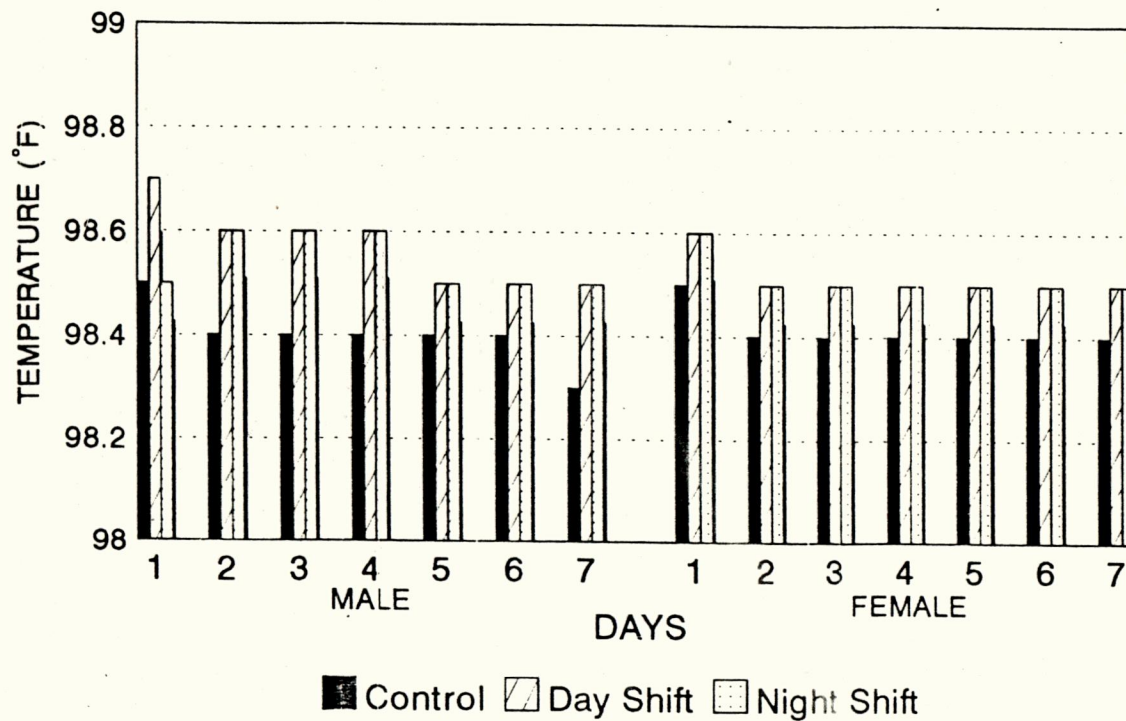


FIG- 5

**Fig - 5    BODY TEMPERATURE PATTERN OF MALE AND FEMALE  
DAYWISE AVERAGE - INDUSTRY**

Figure shows everyday average (24 hour average) of the body temperature of the male and female Day shift and Night shift workers of an industry compared with that of the control. Every one hour readings, recorded continuously for 24 hours, were pooled and computed for each day and expressed as average it could be noticed that in both day and night shift male female workers, everyday average of Body temperature is distinctly higher than that of the respective control group.

**Fig - 9 COMPARISON OF THE BODY TEMPERATURE RHYTHM OF MALE AND FEMALE NIGHT SHIFT WORKERS - HOSPITAL**

Figure shows the pattern of the body temperature rhythm of male and female night shift workers of an Hospital. Observe the maximum temperature of  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hrs exhibited by female night shift workers which appears to be more when compared to that of male night shift workers. In male night shift workers the maximum temperature is  $99.2 \pm 0.08^{\circ}\text{F}$ . A significant difference of  $0.05^{\circ}\text{F}$  of Body Temperature is exhibited between female and Male night shift workers.

