

Original Research Article

Knowledge and awareness of chronopharmacology among medical undergraduates in a tertiary care teaching hospital

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ABSTRACT

Background: Chronopharmacology examines the effect of circadian rhythms on drug response. Optimizing medication timing can improve efficacy and reduce adverse effects, but awareness among medical students remains unclear. This study assessed the knowledge and awareness of chronopharmacology among undergraduate medical students and interns.

Methods: A cross-sectional questionnaire-based study was conducted among MBBS students and interns at KAMSRC. A pre-validated Google Forms questionnaire assessed knowledge of chronopharmacological concepts, circadian rhythms, and appropriate medication timing. Data were analysed using descriptive statistics in SPSS.

Results: Among 217 participants (59 males, 158 females), most were third-year MBBS students. While 89.4% were familiar with chronopharmacology, only 76.5% correctly identified the circadian rhythm as a 24-hour cycle. Knowledge regarding optimal drug administration timing varied considerably, with notable gaps observed for H₂ receptor antagonists and anti-asthmatic medications.

Conclusion: Although general awareness of chronopharmacology was high, important deficiencies were identified in its practical application. Integrating chronotherapy concepts into the undergraduate medical curriculum may enhance future prescribing practices and improve patient care.

Keywords: Chronopharmacology, KAPB studies, Pharmacology, Circadian rhythm, Chronotherapy, Prescribing practices

INTRODUCTION

Chronopharmacology examines the relationship between biological rhythms and drug action, with the aim of optimising therapeutic efficacy and minimising adverse effects through appropriate timing of medication administration. The response to a drug may vary according to the time of administration because physiological processes and the sensitivity of biological systems are not constant throughout the day.^{1,2} Understanding these temporal variations provides a basis for investigating how medication schedules can be adapted to the body's biological rhythms. The development of

chronopharmacology has been informed by research into circadian rhythms and their influence on drug responses, with both clinical applications and educational implications explored in subsequent studies.^{3,4}

Chronopharmacology contributes to the understanding of time-dependent variations in drug efficacy, tolerability and toxicity. Chronopharmacokinetics specifically investigates changes in drug absorption, distribution, metabolism and excretion in relation to biological rhythms. These variations may influence the pharmacological response and the duration or intensity of drug effects, making administration time a relevant

consideration in selected clinical situations.^{5,6} However, despite the potential benefits of chronotherapeutic approaches, awareness and application of these principles may vary among healthcare professionals and medical trainees. Research examining knowledge and awareness of chronopharmacology has highlighted the importance of strengthening understanding of its clinical relevance.⁷ Biological rhythms may also influence the timing and severity of disease manifestations. Respiratory disorders, for example, may exhibit variations in symptoms across the day, and research has examined whether the administration of selected medications corresponds with these patterns.⁸ The concept of diurnal variation in drug action further illustrates the potential significance of considering biological timing when planning pharmacotherapy.⁹ Appropriate application of chronopharmacological principles requires healthcare professionals to recognise such variations and understand when adjustments to medication schedules may be clinically justified. Studies evaluating chronotherapeutic knowledge and prescribing practices have explored this issue among healthcare professionals.¹⁰ The application of these principles in therapeutics may help improve treatment outcomes when the timing of medication is supported by evidence relevant to the drug and the underlying disease.¹¹

Circadian rhythms are closely associated with the regulation of physiological processes, including hormonal secretion and metabolic homeostasis. Variations in these processes may influence disease mechanisms and contribute to differences in drug responses at different times of the day. A better understanding of the interactions between biological rhythms, physiological regulation and pharmacological effects may therefore support the development of appropriately timed therapeutic strategies.¹² Although chronopharmacology has potential implications for rational prescribing, familiarity with its principles does not necessarily translate into their effective clinical application. Medical undergraduates and interns are future prescribers who must develop the knowledge required to make informed therapeutic decisions. Limited understanding of medication timing and biological rhythms may result in missed opportunities to optimise treatment when clinically relevant temporal patterns are present. Assessing knowledge and awareness among medical students can help identify educational gaps and determine areas that require greater emphasis in pharmacology teaching. Therefore, the present study was undertaken to assess knowledge and awareness of chronopharmacology among undergraduate medical students and interns at a tertiary care teaching hospital in Hyderabad. These findings may help identify deficiencies in existing knowledge and inform educational initiatives to strengthen understanding of chronotherapeutic principles.

METHODS

A cross-sectional, questionnaire-based study was carried out among undergraduate medical students and interns at

Kamineni Academy of Medical Sciences and Research Centre (KAMSRC), Hyderabad from October 2025 to December 2025. The study was conducted after obtaining approval from the Institutional Ethics Committee.

