Smartphone Addiction and Sleep Among Medical Students: A Protocol for Systematic Review and Meta-Analysis

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Abstract. Introduction: The widespread use of smartphones has transformed daily life. Despite the many positive benefits of using smartphones, concerns have been raised about potential problematic use and addiction among specific cohorts, including medical students. The present systematic review and meta-analysis aims to examine the relationship between smartphone addiction and its effects on sleep quality among the medical students. **Methods and analysis:** The research team will search the *Medline (PubMed), Scopus, Web of Science, PsycINFO* and *Google Scholar,* electronic databases from January 1994 to December 31, 2024, using truncated and phrase-searched keywords (MeSH terms). Observational or descriptive designed studies published in English, focusing on smartphone addiction and sleep, using validated psychometric tools for assessing sleep and smartphone addiction among medical students will be included. The review will be conducted using a three-step sequential search strategy and screening process. The Rayyan application will be used for title-abstract screening, and the Joanna Briggs Institute (JBI) critical appraisal checklist for quality assessment will be used. The meta package in R 4.4.2 statistical software will be used for testing heterogenicity and meta-synthesis. All extracted data will be documented following PRISMA-P guidelines, and a narrative synthesis will be conducted on relevant factors that cannot be meta-analyzed. **Ethics and dissemination:** The review will synthesize evidence from published studies without any primary data collection. Therefore, no ethical clearance will be required. However, the insights from the review will be shared with broader scientific community via oral presentation (conferences or webinars) and written formats, including an internationally peer-reviewed journal.

Keywords: Protocol**,** Review, Sleep, Smartphone, Addiction, Medical Students.

Introduction

The rapid advancement in technology has led to the emergence of many digital devices (such as the smartphone) which make people's lives easier (McNutt et al., 2024). Smartphones have become a daily essential in contemporary society, and 4.3 billion individuals worldwide own a smartphone (54%) (Leow et al., 2023). Moreover, the global number of smartphone users is expected to be 6.2 billion users by 2029 (Statistics, 2024). Based on the Word Bank income classifications, 45% of adults in emerging economies own a smartphone compared to 76% in advanced economies (Silver, 2019). In 2023, internet users spent an average of six hours and 35 minutes online daily (including smartphone use), indicating a nearly 1% decrease from the previous year (Statistics & Facts, 2024). Moreover, a recent systematic review and meta-analysis reported that the mean duration of smartphone use was 4.90 hours daily (Leow et al., 2023).

Smartphone addiction (SA) is viewed by a growing number of scholars a behavioral addiction characterized by uncontrollable urges to use the smartphone, withdrawal symptoms, mood swings, and conflicts in daily life (Kwon et al., 2013; Ratan et al., 2021). Smartphones have revolutionized communication in terms of social connectivity, educational resources, access to information, and productivity, but for a minority of individuals (particularly adolescents and emerging adults), smartphone use can be potentially addictive (Vujic & Szabo, 2021). Screen time refers to the time spent using devices such as computers, tablets, smartphones, televisions, or game consoles(Biddle et al., 2017; Liebig et al., 2023). According to Australian guidelines (2018), for young people, no more than two hours of sedentary recreational screen time per day is recommended. However, the literature reports that excessive screen time is correlated with behavioral problems, poor mental health outcomes (e.g., depression), sleep, and poor academic achievement (Eirich et al., 2022).

Sleep is a public health issue. The prevalence of sleep disturbance among the global population varies widely ranging from 3.9% to 45% (Nelson et al., 2022). Poor sleep quality is an underreported problem (Filip et al., 2017), and increases the risk of depressive symptoms, anxiety, low life satisfaction and suicide (Barahona-Correa et al., 2018). In the long-run, poor or inadequate sleep (which is a modifiable risk factor) can become detrimental to health causing musculoskeletal disorders, chronic diseases, neurodegeneration, and Alzheimer's disease (Grandner et al., 2018; Ju et al., 2014).

Compared to students from other disciplines, medical students and doctors' sleep hours are inadequate and altered (Hasan et al., 2022) due to the nature of learning environment, the competitive nature of the discipline, and academic pressure (Rahman et al., 2024). A meta-analysis of 57 studies involving 25,735 medical students using Pittsburgh Sleep Quality Index (PSQI) found, 52.7% had poor sleep quality, with the highest rates in Europe, followed by the Americas, Africa, Asia, and Oceania (Rao et al., 2020).