COMPARISON OF THE BODY TEMPERATURE RHYTHM OF MALE AND FEMALE DAY SHIFT WORKERS - HOSPITAL

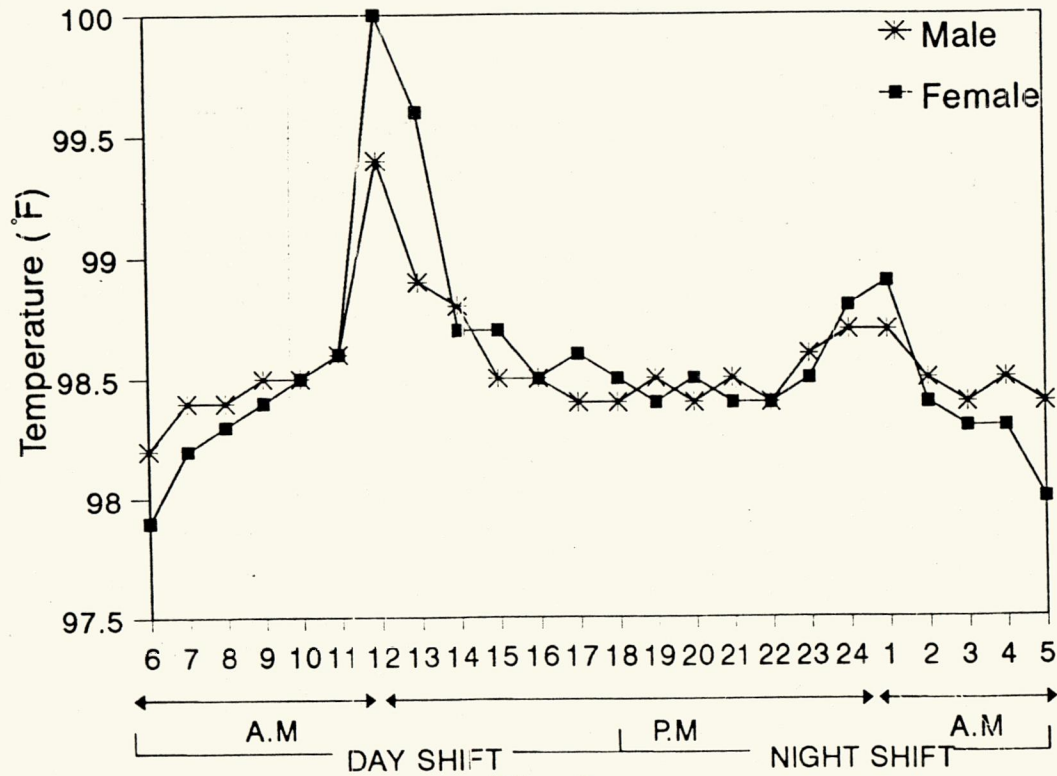


Fig-8

**Fig- 8 COMPARISON OF THE BODY TEMPERATURE RHYTHM OF MALE AND FEMALE DAY SHIFT WORKERS - HOSPITAL**

Figure shows the pattern of the body temperature rhythm of male and female day shift workers of an hospital. Observe the peak temperature in female day shift workers which is  $100.0 \pm 0.06^{\circ}\text{F}$  at 12.00 hours. This is more when compared to that of the male day shift workers where the peak temperature is  $99.4 \pm 0.05^{\circ}\text{F}$  at 12.00 hours. This brings a difference of body temperature of  $0.06^{\circ}\text{F}$  between female and male day shift workers of an hospital.

PATTERN OF THE BODY TEMPERATURE RHYTHM IN THE CONTROL GROUP AND EXPERIMENTAL GROUP OF FEMALE SHIFT WORKERS (DAY AND NIGHT)- HOSPITAL

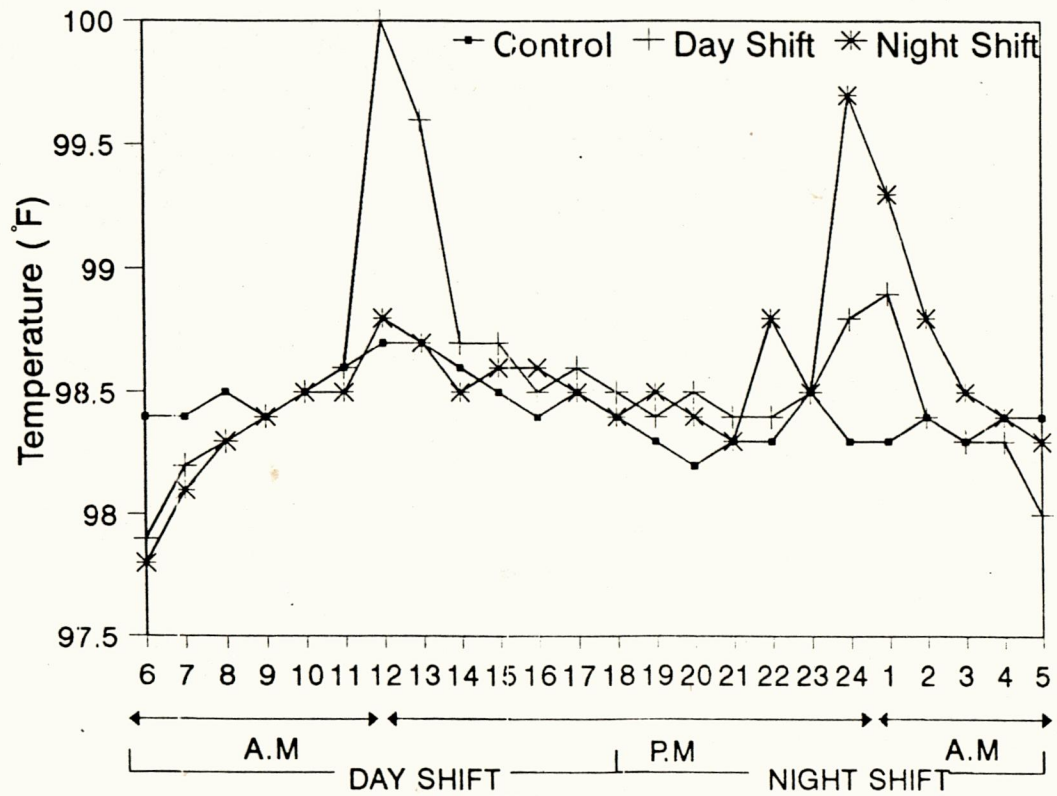


Fig-7

**Fig - 7 PATTERN OF THE BODY TEMPERATURE RHYTHM IN THE CONTROL GROUP AND EXPERIMENTAL GROUP OF FEMALE SHIFT WORKERS (Day and Night) - HOSPITAL**

Figure shows the body temperature rhythm of day and night shift female workers of an hospital and control group. Note the higher elevation of body temperature in Day and night shift workers which is significantly more when compared to that of the control. This shows the peak body temperature of  $100.0 \pm 0.06^{\circ}\text{F}$  in day shift female workers at 12.00 hrs which is more when compared to that of the peak body temperature of night shift female workers which is  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hrs.

