Open Access

ORIGINAL ARTICLE

Problematic mobile phone use and sleep quality in medical students: A cross-sectional study

Rabia Rasheed[1], Umbreen Navied[1], Humayun Mirza[1], Hina Ali[1], Ayesha Mansoor[1], Bensih Ziasahi[1]

Department of Community Medicine, Lahore Medical and Dental College, Lahore, Pakistan[1]

ABSTRACT

Background: Mobile phone usage has increased significantly, with estimates of more than 1.5 billion users worldwide.
Objective: To assess the level of problematic mobile phone use and its association with sleep quality among medical students.
Methods: It was a cross-sectional study conducted at Lahore Medical and Dental College, Lahore, from August 2021 to February 2022. Medical students in the MBBS program who were using a mobile (smart) phone between 21 and 23 years of age, male or female, and involved in clinical rotations were included in the study. A convenience sampling technique was used. A structured questionnaire was administered, comprising demographic data, the Problematic Use of Mobile Phones (PUMP) scale, and the Pittsburgh Sleep Quality Index (PSQI). Data was analyzed using SPSS 21. The Chi-square test was used to examine the associations between PUMP and PSQI.
Results: Out of the 256 participants, 181 (71%) scored <62 on the PUMP scale, indicating non-problematic mobile phone use. In contrast, 75 students (29.3%) had PUMP scores ≥62 and were classified as problematic mobile phone users with a statistically significant difference in PUMP scores between problematic and non-problematic users ($p < 0.001$). Regarding sleep quality, 163 participants (63.6%) had a PSQI score above 5, indicating poor sleep quality, whereas 93 (36.3%) had a score below 5, indicating good sleep quality. Problematic mobile phone use did not differ significantly across demographic groups, while sleep quality differed significantly by residence, with poorer sleep quality observed among hostel residents ($p = 0.037$). The association between PUMP and PSQI was statistically not significant ($p = 0.134$).
Conclusion: Problematic mobile phone use was not associated with poor sleep quality among medical students.

Key Words: Problematic Mobile Phone, Mobile Phone, Students, Medical, Sleep, Sleep Quality

DOI: https://doi.org/10.53685/jshmdc.v6i2.262

Corresponding Author:
Rabia Rasheed
Medical Social Worker
Department of Community Medicine, Lahore Medical and Dental College, Lahore, Pakistan.
Email address: rabia.rasheed@ubas.edu.pk
Received: 25.09.24, 1st Revision: 23.05.25
2st Revision: 01.10.25, Accepted 16.11.25

……
……
……
……
……

How to cite this article: Rasheed R, Navied U, Mirza H, Ali H, Mansoor A, Ziasahi B. Problematic mobile phone use and sleep quality in medical students: A cross-sectional study: J Shalamar Med Dent Coll. 2025; 6(2): 83-89. doi: https://doi.org/10.53685/jshmdc.v6i2.262

INTRODUCTION

Mobile phones have become an integral part of daily life, and there are growing concerns about their excessive use across all age groups. Research indicates that smartphones are often used for stimulation and mood regulation, which may reinforce patterns of problematic use.[1] Problematic mobile phone use has been reported to range from 10.0% to 38.5% worldwide.[2] Easy access to the internet, even in developing countries such as Pakistan, has significantly contributed to the growing dependency on mobile phones.[3] In Pakistan, smartphone penetration rose from 10% in 2014 to 51% by 2020, with similar upward trajectories observed worldwide.[4]

Mobile phone use is typically unstructured and lacks defined start or stop times, which often displaces essential activities such as sleep. Prolonged and

sometimes unconscious use further aggravates sleep-related problems, emphasizing the need for greater awareness and targeted interventions, particularly among younger populations.[5]

Problematic mobile phone use has been strongly associated with sleep disturbances among adolescents and young adults.[6] Evidence suggests that shorter weekday sleep duration is associated with higher levels of smartphone dependence.[7] Night-time phone use, such as texting, browsing, or calling after lights-out, has been shown to impair sleep quality, increase fatigue, and contribute to insomnia, ultimately leading to excessive daytime sleepiness and reduced perceived sleep quality.[8]

Although global evidence highlights a link between mobile phone use and sleep disturbances, there is limited regional research on this issue among medical students. This gap restricts the development of context-specific interventions tailored to local needs. Understanding the relationship between mobile phone use and sleep quality is critical, as sleep disturbances not only hinder academic performance but also negatively impact mental health and overall well-being. Generating such evidence can guide preventive measures, encourage healthier digital habits, and support the academic and personal well-being of future healthcare professionals. Therefore, this study was conducted to determine the association between mobile phone use and sleep quality among medical students.