Both smartphone addiction and longer screen time can have a detrimental impact on medical student's health, sleep quality, academic performance, and quality of life (QoL) (Liebig et al., 2023; Pagnin & De Queiroz, 2015; Samaha & Hawi, 2016; Shahrestanaki et al., 2020). A 2021 meta-analysis of 5497 Asian medical students reported that 41.93% of medical students had smartphone addiction (Zhong et al., 2022) compared to a meta-analysis reporting 22% smartphone addiction among 2780 nursing students (Osorio-Molina et al., 2021). Moreover, in a meta-analysis of worldwide studies among 18,619 medical students, the mean sleeping duration among medical students was reported to be 6.3 h/per night (Jahrami et al., 2020), and in a meta-analysis among 9466 medical students, it was reported their daily duration of smartphone use was 4.90 h/day (Leow et al., 2023). Smartphone addiction accounted for 6% of the variation of QoL in one study (Samaha & Hawi, 2016), and 62.05% of the variation in poor health status in another (Chatterjee & Kar, 2021), as well as being significantly correlated with poor academic performance and substance abuse among medical students (Liu et al., 2022; Ou-Yang et al., 2023). However, another study among medical students reported that although smartphone overuse increased napping in the classroom, it was not associated with overall learning outcomes (Boonluksiri, 2018). In addition, screen time < 2 h/day and sleep not more or less than 6 - 9 h/day had significant relationship with excellent academic performance as reported using a prediction algorithm (Almurtadha et al., 2022).

Smartphone addiction can negatively impact physical health, mental health status, and academic learning. Therefore, the present systematic review and meta-analysis aimed to examine the association between smartphone addiction on sleep among medical students. Additionally, it aimed to estimate the pooled prevalence of smartphone addiction, poor sleep, sleep duration and quality, and medical students' engagement in smartphone use, along with associated factors.

Aim and research question

The primary aim of the systematic review and meta-analysis is to explore the relationship between smartphone addiction, sleep quality, sleep quantity, and sleep disturbance among medical students. The secondary aim is to meta-analyze the prevalence of smartphone addiction and poor sleep, smartphone usage duration, types of smartphone activities, and the impact of smartphone use on sleep onset, duration, and daytime functioning. Additionally, it aims to explore potential moderating factors that may influence the relationship between smartphone use and sleep outcomes.

The Joanna Biggs Institute (JBI); PICO (Population, Exposure, Comparator, and Outcomes) (Munn et al., 2014), will be used to formulate the research question. Here, the exposure is smartphone addiction, the outcome is different aspects of sleep including, sleep quality, quantity, and disturbance, and the population is medical students. The research question

is "What is the relationship between smartphone addiction and sleep among medical students?"

Methods

Study design

The systematic review protocol will be carried out in accordance with the Preferred Reporting Items for Systematic Review and Meta-analysis Protocols (PRISMA-P) 2015 guidelines and reported using the PRISMA checklist (Page et al., 2021). The meta-analysis will be followed by the Meta-analysis of observational studies in Epidemiology (MOOSE) guidelines(Brooke et al., 2021). The protocol has been registered in PROSPERO (CDR 42024603342), allowing for transparent and rigorous research (Schiavo, 2019).

Eligibility criteria

The systematic review will include all empirical studies with available full texts, published from January 1, 1994 to December 31, 2024. This timeframe not only ensures the comprehensive inclusion of recent research but also captures a substantial body of literature, because the first smartphone, the IBM Simon Personal Communicator, was invented in 1992 and released in 1994 (Shen & Su, 2019). Only papers published in English with human participants (medical students) focused on smartphone addiction and sleep of medical students studying in either undergraduate or postgraduate medicine will be included. Quantitative studies which used an observation study design (e.g., cross-sectional studies, cohort studies, case-control) or any descriptive designed studies will be eligible for the review. However, those studies involving university students (undergraduate or postgraduate) that fail to specify the exact number of medical students focusing smartphone addiction related to sleep will be excluded from the review. In addition, the review will exclude review papers, reports, expert opinion papers, narratives, study protocols, books, book chapters, preprints, meeting abstracts, commentaries, and letters or editorials.