PATTERN OF THE BODY TEMPERATURE RHYTHM IN THE CONTROL GROUP AND EXPERIMENTAL GROUP OF MALE SHIFT WORKERS (DAY AND NIGHT)- HOSPITAL

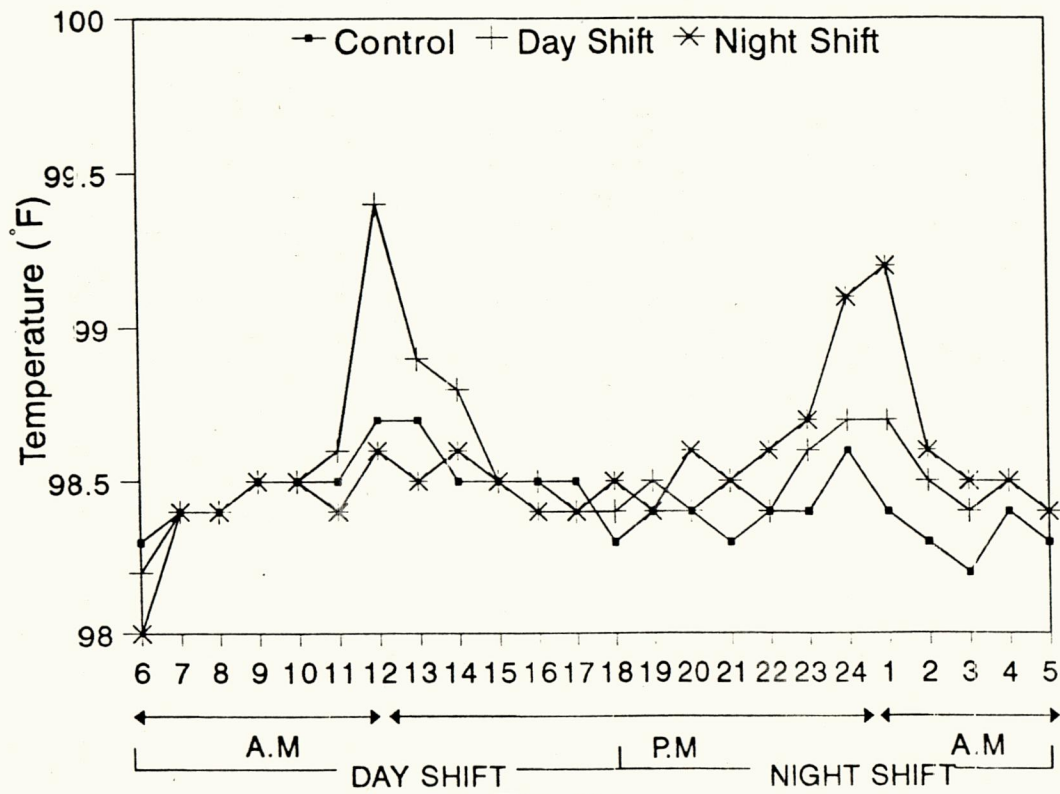


Fig-6

COMPARISON OF THE BODY TEMPERATURE RHYTHM OF MALE AND FEMALE NIGHT SHIFT WORKERS - HOSPITAL

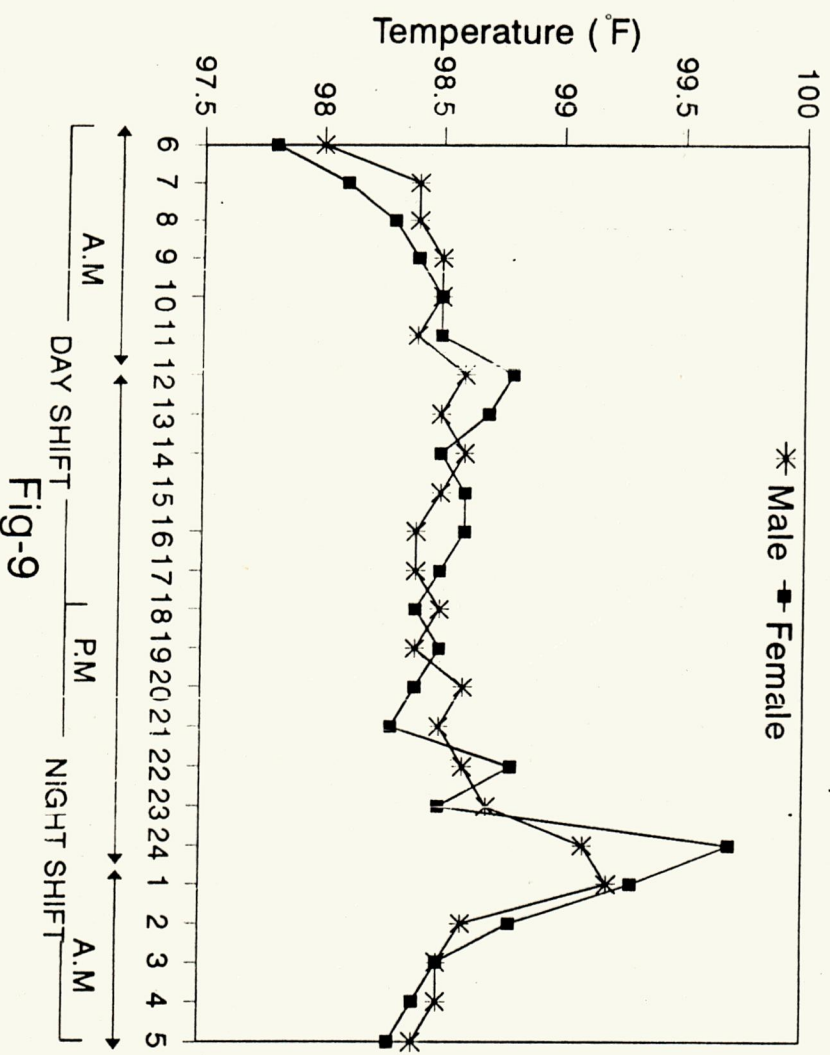


Fig-9

**Fig - 10 BODY TEMPERATURE PATTERN OF MALE AND FEMALE DAYWISE  
AVERAGE - HOSPITAL**

Figure shows everyday average (24-hour average) of the body temperature of the male and female day shift & night shift workers of an Hospital compared with that of the control. Every one hour readings, recorded continuously for 24 hours, were pooled and computed for each day and expressed as average. It could be noticed that in both day and night shift male and female workers, the everyday average of Body temperature is distinctly higher than that of the respective control group.

