THE MUSCULOSKELETAL STRENGTH, BALANCE, CARDIORESPIRATORY FUNCTION, PSYCHOLOGY, AND LEVEL OF PHYSICAL ACTIVITY AMONG MORNING AND EVENING CHRONOTYPE

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THE MUSCULOSKELETAL STRENGTH, BALANCE, CARDIORESPIRATORY FUNCTION, PSYCHOLOGY, AND LEVEL OF PHYSICAL ACTIVITY AMONG MORNING AND EVENING CHRONOTYPE

ABSTRACT

Background and Objectives: Chronotype is the individual's preferred time of sleep and activity. Sleep disturbance is a common problem among university students that may influence physical and mental health. The objectives of this study were to (i) compare the musculoskeletal strength, balance, and cardiorespiratory function and (ii) determine the association between psychological status and level of physical activity among morning and evening chronotypes.
Methods: A cross-sectional survey was conducted among 257 health sciences students. The subject undergone screening using the International Physical Activity Questionnaire (IPAQ), Morningness-Eveningness Questionnaire (MEQ), Depression, Anxiety, and Stress Questionnaire (DASS-21), Hand grip dynamometer, Countermovement jump, Peak Flow meter (PEFR) and Modified Star Excursion test (SEBT).
Results: Mean ± SD age was 21.3 ± 3.32 years, 146 female students and 111 male students. 200 students intermediate chronotype, 46 students morning chronotype, and 11 evening chronotype. Balance for posterolateral and posteromedial (09:00) shows a significant difference between chronotypes.
Conclusion: Our results indicate that the morning chronotype has more balance than the evening chronotype. Future studies can be focused on the athlete by taking account the influence of time of day and physical performance.

Keywords: circadian rhythm; chronotype; strength; balance; cardiorespiratory; physical activity

KEKUATAN OTOT, KESEIMBANGAN, FUNGSI KARDIORESPIRATORI, PSIKOLOGI, DAN TAHAP AKTIVITI FIZIKAL DALAM KALANGAN CHRONOTYPE PAGI DAN PETANG

ABSTRAK

Latar Belakang dan Objektif: *Chronotype* ialah masa tidur dan aktiviti pilihan individu. Gangguan tidur adalah masalah biasa dalam kalangan pelajar universiti yang mungkin mempengaruhi kesihatan fizikal dan mental. Objektif kajian ini adalah untuk (i) membandingkan kekuatan muskuloskeletal, keseimbangan, dan fungsi kardiorespiratori dan (ii) menentukan perkaitan antara status psikologi dan tahap aktiviti fizikal antara kronotaip pagi dan petang.

Kaedah: Tinjauan keratan rentas telah dijalankan di kalangan 257 pelajar sains kesihatan. Subjek menjalani saringan menggunakan Soal Selidik Aktiviti Fizikal Antarabangsa (IPAQ), Soal Selidik Morningness-Eveningness (MEQ), Soal Selidik Kemurungan, Kebimbangan dan Tekanan (DASS-21), Dinamometer cengkaman tangan, Lompat Gerakan Balas, Meter Aliran Puncak (PEFR) dan Modified Ujian Star Excursion (SEBT).

Keputusan: Min ± umur SD ialah 21.3 ± 3.32 tahun, 146 pelajar perempuan dan 111 pelajar lelaki. 200 pelajar chronotype pertengahan, 46 pelajar chronotype pagi, dan 11 kronotaip petang. Imbangan untuk posterolateral dan posteromedial (09:00) menunjukkan perbezaan yang ketara antara chronotype.

Kesimpulan: Keputusan kami menunjukkan bahawa chronotype pagi mempunyai keseimbangan yang lebih daripada kronotaip petang. Kajian masa depan boleh ditumpukan kepada atlet dengan mengambil kira pengaruh masa dalam sehari dan prestasi fizikal.

Kata kunci: irama sirkadian; kronotaip; kekuatan; seimbang; kardiorespiratori; aktiviti fizikal

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Circadian rhythms are biological processes that display endogenous oscillation for about 24 hours. It is simple to mention as a sleep-wake cycle. It regulates the activity of the body system to function effectively based on natural functions. With such a crucial function, some disruption might cause several setbacks. Many factors affect the circadian rhythm, such as heredity and lifestyle (Farhud & Aryan, 2018). Sleep is an essential component for the human body to function well. Sleep also controls the circadian clock, which generates a 24-hour biochemical rhythm. The circadian clock, a biological electric device that cycles with solar time, is the primary mechanism that indicates sleep pathways. Any disturbance in the sleep schedule can cause sleep and wake cycles to be imbalanced, which can impact individuals' health status and psychology.