Information sources

The research team will screen major electronic databases including *Medline* (*PubMed*), *Scopus*, *Web of Science, PsycINFO* and *Google Scholar*, using a comprehensive and advanced search strategies. The search strategy will be based on the Medical Subject Headings (MeSH) heading to identify key search terms related to exposure and outcome, visualized using clustering of searched keywords in PubMed (Figure 1). By utilizing built-in filters in the specified databases, the team will tailor final search output results for maximum relevance and precision.
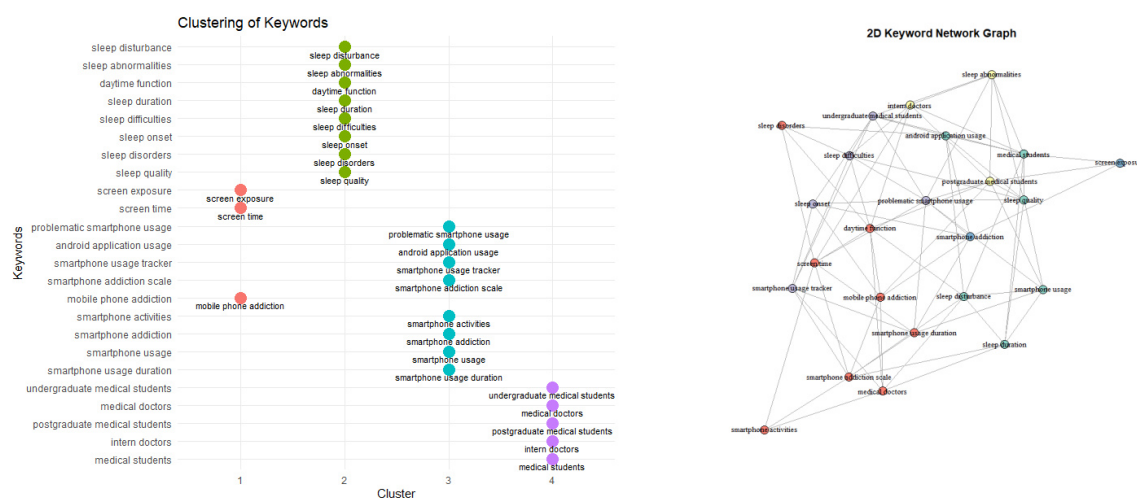
Figure 1: Cluster Analysis showing searched keywords from PubMed database
Clustering of keywords and network graph visualizing the relevant searching keywords across each domain of population (P), outcome (O), and exposure (E) group. In the clustering keywords color coding includes exposures (maroon), outcome (green and paste), population (purple).

Search strategy

The review will use a three-step sequential search strategy. Firstly, a preliminary search on *PubMed (Medline), Scopus*, *Web of Science, PsycINFO* and *Google Scholar* electronic databases will be conducted, followed by analyzing the keywords in the title and the indexed terms used to describe the theme of the study output (see Table 1 for indicative search terms to be used). Secondly, a comprehensive search using all the identified keywords and indexed terms across the included databases will be used to find additional papers. This process will be under the guidance of an expert in systematic review or a librarian. During the process, all different terminology and spelling variations of keywords (MeSH terms) will be taken into consideration, because these factors could influence the final search output (Table 1). Finally, an additional hand search from the reference lists and bibliographies of retrieved papers will be conducted to identify any further studies found in the initial screening process. Each step of the search process will be documented to ensure transparency and reproducibility.

Condition/domain being studied

The conditions being studied include the relationship between smartphone addiction and sleep (including, sleep quality, quantity, and disturbance) among medical students.

Population/Participants

The review will include students of all ethnicities, genders, and all over the world including medical students (bachelor in medicine or bachelor in dental surgery), undergraduate medical students (intern doctors, pre-clinical students, clinical students), and post-graduate medical students (residency or non-residency medical graduate trainees).

Exposure

Smartphone addiction.

Comparator (s)/Control

Not applicable. There will be no comparison group.

Context

Understanding relationship between smartphone addiction and sleep including sleep disturbances, sleep onset, duration, quality, and daytime functioning among medical students.

Exclusion criteria
For the paper to be excluded

1. Review papers, reports, expert opinion papers, narratives, study protocols, books, chapters, preprints, meeting abstracts, commentaries, and letters or editorials.
2. Studies not reporting any specified validated instrument for assessing sleep and smartphone addiction.
3. Full text inaccessible studies.
4. Papers not published in the English language.
5. Studies including university students without specifying the exact number of medical students.
6. Studies published before January 1, 1994.

