**FACULTY OF ALLIED HEALTH SCIENCES**

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**Topic:** The Role of Chrono-nutrition in Youth

**Subject:** Capstone Project

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**Abstract**

**Introduction:**

Living organisms have an internal 24-hour cycle that controls one’s ability to carry out daily physiological activities1 based upon availability of light and feeding pattern. The pattern of carrying out certain physiological activities at certain times is influenced by an individual’s clock genes, circadian clock system. Certain genes like Clock Bmal1, Per1. Per2, Cry1 and Cry2 are responsible for generating circadian oscillations in mammals2. The oscillations may be endogenous; self-sustainable or entrain-able; adjustable by external cues called zeitgebers.

Chrononutrition is a field that describes the interaction of nutrition and human circadian system. Chrononutrition is synchronisation of our food intake with our sleeping pattern ie, circadian clock system.

The circadian clock system systemizes entire energy homeostasis that is, food intake, fat accumulation and calorie expenditure3. The central clock controls activity rhythms as per the light or dark cycles, by activating the sympathetic nervous system. The activation of sympathetic nervous system leads to an increase in body temperature and blood pressure, enabling the start of activities. The peripheral clock system controls the metabolic rhythms as per the feeding and fasting cycles. Feeding time and pattern influences the phase of peripheral circadian clocks. Disruption of the synchronisation can lead to metabolic disorders, cancer and psychiatric disorders4.

The molecular mechanism of central circadian clock takes place in hypothalamus, in SCN (Suprachiasmatic Nucleus), which, regulates sleep-wake cycle. In 1995, Czeilser, for a review of human studies, stated that light is the fundamental synchronizer of biological clock in SCN. The melanopsin in photosensitive retinal ganglion cells on retina signals the presence or absence of light to optic nerves. The SCN receives input from optic nerves (which follows RHT pathway for entrainment) and gives output in form of hormone secretion through targeted gland.

Peripheral clocks are located usually in tissues, only some in brain5. Peripheral clocks have little affect on the phase of SCN.

The association between circadian clock system and nutrition is generally referred to as “Chrononutrition”5. The field has emerged as a tool to improve health in several ways.

Along with light, there are other zeitgebers for entrainment of clocks like temperature, hormones, nutrients, fasting and feeding state, sleep-wake state, physical activity etc6.

**1.1 Effect of changes in circadian rhythms on metabolic activities:**

The hormone leptin is known to increase the activation of sympathetic nervous system and thermogenesis which ultimately results in production of more ATP, more energy7. A study shows that leptin’s maximum expression was observed during the night8. Another study suggests that leptin levels are reduced during short sleep duration in human beings9. This suggests that disruption of circadian clock can alter the leptin secretion, indirectly can affect energy homeostasis and thermogenesis. A study done in 2009, states that circadian misalignment reduces serum leptin levels19.

The hormone cortisol, which, is generally released just before waking up by adrenal gland. The cortisol levels are lowermost after midnight, all through sleep10. Cortisol performs significant functions like regulation of metabolic processes (glycogenolysis, lipolysis and proteolysis)11, reduces lean body and muscle mass and increase energy consumption12. Thus, some disruption in circadian clock system due to sleep disorder or anything else might affect certain metabolic processes.

Proteins like ApoB, ApoA1, and ApoA4 show changes during the day as per a recent study13. A study shows that cholesterol and lipid absorption in higher when not exposed to light as compared to when they are exposed to light14. it is indicated that circadian oscillation can affect lipid metabolism.

Haugen et al, said, the resting metabolic rate was 6% higher at noon than in morning15.

**1.2 Effect of timings:**

Feeding time affects the phase of peripheral clocks. Some studies indicated that time restricted feeding all through daytime changed the phase of circadian clock in peripheral tissues of nocturnal rodents16-18. Leptin, the appetite supressing hormone, levels are the highest during the night8 while the levels are high during short sleep duration in humans9. Sleep disorder or sleep deprivation may affect energy intake levels. This suggests that intake timing may alter the phase of clocks. DIT (diet induced thermogenesis) is highest in morning, followed by afternoon and night20. Liver is known to adapt the feeding times in just three days as liver clocks are rapidly entrained by feeding signals16. Starvation interval is an important factor in determining the phase of biological clocks. In a study of mice, it was observed that breakfast altered the phase of liver clocks. A possible reason for that can be the starvation time as breakfast, is known to be consumed after the longest starvation time21. Skipping breakfast increases the starvation time which may disrupt the intrinsic clock system. In a cohort study, the frequency of breakfast was found to be inversely proportional to weight gain22. Thus, skipping breakfast might lead to increase in weight gain. Regular breakfast consumption may decrease the risk of adverse effects related to glucose and insulin metabolism23.Late night eating/snacking disrupts the starvation interval which then disturpts the phase of peripheral clocks24. The phase of clock was altered in rats when feed after a long starvation interval25. When exposed with light continuously for four days, energy consumption and expenditure altered, resulting in weight gain in mice26. This indicates that association between nutrient intake and circadian clock system, chrononutrition, is important for synchronisation of daily activities. Glucose intolerance can be caused due to inadequate meal timings which might alter the phases of circadian clocks in rodents27.