Sleep quality is essential, especially among undergraduate students, because it could affect academic performance and mental and physical health. Based on the study by Schlarb et al. (2017), about 60% of college students have poor sleep quality. University students from Malaysia also had poor sleep quality during the pandemic, ranging between 45.2% (Kwan et al., 2021) and 57.3% (Zuki et al., 2021). Many factors are associated with changes in circadian rhythm, such as irregular study schedules, examination preparation, and nighttime internet surfing. This situation causes changes in the normal circadian rhythm and leads to prolonged sleepiness. Prolonged sleepiness may lead to health problems such as cardiovascular and metabolic disease (Chen & Yang, 2015; Gnocchi & Bruscalupi, 2017).

The imbalance of the sleep-wake cycles might harm the student's learning process and memory consolidation. This research is essential to educate students regarding the effect of circadian rhythm on their lives, helping undergraduate students develop healthy lifestyles by improving sleep quality. Prolonged exposure to disruptions in the circadian rhythm can cause health problems, including cardiovascular disease, metabolic disorders, and depression (Chen & Yang, 2015; Gnocchi & Bruscalupi, 2017; Walker et al., 2020). With any disturbance of the body's physiological division, some of the structures in the body start to deplete in function and are not well developed (Choi et al., 2019).

Sleep deprivation is also significant, especially among medical and health sciences students. Sleep deprivation is also known as insufficient sleep or not enough sleep. Sleep deprivation is a significant source of health-related diseases such as

hypertension, diabetes, obesity, heart attack, and stroke (Ismail et al., 2021). Sleep deprivation behaviour is also one of the factors for motor vehicle accidents. Sleep deprivation can impact the learning process; the individual cannot focus optimally, so learning cannot be efficient. Thus, it can impact memory consolidation.

Increasing evidence supports the importance of maintaining a normal circadian rhythm in the basic cellular physiology of skeletal muscles (Chang et al., 2017; Sarowar et al., 2016). Furthermore, an excellent circadian rhythm improves muscle growth and delays the atrophy process (Vitale et al., 2019). In contrast, disobeying this rhythm deprives muscles of mass and leads to poor healing. Chen et al. (2017) found poor sleep quality associated with reduced muscle mass and strength. This would limit students' full potential and impact their physical quality.

In addition, the disruption of the circadian rhythm also impacts balance. A study by Bessot et al. (2006) demonstrates that circadian rhythm changes can affect athletic performance. There is a 5-7% difference between morning and evening for multiple jumping tests, peak isometric grip strength, and power output on the swim bench (Bessot et al., 2006). Gribble and Hertel (2003) mention that morning performance is much better than afternoon performance. Karagul et al. stated that altering circadian rhythms affects the dynamic balance. Balance changes may impact the well-being of the student.

Besides, alterations in circadian rhythm also impact cardiorespiratory function. In humans, the suprachiasmatic nucleus at the hypothalamus controls the circadian rhythm and synchronises with the body's physiological changes day and night (Guyton & Hall, 2016). The rhythm passively influences the changes in this airway (Dhokane et al., 2015). The changes can be seen in cardiorespiratory parameters. Students with different chronotypes may experience variations in cardiorespiratory functions due to their natural circadian preferences. The dynamic lifestyles of students lead to changes in sleep patterns and disruptions in circadian rhythms, which affect cardiorespiratory functions.

The circadian rhythm plays a crucial role in regulating sleep-wake cycles. Disruptions to these cycles, such as irregular or insufficient sleep, can impact psychological factors such as mood, cognitive function, and emotional well-being. Students with different chronotypes may experience variations in sleep patterns and changes in psychological state. Studies have shown that disruptions to circadian rhythms, such as irregular sleep schedules, can contribute to mood disorders and increase the risk of depression and anxiety (Germain & Kupfer, 2008). The circadian system also affects the secretion of hormones such as cortisol and melatonin, which affect mood regulation.

Individuals have different chronotypes, reflecting their preference for certain times of the day. Some people are "morning types," while others are "evening types." These preferences can influence when students feel most alert and ready for physical activity. Aligning exercise schedules with individual chronotypes can optimise

performance and adherence to exercise routines (Thomas et al., 2020). Regular physical activity can influence the circadian regulation of sleep-wake cycles. Exercise, especially during daylight hours, may improve sleep quality and synchronization with the circadian rhythm. However, intense exercise close to bedtime may have stimulated effects, potentially affecting sleep for some individuals.

