ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 20(8): 842-848 (2024)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

OPEN ACCESS GOLD

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 20(8)

Research Article

Received August 1, 2024; Revised August 31, 2024; Accepted August 31, 2024, Published August 31, 2024

DOI: 10.6026/973206300200842

BIOINFORMATION 2022 Impact Factor (2023 release) is 1.9.

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required. Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/Biomedical domain.

Edited by P Kangueane
Citation: Sivakumar *et al.* Bioinformation 20(8): 842-848 (2024)

Phantom vibration and ringing syndromes among Indian medical students

Viveka Sivakumar[1], Shalini Lakshmanan[2,*], Leena Chand[1], Anusha Rajajagadeesan[2] & Vadivel Mani[3]

[1]Department of Biochemistry, Sri Ramachandra Institute of Higher Education and Research, Chennai - 6000116, Tamil Nadu, India; [2]Department of Biochemistry, Panimalar Medical College Hospital & Research Institute, Chennai - 6000123, Tamil Nadu, India; [3]Department of Biochemistry, Konaseema Institute of Medical Sciences & Research Foundation, Amalapuram, East-Godavari- 533201, Andhra Pradesh, India; *Corresponding author

Author contacts:
Viveka Sivakumar - E-mail: vivekasivakumar1501@gmail.com; Phone +91 9551277599
Shalini Lakshmanan - E-mail: drshalini.lakshmanan@gmail.com
Leena Chand - E-mail: leenasrmc@gmail.com
Anusha Rajajagadeesan - E-mail: maya.anusha@gmail.com
Vadivel Mani – E-mail: velvdm.vel5@gmail.com

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 20(8): 842-848 (2024)

Abstract:
Mobile phones are now crucial to our everyday routines, transforming how we interact, granting immediate access to information, fostering social bonds, facilitating shopping, advancing healthcare, enriching education, increasing productivity, and broadening entertainment choices. However, excessive phone usage can result in a higher prevalence of physical or psychological disorders. Phantom sensations, such as Phantom Vibration Syndrome (PVS) and Phantom Ringing Syndrome (PRS), describe the experience of feeling vibrations or hearing ringing from a phone when it is not actually vibrating or ringing. The objectives of the present study are a) to develop a self-administered smartphone addiction scale (SAS) among medical students at a tertiary care facility and b) to find out the aggravating factors for PVS and PRS among medical students in a tertiary care hospital. Our study was a cross-sectional observational survey conducted among 473 medical undergraduate students, using stratified random sampling to select the participants. The self-administered questionnaire was developed based on the Smartphone Addiction Scale (SAS), which is validated and efficient for evaluating smartphone addiction. Among the participants, 46% were males and 54% were females. Our study reported that 60% of the students experienced phantom vibration/ringing syndrome, 53% had poor sleep patterns due to excessive use of mobile phones, 58% felt their lives would be empty without phones, 57% thought about mobile phones even when they were not in their hands, and 56% felt the urge to use their smartphones again right after they stopped using them. About 58% of the students preferred talking with smartphone buddies to hanging out with real-life friends or other family members, reflecting poor socialization among young adults. We recommend a qualitative analysis of behavioural and psychological components to explore the root cause of this issue. Literature on the causes of phantom sensations/vibrations has been limited, with existing theories lacking a comprehensive perspective.

Keywords: Phantom vibration syndrome, phantom ringing syndrome, mobile phones, smartphone addiction scale, stress, lack of sleep.

Background:
Mobile phones are an integral part of our day-to-day activities, revolutionizing interpersonal communication, providing easy access to information, strengthening social connectivity, simplifying purchasing processes, improving healthcare services, enhancing educational experiences, boosting productivity, and enriching our entertainment options. While they offer a wide range of utilities and significantly impact self-development, excessive usage can have long-term effects. According to our literature review, the number of mobile users surged from 4.01 billion in 2013 to 5.07 billion in 2019. As per the statistical portal website, 2017), 75% of the population in China were cell phone users, and in India, the figure was 70% [**1**]. According to the 2024 report by the Boston Consulting Group (BCG), nearly nine out of ten individuals, precisely 84%, habitually check their phones within the first 15 minutes upon waking up, and on average, users check their phones 80 times a day [**2**]. Excessive usage can result in a greater prevalence of physical or psychological disorders. Phantom sensations like phantom vibration syndrome (PVS) and phantom ringing syndrome (PRS) include the "sensation of vibration and ringing of the phone when it's not" [**3**]. These two syndromes share common associated factors and mechanisms. Researcher Robert D. Jones stated that our mind or body detects the imaginary vibration in our belts, pockets, and even purses, which may result from physical nerve damage, mental health issues, or both [**4**]. A syndrome indicates conditions that occur together and suggests an increased chance of developing disease [**5**]. Phantom vibration and ringing syndrome are not diseases. Some even argue that the terms PVS and PRS are misnomers. Rothberg explained: "Just as the Holy Roman Empire was not holy, Roman, or an empire, phantom vibration syndrome does not involve a phantom, nor is it technically a syndrome" [**6, 7**]. A few users report it as "very bothersome".