Participants from different phases of the MBBS course, including interns, were invited to participate voluntarily. Written informed consent was obtained electronically before enrolment. A pre-validated structured questionnaire was administered through Google Forms. The questionnaire consisted of sections assessing demographic characteristics, awareness of chronopharmacology, understanding of circadian rhythm concepts, and knowledge regarding the optimal timing of administration of commonly prescribed medications.

The survey link was circulated through official student communication channels, and participants were allowed adequate time to complete the questionnaire. Responses were collected anonymously to maintain confidentiality and reduce response bias. Incomplete questionnaires were excluded from the final analysis.

All collected data were coded and entered into Microsoft Excel before being analysed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise the data. Participants achieving a score of 50% or higher on the knowledge-based questions were considered to possess adequate knowledge of chronopharmacology.

RESULTS

The study included 217 participants (mean age: 21.51±1.40 years), with females (72.8%) outnumbering males (27.2%). Regarding the academic year of study, most participants were from 3rd year MBBS (47%), followed by final year MBBS students (37.3%), while interns constituted 15.7% of the study population as depicted in Table 1.

Among the 217 participants, 89.4% were familiar with the term chronopharmacology, and 76.5% correctly identified the circadian rhythm as a 24-hour biological cycle. However, knowledge regarding the clinical application of chronopharmacology varied considerably across different therapeutic areas. Only 36.4% of respondents correctly recognized that gastric acid secretion is highest during the night, and an equal proportion were aware that peptic ulcer symptoms tend to worsen during nighttime hours. Furthermore, only 12.4% correctly identified bedtime as the optimal time for administering H₂ receptor antagonists. In the context of respiratory disorders, 41.5% of participants knew that asthma symptoms are more likely to exacerbate at night, while 35.5% correctly identified nighttime administration as the most effective schedule for sustained-release bronchodilators. Awareness regarding the optimal timing of inhaled corticosteroid therapy was lower, with only 22.1% selecting nighttime administration.

Knowledge related to cardiovascular chronotherapy was also limited, as only 32.3% correctly identified the early morning period as the time of greatest risk for myocardial infarction. Similarly, 26.3% and 34.6% of respondents correctly recognized nighttime administration of ACE inhibitors and morning administration of calcium channel blockers, respectively, as the preferred dosing schedules. Regarding chronomodulated cancer chemotherapy, only 22.6% correctly identified 4 pm as the optimal time for oxaliplatin administration in bowel cancer. In contrast,

awareness of chronobiological aspects of lipid metabolism was comparatively better, with 64.1% of participants recognizing that cholesterol synthesis predominantly occurs during the night, and 49.3% identifying nighttime as the most appropriate time for statin administration as given in Table 2. These findings indicate that although participants demonstrated satisfactory awareness of basic chronopharmacological concepts, their understanding of the practical application of chronotherapeutic principles in clinical settings was variable.

Table 1: Demographic characters of study participants (n=217).

Variable	Category	Frequency (N)	%
Gender	Male	59	27.2
	Female	158	72.8
Academic year of study	3rd Year MBBS	102	47.0
	Final Year MBBS	81	37.3
	Intern	34	15.7
Age (in years)	Mean±SD	21.52±1.40	—
	Median (IQR)	21 (20–23)	—
	Range	19–26	—

Table 2: Frequency of responses related to chronopharmacology (n=217).

S. no.	Question	Response	Frequency (%)
1	The study on effect of drugs which vary with biological timings and endogenous periodicities is called	Chronopharmacology	194 (89.4)
		Chronobiology	13 (6)
		Chronometry	8 (3.7)
		Chronogram	2 (0.9)
2	Circadian rhythm is associated with	6-hour time frame	3 (1.4)
		8-hour time frame	18 (8.3)
		12-hour time frame	30 (13.8)
		24-hour time frame	166 (76.5)
3	In which part of the day is gastric pH least in human body?	Early morning	97 (44.7)
		Mid-day	30 (13.8)
		Night	79 (36.4)
		Remains same throughout	11 (5.1)
4	During which part of the day would symptoms of peptic ulcer disease worsen?	Early morning (6–8 am)	71 (32.7)
		Mid-day (11 pm–1 pm)	63 (29)
		Night (11 pm–1 am)	79 (36.4)
		Remains same throughout	4 (1.8)
5	Ideal time to administer H2 blockers like ranitidine in peptic ulcer is	Before breakfast	144 (66.4)
		Before dinner	27 (12.4)
		Before lunch	38 (17.5)
		Anytime	8 (3.7)
6	The symptoms of bronchial asthma particularly exacerbate during	Early morning	92 (42.4)
		Mid-day	16 (7.4)
		Night	90 (41.5)
		Anytime	19 (8.8)
7	Bronchodilators like theophylline or salbutamol sustained release preparations is more effective at	Morning	68 (31.3)
		Noon	16 (7.4)
		Evening	56 (25.8)
		Night	77 (35.5)
8	Administering a single daily dose of inhalational corticosteroid will be more effective at what time during the day	Morning	80 (36.9)
		Afternoon	35 (16.1)
		Evening	54 (24.9)

Continued.