For the population/ participants to be excluded

1. Non-medical students or any healthcare professionals (e.g., nurses) other than doctors or medical students.
2. Participants reporting or diagnosed with any diseases at baseline.

Outcome

The primary outcome is to explore how smartphone addiction affects the quality, quantity, and disruption of sleep among medical students. The secondary outcome is to analyze the prevalence of smartphone addiction, poor sleep, and smartphone use patterns, including the duration and types of activities, how time spent on smartphones impacts sleep onset, sleep duration, and daytime functioning. Additionally, the review will also examine the factors that might influence the relationship between smartphone use and sleep outcomes. The interrelationships between smartphone addiction, time spent on smartphones, smartphone use

types, sleep quality, and sleep disturbances among medical students will be explored, highlighting how the potential impacts of smartphone use may affect the well-being of medical students (Figure 3).
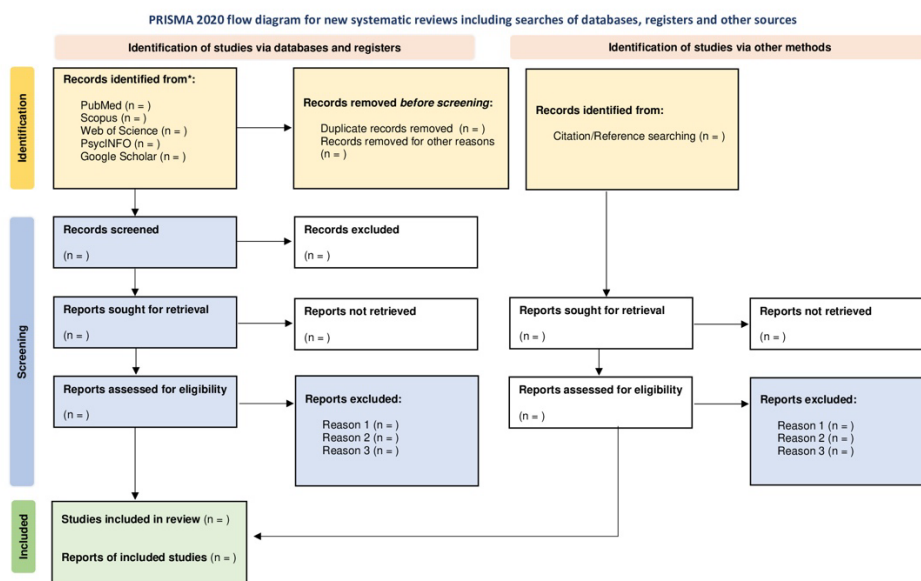
Figure 2: PRISMA flow diagram of study-selection process. (PRISMA- Preferred Reporting Items for Systematic Reviews and Meta-Analysis)
PRISMA flow diagram outlines the articles identification, screening and inclusion process. In systematic review the flow diagram keeps record for the entire screening process from the predefined database searching process.

Study records
Data management
        EndNote TM[21.0] reference management software (Clarivate Analytics, Philadelphia, USA) will be used to compile all the screened papers retrieved from the comprehensive search. The searched papers from the electronic databases and relevant references (if needed) will be compiled and duplications will be removed. The remaining papers will be exported to the web-based application 'Rayyan QCRI' to facilitate article title-abstract screening followed by full-text screening of the papers for review and collaboration among the team. Cause of exclusion will also be recorded in the Rayyan web application.