Due to India's overwhelming medical education curriculum, medical students have a poor quality of life and excessive stress. To cope with these issues, they increase their easily accessible mobile phone usage, which offers entertainment and social connectivity. However, the benefits may lead to addiction and mental health issues. Stress levels and smartphone usage are associated with increased incidence of PVS and PRS [**8**]. It is now easy to express our emotions on social media, which can become habitual and addictive. Many factors can contribute to checking the phone often and thus may influence PVS and PRS, which can be considered tactile and auditory hallucinations [**9**]. In addition, as cellular technology advances, so do the accompanying issues, such as high blood pressure and specific psychological problems [**10**]. Medical students and resident doctors must carry their phones for an extended period due to the nature of the job. And they frequently use the phone in vibration mode, placing it in the chest pocket. In addition, medical students are exposed to high-stress levels. Only very few studies have focussed on this issue. Therefore, it is of interest to develop a self-administered Smartphone Addiction Scale (SAS) among medical students in a tertiary care hospital & to discover the aggravating factors for PVS and PRS among medical students in a tertiary care hospital.

Material and Methods:
The present study was a cross-sectional observational survey among medical undergraduate students at Sri Ramachandra Medical College and Research Institute, Porur, Chennai, India. The study was conducted from May 2019 to October 2019. All the male and female medical students (Bachelor of Medicine and Bachelor of Surgery (MBBS) students from the first and second years were enrolled in this study. Considering the 42% prevalence of PVS reported by Mangot *et al.* [**11**], 98% confidence interval, and 5.5% margin of error, the estimated sample size

was 425 participants. By adding a 10% non-response rate, we finalized the number at 473 participants. We utilized stratified random sampling to choose the participants [**12**]. In the first stage, we separated the students into different strata based on the year of study (first year, second year, third year, fourth year, fifth year). We picked 94–96 students in each stratum based on the unique random numbers generated using the Openepi random program [**13**] until we attained our estimated sample size. We asked the students who consented to participate in the study to complete the self-administered questionnaire.

The questionnaire was based on the SAS developed by Kwon *et al*. [**14**] to evaluate smartphone addiction in South Korea. We modified the questionnaire based on our setting, an extensive literature review, and the SAS scale. We measured both face validity and content validity. To measure content validity, we formed a panel of experts, including 3 psychiatrists, 2 psychologists, and 2 public health specialists. We explained our study's objectives and the implications resulting from the answers to the questionnaire. The experts rated the questionnaire based on the study's goals, and we made further qualifications before initiating the reliability testing of the questionnaire, for which we used the test-retest method **[15]**.

We conducted face-to-face interviews with 30 students over a period of 14 to 21 days. Then, we calculated the intra-class correlation coefficient, which was more than 0.8 and was therefore reliable. The questionnaire featured a quantitative section designed to measure phantom vibration/ringing syndrome (PVRS) using a 26-variable scale. Each variable was rated from 0 to 5, where 0 indicated "strongly disagree," 1 indicated "disagree," 2 indicated "neither agree nor disagree," 3 indicated "moderately agree," 4 indicated "agree," and 5 indicated "completely agree". The initial section of the questionnaire asked participants about the number of mobile phones they carry, where they keep their phone, the number of hours it is set to vibration mode, silent mode, and ringing mode, and the average number of calls they receive daily. The self-administered PVRS 26 scale followed this.