BODY TEMPERATURE PATTERN OF MALE AND FEMALE-  
DAYWISE AVERAGE - HOSPITAL

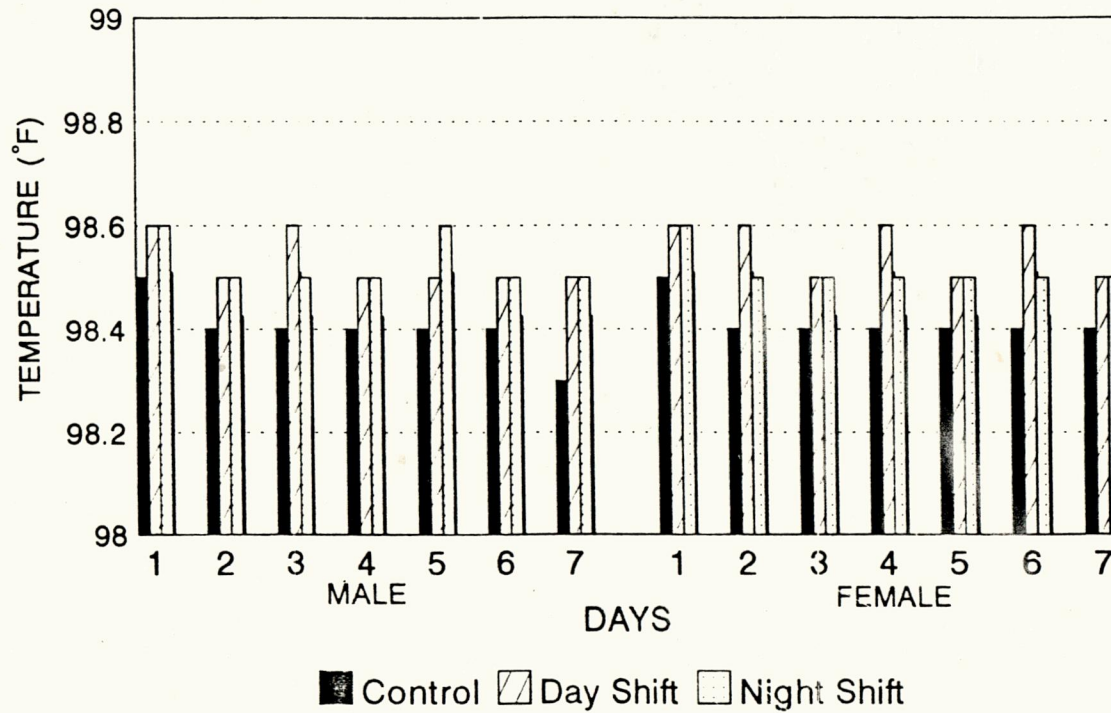


FIG- 10

Fig - 11 Comparison of daywise average of the body temperature pattern of male and female shift workers of an Industry and Hospital

Figure shows the comparison of daywise average of body temperature of male and female day shift and night shift workers of an Industry & Hospital

It could be noticed that the variation in everyday average of body temperature between the male shift workers and female shift workers of an industry and hospital is not significant.

The 24 hour average of the body temperature of each day of male & female dayshift workers & night shift workers of an industry is significant with that of the control - (Vide Fig - 5) similarly the 24 hour average of the body temperature of each day of male and female shift workers of an hospital is also significant when compared to that of the control - (Vide Fig - 10)