In summary, the circadian rhythm can cause changes in the sleep-wake cycle. These can influence the student's psychological and physical aspects. Different chronotypes may influence peak alertness, attention, and mood timing. To optimise cognitive and psychological outcomes, the students should align the chronotypes with their study schedules, exams, and physical activities. This study aims to determine and compare the musculoskeletal strength and balance, cardiorespiratory functions, and psychology following the circadian rhythm alteration between the morning and evening chronotypes.

1.2 Problem Statement

Circadian rhythm plays a crucial role in students' lives; irregular sleep patterns can negatively impact cognitive function, memory consolidation, and academic performance. Many factors influence the changes in circadian rhythm among students, such as class schedules, chronotypes, the impact of technology, social activities, and examinations. This study focuses on chronotypes that impact the students' physical performance in terms of musculoskeletal strength, balance, cardiorespiratory functions, psychology, and level of physical activity.

Poor sleep quality is a common problem among undergraduate students, especially medical and health sciences students. Limited evidence focuses on identifying sleep problems among health sciences students and the effect on muscle strength, balance and cardiorespiratory functions. Many studies focus on psychology and the level of physical activity. Zaid, Rahman, and Haque (2018) conducted a study in Malaysia on the association between sleep quality and well-being among health sciences students. Another study by Abdullah and Chung (2023) focuses on daytime sleepiness and sleep quality among health sciences students at City University Malaysia. More study on sleep quality among undergraduate students but less focus on the physiological effect on musculoskeletal strength, balance and cardiorespiratory functions.

Short sleep duration is also associated with an increased risk of mass reduction. Thus, it influences muscle strength. Sleep is a homeostatic process that is crucial for physical and mental health. Previous studies showed that short and prolonged sleep increased the risk of mortality, hypertension, diabetes and obesity (Tahari et al., 2004). Insufficient sleep leads to an inability to concentrate, cognitive deterioration and a decreased quality of life. There are limited studies on the relationship between sleep duration, sleep quality, and muscle strength among young adults. A study by Chen et al. (2017) shows that good sleep quality is associated with greater muscle strength, while short sleep duration increases the risk of muscle strength in university students. Buchmann et al. (2016) state that sleep can influence older people's muscle mass and function. There is a knowledge gap based on the previous research but no latest research based on this related issue.

Balance is the ability to control center gravity while passing one movement to another during a dynamic performance. Circadian rhythm has been found to affect athlete performance about a 5-7% difference in athlete performance between morning and evening. A study by Gribble and Hertel. (2003) show morning is better compared to evening performance while Zouabi et. al (2016), claim no time effect on dynamic and static balance. Waterhouse et. al, (2005), mention that complicated balance movements, required concentration and attention, sleep state and body temperature are one of the factors affecting circadian rhythm. Karagul et al (2017) mention circadian rhythm was found to be affected dynamic balance performance. In conclusion, there is a knowledge gap in identifying balance abilities with chronotype differences.

Circadian rhythm passively can influence the circadian rhythm that varies with endogenous stimuli. Peak expiratory flow rate (PEFR) is widely used to identify pulmonary function. This depends on the muscle strength and voluntary effort. There is limited study on finding the effect of circadian rhythm on respiratory functions. In the study by Dhokane et. al (2015), PEFR vary between morning and evening which causes diurnal variation in the healthy population. There is limited evidence to identify the effect of circadian rhythm and cardiorespiratory functions.

University students tend to suffer anxiety symptoms that may be caused by poor sleep quality. There is a lot of pressure faced by students during academic courses that causes them to easily get anxiety attacks. Sleep is one of the factors that may cause the anxiety problem among students. This can influence attention, memory and problem-solving. Sleep quality is the crucial part for the body to function well for optimal physical, mental and emotional health. Latest study by Silva, Magalhaes, and Duarte.

(2020), show the relationship between the chronotype, sleep and quality of anxiety among university students. There is important to explore more the effect of psychological aspects on students.

Regular physical activity can influence the circadian regulation of sleep-wake cycles. Exercise, especially during daylight hours, may improve sleep quality and synchronization with the circadian rhythm. However, intense exercise close to bedtime may have stimulated effects, potentially affecting sleep for some individuals. Physical activity was negatively associated with the circadian rhythm. University students commonly face lifestyle changes, night eating ad physically inactive (Lopez-Valenciano et. al, 2021).

In conclusion, understanding the value of sleep should be promoted among undergraduate students. It is necessary to detect the psychological problem earlier and give effective strategies for handling mental health before it gets worse. There are knowledge gaps and evidence gaps in this study topic to be explored for identifying a better strategy for encountering poor sleep quality, especially among health sciences students.

1.3 Objectives of The Study

General objectives:

1. To determine musculoskeletal strength and balance, cardiorespiratory functions, psychology, and level of physical activity following circadian rhythm alteration among student.