**1.3 Effect of different foods:**

High fat diet increases the risk of various metabolic diseases. Time restricted feedings are observed to restore amplitude of clocks while high fat diet may induce a devalue in amplitude of clocks3. A recent study presented that a high fat diet leads to oscillation reorder in transcripts and metabolites in liver28. A ketogenic diet, low in carbohydrate content and high in fat content, has an impact on circadian rhythms too, generally abbreviates the circadian locomotor activity rhythms29. A high salt diet advances molecular circadian rhythms in mouse liver in just 3 hours while feeding and drinking behaviour remained unaffected30.

There are several food components affecting the circadian clock system, thus are important to determine the role of chrononutrition in humans. A polyphenol called resveratrol, generally found in red wine, resets clocks while polyphenols, in general, can interact with circadian clocks31,32. Consumption of coffee on a regular basis elongates the circadian period of molecular oscillation33. Also, evening intake of coffee postponements the melatonin rhythm33

Review of literature:

1. A Arola-Arnal, 2019

# Methodology

Methodology is the logic of scientific investigation. It is a preocedure of research technique. Methodology means description, explanation and justification of methods of themselves. It contains the structure use of methods that are directed by underlying. Methodology can properly refer to the theoretical analysis of methods appropriate to the field of study or to the body of methods and principles particularly to the branch of knowledge.

This study is based on determining the role and importance of chrono-nutrition among youth (18-24 years of age) in Palwal and Faridabad district.

The different phases that followed to conduct this study are: Locale of study

1. Selection of subjects
2. Tools and collection of data
3. **LOCALE OF THE STUDY**

This study was conducted on the residents of area of two districts, namely, Palwal and Faridabad, India in order to achieve an adequate number of sample size for the study.

1. **SELECTION OF SUBJECTS**

2.1) Study subject: female and male population of age between 18-24.

2.2) Sample size: 200 samples were recruited for the study

2.3) Criteria for selection of subjects

* + 1. Inclusion Criteria:

1) Students were from Palwal and Faridabad

2) Subjects were required to be of age 18 to 24 years.

3) both genders were selected

4) Subjects who were willing to participate were selected

2.3.2 Exclusion Criteria:

1) Subjects not from college in Palwal and Faridabad.

2) Subjects not falling in age group 18 to 24 years.

3) Subjects not willing to participate.

Period of Data collection: November 2021 to December 2021

The study was conducted on 200 young adults, aged 18 to 24 years. The subjects were 100 females and 100 males of varied body mass indices and were student of college in Palwal and Faridabad district. Study data was collected using questionnaire forms filled by the subjects. Before the study, the participants were informed about the study and volunteers who accepted to respond to it were included. After subjects were accepted into the study they were asked to fill a questionnaire, where they self-reported their weights and heights which was also measured using weighing scale and inch tape respectively and answered some questions related to their sleeping and eating habits. Their responses were then used to assess the association between sleeping pattern and eating habits, also called chrono nutrition.

Sampling Method

Purposive sampling technique was adopted for achieving the desired number of subjects.

1. Tools and collection of data
   1. Questionnaire Method

In the questionnaire method, a series of questions were prepared, and then the subjects were asked to fill the questionnaire. The questions were based on the knowledge, attitude, and practice on awareness about chrono nutrition among college students in Palwal and Faridabad.

3.1.1 Demographic Profile

Demographic profile includes the subjects age, gender, education, family type, family education and occupation, family disease history etc.

* + 1. Anthropometric Profile

Anthropometric measurements such as height, weight and BMI were recorded of all subjects.

Body Mass Index (BMI)

BMI was computed using the formula as

BMI= Weight (in kgs)/ Height (in m) sq.

BMI is the ratio of weight and height in BMI calculation, weight is taken in kilograms (kg) and height in meter square (m sq.). BMI is a measure of body fatness to evaluate risk factors associated with obesity. It is classified on the basis of the Asian BMI range.