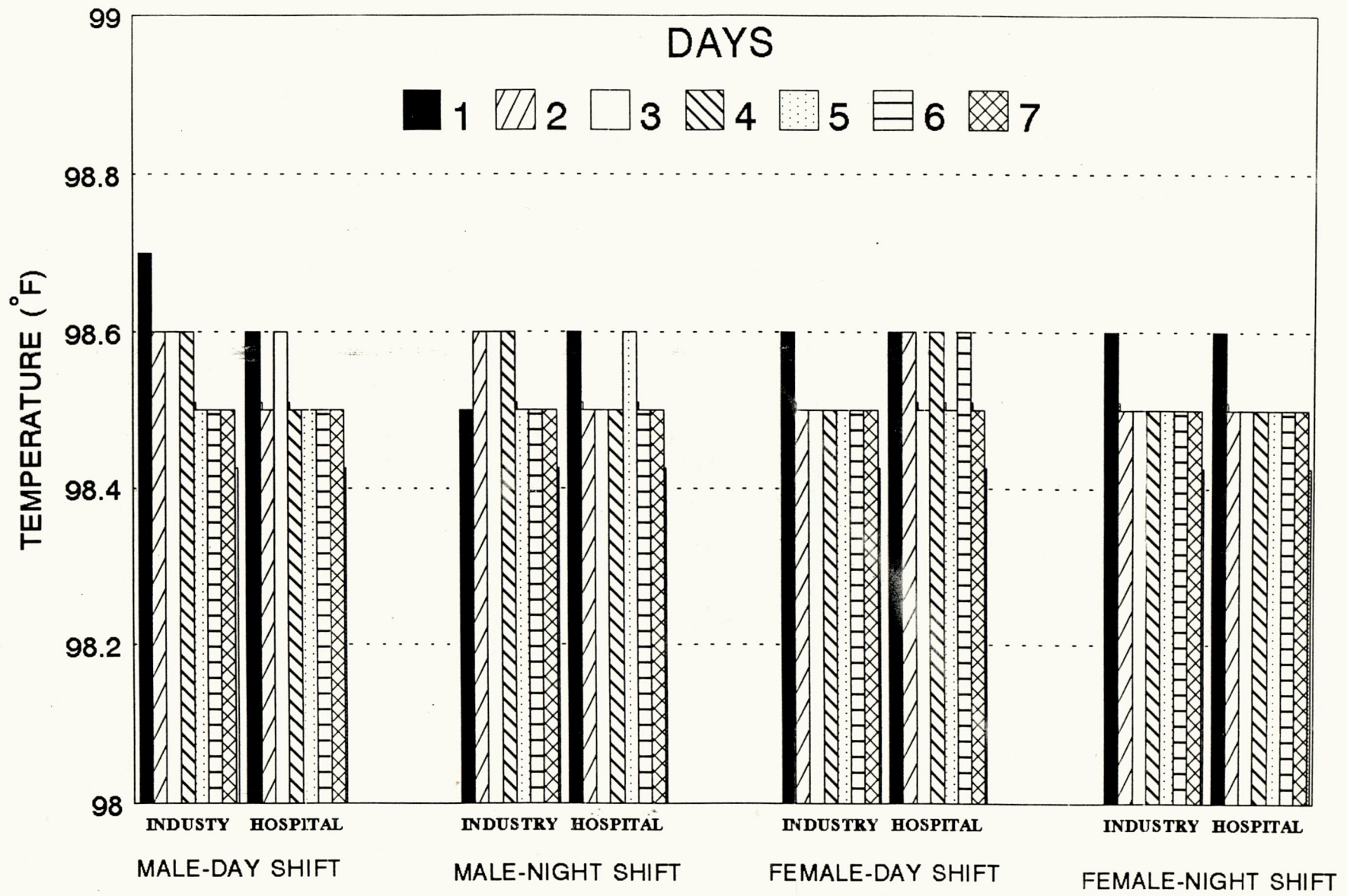


FIG- 11

control group ( $98.4 \pm 0.01^{\circ}\text{F}$ ) as well as with that of an industry. ( $98.4 \pm 0.02^{\circ}\text{F}$ )

#### **Industry:**

The overall average of Body temperature of ( $98.6 \pm 0.02^{\circ}\text{F}$ ) male day shift and night shift ( $98.5 \pm 0.05^{\circ}\text{F}$ ) workers are significantly more when compared to that of the female day shift ( $98.5 \pm 0.07^{\circ}\text{F}$ ), whereas the comparison of the overall average of Body temperature of male and female day shift and night shift workers shows a significant increase in day shift.

#### **Hospital:**

The overall average of Body temperature of female day shift workers  $98.6 \pm 0.02^{\circ}\text{F}$  and night shift workers ( $98.5 \pm 0.03^{\circ}\text{F}$ ) are significantly higher when compared to the overall average of the body temperature of male day shift workers ( $98.5 \pm 0.02^{\circ}\text{F}$ ) and night shift workers ( $98.4 \pm 0.05^{\circ}\text{F}$ ).

Amongst the dayshift workers and the night shift workers of female, the overall average of Body temperature of day shift workers ( $98.6 \pm 0.02^{\circ}\text{F}$ ) is significantly more when compared to that of the night shift workers ( $98.5 \pm 0.03^{\circ}\text{F}$ ).

**Fig - 12 Overall average of the Body temperature of Male and Female day and night shift workers**

Figure shows the overall average of body temperature of control and experimental male and female shift workers of an industry and hospital

**Male workers:**

**Day shift:** The overall average of body temperature is  $98.6 \pm 0.02^{\circ}\text{F}$  in male workers of an industry which is significantly more when compared to that of the control ( $98.4 \pm 0.04^{\circ}\text{F}$ ) as well as with that of the male workers of an hospital ( $98.5 \pm 0.02^{\circ}\text{F}$ ).

**Night shift:** The overall average of the body temperature in male night shift workers of industry is significantly more (i.e,  $98.5 \pm 0.05^{\circ}\text{F}$ ) when compared to that of the control as well as with that of the male night shift workers of an hospital (i.e.  $98.4 \pm 0.05^{\circ}\text{F}$ ).

**Female workers:**

**Day shift:** In female day shift workers of an hospital the overall average of body temperature is  $98.6 \pm 0.02^{\circ}\text{F}$  which is significantly more when compared to that of the control ( $98.4 \pm 0.01^{\circ}\text{F}$ ) as well as with that of the industry. ( $98.5 \pm 0.07^{\circ}\text{F}$ )

**Night shift:** In female night shift workers of an hospital the overall average of body temperature is  $98.5 \pm 0.03^{\circ}\text{F}$  which is significantly higher when compared to that of the