Specific objectives:

1. To compare musculoskeletal strength, balance, and cardiorespiratory function between morning and evening chronotype.
2. To identify the association between psychology and chronotype.
3. To identify the association between the level of physical activity and chronotype.

1.4 Research Questions

1. Is there any differences in musculoskeletal strength, balance, and cardiorespiratory function between morning and evening chronotypes?
2. Is there any association between psychology and chronotype?
3. Is there any association between physical activity and chronotype?

1.5 Research Hypothesis

This study was conducted specifically to determine the following research hypothesis:

1.5.1 Hypothesis null ($H_{o)}$

- There is no mean differences in musculoskeletal strength, balance, and cardiorespiratory function among morning and evening chronotypes.
- There is no association between psychology and chronotypes.
- There is no association between physical activity and chronotype.

1.5.2 Hypothesis alternative ($H_{A)}$

- There is differences in mean muscle strength, balance, and cardiorespiratory function among morning and evening chronotypes.
- There is an association between psychology and chronotypes.
- There is an association between physical activity and chronotype.

1.6 Conceptual Framework

The study aims to determine and compare mean musculoskeletal strength, balance, and cardiorespiratory function among morning and evening chronotypes and to identify the association between psychology and physical activity and chronotype. The conceptual framework of the studies is based on the Neural Theory of Circadian Rhythm developed by Aschoff's Rule (1984).

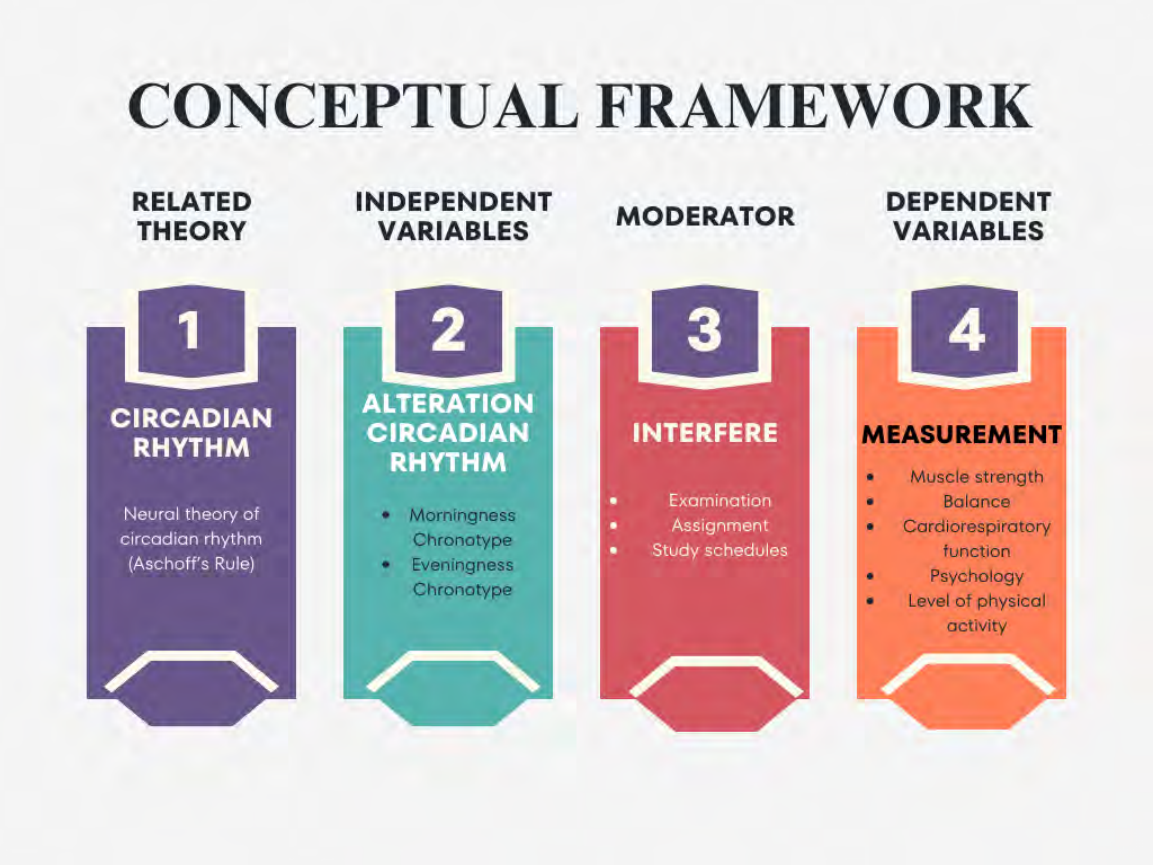

Figure 1.1 Conceptual Framework

The neural theory of circadian rhythm involves the brain as the primary function that regulates the circadian rhythm. The circadian rhythm is a 24-hour cycle that influences various physiological and behavioural processes in living organisms, including the sleep-wake cycle. The neural model suggests that behavioural activity, rest, and circadian rhythm depend on light intensity in diurnal and nocturnal mammals (Carpenter & Grossberg, 1984). Aschoff's rule is a principle that describes the relationship between the free-running period of an organism's circadian rhythm and the range of environmental conditions to which it is exposed. The rule mentions the relationship between an organism's biological clock and external cues to regulate daily activity.