We submitted the study's proposal to the Institutional Human Ethics Committee (IHEC), Sri Ramachandra Institute of Higher Education and Research (SRIHER DU). The ethical committee reviewed and approved it (CSP/19/JUN/78/226). We entered the collected data into Epi Info 7 software and performed statistical analysis using SPSS version 21.0 (IBM). We used descriptive statistics to describe the gender, number of mobile phone users, and place of keeping the phone between uses, and we applied a chi-square test to find the association between the variables. We used descriptive statistics for the scales based on the usage of mobile phone influencers. We considered a p-value of less than 0.05 to be statistically significant.

Table 1: General information and usage of mobile phones among participants

Variables	N (%)
Gender	
Male	219 (46)
Female	254 (54)
Phone placement	
Apron	198 (42)
Side pocket	187 (40)
Shirt pocket	15 (3)
Others	73 (15)
Average number of calls per day	
< 5 calls	249 (53)
6–10 calls	168 (36)
> 11 calls	56 (12)
Hearing impairments	
No hearing impairment	473 (100)

(This table presents the distribution of participants based on gender, phone placement, average number of calls per day, and hearing impairments. The data includes the number of participants (n) and the percentage (%) for each category)

Table 2: Comparison of phone hours in silent, vibration, and ringing modes

No. of hours in different modes	< 1 hour n (%)	2–5 hours n (%)	6–10 hours n (%)	11–15 hours n (%)	16-24 hours n (%)	*p-value*
Vibration	123 (26)	59 (12)	147 (31)	68 (14)	76 (16)	< 0.000*
Silent	101 (21)	107 (23)	124 (26)	51 (11)	90 (19)	
Ringing	103 (22)	117 (25)	82 (17)	129 (27)	42 (9)	
p < 0.05 is considered to be statistically significant						

This table compares the number of hours participants' phones were in silent, vibration, and ringing modes. The data includes the number of participants (n) and the percentage (%) for each category of hours spent in each mode

Table 3: Relationship of the perceptions among the individuals who felt the phantom vibrations, on a scale of 1 to 5

Scale No.	PVRS 26 Scale	(0) Strongly disagree	(1) Disagree	(2) Neither agree nor disagree	(3) Moderately agree	(4) Agree	(5) Strongly agree	P value
1	Do you check the duration of using your phone per day?	68 (14%)	75 (16%)	95 (20%)	77(16%)	90(19%)	68(14%)	
2	Have you ever felt the need to check your phone even when it's not Ringing/Vibrating?	34(7%)	42(9%)	76(16%)	108(23%)	114(24%)	99(21%)	< 0.000*
3	Have you ever assumed that the phone was Ringing/Vibrating when it was not?	38(8%)	49(10%)	104(22%)	87(18%)	126(27%)	69(15%)	
4	If so, how many times per day?	20(4%)	74(16%)	99(21%)	112(24%)	101(14%)	67(14%)	
	(0: never/							
	1: 1–2 times/							
	2: 3–4 times/							
	3: 5–6 times/							
	4: 6–7 times/							
	5: more than 7 times)							

This table examines the relationship of perceptions among individuals who experienced phantom vibrations, rated on a scale from 0 (strongly disagree) to 5 (strongly agree). The data includes the number of participants (n) and the percentage (%) for each scale level

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 20(8): 842-848 (2024)