OVERALL AVERAGE OF THE BODY TEMPERATURE OF MALE AND FEMALE - DAY AND NIGHT SHIFT WORKERS

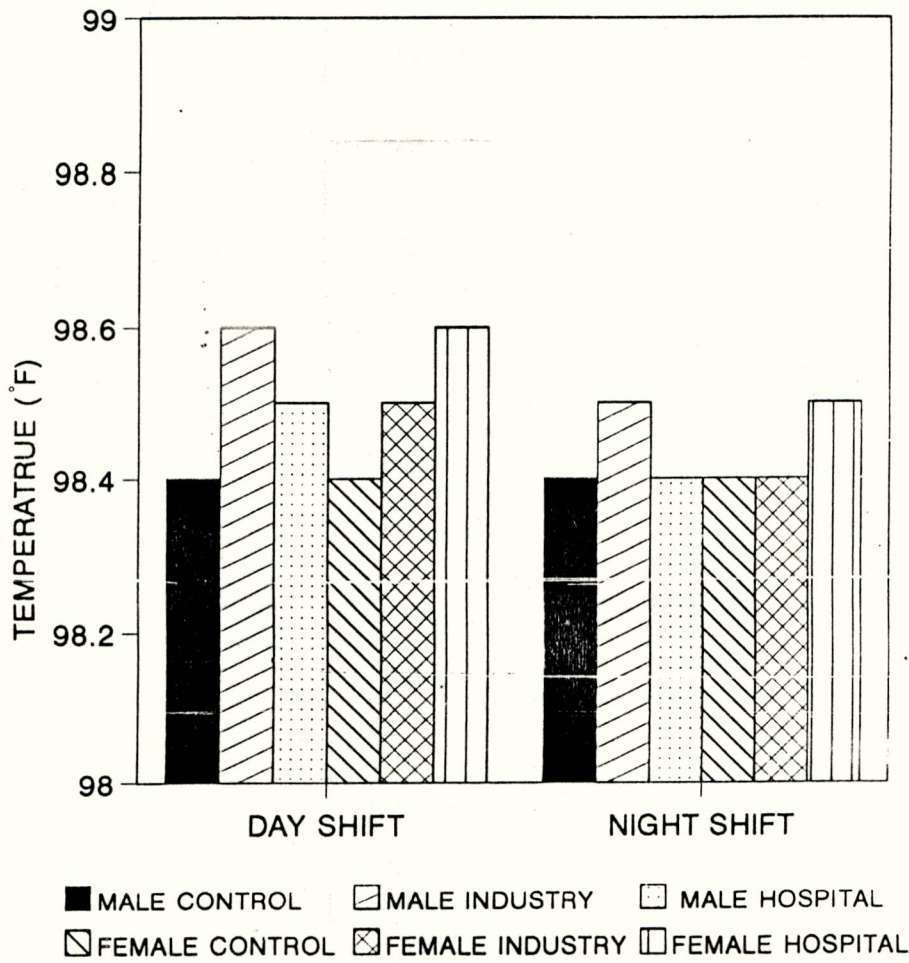


Fig-12

## Discussion

## V. DISCUSSION

The results of the study indicate that it is inevitable to evolve novel work schedules in the different sectors of human activity involving man-power and human resources, physical and mental. The modifications of work distribution, Of duration of working hours, of the nature of work assigned in recent years, have been based on studies like the present one in which man's exposure to his environment and his physiological reactions and bodily changes especially, body temperature, are used as guidelines. Further, such results highlight the need for improvement of industrial hygiene, hospital working conditions, technical efficiency etc.

The differential susceptibility of individual human organisms to the influence of environmental stressors and demands evidenced by changes in the body temperature rhythm are useful norms in offering suggestions towards understanding that the rhythmic functions of the body are regulated also by factors outside the body. Biological clocks, for instance are normally synchronoized with external as well as internal metabolic functions (i.e. to both endogenous and exogenous factors). Such factors, among workers of both sexes, like period of duty, shift timing, man's diurnal nature, quantity

and quality of workdone, working atmosphere, adaptation ability influence the organic body rhythm and produce fluctuations in the normal body temperature rhythm.

The study of fluctuations during a 24 hour period in the body temperature of shift-workers (male and female) in industrial workplace and hospitals, carried out with factual experimentation with control and experimental sets of subjects yielded results similar to Bunker Experiments. Many physiological and psychological functions vary rhythmically under constant conditions-so called free-running rhythms. For example, time activity and temperature rhythms in man under free-running conditions shows variations in body temperature readings. There are differences in maxima and minima body temperature readings between male and male, male and female and between night and day-shift workers.

The differences recorded in the maxima (peak body temperature), between day shift male and night shift male industrial workers could then, in the light of inferences, be attributed to environment as well the endogenous factor. I.e. man's diurnal nature besides environmental influence. In the case of female workers, the maxima difference between day and night shift workers is significant. This could be due to sex characteristics, such as hormonal influence-an endogenous cause.

The difference in the body temperature rhythm among exclusively male day shift industrial workers and exclusively night shift workers (in male a recordable elevation) could be traced to factors like nature of work done by the male workers (harder manual labour demanding physical exhaustion). Therefore, it is proved that physical exhaustion generates more bodily heat and elevates body temperature. Therefore exogenous causes do influence the human biological clock.

Among hospital male employees too, the noticeable difference in body temperature rhythm between that of the day shift workers and that of the night shift workers (higher in the day shift male worker) is presumably due to the diurnal nature of the human organism in the case of female hospital workers (Nurses, Maid-servants) such a comparison in Body temperature reading is a significant difference that may be related to the pattern of work done by them (tension suffered), apart from their diurnal nature and hormonal functioning. The nurse's job, for instance, involves lot of physical movement, raising the body temperature. Therefore tension movement, raising the body temperature. Therefore tension proves to be an endogenous factor in affecting human body temperature rhythm besides the diurnal nature and hormonal functioning. Similar casuses could be

held responsible to justify the peak temperature in the female day shift hospital worker. The higher reading in body temperature rhythm in the case of the female night-shift hospital worker could again be due to the work executed, the tension-filled environmental influence and sleeplessness.

A comparative analysis of the recorded daywise average of body temperature pattern of the control and the experimental groups among industrial and hospital workers shows that despite different fluctuations in reading, the rise is uniform in the experimental groups in both sexes whether hospital employees or industrial employees.

The comparative analysis of the overall average of body temperature pattern of control and experimental male and female industrial and hospital workers during either shifts (day and night) exhibits a higher reading in the experimental group of male and female. This perhaps is due to the conditioning of the work atmosphere in the experimental environment created for the subjects.

The female hospital day-shift workers exhibit a higher body temperature compared to their industrial counterparts, irrespective of shift timings. And this

disparity in body temperature maybe consquently due to the nature of work done by them more or less of physical involvement and more or less of mental involvement.