METHODS

A cross-sectional study was conducted at Lahore Medical and Dental College, Lahore, Pakistan, from August 2021 to February 2022. The medical students of the MBBS program involved in the clinical rotations (fourth and final year), who were using a mobile (smart) phone, between 21 and 23 years of age, both male and female, were included in the study. A non-probability convenience sampling technique was used to recruit eligible participants. The sample size was calculated using OpenEpi. Assuming an anticipated prevalence of 48%[6] of problematic mobile phone use, 99.99% confidence interval, and a margin of error of 5%, the minimum required sample size was calculated to be 251 participants from a total population of 300 medical students. To compensate for potential incomplete responses and data, the sample size was increased, and 256 students were ultimately included in the study, which was considered sufficient to achieve the desired statistical precision.

Informed consent was obtained from each participant before data collection. Students were excluded based on antipsychotic drug use / mental illness, recent history of trauma, or any chronic disorder. Data was collected using a structured, self-administered, validated questionnaires[9,10] consisting of three sections:

Section I: Comprised of demographic and baseline information such as age, gender, year of study, and place of residence.

Section II: Assessed mobile phone usage using the Problematic Use of Mobile Phones (PUMP) scale.[9] This 20-item validated questionnaire evaluated the extent of problematic mobile phone behaviours. The responses were recorded on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (agree), yielding a total score between 20 and 100. Participants scoring below 62 on the PUMP scale were categorized as having non-problematic mobile phone use. [9]

Section III: Evaluated the sleep quality using the Pittsburgh Sleep Quality Index (PSQI).[10] This is a standardized instrument comprising 19 items grouped into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The global PSQI score ranges from 0 to 21, with higher scores indicating poorer sleep quality. A global score >5 denotes poor sleep quality, while scores ≤5 indicate good sleep.[10]

Ethical Approval

The institutional review board and ethical committee (IRB & EC) of Lahore Medical and Dental College, Lahore, approved the study (LM&DC/6631-32/2021) on 25th June 2021. Informed consent was obtained from study participants, with assurances that confidentiality would be maintained.

Statistical Analysis

Data was entered and analysed using the Statistical Package for the Social Sciences (SPSS), version 21. Categorical data were reported using frequencies and percentages. The Chi-square test was used to assess the association between PUMP scores and PSQI scores, as well as between the PUMP scores and demographic variables such as academic year,

gender, and place of residence. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

A total of 256 medical students undertaking clinical rotations participated in the study, comprising 141 (55.1%) in the fourth year and 115 (44.9%) in the final year of the MBBS. Among the participants, 138 (53.9%) were female, and 118 (46.1%) were male. A substantial proportion of participants exhibited problematic mobile phone use, with nearly one-third classified as problematic users (29%). A statistically significant difference in PUMP scores was observed between problematic and non-problematic users (p < 0.001), demonstrating a clear distinction between the two groups (Table 1). Poor sleep quality was prevalent among the study population, affecting more than half of the participants. Although participants with poor sleep quality showed higher PSQI scores compared to those with good sleep quality, this difference did not reach statistical significance (p = 0.096) (Table 1). There was no significant association found between the problematic mobile phone use and sleep quality (p=0.134) (Table 2). Problematic mobile phone use did not differ significantly across year of clinical rotation, gender, or residence status (p > 0.05 for all comparisons). Similarly, sleep quality was not significantly associated with year of clinical rotation or gender (p > 0.05). However, residence status was significantly associated with sleep quality, with hostel residence linked to poorer sleep quality (p = 0.037) (Table 3).