Table 3.1.2: Asian Classification of BMI

|  |  |
| --- | --- |
| CATEGORY | BMI |
| Underweight | <18 |
| Normal | 18.0-22.9 |
| Overweight | 23.0-24.9 |
| Obesity | >25 |

3.1.3 Lifestyle and Eating Habit

The information regarding the lifestyle and eating habits were collected on the basis of the questionnaire and food frequency questionnaire. To track sleeping and eating habits CP-Q questionnaire was referred.

4) STATISTICAL ANALYSIS

To analyse the data collected we organised the data into the coding form to correctly interpret the data and extract the respective result by calculating the standard deviation and variance.

ANNEXURE I

Questionnaire chrono nutrition

. Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. Age

□ 18-21

□ 22-24

3. Gender

□ Male

□ Female

4. Your education

□ Elementary

□ High school

□ Graduate

□ Postgraduate

5. what type of family do you live in?

□ Nuclear family

□ Joint family

6. How many people live in your household including yourself?

□ 1-4

□ 5-6

□ 7-8

□ More than 8

7. what’s your occupation?

□ Student

□ Government official/company manager

□ Technician/engineer

□ Business

□ others

8. what’s your mother’s occupation?

□ Housewife

□ Government official/company manager

□ Technician/engineer

□ Business

□ others

9. what’s your father’s occupation?

□ Government official/company manager

□ Technician/engineer

□ Business

□ others

10. what’s your father’s education?

□ Elementary

□ High school

□ Graduate

□ Postgraduate

11. what’s your mother’s education?

□ Elementary

□ High school

□ Graduate

□ Postgraduate

12. Has anyone in your family had any of the following diseases? (You can choose more than one option)

□ Diabetes

□ Hypertension

□ Heart disease

□ Thyroid disorder

□ Stroke

□ Kidney disease

□ Cancer & site

□ Injury and type

□ Other diseases

13. How often do you smoke/drink?

□ Never

□ Occasionally

□ Sometimes

□ Often

□ Always

14. For how long you do physical activities?

□ 20 minutes or less per day

□ 20-45 minutes per day

□ 1-2 hours per day

15. What type of activity you often perform?

□ Walking

□ Recreational activities

□ Exercise/yoga

□ Household chores

□ others

PRELIMINARY CHRONONUTRITION PROFILE - QUESTIONNAIRE

16. How often do you eat breakfast?(in a week)

□ never

□ once a week

□ twice a week

□ 3-4 days per week

□ More than 4 days per week

□ everyday

17. What is your largest meal of the day?

□ Breakfast

□ Lunch

□ Dinner/Supper

□ Other meal

(If other meal, please describe: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)

18.How often do you eat a snack after your last meal of the day? (in a week)

□ never

□ once a week

□ twice a week

□ 3-4 days per week

□ More than 4 days per week

□ everyday

19.How frequently do you wake up in the night to eat? (weekly)

□ never

□ once a week

□ twice a week

□ 3-4 days per week

□ More than 4 days per week

□ everyday

On a typical workday or school day,

20. What time do you wake up? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

21. What time do you eat your first meal or snack of the day? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

22. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select “I do not eat lunch” if you do not typically eat lunch.

\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

□ I do not eat lunch.

23. What time do you eat your last meal or snack of the day? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

24. What time do you go to bed? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

On a typical weekend day or free day,

25. What time do you wake up? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

26. What time do you eat your first meal or snack of the day? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

27. What time do you eat lunch? Please indicate A.M./P.M. as part of your response. Select “I do not eat lunch” if you do not typically eat lunch.

\_\_\_\_\_\_\_\_ A.M./ P.M.

□ I do not eat lunch.

28. What time do you eat your last meal or snack of the day? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

29. What time do you go to bed? Please indicate A.M./P.M. as part of your response.

\_\_\_\_\_\_\_\_\_\_\_\_\_ A.M./ P.M.

FFQ

The following food frequency questionnaire is designed to estimate you usual eating pattern. For each food listed, check the box indication how often during the past year you usually ate the amount specified in the parentheses.

If you ate a food only at certain times of year (ex. summer), average your intake over the year. The pattern you report should reflect usual eating habits no the pattern of a short term diet, some other unusual circumstance, or what you think you should eat.

The boxes include monthly, weekly and daily categories:

Never or (about) less than once a month (<1/month)

1-3 (times) per month

1 per week (about once a week)

2-4 (times) per week

5-7 times a week (or about once a day)

2-3 times a day

4 + times a day

Note that the “5-7 times a week” category is a frequency pattern of about “once a day”.