## **Summary and Conclusion**

## VI. SUMMARY AND CONCLUSION

### SUMMARY

The Summary of this work on the comparison of the body temperature rhythm in male and Female shift workers of an Industry & hospital are as follows.

#### VI. (A). BODY TEMPERATURE RHYTHM IN DAY SHIFT WORKERS OF AN INDUSTRY

##### (1). MALE

There is a rhythmic pattern of Body temperature found to occur both in the male control as well as in the Experimental group. In control there is a peak of Body temperature of  $98.7 \pm 0.03^{\circ}\text{F}$  at 12.00 hours where as in experimental male the peak body temperature of  $99.8 \pm 0.1^{\circ}\text{F}$  occurs at 13.00 hours (Table I,II&Fig.1). The difference in the peak Body temperature between control and Experimental male workers is significantly higher.

##### (2). FEMALE

The Body temperature occurs in a rhythmic manner both in the Female control and Experimental group. The

control Female exhibit a peak body temperature of  $98.7 \pm 0.04^{\circ}\text{F}$  at 12.00 hours. Whereas the experimental Female workers shows a peak body temperature of  $99.6 \pm 0.1^{\circ}\text{F}$  at 12.00 hours. Which is significantly higher than that of the control. (Table - IV, V & Fig.2)

### **(3). COMPARISON BETWEEN MALE AND FEMALE DAY SHIFT WORKERS OF AN INDUSTRY**

Comparison of the body temperature rhythm in male and Female day shift workers of an industry reveals that in male day shift workers, the body temperature, ( $99.8 \pm 0.1^{\circ}\text{F}$ ) is significantly higher when compared to that of the Female shift workers. (Table - II, V & Fig.3).

### **(4). 24 HOUR AVERAGE (DAYWISE) OF BODY TEMPERATURE OF MALE AND FEMALE SHIFT WORKERS**

Everyday average (24 hour average) of the body temperature of the male and female day shift workers of an industry were compared with that of the control. It could be noticed that, everyday average of Body temperature of male and female dayshift workers is distinctly higher than that of the control. (Table-XI,XII,XIV,XV,&FIG.5).

#### (5). OVERALL AVERAGE OF BODY TEMPERATURE

In Industrial workers, the overall average of Body temperature ( $98.6 \pm 0.02^{\circ}\text{F}$ ) of male day shift workers is significantly more when compared to that of the female day shift workers ( $98.5 \pm 0.07^{\circ}\text{F}$ ). (Table XXI & Fig.12)

#### VI. (B). BODY TEMPERATURE RHYTHM IN DAY SHIFT WORKERS OF AN HOSPITAL

##### (6). MALE

There is a rhythmic pattern of Body temperature found to occur both in the male control as well as in the Experimental group. The control male represent a peak body temperature of  $98.7 \pm 0.03^{\circ}\text{F}$  show a peak body temperature of  $99.4 \pm 0.05^{\circ}\text{F}$  at 12.00 hours.(Table I, VII & Fig.6) it is observed that, the peak body temperature of experimental group is significantly higher than that of the control group.

##### (7). FEMALE

The body temperature occurs in a rhythmic fashion in Female group both in the control and Experimental group. The control Female shows a peak body temperature of  $98.7 \pm 0.04^{\circ}\text{F}$  at 12.00 hours, But the experimental Female workers

shows a peak body temperature of  $100 \pm 0.06^{\circ}\text{F}$  at 12.00 hours. This peak temperature is significantly more when compared to that of the control. (Table - IV, IX & Fig.7)

**(8). COMPARISON BETWEEN MALE&FEMALE DAY SHIFT WORKERS OF AN HOSPITAL**

The peak body temperature in Female day shift workers is  $100.0 \pm 0.06^{\circ}\text{F}$  at 12.00 hours. This is more when compared to that of the male day shift workers where the peak body temperature is  $99.4 \pm 0.5^{\circ}\text{F}$  at 12.00 hours. This brings a difference of body temperature of  $0.6^{\circ}\text{F}$  between Female and male day shift workers of an hospital. Thus it proves that the Female day shift workers of an hospital shows a higher elevation of body temperature than that of the male day shift workers. (Table - VII, IX & Fig.8)

**(9). 24 HOUR AVERAGE (DAYWISE) OF BODY TEMPERATURE OF MALE AND FEMALE SHIFT WORKERS**

Everyday average (24-hour average) of the body temperature of the male and Female day shift and night shift workers of an hospital was compared with that of the control. It could be observed that in both day and night shift male and Female workers, the everyday average of body temperature

is distinctly higher than that of the respective control group. From this it is clear that there is significant increase in the body temperature of experimental group, compared to that of the control group. (Table - XI, XIV, XVII, XVIII, XIX, XX & Fig.10)

#### (10) OVERALL AVERAGE OF BODY TEMPERATURE

In hospital workers, the overall average of Body temperature of Female day shift workers ( $98.6 \pm 0.02^{\circ}\text{F}$ ) is significantly more when compared to that of the overall average of the body temperature of male day shift workers ( $98.5 \pm 0.02^{\circ}\text{F}$ )

#### VI (C) BODY TEMPERATURE RHYTHM IN NIGHT SHIFT WORKERS OF AN INDUSTRY

##### (11). MALE

The Body temperature occur in a rhythmic manner both in control and experimental group of male workers. The control male exhibit a peak body temperature of  $98.7 \pm 0.03^{\circ}\text{F}$  at 12.00 hours, whereas the experimental male shows a peak body temperature of  $99.7 \pm 0.1^{\circ}\text{F}$  at 24.00 hours. The difference in the peak body temperature (i.e.  $1^{\circ}\text{F}$ ) between control male and Experimental male is significantly more (Table I, III & Fig.1).