Problematic mobile phone use was significantly associated with year of study, with final-year students exhibiting a higher prevalence than fourth-year students ($\chi^2 = 4.509$, $p = 0.034$). Residence status was also significantly associated with problematic mobile phone use, with hostel residents exhibiting a greater tendency toward problematic use than day scholars ($\chi^2 = 4.352$, $p = 0.037$). In contrast, gender was not significantly associated with problematic mobile phone use, indicating comparable usage patterns among male and female students ($p = 0.694$) (Table 4). A significant association was observed between students' residence and sleep quality ($p = 0.002$). Good sleep quality was more commonly observed among day scholars, whereas poor sleep quality was proportionally more prevalent among hostel residents (Table 5).

Table 1: Distribution and comparison of participants according to problematic use of mobile phone (PUMP) and Pittsburgh sleep quality index (PSQI) scores

Variables	n (%)	Scores mean±SD	p-value
Problematic use of mobile phone (PUMP)			
Not Problematic (<62)	181(70.7)	50.02±9.42	<0.001[a]*
Problematic user (≥62)	75(29.30)	70.00±5.73	
Pittsburgh Sleep Quality Index (PSQI)			
Good sleep quality (≤5)	93(36.30)	6.75±3.12	0.096[a]
Poor sleep quality (>5)	163(63.7)	7.47±3.20	

[a]*Independent samples t-test was applied. *p-value < 0.05 was considered statistically significant.*

Table 2: Association of problematic use of mobile phone (PUMP) with Pittsburgh sleep quality index (PSQI)

PUMP Category	Pittsburgh Sleep Quality Index (PSQI)		Total n (%)	χ^2/p-value
	Good Sleep (PSQI ≤5) n (%)	Poor Sleep (PSQI >5) n (%)		
Not problematic (score <62)	71 (76.3)	110 (67.5)	181 (70.7)	
Problematic (score ≥62)	22 (23.7)	53 (32.5)	75 (29.3)	2.244/0.134[a]
Total	93 (100)	163 (100)	256 (100)	

[a]*Chi-square test was applied. p-value < 0.05 was considered statistically significant.*

Table 3: Comparison of problematic mobile phone use (PUMP) scale scores and Pittsburgh sleep quality index (PSQI) scores across demographic subgroups of the study population

Variables	PUMP Score mean±SD	p-value	PSQI score mean±SD	p-value
Clinical rotation				
Fourth year	56.77±12.08	0.206[a]	6.87±3.06	0.607[a]
Fifth year	54.78±12.87		7.07±3.28	
Gender				
Male	57.28±12.72	0.095[a]	6.80±2.95	0.453[a]
Female	54.67±12.14		7.09±3.32	
Residence				
Day scholar	56.20±12.87	0.501[a]	6.70±3.27	0.037[a]*
Reside in hostel	55.03±11.34		7.62±2.74	

[a]*Independent samples t-test was applied. *p-value < 0.05 was considered statistically significant.*

Table 4: Association of problematic use of mobile phone (PUMP) with respect to year of clinical rotation, gender and residence

Demographic characteristics	Mobile phone Users		Total n (%)	χ^2/p-value
	Non- Problematic (score<62) n (%)	Problematic (score≥62) n (%)		
Clinical rotation				
Fourth year	92 (50.80)	49(65.30)	141(55.10)	
Fifth year	89 (49.20)	26(34.70)	115(44.90)	4.509/0.034[a]*
Total	181(100.0)	75(100.0)	256(100.0)	
Gender				
Male	82 (45.30)	36(48.00)	118(46.07)	
Female	99 (54.70)	39(52.00)	138(53.90)	0.155/0.694[a]
Total	181(100.0)	75(100.0)	256(100.0)	
Residence				
Day scholar	124(68.50)	57(81.30)	181(70.70)	
Reside in hostel	61 (31.50)	14(18.70)	75 (29.30)	4.352/0.037[a]*
Total	181(100.0)	75(100.0)	256(100.0)	

[a]*Chi-square test was applied. *p-value <0.05 was statistically significant.*

Table 5: Association of Pittsburgh Sleep Quality Index (PSQI) with respect to clinical rotation year of study, gender and residence