S. no.	Question	Response	Frequency (%)
9	There is an increased risk of Myocardial Infarction between	Night	48 (22.1)
		6 am–12 pm	72 (32.3)
		12 pm–6 pm	41 (18.9)
		6 pm–12 am	59 (27.2)
		Same at all intervals	47 (21.7)
10	ACE inhibitor: enalapril are highly effective in reduction of blood pressure if given in	Morning	103 (47.5)
		Afternoon	47 (21.7)
		Night	57 (26.3)
		Evening	10 (4.6)
11	The ideal time to administer calcium channel blockers nifedipine in the treatment of hypertension	Morning	75 (34.6)
		Mid-day	52 (24)
		Evening	30 (13.8)
		Bed time	60 (27.6)
12	The ideal time to administer platinum based chemotherapeutic agent oxaliplatin for treating bowel cancer is	8 am	54 (24.9)
		4 pm	49 (22.6)
		12 pm	60 (27.6)
		Any time	54 (24.9)
13	Cholesterol synthesis occurs mainly during	Morning	25 (11.5)
		Afternoon	34 (15.7)
		Night	139 (64.1)
		Same throughout	19 (8.8)
14	When do you think administration of statins would be more efficacious	During morning	45 (20.7)
		During afternoon	46 (21.2)
		During night	107 (49.3)
		Remains same throughout	19 (8.8)

DISCUSSION

Chronopharmacology has gained increasing importance in recent years because of its potential to improve therapeutic outcomes through the optimization of medication timing. The present study evaluated the knowledge and awareness of chronopharmacological principles among undergraduate medical students and interns in a tertiary care teaching hospital. Although a large proportion of participants were familiar with the term chronopharmacology and understood the concept of circadian rhythm, substantial deficiencies were observed in their knowledge of the practical application of chronotherapeutic principles.

In the present study, 89.4% of participants correctly identified the term chronopharmacology, while 76.5% recognized the circadian rhythm as a 24-hour biological cycle. These findings suggest satisfactory awareness of the theoretical aspects of chronopharmacology among medical undergraduates. Similar observations were reported by Abilesh et al and Vandna et al who found that most healthcare professionals and postgraduate medical students were familiar with the concept of chronopharmacology, although detailed knowledge regarding its clinical application remained inadequate.^{6,7} Despite adequate theoretical knowledge, participants in the present study exhibited deficiencies in understanding

the chronotherapeutic management of gastrointestinal disorders. Only 36.4% correctly identified nocturnal variation in gastric acid secretion and worsening of peptic ulcer symptoms during nighttime hours. Furthermore, awareness regarding the optimal timing of H₂ receptor antagonist administration was poor. Similar observations were made by Pankaj et al who found that medical students were generally aware of chronopharmacology but lacked knowledge regarding specific therapeutic applications.³ These findings suggest that while students may understand the concept, they often fail to translate it into clinical decision-making.

Knowledge regarding respiratory chronotherapy was also suboptimal. Less than half of the participants recognized that bronchial asthma symptoms typically worsen at night, and only a minority correctly identified the ideal timing of inhaled corticosteroids and sustained-release bronchodilators. These findings are consistent with those reported by Devangi et al who emphasized the importance of medication timing in the management of respiratory disorders and demonstrated limited awareness of these principles among healthcare professionals.⁸ Since asthma is one of the classic examples of a disease exhibiting circadian variation, inadequate understanding of its chronotherapeutic management may have implications for future prescribing practices.

Awareness of cardiovascular chronotherapy was similarly limited. Only 32.3% of participants correctly identified the early morning period as the time of greatest risk for myocardial infarction. Knowledge regarding the optimal timing of ACE inhibitors and calcium channel blockers was also inadequate. Comparable findings have been reported by Dharani et al who demonstrated that knowledge regarding the chronopharmacological use of antihypertensive agents remains limited despite strong evidence supporting time-dependent variations in blood pressure and cardiovascular events.⁴ Given the clinical importance of cardiovascular diseases, improved understanding of chronotherapeutic strategies could contribute to better patient outcomes. Knowledge related to chronomodulated chemotherapy was among the poorest domains evaluated in the study. Less than one-fourth of respondents correctly identified the preferred timing of oxaliplatin administration. This finding may be explained by limited exposure to chronotherapy in oncology during undergraduate training. Similar concerns have been raised in previous studies, which have highlighted the need for greater emphasis on emerging applications of chronopharmacology beyond commonly discussed examples such as asthma and hypertension.