Table 4: Scales are classified based on the impacts of mobile usage

Scale No.	PVRS 26 Scale	0 Strongly disagree	1 Disagree	2 Neither agree nor disagree	3 Moderately agree	4 Agree	5 Strongly agree
	Impact on sleep						
7	Feeling tired and lacking adequate sleep due to excessive smartphone usage	34 (7%)	83 (18%)	108 (23%)	96 (20%)	97 (21%)	**55 (12%)**
	Seeking information						
17	Constantly checking my smartphone so no important notifications are left unnoticed	28 (6%)	72 (15%)	99 (21%)	111 (23%)	95 (20%)	**68 (14%)**
	Social interaction						
8	My life would be empty without my smartphone	38 (8%)	62 (13%)	100 (21%)	93 (20%)	103 (22%)	**77 (16%)**
9	Feeling pleasant or excited while using a smartphone	28 (6%)	67 (14%)	113 (24%)	100 (21%)	93 (20%)	**72 (15%)**
18	Checking SNS (social networking services) sites like Twitter and Facebook after waking up	37 (8%)	80 (17%)	88 (19%)	103 (22%)	105 (22%)	**60 (13%)**
	Stressful						
13	Are you procrastinating more than you should?	37 (8%)	58 (12%)	83 (18%)	114 (24%)	109 (23%)	**72 (15%)**
14	Getting irritated when bothered while using my smartphone	46 (10%)	118 (25%)	66 (14%)	72 (15%)	107 (23%)	**64 (14%)**
	Source of entertainment						
5	Feeling calm and cozy while using a smartphone	42 (9%)	95 (20%)	108 (23%)	75 (16%)	96 (20%)	**57 (12%)**
6	Being able to get rid of stress by using smartphones	43 (9%)	61 (13%)	106 (22%)	112 (24%)	100 (21%)	**51 (11%)**
19	Prefer talking with smartphone buddies over hanging out with my real-life friends or with other members of my family	30 (6%)	67 (14%)	102 (22%)	99 (21%)	99 (21%)	**76 (16%)**
20	Prefer searching from my smartphone over asking other people	34 (7%)	92 (19%)	95 (20%)	102 (22%)	88 (19%)	**62 (13%)**
	Social status						
10	Will not be able to stand not having a smartphone	34 (7%)	76 (16%)	85 (18%)	100 (21%)	101 (21%)	**77 (16%)**
16	Feeling great meeting more people via smartphone use	27 (6%)	91 (19%)	88 (19%)	88 (19%)	102 (22%)	**77 (16%)**
	Dependence on the gadget						
11	Feeling impatient and fretful when I am not holding my smartphone	166 (35%)	142 (30%)	46 (10%)	23 (5%)	43 (9%)	**53 (11%)**
12	Having my smartphone in my mind even when I am not using it	42 (9%)	67 (14%)	92 (19%)	94 (20%)	101 (21%)	**77 (16%)**
15	Bringing my smartphone to the toilet even when I am in a hurry to get there	51 (11%)	61 (13%)	88 (19%)	105 (22%)	89 (19%)	**79 (17%)**
17	Constantly checking my smartphone so no important notifications are left unnoticed	28 (6%)	72 (15%)	99 (21%)	111 (23%)	95 (20%)	**68 (14%)**
21	My fully charged battery does not last for a whole day (depending on the type and age of your phone)	27 (6%)	82 (17%)	89 (19%)	111 (23%)	103 (22%)	**61 (13%)**
22	Using my smartphone longer than I intended	22 (5%)	103 (22%)	87 (18%)	90 (19%)	99 (21%)	**72 (15%)**
23	Feeling the urge to use my smartphone again right after I stop using it	18 (4%)	74 (16%)	115 (24%)	111 (23%)	90 (19%)	**65 (14%)**
24	Having tried time and again to shorten my smartphone-use time but failing all the time	18 (4%)	74 (16%)	115 (24%)	111 (23%)	90 (19%)	**65 (14%)**
25	Always think that I should shorten my smartphone use time	49 (10%)	74 (16%)	87 (18%)	111 (23%)	94 (20%)	**58 (12%)**
26	**The people around me tell me that I use my smartphone too much**	**21 (4%)**	**90 (9%)**	**76 (16%)**	**104 (22%)**	**101 (21%)**	**81 (17%)**

This table classifies scales based on the impacts of mobile usage among participants. The data includes the number of participants (n) and the percentage (%) for each scale level, ranging from 0 (strongly disagree) to 5 (strongly agree), across various impact categories

Results and Discussion:

We conducted this study to develop a self-administered SAS for medical students in a tertiary care hospital and to discover the aggravating factors for PVS and PRS among those students. This cross-sectional observational survey was done among medical undergraduate students at Sri Ramachandra Medical College and Research Institute, Porur, Chennai, India. We used a stratified random sampling to select the 473 participants. We developed a modified version of the validated SAS scale based on our study's setting and literature

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 20(8): 842-848 (2024)

reviews [**26**]. The modified PVRS 26 scale was 0-5, with 0 indicating strongly disagrees, 1 disagree, 2 neither agree nor disagree, 3 moderately agree, 4 agree, and 5 completely agree.