Demographic characteristics	Pittsburgh Sleep Quality Index (PSQI)		Total n (%)	χ^2/p-value
	Good Sleep (PSQI ≤5) n (%)	Poor Sleep (PSQI >5) n (%)		
Clinical rotation				
Fourth year	50(53.80)	91 (55.80)	141(55.10)	
Fifth year	43(46.20)	72 (44.20)	115(44.90)	0.102/0.749[a]
Total	93(100.0)	163(100.0)	256(100.0)	
Gender				
Male	45(48.40)	73 (44.80)	118(46.10)	
Female	48(51.60)	90 (55.20)	138(53.90)	0.309/0.578[a]
Total	93(100.0)	163(100.0)	256(100.0)	
Residence				
Day scholar	78(83.90)	107(65.60)	185(72.30)	
Hostel resident	15(16.10)	56 (34.40)	71 (27.70)	9.815/0.002[a]*
Total	93(100.0)	163(100.0)	256(100.0)	

[a]*Chi-square test was applied. *p-value <0.05 was statistically significant.*

DISCUSSION

The present study aimed to explore the patterns of mobile phone use and sleep quality among medical students. Findings revealed that a considerable proportion of the participants exhibited problematic mobile phone use, while the majority reported poor sleep quality. These findings align with a previous study in which over 40% of the medical students reported problematic smartphone use, highlighting

the growing concern over excessive mobile phone dependence amongst students in healthcare training programs.[11]

In the present study, slightly less than one-third of the participants reported poor sleep quality. Similarly, an Indian study conducted among medical students reported that approximately 63% of students experienced sleep deprivation, which was strongly linked to problematic smartphone use and longer daily screen time, resulting in lower-quality sleep and more psychological stress.[12] The lower frequency in our study might be due to more regulated daily routines and comparatively lower smartphone and screen usage among our participants, which could have contributed to better sleep quality. Additionally, cultural and environmental factors, such as earlier bedtimes, early wake times for prayer, supportive family routines, and greater awareness of sleep hygiene, may have contributed to mitigating sleep disturbances.

Interestingly, no significant association was found between problematic mobile phone use and PSQI scores in this study. Although students with problematic mobile use tended to report poor sleep, this association did not reach statistical significance. This finding is consistent with previous studies, which have reported that problematic smartphone use often affects specific components of sleep—such as sleep latency, disturbances, and daytime dysfunction—rather than the overall global sleep quality score. [13]

Additionally, problematic smartphone use is primarily a psychological construct, reflecting dependency, compulsive behaviours, and associated stress or anxiety, rather than the total duration or timing of phone use that directly disrupts sleep.[14] Consequently, its impact on sleep may be indirect or mediated through behaviours like bedtime procrastination, delayed sleep onset, or stress-related arousal, which are not fully captured by the PSQI global score. Differences in sample characteristics, usage patterns, and environmental factors can further weaken a direct correlation in cross-sectional analyses. Although high smartphone use is associated with poor sleep patterns, a statistically significant direct association with global sleep quality may not always be evident.

In contrast, numerous previous studies have found a significant association between problematic smartphone use and poor sleep quality, suggesting that excessive mobile phone use—especially before bedtime—may delay sleep onset, reduce sleep duration, and lead to daytime dysfunction.[15,16] Some studies, for instance, have shown that mobile phone use may contribute to poor sleep due to cognitive stimulation and light exposure at night,[17,18] while others indicate that students with good self-regulation may limit mobile use before bed, thus reducing its impact on sleep.[19]

There was a statistically significant association between year of clinical rotation and problematic mobile phone use, with a notably higher prevalence among fourth-year students compared to final-year students. More than 60% of problematic users were fourth-year students, suggesting that students at earlier stages of medical training may be more vulnerable to excessive mobile phone use. This trend is consistent with prior research reporting greater smartphone addiction among students in junior academic years, possibly due to lower academic pressure and more unstructured time.[20]

Residence status was also significantly associated with mobile phone use. Day scholars reported a higher prevalence of problematic mobile phone use compared to hostel residents. This observation is supported by a previous study, where students living at home exhibited higher smartphone addiction scores, possibly due to fewer restrictions, greater privacy, and less supervision over screen use.[21]

However, no significant association was found between gender and problematic mobile phone use in the present study. These findings are consistent with other research indicating that both male and female students exhibit similar patterns of problematic mobile phone use, suggesting that gender may not play a determining role in mobile phone addiction among university students .[22]

Sleep quality was also significantly associated with place of residence. Hostel residents had poorer sleep quality compared to day scholars. These results align with earlier findings that students residing in hostels often face environmental challenges such as noise, peer disturbance, and lack of routine, all of which can negatively affect sleep quality.[23]

CONCLUSION

Although a considerable proportion of medical students demonstrated problematic mobile phone use and poor sleep quality, no statistically significant

association was observed between problematic mobile phone use and sleep quality. Problematic mobile phone use was more prevalent among students in advanced clinical years, particularly fourth-year students. Sleep quality varied significantly by residence: hostel residents reported poorer sleep, whereas day scholars reported higher rates of problematic phone use but relatively better sleep quality.