Selection process

To identify the studies that will qualify for inclusion in the review, two independent reviewers (IA, ATS) will independently be involved in the title-abstract screening, full-text screening, and appraisal of the included studies. In the Rayyan web application, blinding between the independent reviewers will be ensured throughout the process by separate assessment. A third reviewer (UKA) will resolve if any disagreements exist within the two reviewers through discussion. There will be a documented log of the reasons for exclusion. To visualize the number of retrievals, the process of including and excluding research papers in the study will be summarized using the PRISMA flow diagram (Figure 2).
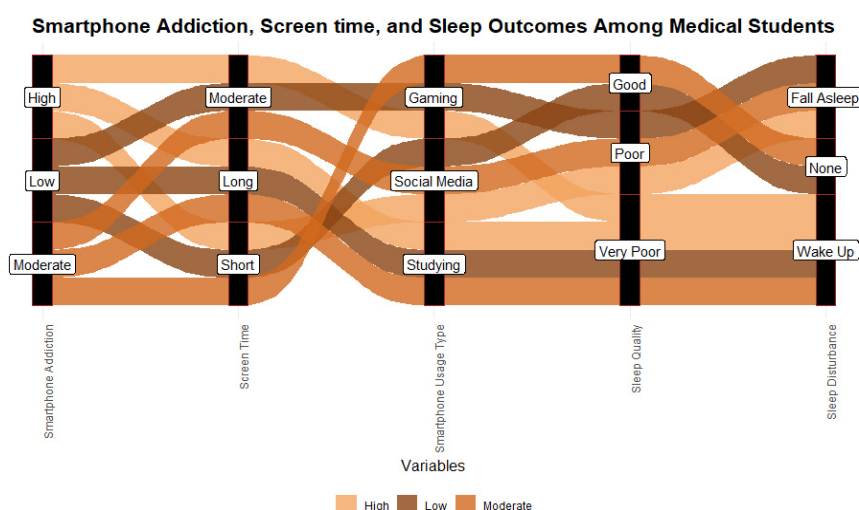
Figure 3: Interrelationship among smartphone addiction, screen time and sleep outcomes among medical students

The alluvial plot showing smartphone addiction, screen time, smartphone usage type, sleep quality and sleep disturbance grading (High, Low, Moderate) among the population (medical students) interpreting people with high smartphone addiction, long screen time for studying purposes had very poor sleep quality and walk up early for sleep disturbances.

Data extraction

Microsoft Excel spreadsheet (Microsoft Corporation, Washington, USA) will be used to carry out data extraction process. All relevant data from the final included studies will be incorporated into an Excel spreadsheet containing authors, year of publication, sample size, study design, assessment tools, participant characteristics, participant demographics, outcome measures, findings of the study, influencing factors, and conclusions of the study will be extracted from the papers. Furthermore, smartphone addiction and its relation to sleep will be evaluated by assessing the tools or scales used in the included studies

Risk of bias (quality) assessment

The Joanna Biggs Institute (JBI) critical appraisal checklist (for observational study design or descriptive design tool for the respective type screened papers) will be used to assess each study's risk of bias (Munn et al., 2014) and will be documented in Microsoft Excel spreadsheet. Both Cochran's Q statistic (low or high Q value) and the I^2-statistic (25 - 49.9%: Low heterogenicity, 50-74.9%: Moderate heterogenicity, $\geq$ 75%: High heterogenicity) will be used to assess whether and how much heterogenicity exists (Hoaglin, 2016). In addition, for a more comprehensive evaluation of heterogenicity, a prediction interval will also be used. The assessment of the risk of bias in studies will be conducted by two review authors (IA, ATS) independently and a third researcher (UKA).

Strategy for data synthesis

An advanced electronic search including *Medline* (*PubMed*), *Scopus*, *Web of Science, PsycINFO* and *Google Scholar* databases using the main keywords (MeSH terms). The PICO framework will be adopted based on the predefined inclusion criteria. To build the search strategy, a list of relevant indexed terms and keywords will be gathered from the existing literature, expert opinion, and if needed the search strategy will be refined accordingly before conducting preliminary search. A preliminary search in *PubMed (Medline)* database was performed using the attached keywords in the initial stage in Table 1.

Table 1: Tentative search strategy using the PubMed database	
PubMed	1. ((((medical students[MeSH Terms]) OR (intern doctors[MeSH Terms])) OR (undergraduate medical students[MeSH Terms])) OR (postgraduate medical students[MeSH Terms])) OR (medical doctors[MeSH Terms]) AND 2. ((((smartphone[Title/Abstract]) OR (mobile phone[Title/Abstract])) OR (cellular phone[Title/Abstract])) OR (cell phone[Title/Abstract])) OR (digital device[Title/Abstract]) AND 3. ((((((addiction[Title/Abstract]) OR (dependence[Title/Abstract])) OR (compulsion[Title/Abstract])) OR (obsession[Title/Abstract])) OR (excessive[Title/Abstract])) OR (overuse[Title/Abstract])) OR (abuse[Title/Abstract]) AND 4. (((((((((sleep quality[MeSH Terms]) OR (sleep disorders[MeSH Terms])) OR (sleep onset[MeSH Terms])) OR (sleep difficulties[MeSH Terms])) OR (sleep duration[MeSH Terms])) OR (daytime function[MeSH Terms])) OR (sleep abnormalities[MeSH Terms])) OR (sleep disturbance[MeSH Terms])) OR (((sleep difficulties[MeSH Terms]) OR (insomnia[MeSH Terms])) OR (sleep irregularity[MeSH Terms]))
Combined	#1 AND #2 AND #3 AND #4