**(12). FEMALE**

The body temperature shows a rhythmic pattern in Female group both in the control and Experimental group. The control Female exhibit a peak body temperature of  $98.7 \pm 0.04^{\circ}\text{F}$  at 12.00 hours, whereas the experimental group of Female workers shows a peak body temperature of  $99.2 \pm 0.09^{\circ}\text{F}$  at 12.00 hours which is significantly more when compared to that of the control. (Table - IV, VI & Fig.2)

**(13) COMPARISON BETWEEN MALE AND FEMALE NIGHT SHIFT WORKERS OF AN INDUSTRY**

Comparison of the body temperature rhythm of male and female night shift workers of an industry shows a higher elevation of the body temperature of  $99.7 \pm 0.1^{\circ}\text{F}$  at 24.00 hours which is the peak body temperature in male night shift workers than that of the Female night shift workers who shows a peak body temperature of only  $99.2 \pm 0.09^{\circ}\text{F}$  at 24.00 hours. Thus there is a higher amplitude of Body temperature in male night shift workers than that of the female night shift workers of an industry. (Table - III, VI & Fig.4)

**14) 24 HOUR AVERAGE (DAYWISE) OF BODY TEMPERATURE OF MALE AND FEMALE SHIFT WORKERS.**

Everyday average (24 hour average) of the body temperature of the male and Female night shift workers of an industry was compared with that of the control. It could

be noticed that in night shift male and Female workers, everyday average of body temperature is distinctly higher than that of the respective control group (Table - XI, XIII, XIV, XVI, & Fig.5)

**(15). OVERALL AVERAGE OF BODY TEMPERATURE:**

In Industrial workers the overall average of the body temperature in male night shift ( $98.5 \pm 0.05^{\circ}\text{F}$ ) workers is significantly more when compared to that of the Female night shift workers ( $98.4 \pm 0.02^{\circ}\text{F}$ ). (Table - XXI, & Fig.12).

**VI. BODY TEMPERATURE RHYTHM IN NIGHT SHIFT WORKERS OF AN HOSPITAL**

**(16) MALE**

The body temperature exhibits a rhythmic pattern both in the control and Experimental group of male workers. The control exhibits a peak body temperature of  $98.7 \pm 0.03^{\circ}\text{F}$  at 12.00 hours; whereas the experimental group of male workers exhibit a peak body temperature  $99.2 \pm 0.08^{\circ}\text{F}$  at 01.00 hours which is significantly more than that of the control (Table - I, VIII, & Fig.6)

**(.17) FEMALE**

The body temperature occurs in a rhythmic pattern in Female group of both control and experimental group. The control Female shows a peak body temperature of  $98.7 \pm 0.04^{\circ}\text{F}$  at 12.00 hours whereas the experimental group of Female workers shows a peak body temperature of  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hours it is obvious that there is higher elevation of body temperature in night shift workers which is significantly more when compared to that of the control. (Table -x & fig.7)

**(18) Comparison between male and Female night shift workers of an Hospital.**

Comparison of the body temperature rhythm in male and Female night shift workers of an hospital reveals the maximum body temperature of  $99.7 \pm 0.05^{\circ}\text{F}$  at 24.00 hours by Female night shift workers which appears to be more when compared to that of male night shift workers ( $99.2 \pm 0.08^{\circ}\text{F}$ ). Thus a significant difference of  $0.5^{\circ}\text{F}$  of Body temperature is exhibited between Female and male night shift workers (Table -VIII, X & Fig. 9).

**(19). 24 HOUR AVERAGE (DAYWISE) OF BODY TEMPERATURE OF MALE AND FEMALE SHIFT WORKERS.**

Everyday average (24 hour average) of the body temperature of the male and Female night shift workers of an hospital compared with that of the control. It could be noticed that in male and Female night shift workers the everyday average of body temperature is distinctly higher than that of the respective control group. (Table - XI, XIV, XVIII, XX & Fig.10)

**(20). OVERALL AVERAGE OF BODY TEMPERATURE**

The overall average of body temperature of Female night shift workers ( $98.5 \pm 0.03^{\circ}\text{F}$ ) are significantly higher when compared to that of the overall average of the body temperature of male night shift workers ( $98.4 \pm 0.05^{\circ}\text{F}$ )

**VI. (E). BIOCHEMICAL TESTS**

The analysis of biochemical test for control, Day shift & Night shift workers of an industry and hospital have not revealed any significant change between the shifts. (Table - XXII)

## CONCLUSION

This experimental study of body temperature rhythm in the human workers of both sexes in hospitals and industries reveals that various external factors like environment, work executed, occupational demands on the human body and mind, besides internal causes like hormonal functioning, biological activities are responsible for fluctuations in the body temperature rhythm, any apparent increase or decrease in body temperature could be the result of anyone or more of these above factors that directly or indirectly affect the physiology of the human organism.

These findings as relevant conclusions implicate that the human resources for (mechanical) industrial efficiency, technical efficiency (as in hospital work) could be better tapped and systematically utilised for the welfare of human communities. It would be worthwhile to bear in mind the revelations of such a study to plan and organise all future sociological activities of mankind in an industrialised scientific society. It would also be contributory to the harmony among the sexes by implementing equity and equality between male and female workers through a fair scheduling and division of work among them.

The results of these experiments show that shifting of working hours cause disruption of normal social routine and produces in workers restlessness, nervousness, headache, gastrointestinal tract irregularities, fatigue and inefficiency, Although a definitive relationship linking phase shifting and disruption of circadian rhythms to increased susceptibility of humans to environmental stressors, this definitely appears to be an area of potential concern for the development of novel work schedule standards.

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