Limitations and future recommendations

This study included only fourth- and final-year MBBS students; therefore, the findings may not be generalizable to students in earlier years of the MBBS program. The reliance on self-reported questionnaires introduces the possibility of recall and social desirability bias; furthermore, the cross-sectional design limits causal inference regarding the association between problematic mobile phone use and sleep quality.

Future research should include students from all MBBS years, particularly preclinical students (1st–3rd year), to better assess trends in mobile phone use and their potential long-term impact. Educational institutions are encouraged to implement regular counselling sessions and awareness programs highlighting the risks and consequences of problematic mobile phone use. Additionally, hostel living conditions should be evaluated to identify factors contributing to poor sleep quality, and targeted interventions to promote healthy sleep hygiene among hostel residents should be considered.

REFERENCES

1. Gligor Ş, Mozoș I. Indicators of smartphone addiction and stress score in university students. Wien Klin Wochenschr. 2019; 131: 120–125. doi: 10.1007/s00508-018-1373-5.
2. Gao L, Zhang J, Xie H, Nie Y, Zhao Q, Zhou Z. Effect of the mobile phone-related background on inhibitory control of problematic mobile phone use: an event-related potentials study. Addict Behav. 2020; 108: 106363. doi: 10.1016/j.addbeh.2020.106363.
3. Raza SH, Naqvi SMH, Zehra F, Rana RF, Naqvi SMA, Niazi MI, et al. Prevalence of internet addiction and its associated factors among adolescents in private education institutes in Sargodha, Pakistan. J Basic Clin Med Sci. 2025;4(1):4-14. doi:10.58398/0002.000021.
4. Waqas E, Altay S, Naeem G. Smartphone use and well-being in Pakistan: comparing the effect of self-reported and actual smartphone use. Digit Health. 2023; 9. doi: 10.1177/20552076231186075.
5. Sohn SY, Rees P, Wildridge B, Kalk NJ, Carter B. Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: a systematic review, meta-analysis and GRADE of the evidence. BMC Psychiatry. 2019; 19: 356. doi: 10.1186/s12888-019-2350-x.
6. Kamal S, Kamal S, Mubeen SM, Shah AM, Samar SS, Zehra R, et al. Smartphone addiction and its associated behaviors among medical and dental students in Pakistan: A cross-sectional survey. J Educ Health Promot. 2022; 11(1): 220. doi: 10.4103/jehp.jehp_494_21
7. Siebers T, Beyens I, Baumgartner SE, Valkenburg PM. Adolescents' digital nightlife: the comparative effects of day- and nighttime smartphone use on sleep quality. Commun Res. 2024. doi: 10.1177/00936502241276793
8. Chu Y, Oh Y, Gwon M, Hwang S, Jeong H, Kim HW et al. Dose-response analysis of smartphone usage and self-reported sleep quality: a systematic review and meta-analysis of observational studies. J Clin Sleep Med. 2023; 19(3) :621-630. doi: 10.5664/jcsm.10392.
9. Merlo LJ, Stone AM, Bibbey A. Measuring Problematic Mobile Phone Use: Development and Preliminary Psychometric Properties of the PUMP Scale. J Addict. 2013; 2013: 912807. doi: 10.1155/2013/912807.
10. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989; 28(2): 193–213. doi: 10.1016/0165-1781(89)90047-4.
11. Candussi CJ, Kabir R, Sivasubramanian M. Problematic smartphone usage, prevalence and patterns among university students: A systematic review. J Affect Disord Rep. 2023; 14: 100643. doi: 10.1016/j.jadr.2023.100643.
12. Chatterjee S, Kar SK. Smartphone Addiction and Quality of Sleep among Indian Medical Students. Psychiatry. 2021; 84(2): 182-191. doi: 10.1080/00332747.2021.1907870.
13. Exelmans L, Van den Bulck J. Bedtime mobile phone use and sleep in adults. Soc Sci Med. 2016 ;148:93-101. doi: 10.1016/j.socscimed.2015.11.037.
14. Mohammadbeigi A, Absari R, Valizadeh F, Saadati M, Sharifimoghadam S, Ahmadi A, et al. Sleep quality in medical students; the impact of over-use of mobile cellphone and social networks. J Res Health Sci. 2016; 16(1): 46–50. PMCID: PMC7189085.
15. Feng Z, Diao Y, Ma H, Liu M, Long M, Zhao S, et al. Mobile phone addiction and depression among Chinese medical students: the mediating role of sleep quality and the moderating role of peer relationships. BMC Psychiatry. 2022; 22: 567. doi: 10.1186/s12888-022-04183-9.
16. Saman JA, Valinejadi A, Mohammadi S, Karimpor H, Mirzaei M, Kawyannejad R. Assessment of relationship between the use of cell phone and social networks and sleep quality in students of medical sciences: a cross-sectional study. Interv Med Appl Sci. 2020; 11(3): 131–135. doi: 10.1556/1646.10.2018.3.
17. Leow MQ, Chiang J, Chua TJ, Wang S, Tan NC. The relationship between smartphone addiction and sleep among medical students: A systematic review and meta-analysis. PLoS One. 2023; 18(9): e0290724. doi: 0.1371/journal.pone.0290724.
18. Terzi H, Ayaz-Alkaya S, Köse-Kabakcıoğlu N. Nomophobia and eHealth literacy among adolescents: A cross-sectional study. J Pediatr Nurs. 2024; 75: 158-63. doi: 10.1016/j.pedn.2023.12.024.
19. Amin MH, Alhadi HA, Mohamed AE, Yacoub HK, Khalifa RM, Dafallah IA, et al. Impact of smartphone addiction on health status, mental well-being, and sleep quality among medical students in Sudan. BMC Psychiatry. 2024; 24(1): 965. doi: 10.1186/s12888-024-06377-9.