Chronotype is an individual's natural preference for being active and alert during certain parts of the day. It is the time of day when a person's physical and mental functions are most active and at their peak. The concept of chronotype is closely related to the internal biological clock, known as the circadian rhythm. The chronotype is categorised into morning, intermediate, and evening types. The researcher focuses on morningness and eveningness chronotype as independent variables in this study.

The dependent variable for this study is the measurement involved during analysis, which involved muscle strength, balance, cardiorespiratory functions, psychology, and the level of physical activity among participants. Moderator is a variable that can affect the strength between independent and dependent variables. In this study, the examination, assignment, and study schedules may interfere with or cause changes in circadian rhythm.

1.7 Operational Definition

1. **Circadian rhythm** is the 24-hour internal clock in our brain that regulates cycles of alertness and sleepiness by responding to light changes in our environment (Reddy et. al, 2023).
2. **Strength** is the ability to withstand force, stress, or pressure (Harman, 1993).
3. **Balance** is a state of equilibrium or stability (Pollock, et, al, 2000)
4. **Cardiorespiratory** is the combined effort of the heart and lungs to supply oxygen to muscles throughout the body (Raghuveer et. al, 2020).
5. **Psychology** is the study of mind and behaviour (Skinner, 1980).

6. **Physical activity** is any body movement that requires energy and is generated by the skeletal muscles (Caspersen et. al, 1985).

1.8 Study Limitation

Participants in this study were individuals between 18 to 35 years of age, undergraduate students from the Ministry of Health Training Institute (ILKKM), Sungai Buloh, without chronic diseases, insomnia, mental health, and lower limb injury; therefore, the outcomes may not be representative of the entire population. Usually, the students at clinical practice are excluded from sampling procedures because they cannot do physical performance tests. Participants have been encouraged to perform at their best. They are also being told to acknowledge the researcher if there are any symptoms of injuries while performing physical performance tests. The participants were also informed that if they found difficulties in continuing the study, they were free to withdraw from the study without penalty.

The study also involved using the My Jump 2 application, which required the researcher to buy the application for video analysis. The problems faced while recording the video: (1) Some participants jumped before the recording started, (2) participants needed to prepare for countermovement jumps, which required the researcher to repeat the procedures. For the modified standing excursion balance test (SEBT), some participants change their body position, which may cause some changes in measurement.

1.9 Importance of Research

Sleep quality is essential among undergraduate students. Poor sleep quality is one of the most public health problems among students. Disturbance in sleep quality could impact not only the physical health but also the mental health of the students. The imbalance of sleep and wake cycles could harm students' learning process and memory consolidation. This research is essential to educate regarding the effect of circadian rhythm among students, helping undergraduate students develop healthy lifestyles by improving sleep quality. Frequent alteration of sleep patterns among undergraduates contributes to changes in one's circadian rhythm. The prolonged exposure to the setback of circadian rhythm might lead to various health issues such as cardiac disease, metabolic diseases, depression, and hormonal changes (Chen & Yang, 2015; Gnocchi & Bruscalupi, 2017; Walker et al., 2020). With the disturbance of the body's physiological division, some of the structures in the body started to deplete in function and were not well developed (Choi et al., 2019). The changes also affect the musculoskeletal system. Therefore, it is essential to explore the impact of circadian rhythm on musculoskeletal strength, balance, cardiorespiratory function, psychology, and level of physical activity.

1.10 Summary

In summary, this chapter discusses the research background, problem statement, objectives of the study, research questions, research hypothesis, conceptual framework, importance of study, study limitations, and operational definition. This chapter provides basic information about circadian rhythm and the changes in musculoskeletal strength and balance, cardiorespiratory function, psychology, and level of physical activity. As students, sleep habits start to change when they start university life and start a disorganised lifestyle with packed academic schedules, assignments, and extracurricular activities that cause deterioration in sleep quality and affect learning (Saat et al., 2020). The coping strategy is essential to adapt to the changes in circadian rhythm.