The "meta package" in R statistical software will be used for meta-analysis (Balduzzi et al., 2019) and further visualization. The studies reporting odds ratio, will be converted into correlation coefficients to allow pooling of data and easy interpretability (Cleophas et al., 2017). Additionally, studies reporting median scores will be converted into means and standard deviations for better comparability across the included studies based on a formula by Hozo et al. (Hozo et al., 2005). The random effect liner model (REML) will be used if heterogenicity (I^2 statistic) is higher than 50% (moderate heterogenicity), otherwise, the fixed-effect model (FEM) will be used (Higgins et al., 2003) and will be visualized using a forest plot (Hansen et al., 2022). Funnel plot for asymmetry tests and Egger's test will

be conducted among the included studies to analyze the possibility of publication bias. However, a narrative synthesis may be carried out, if quantitative synthesis is not possible.

Patients and Public Involvement

The present systematic review protocol aims to explore the relationship between smartphone addiction and sleep among medical students globally, providing insight into a crucial issue affecting well-being. No patients OR public are directly involved in this research.

Ethics and Dissemination

The study will bring together evidence from existing literature. Therefore, ethical approval will not be needed because no new data will be collected. A manuscript will be written and submitted to an international peer-reviewed journal, adhering to PRISMA and PRISMA-NMA guidelines. The authors also plan to share the research findings widely through webinars, national or international conferences and other relevant platforms, ensuring the insights reach broad scientific and non-scientific communities.

RELATIVE CONTRIBUTIONS

MR conceptualized the review with UKA and MDG providing expert guidance on its design. MR lead the drafting of protocol manuscript. MR, IA, SST and ATS will handle articles screening. UKA and MDG will contribute to revising manuscript for intellectual content. All authors read and approved the final version of the protocol manuscript, with MR taking sole responsibility for the overall content of the protocol (as guarantor).

COMPETING INTERESTS

The authors declare no competing of interest.

ETHICS APPROVAL

Not required. The study will review secondary data, and therefore no formal ethical approval will be required.

DECLERATIONS

We declare that this paper has not been under consideration by, any other journal for publication. Furthermore, no significant portion of this paper has been published previously or is currently being considered for publication elsewhere. In addition, a version of this paper has not been presented at any conference.

References

Almurtadha, Y., Mohammed, O. S., Mirghani, H., & Ghaleb, M. (2022). Investigating the Relationship Between Medicine Student's Lifestyle and Their Academic Performance. Proceedings of International Conference on Emerging Technologies and Intelligent Systems: ICETIS 2021 Volume 2,

Austrilian Institute of Family StudiesToo much time on screens? Screen time effects and guidelines for children and young people. (2021). https://aifs.gov.au/resources/short-articles/too-much-time-screens#:~:text=For%20screen%20time%2C%20the%20guidelines%20recommend:%20*,people%20aged%205%E2%80%9317%20years%20(not%20including%20schoolwork)

Balduzzi, S., Rucker, G., & Schwarzer, G. (2019). How to perform a meta-analysis with R: a practical tutorial. *Evid Based Ment Health*, *22*(4), 153-160. https://doi.org/10.1136/ebmental-2019-300117

Barahona-Correa, J. E., Aristizabal-Mayor, J. D., Lasalvia, P., Ruiz, A. J., & Hidalgo-Martinez, P. (2018). Sleep disturbances, academic performance, depressive symptoms and substance use among medical students in Bogota, Colombia. *Sleep Sci*, *11*(4), 260-268. https://doi.org/10.5935/1984-0063.20180041

Biddle, S. J., Bengoechea García, E., Pedisic, Z., Bennie, J., Vergeer, I., & Wiesner, G. (2017). Screen time, other sedentary behaviours, and obesity risk in adults: a review of reviews. *Current obesity reports*, *6*, 134-147.