20. Alhazmi AA, Alzahrani SH, Baig M, Salawati EM, Alkatheri A. Prevalence and factors associated with smartphone addiction among medical students at King Abdulaziz University, Jeddah. Pak J Med Sci. 2018; 34(4):984-988. doi: 10.12669/pjms.344.15294.
21. Aftab T, Khyzer E. Smartphone addiction and its association with hypertension and quality of sleep among medical students of Northern Border University, Arar, Saudi Arabia. Saudi Med J. 2023; 44(10): 1013 1019. doi: 10.15537/smj. 2023.44.10.20230402.
22. Almetwally A, El Manzalawy SF, Adel M, Hassan ME. Impact of smartphone use at bedtime on sleep quality and academic activities among medical students at Al Azhar University, Cairo. J Public Health (Berl). 2024; 32(2): 2091-2100. doi: 10.1007/s10389-023-01964-8.
23. Li Y, Li GX, Yu ML, Liu CL, Qu YT, Wu H. Association between anxiety symptoms and problematic smartphone use among Chinese university students: the mediating/ moderating role of self-efficacy. Front Psychiatry. 2021; 12: 581367. doi: 10.3389/fpsyt.2021.581367.

AUTHOR'S CONTRIBUTIONS:

RR: Conceptualization of the study, data analysis, critical revision of the manuscript, final approval of the version to be published.

UN: Study design, data acquisition, manuscript drafting, final approval of the version to be published.

HM: Interpretation of data, manuscript drafting, critical review, final approval of the version to be published.

HA: Data acquisition and analysis, critical revision of the manuscript, final approval of the version to be published.

AM: Conception of the study, data collection, manuscript drafting, final approval of the version to be published.

BZ: Study design, data analysis, manuscript drafting, final approval of the version to be published.

All authors agreed to be accountable for all aspects of the work, ensuring that any questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

CONFLICT OF INTEREST:

All authors declared no conflict of interest.

GRANT SUPPORT AND FINANCIAL DISCLOSURE:

No specific grant was taken for this research from any funding agency in the public, commercial or not-for-profit sectors.

DATA SHARING STATEMENT:

The data are available from the corresponding author upon request.

……..……..……