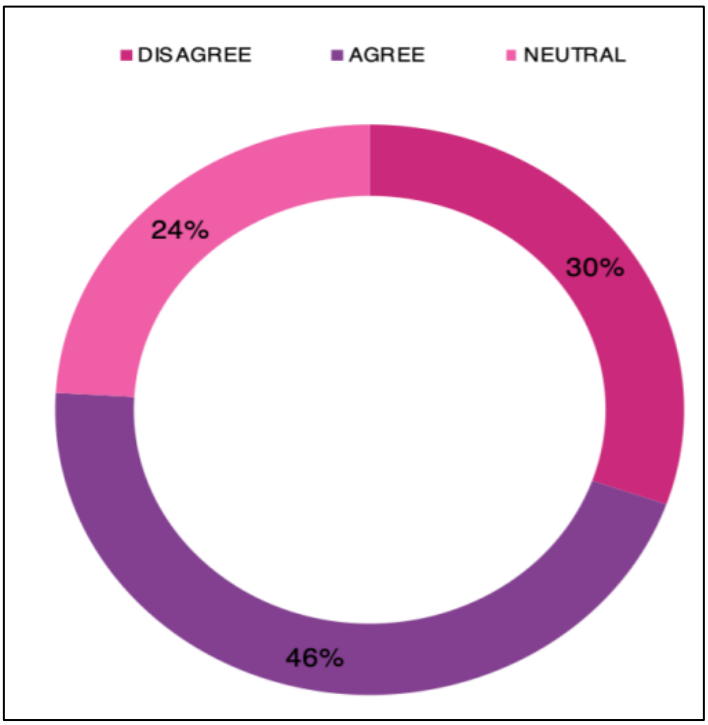

Figure 1: Illustrates the use of phones in the toilet even if they are in a hurry

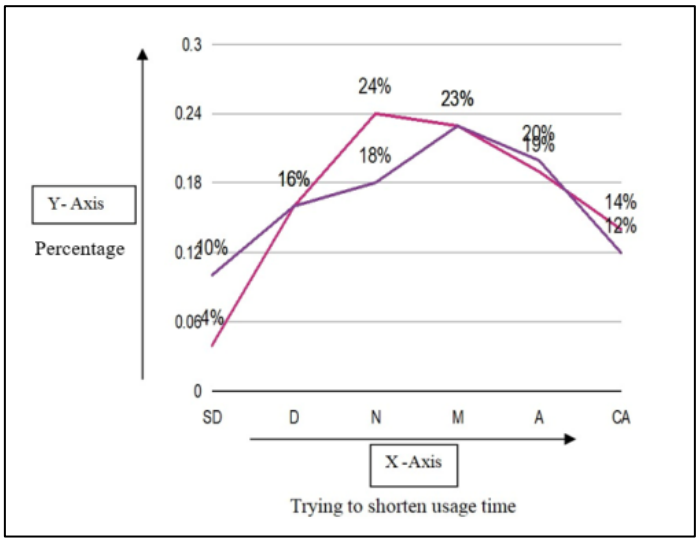

Figure 2: Compares the intention to reduce mobile phone usage with the failure to do so

A study of medical students found that 46% were male and 54% were female. The majority kept their phones in their apron, with 42% using them (**Table 1; Figure 1**). The majority received fewer than 5 calls daily and had no hearing impairments. Intergroup differences were significant ($p < 0.000$*) (**Table 2**), with 21% of students feeling the need to check their phones even when they were not ringing or vibrating. The prevalence of excessive mobile phone use was high; with 21% feeling tired and lacked sleep (**Table 3**). 35% had pleasant feelings while using their phones and 33% tried to reduce usage but failed (**Table 4; Figure 2**). Data also shows that 53% of students with PVRS reported poor sleep patterns, 58% felt life would be empty without phones, and 56% felt the urge to use their smartphones. However, 48% felt calm and relieved stress while using smartphones and 54% preferred searching without relying on others. About 58% preferred talking with smartphone buddies to hanging out with real-life friends or other family members, which reflects poor socialization among young adults. Though we found the negative side of excessive usage, the coin still has its opposite side. About 48% of medical students felt calm and cozy while using a smartphone, 56% of students relieved stress by using smartphones, and 54% preferred searching from their smartphone without depending on other people.