In contrast, participants demonstrated relatively better knowledge regarding lipid metabolism and statin therapy. More than half of the respondents correctly recognized that cholesterol synthesis predominantly occurs during the night, and nearly half identified nighttime administration as the preferred timing for statins. This finding may reflect greater exposure to the commonly taught principle of administering short-acting statins in the evening to coincide with peak endogenous cholesterol synthesis.

The findings of the present study are also comparable to those reported by Pichholiya et al who evaluated knowledge and practices of chronotherapeutics among healthcare professionals and found that although participants were aware of the concept, detailed understanding of its practical application remained inadequate.¹⁰ Together, these studies indicate that awareness of chronopharmacology is generally higher than the ability to apply chronotherapeutic principles in clinical settings.

Limitations

The findings of this study should be interpreted in light of certain limitations. As the study was conducted in a single tertiary care teaching institution, the results may not be representative of medical students in other settings. The cross-sectional design provides information at a single point in time and does not allow assessment of changes in knowledge over time. Data collection was based on self-reported questionnaire responses, which may be influenced by recall bias or guessing. In addition, the distribution of participants across different academic years was not uniform, which may have affected the overall results. Finally, while the study assessed knowledge and

awareness of chronopharmacology, it did not evaluate the participant's ability to apply these concepts in real clinical scenarios. Further multicentric studies involving larger and more diverse populations are needed to provide a more comprehensive understanding of chronopharmacology awareness among medical students.

CONCLUSION

Overall, the findings of the present study indicate that while undergraduate medical students possess a basic understanding of chronopharmacology, important gaps remain in translating this knowledge into clinical decision-making. Given the growing role of chronotherapy in the management of various diseases, incorporation of chronopharmacological concepts into undergraduate teaching may help future physicians develop a more rational and patient-centred approach to prescribing medications.

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REFERENCES

1. Vaishnav DH, Balat JD, Trivedi HR. Study of chronopharmacology and drug prescribing pattern in tertiary care hospital. *Int J Sci Res.* 2024;13(4):890–3.
2. Motghare VM, Faruqui AA, Dudhgaonkar S, Turankar AV. Chronopharmacology. In: Seth SD, Seth V, editors. *Textbook of Pharmacology*. 3rd ed. Elsevier India. 2009.
3. Pankaj A, Tom B, Narasimhaiah MG, Kalaburgi RA. Chronopharmacology: an insight into its knowledge among medical students. *Int J Basic Clin Pharmacol.* 2023;12(1):83–7.
4. Devangi RD, Shashirekha CH, Shruthi SL. A study of chronopharmacological relevance of antihypertensive drugs at a tertiary care hospital: a prospective observational study. *Natl J Physiol Pharm Pharmacol.* 2018;8(3):446–52.
5. Bairy LK. Chronotherapeutics: a hype or future of chronopharmacology. *Indian J Pharmacol.* 2013;45(6):545–6.
6. Abilesh HR, Josephine IG, Panjwani S, Nivedhitha N. Assessment of knowledge, attitude and behaviour related to chronopharmacology among doctors in a tertiary care hospital. *Int J Toxicol Pharmacol Res.* 2024;14(7):129–33.
7. Vandna, Patidar A, Tiwari RN, Gupta S. Assessment of knowledge and awareness about chronopharmacology among postgraduate medical students of Government Medical College, Rewa (MP). *Int J Pharm Clin Res.* 2024;16(12):13–7.
8. Devangi D, Shashirekha CH, Shruthi SL. Analysis of clinical relevance of chronopharmacology in therapy of respiratory disorders in a tertiary care hospital: a

- prospective observational study. *Indian J Pharm Pharmacol.* 2017;4(4):184–7.
9. Nandave M, Patel D, Chandarana A, Prakash A. Chronopharmacology: diurnal variation of drug action. In: Medhi B, Prakash A, editors. *Advanced Pharmacology*. 2nd ed. Hyderabad: PharmaMed Press. 2015: 35–49.
10. Pichholiya M, Yadav AK, Gupta S. Knowledge and practices of chronotherapeutics among health-care professionals in a tertiary care teaching institute of South Rajasthan. *Natl J Physiol Pharm Pharmacol.* 2021;11(7):751–5.
11. Kohli K, Gupta M. Role of chronopharmacology in therapeutics. *Contemporary perspectives on clinical pharmacotherapeutics*. 1st ed. New Delhi: Elsevier. 2006: 835–40.
12. Gnocchi D, Bruscalupi G. Circadian rhythms and hormonal homeostasis: pathophysiological implications. *Biology (Basel)*. 2017;6(1):10.

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