For example, foods you never or rarely eat would be checked “never”. A food eaten only a few times during a particular season would also be checked “never”. Foods eaten only a few times during the week or eaten a few times on the weekend would be checked “2-4 times a week”. A food eaten more than once a day would check “2-3 times a day” or “4 + times a day” depending on your eating pattern.

If you cannot estimate your usual intake of the food for any reason, leave the item blank.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FOOD AND AMOUNTS PER SERVING** | | | Never or <1/month | 1-3 per month | 1 per week | 2-4 per week | 1 per day | 2-3 per day | 4+ per day |
| **Meat and other alternatives**  Bacon | | |  |  |  |  |  |  |  |
| Liver, brains, kidneys, sweetbreads | | |  |  |  |  |  |  |  |
| Beet, hamburgers | |  | |  |  |  |  |  |  |
| Poultry | |  | |  |  |  |  |  |  |
| Pork, ham | |  | |  |  |  |  |  |  |
| Hot dogs | |  | |  |  |  |  |  |  |
| Eggs | |  | |  |  |  |  |  |  |
| **Dairy foods and fats**  Skim milk, buttermilk, powder skim milk | |  | |  |  |  |  |  |  |
| Whole milk | |  | |  |  |  |  |  |  |
| Soy milk | |  | |  |  |  |  |  |  |
| Yogurt | |  | |  |  |  |  |  |  |
| Ice cream | |  | |  |  |  |  |  |  |
| Cheese | |  | |  |  |  |  |  |  |
| Butter | |  | |  |  |  |  |  |  |
| **Fruits**  Fresh apple or pears | |  | |  |  |  |  |  |  |
| Apple juice or cider | |  | |  |  |  |  |  |  |
| Orange or orange juice | |  | |  |  |  |  |  |  |
| Grapefruit | |  | |  |  |  |  |  |  |
| Peaches, apricots, plums or nectarines | |  | |  |  |  |  |  |  |
| Raisins and dates | |  | |  |  |  |  |  |  |
| Bananas, Strawberries, cherries, berries | |  | |  |  |  |  |  |  |
| **Vegetables**  Broccoli | |  | |  |  |  |  |  |  |
| Cabbage, cauliflower | |  | |  |  |  |  |  |  |
| Sprouts | |  | |  |  |  |  |  |  |
| Carrots | |  | |  |  |  |  |  |  |
| Corn | |  | |  |  |  |  |  |  |
| Spinach | |  | |  |  |  |  |  |  |
| Peas | |  | |  |  |  |  |  |  |
| Green or red peppers | |  | |  |  |  |  |  |  |
| **Sweet or baked goods**  Cake or pastries | |  | |  |  |  |  |  |  |
| Biscuits/cookies | |  | |  |  |  |  |  |  |
| Doughnut | |  | |  |  |  |  |  |  |
| **Bread, Cereals, Starches**  Refined uncooked cereals like cornflakes,  Cheerios | |  | |  |  |  |  |  |  |
| Refined hot cereals like cream of wheat,  instant oatmeal, etc | |  | |  |  |  |  |  |  |
| Potato chips, fritos, tortilla chips, pretzels, etc. | |  | |  |  |  |  |  |  |
| Brown rice | |  | |  |  |  |  |  |  |
| White rice | |  | |  |  |  |  |  |  |
| Pasta (spaghetti, noodles etc.) | |  | |  |  |  |  |  |  |
| Other grains like barley, bulger, kasha etc. | |  | |  |  |  |  |  |  |
| **Beverages**  Coffee | |  | |  |  |  |  |  |  |
| Tea | |  | |  |  |  |  |  |  |
| Decaffeinated coffee, herbal tea etc. | |  | |  |  |  |  |  |  |
| Caffeinated beverages like pepsi, coke, etc | |  | |  |  |  |  |  |  |
| Diet coke, diet soda | |  | |  |  |  |  |  |  |
| Beer | |  | |  |  |  |  |  |  |
| Red wine or sherry | |  | |  |  |  |  |  |  |
| White wine | |  | |  |  |  |  |  |  |
| **Miscellaneous**  Peanut butter | |  | |  |  |  |  |  |  |
| Mayonnaise | |  | |  |  |  |  |  |  |
| Honey | |  | |  |  |  |  |  |  |
| Jams, jellies, syrups | |  | |  |  |  |  |  |  |
|  |