The reliance on mobile phones has become so integral to daily life that life can feel unbearable without them. Many studies have recognized the importance of observing and documenting individuals' relationships with their smartphones [**16**]. These devices emit radiofrequency electromagnetic waves ranging from 800 to 2200 MHz [**17**]. These waves are considered harmful and a risk factor for many diseases because the human body absorbs them, converting them into eddy currents that produce heating and damping effects [**18**]. Brain metabolism rates increase in regions exposed heavily to cell phone radiation through increased oxidative stress and decreased antioxidants, directly affecting neuronal physiological functions [**19**]. The excessive use of mobile phones has led to addiction not only among youth but also across all generations, resulting in nomophobia, which is the fear of being without a mobile phone or, also known as FOMO, i.e., fear of missing out [**20**]. People tend to spend excessive time on their phones, checking social media, and comparing themselves unfavourably to the unrealistic beauty standards of celebrities, leading to feelings of inadequacy. These findings underscore the urgent need for further research and interventions to address the negative effects of excessive mobile phone usage.

We found that 60% of medical students had PVS/PRS, which is similar to the percentage found by Mangot *et al.* [**3**], who found the prevalence of PVS to be 60% and PRS to be 49% in western India among medical interns. Another study by Goyal *et al.* [**21**] among postgraduate students of science from eastern India found 74% of students living with PVS/PRS. Ramasubramani P *et al.* [**22**] found in southern India that 74% of medical students had PVS, but they used the perceived stress scale, Hamilton anxiety rating score, and Hamilton depression rating. Vujić *et al.* [**23**] found 59.1% with PVS and 61% with PRS in the medical students in Kerala. An Iranian study reported the prevalence of PVS and PRS among medical students to be 54.3% and 49.3%, respectively [**24**]. The varying prevalence levels in these studies-

ranging from 44.9% to 74% may be due to the different geographical regions and variations in individual stress levels and emotions.

In our study, 58% felt their life would be empty without phones (nomophobia), and 53% felt tired and lacked adequate sleep due to excessive use of smartphones. Another study conducted by Dixit S et al. among medical students in Bangalore found that 39.5% had nomophobia [**25**]. Another Indian study of undergraduate medical students found that 85.1% had smartphone dependence, which seems very high [**26**]. Dependence can be a pre-disease stage, which can lead to nomophobia at any time. Another study among medical students done by Alam *et al.* in Pakistan reported 67% having nomophobia [**27**]. Alkalash *et al.* found that 99% of medical students had nomophobia, of whom 59.3% had moderate nomophobia and 27.9% had severe nomophobia [**28**]. Sleep is indispensable for overall well-being and a basic human need. The increasing use of mobile phones can negatively impact sleep quality. Overuse of mobile phones has been linked to several adverse health effects, such as headaches, fatigue, tension, and sleep disorders [**29**]. This is particularly alarming among medical students, who frequently rely heavily on smartphones. The dependency on mobile phones among this group is a significant concern for parents, educational institutions, and medical councils. Quality sleep is essential for the cognitive performance of medical students [**30**], and impaired sleep can lead to decreased cognitive function, potentially jeopardizing patient safety.

Excessive mobile phone use may lead to infertility due to disruption of hormonal homeostasis, impacting reproductive hormones like testosterone [**31**]. This can compromise spermatogenesis and ovarian function in both genders [**32**]. Persistent phantom sensations significantly disrupt daily activities and productivity [**33**]. Managing PVS/PRS is critical for preserving cognitive function and operational efficiency in both personal and professional spheres [**34**]. Early identification and interventions, such as cognitive-behavioural therapy, mindfulness-based practices, and structured digital detox programs, are pivotal in mitigating PRS and preventing its progression to more severe psychological conditions. These approaches underscore the imperative of promoting healthier technology habits, thereby fostering comprehensive well-being. Heightened awareness and rigorous research efforts into PRS are essential for advancing treatment modalities and deepening our understanding of its underlying mechanisms. This research also illuminates the broader implications of technology on mental health, informing future public health strategies and educational initiatives. Embracing a more informed approach to technology usage holds promise in mitigating the detrimental effects of PRS and promoting mental resilience.

Conclusion:

Our study sheds light on smartphone addiction and related issues among medical students, including stress levels and phantom sensations like vibrations and ringing, measured by the phantom vibration/ringing scale. The main contributions of our study include the sampling method, large sample size, and use of a standardized questionnaire tool. Future research might examine other smartphone addiction scales to test the validity of our scale. Our study's insights might help develop targeted interventions to improve students' physical, mental, and psychological well-being and focus.