Boonluksiri, P. (2018). Effect of smartphone overuse on sleep problems in medical students. *The Asia Pacific Scholar*, *3*(2), 25.

Brooke, B. S., Schwartz, T. A., & Pawlik, T. M. (2021). MOOSE reporting guidelines for meta-analyses of observational studies. *JAMA surgery*, *156*(8), 787-788.

Chatterjee, S., & Kar, S. K. (2021). Smartphone addiction and quality of sleep among Indian medical students. *Psychiatry*, *84*(2), 182-191.

Cleophas, T. J., Zwinderman, A. H., Cleophas, T. J., & Zwinderman, A. H. (2017). Transforming Odds Ratios into Correlation Coefficients: Correlation Coefficients as a Replacement of Odds Ratios. *Modern Meta-Analysis: Review and Update of Methodologies*, 233-242.

Eirich, R., McArthur, B. A., Anhorn, C., McGuinness, C., Christakis, D. A., & Madigan, S. (2022). Association of screen time with internalizing and externalizing behavior problems in children 12 years or younger: a systematic review and meta-analysis. *JAMA psychiatry*, *79*(5), 393-405.

Filip, I., Tidman, M., Saheba, N., Bennett, H., Wick, B., Rouse, N., Patriche, D., & Radfar, A. (2017). Public health burden of sleep disorders: underreported problem. *Journal of Public Health*, *25*, 243-248.

Grandner, M., Mullington, J. M., Hashmi, S. D., Redeker, N. S., Watson, N. F., & Morgenthaler, T. I. (2018). Sleep duration and hypertension: analysis of> 700,000 adults by age and sex. *Journal of clinical sleep medicine*, *14*(6), 1031-1039.

Hansen, C., Steinmetz, H., & Block, J. (2022). How to conduct a meta-analysis in eight steps: a practical guide. In (pp. 1-19): Springer.

Hasan, M. T., Hossain, S., Gupta, R. D., Podder, V., Mowri, N. A., Ghosh, A., Mahmood, H. R., Ahmmed, F., Khatun, M., & Nodi, R. N. (2022). Depression, sleeping pattern, and suicidal ideation among medical students in Bangladesh: a cross-sectional pilot study. *Journal of Public Health*, *30*(2), 465-473.

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *Bmj*, *327*(7414), 557-560. https://doi.org/10.1136/bmj.327.7414.557

Hoaglin, D. C. (2016). Misunderstandings about Q and 'Cochran's Q test' in meta-analysis. *Stat Med*, *35*(4), 485-495. https://doi.org/10.1002/sim.6632

Hozo, S. P., Djulbegovic, B., & Hozo, I. (2005). Estimating the mean and variance from the median, range, and the size of a sample. *BMC Med Res Methodol*, *5*, 13. https://doi.org/10.1186/1471-2288-5-13

Jahrami, H., Dewald-Kaufmann, J., Faris, M. e. A.-I., AlAnsari, A. M., Taha, M., & AlAnsari, N. (2020). Prevalence of sleep problems among medical students: a systematic review and meta-analysis. *Journal of Public Health*, *28*, 605-622.

Ju, Y.-E. S., Lucey, B. P., & Holtzman, D. M. (2014). Sleep and Alzheimer disease pathology—a bidirectional relationship. *Nature Reviews Neurology*, *10*(2), 115-119.

Kwon, M., Lee, J. Y., Won, W. Y., Park, J. W., Min, J. A., Hahn, C., Gu, X., Choi, J. H., & Kim, D. J. (2013). Development and validation of a smartphone addiction scale (SAS). *PLoS One*, *8*(2), e56936. https://doi.org/10.1371/journal.pone.0056936

Leow, M. Q. H., Chiang, J., Chua, T. J. X., Wang, S., & Tan, N. C. (2023). The relationship between smartphone addiction and sleep among medical students: A systematic review and meta-analysis. *PLoS One*, *18*(9), e0290724. https://doi.org/10.1371/journal.pone.0290724

Liebig, L., Bergmann, A., Voigt, K., Balogh, E., Birkas, B., Faubl, N., Kraft, T., Schöniger, K., & Riemenschneider, H. (2023). Screen time and sleep among medical students in Germany. *Scientific Reports*, *13*(1), 15462.