Limitation of the study:

The study relies on self-reported data, which can introduce bias and inaccuracies due to participants' recall errors or intentional misreporting. The study is limited to medical students in a single tertiary care institute in India, which may not be representative of the general population or even other medical student populations. We also recommend qualitative analysis of behavioural and psychological components to explore the root causes of the phantom sensations/vibrations. Theories proposed so far lack a comprehensive perspective. At present, no widely accepted theory comprehensively explains the phantom syndrome.

References:

[1] Ratan ZA *et al. Int J Environ Res Public Health*. 2022 **19** :24.[PMID: 36554468]
[2] Jameel S *et al. J Behav Addict*. 2019 8:4. [PMID: 31619046]
[3] Elhai JD, *et al. journal of affective disorders*. 2017 **207**.[PMID: 27736736]
[4] Singh RK *et al. J Lifestyle Med*. 2022 **12** :3.[PMID: 36628183]
[5] Chen CP *et al. Neuropsychiatr Dis Treat*. 2014 10**. [**PMID: 25750984]
[6] Lin YH *et al. PLoS One*. 2014 9:6. [PMID: 24896252]
[7] Lin YH *et al. PLoS One*. 2013 8:6. [PMID: 23762302]
[8] Rothberg M B *et al. BMJ*. 2010 341. [PMID: 21159761]
[9] Pisano S *et al. PLoS One*. 2019 **14** :1.[PMID: 30608968]
[10] Misek J *et al. Physiol Res*. 2020 **69:**4.[PMID: 32672045]
[11] Mangot AG *et al. Indian J Psychol Med*. 2018; 40:5. [PMID: 30275619]
[12] Elfil MN *et al. Emergency (Tehran, Iran)*. 2017: **5:**1. [PMID: 28286859]
[13] Sullivan KM *et al. Public Health Rep*. 2009 124:3. [PMID: 19445426]
[14] Kwon M *et al. PLoS One*. 2013 **8:**12. [PMID: 24391787]
[15] Hamamura T *et al. BMC Psychol*. 2023 **11** :1.[PMID: 36959621]
[16] Wu YY *et al. Digit Health*. 2023 **9**. [PMID: 37256009]
[17] Koohestanidehaghi *et al. Clin Exp Reprod Med*. 2024 **51**:1.[PMID: 38263592]
[18] Moon JH. *Et al. Clin Exp Pediatr*. 2020 **63:**11.[PMID: 32683815]
[19] Kıvrak EG *et al. J Microsc Ultrastruct*. 2017 **5 :**4.[PMID: 30023251]
[20] Liu N *et al. Front Public Health*. 2024 12. [PMID: 38584914]
[21] Awasthi S *et al. Family Med Prim Care*. 2020 9:8.[MID: 33110841]

[22] Ramasubramani P *et al. Psychiatry.*2023 **86**:2.[PMID: 36445195]
[23] Vujić A *et al. Addict Behav Rep*. 2022 15. [PMID: 35746955]
[24] Mohammadbeigi A *et al. Asian J Psychiatr*. 2017 ;**27**: [PMID: 28558902]
[25] Dixit S *et al. Indian J Community Med*. 2010 35:2. [PMID: 20922119]
[26] Thapa K *et al. JNMA J Nepal Med Assoc*. 2020 58**. [**PMID: 32417860]
[27] Alwafi H *et al. BMC psychiatry.* 2022 22:1.[PMID: 35918684]
[28] Alkalash, Safa H *et al. Cureus*. 2023 15:12. [PMID: 38269229]
[29] Wacks Y *et al. Front Psychiatry*. 2021 12. [PMID: 34140904]
[30] Gottesman, Rebecca F *et al. A Scientific Statement from the American Heart Association. Stroke*. 2024 55:3. [PMID: 38235581]
[31] Okechukwu CE *et al. J Hum Reprod Sci*. 2020 **13**:3.[PMID: 33311902]
[32] Shahin S *et al. Reprod Toxicol*. 2017 73. [PMID: 28780396]
[33] Schone HR *et al. J Neurol Neurosurg Psychiatry*. 2022; 93:8. [PMID: 35609964]
[34] Lin YH *et al. Int J Environ Res Public Health*. 2020 **17:**20.[PMID: 33066619]

Note: Figures 1 and 2 not cited by authors as on 13.10.2024