Liu, H., Zhou, Z., Huang, L., Zhu, E., Yu, L., & Zhang, M. (2022). Prevalence of smartphone addiction and its effects on subhealth and insomnia: a cross-sectional study among medical students. *BMC Psychiatry*, *22*(1), 305.

McNutt, R. Cell phone addiction and psychological and physiological health in adolescents.

Mobile internet usage worldwide - Statistics & Facts. (2024). https://www.statista.com/topics/779/mobile-internet/

Munn, Z., Tufanaru, C., & Aromataris, E. (2014). JBI's systematic reviews: data extraction and synthesis. *AJN The American Journal of Nursing*, *114*(7), 49-54.

Nelson, K. L., Davis, J. E., & Corbett, C. F. (2022). Sleep quality: An evolutionary concept analysis. Nursing forum,

Number of smartphone users worldwide from 2014 to 2029 (in millions). Statista 2024. (2024). https://www.statista.com/forecasts/1143723/smartphone-users-in-the-world

Osorio-Molina, C., Martos-Cabrera, M. B., Membrive-Jiménez, M. J., Vargas-Roman, K., Suleiman-Martos, N., Ortega-Campos, E., & Gómez-Urquiza, J. L. (2021). Smartphone addiction, risk factors and its adverse effects in nursing students: A systematic review and meta-analysis. *Nurse education today*, *98*, 104741.

Ou-Yang, Q., Liu, Q., Song, P.-Y., Wang, J.-W., & Yang, S. (2023). The association between academic achievement, psychological distress, and smartphone addiction: a cross-sectional study among medical students. *Psychology, Health & Medicine*, *28*(5), 1201-1214.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., & Brennan, S. E. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Bmj*, *372*.

Pagnin, D., & De Queiroz, V. (2015). Influence of burnout and sleep difficulties on the quality of life among medical students. *Springerplus*, *4*, 1-7.

Rahman, M., Kabir, M. I., Sultana, S., Shimu, A. T., & Griffiths, M. D. (2024). Suicidal behaviours and associated factors among medical students in Bangladesh: a protocol for systematic review and meta-analysis (2000–2024). *Bmj Open*, *14*(7), e083720.

Rao, W.-W., Li, W., Qi, H., Hong, L., Chen, C., Li, C.-Y., Ng, C. H., Ungvari, G. S., & Xiang, Y.-T. (2020). Sleep quality in medical students: a comprehensive meta-analysis of observational studies. *Sleep and Breathing*, *24*, 1151-1165.

Ratan, Z. A., Parrish, A. M., Zaman, S. B., Alotaibi, M. S., & Hosseinzadeh, H. (2021). Smartphone Addiction and Associated Health Outcomes in Adult Populations: A Systematic Review. *Int J Environ Res Public Health*, *18*(22), 12257. https://doi.org/10.3390/ijerph182212257

Samaha, M., & Hawi, N. S. (2016). Relationships among smartphone addiction, stress, academic performance, and satisfaction with life. *Computers in human behavior*, *57*, 321-325.

Schiavo, J. H. (2019). PROSPERO: An International Register of Systematic Review Protocols. *Med Ref Serv Q*, *38*(2), 171-180. https://doi.org/10.1080/02763869.2019.1588072

Shahrestanaki, E., Maajani, K., Safarpour, M., Ghahremanlou, H. H., Tiyuri, A., & Sahebkar, M. (2020). The relationship between smartphone addiction and quality of life among students at Tehran University of medical sciences. *Addicta: The Turkish Journal on Addictions*, *7*(1), 23-32.

Shen, L., & Su, A. (2019). Intervention of smartphone addiction. In *Multifaceted approach to digital addiction and its treatment* (pp. 207-228). IGI Global.

Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally. (2019). https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/

Vujic, A., & Szabo, A. (2021). The connection between risk of smartphone addiction, type of smartphone use, life satisfaction, and perceived stress dataset. *Data Brief*, *39*, 107651. https://doi.org/10.1016/j.dib.2021.107651

Zhong, Y., Ma, H., Liang, Y.-F., Liao, C.-J., Zhang, C.-C., & Jiang, W.-J. (2022). Prevalence of smartphone addiction among Asian medical students: A meta-analysis of multinational observational studies. *International journal of social psychiatry*, *68*(6), 1171-1183.

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