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Phantom phone signaling (PPS) and mental health - a review

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Abstract

Introduction: The common usage of mobile phones, with an estimated number of 7.26 billion users, raises the question about their impact on health and daily life. Significant problems with the use of mobile phones are hearing phantom ringing (PR), phantom vibration (PV), or phantom blinking (PB), which collectively refer to phantom phone signaling (PPS). The following systematic review aimed to gather existing knowledge in PRS and PVS phantom phone signaling to identify potential new research areas. The PRISMA systematic review aimed to gather existing knowledge in PRS and PVS phantom phone signaling to identify potential new research areas.

Methods: The literature search was conducted using Pubmed, Web of Science, Scopus, EBSCO, and Google Scholar databases to retrieve publications up to March 3, 2023. An additional search was performed in January 2024. The selection conditions were met by 34 articles that analyzed demographic and psychological factors.

Results: The phenomenon of PR, PV, or PPS in general is inversely correlated with the age of the respondents. The results indicate that the number and intensity of perceived PV are related to where the person carries the phone. Educational or communication purposes of phone use are associated with the experience of PPS. The literature also indicates a correlation between phone addiction and PV, PR, and PPS in general and between depression and, anxiety and phantom experiences.

Discussion: The PPS is a phenomenon that appears to be related to addiction. Future research is worth to be conducted on other and larger research groups. Additionally, longitudinal research could be considered.

Keywords: mobile addiction, phantom phone signaling (PPS), phantom ringing (PR), phantom vibration (PV), phantom blinking (PB).

Streszczenie

Wstęp: Telefony komórkowe są powszechnie używane na całym świecie, a ich liczbę szacuje się na 7,26 miliarda użytkowników. Zastanawiające jest na ile częstotliwość korzystania z telefonów komórkowych ma wpływ na zdrowie i codzienne życie użytkowników. Istotnymi problemami związanymi z korzystaniem z telefonów komórkowych są dzwonki fantomowe (ang. phantom ringing, PR), wibracje fantomowe (ang. phantom vibration, PV) lub mruganie fantomowe (ang. phantom blinking, PB), które zbiorczo określa się mianem fantomowej sygnalizacji telefonicznej (ang. phantom phone signaling, PPS). Celem poniższego przeglądu systematycznego wg PRISMA było zebranie istniejącej literatury w zakresie fantomowej sygnalizacji telefonicznej PRS i PVS w celu zidentyfikowania potencjalnych nowych obszarów badawczych.

Materiał i metoda: Przeszukiwanie literatury przeprowadzono z wykorzystaniem baz danych Pubmed, Web of Science, Scopus, EBSCO i Google Scholar do 3 marca 2023 roku. Dodatkowe wyszukiwanie przeprowadzono 21 stycznia 2024 roku. Warunki selekcji spełniły 34 artykuły, które zostały przeanalizowane pod kątem aspektów demograficznych oraz psychologicznych.

Dyskusja: Zjawisko PR, PV lub ogólnie PPS jest odwrotnie skorelowane z wiekiem respondentów. Wyniki badań wskazują,

że liczba i intensywność odczuwanego PV są związane z miejscem, w którym dana osoba nosi telefon. Edukacyjny lub komunikacyjny cel korzystania z telefonu mają związek z doświadczeniem PPS. Literatura wskazuje także na korelację między uzależnieniem od telefonu a PV, PR i ogólnie PPS oraz związek między depresją i lękiem, a doświadczeniami fantomowymi.
Wnioski: PPS jest zjawiskiem, które wydaje się związane z uzależnieniem. Przyszłe badania warto przeprowadzić na innych, większych grupach badawczych. Dodatkowo można rozważyć przeprowadzenie badań podłużnych.

Słowa kluczowe: uzależnienie od telefonu komórkowego, fantomowa sygnalizacja telefoniczna (PPS), fantomowy dzwonek (PR), fantomowa wibracja (PV), fantomowe mruganie (PB).

Introduction

Mobile phones are commonly used around the world, and there are an estimated number of 7.26 billion users [1]. The fact of universality of their use raises the question of their impact on health and daily life. One of the emerging problems is phantom phone signaling (PPS), which is a condition of hearing the ringing or vibration of a mobile phone even when it is not. Following increased interest in phone signals perception, more specific conditions such as phantom vibration (PV), phantom ringing (PR), or phantom blinking (PB) were introduced, referring to a false perception of the phone vibrating, ringing, and blinking, respectively. There are different names for such phenomena, such as vibranxiety, hypovibrochondria, and fauxcellarms, and more precisely, Phantom Vibration Syndrome (PVS) and Phantom Ringing Syndrome (PRS), which are more inclusive forms of PPS [2]. Those phenomena were described first in 2007 by Laramie, who surveyed 320 adult mobile phone users and found that two-thirds had experienced phantom rings [3]. Increased cell phone usage addiction around the world [4] makes studies of perceptual phenomena connected with mobile phones and searching for their predictors an essential field of research. The aims of this review are to understand the phenomena, summarise findings obtained so far, and provide future directions.

Material and methods

The search strategy aimed to use PRISMA to review papers from the earliest published until March 3, 2023, to identify all relevant studies among the following databases: PubMed, Web of Science, Scopus, EBSCO, and Google Scholar. For the purpose of this review, the following keywords were defined: “ringxiety” OR “phantom vibration” OR “phantom vibration syndrome” OR “phantom ringing” OR “phantom ringing syndrome” (Boolean operator). An additional search for more relevant works was performed on January 21, 2024, to find works published after March 3, 2023.

The inclusion criteria concerned all original quantitative papers published in peer-reviewed journals that measured the prevalence of phantom vibration, phantom ringing, or phantom phone signaling (PPS), assessed predictors for experiencing it, or connected them with other disorders. All studies that did not fulfill the inclusion criteria, as well as reviews, chapters of books, and letters to the editor, were excluded. In the review, the analysis included only articles in the English language.

The articles from each database were retrieved, and duplicated records were identified and removed. Two authors independently analyzed the titles and abstracts of the remaining works. Retrieved full-text papers were independently assessed for relevance. Data extraction was completed by one author, and relevant information such as the place of the study, gender, age, prevalence, and association with other factors were summarized for this report.

Results

The results of the selection process are presented with the use of PRISMA flow diagram [5] (Fig. 1). Google Scholar provided 1280 results; thus, to narrow down search results was used following advanced search: "with the exact phrase" option and keywords "ringxiety" "phantom vibration" "phantom vibration syndrome" "phantom ringing" "phantom ringing syndrome" were used. The usage of more specific keywords resulted in 128 articles from the Google Scholar database.

In the case of the EBSCO database search, we used the "search for only peer-reviewed papers" option; thus, 125 papers were excluded before the screening. For further analysis, 37 articles were considered. One of the articles was excluded because phantom vibration or phantom ringing was included as part of a group of altered body perceptions without specifying PPS [6]. The second article was excluded because only students experiencing fantom vibrations were enrolled [7]. Two of the retrieved articles were in Indonesian [8,9]. The second search revealed one additional article.

Finally, 34 articles were included to analysis among them 24 articles were searched in Google Scholar, 8 articles in Scopus and 3 in Web of Science.

Given the fact that our knowledge concerning forms

of PPS mostly comes from small or non-generic groups extrapolation of results to the general may be risky and biased. Almost all the studies except of Lin et al. [10–12] were cross-sectional. There is no universal questionnaire to measure PPS thus surveys concerning phantom signals were prepared by the researchers which could also cause differences in outcomes.

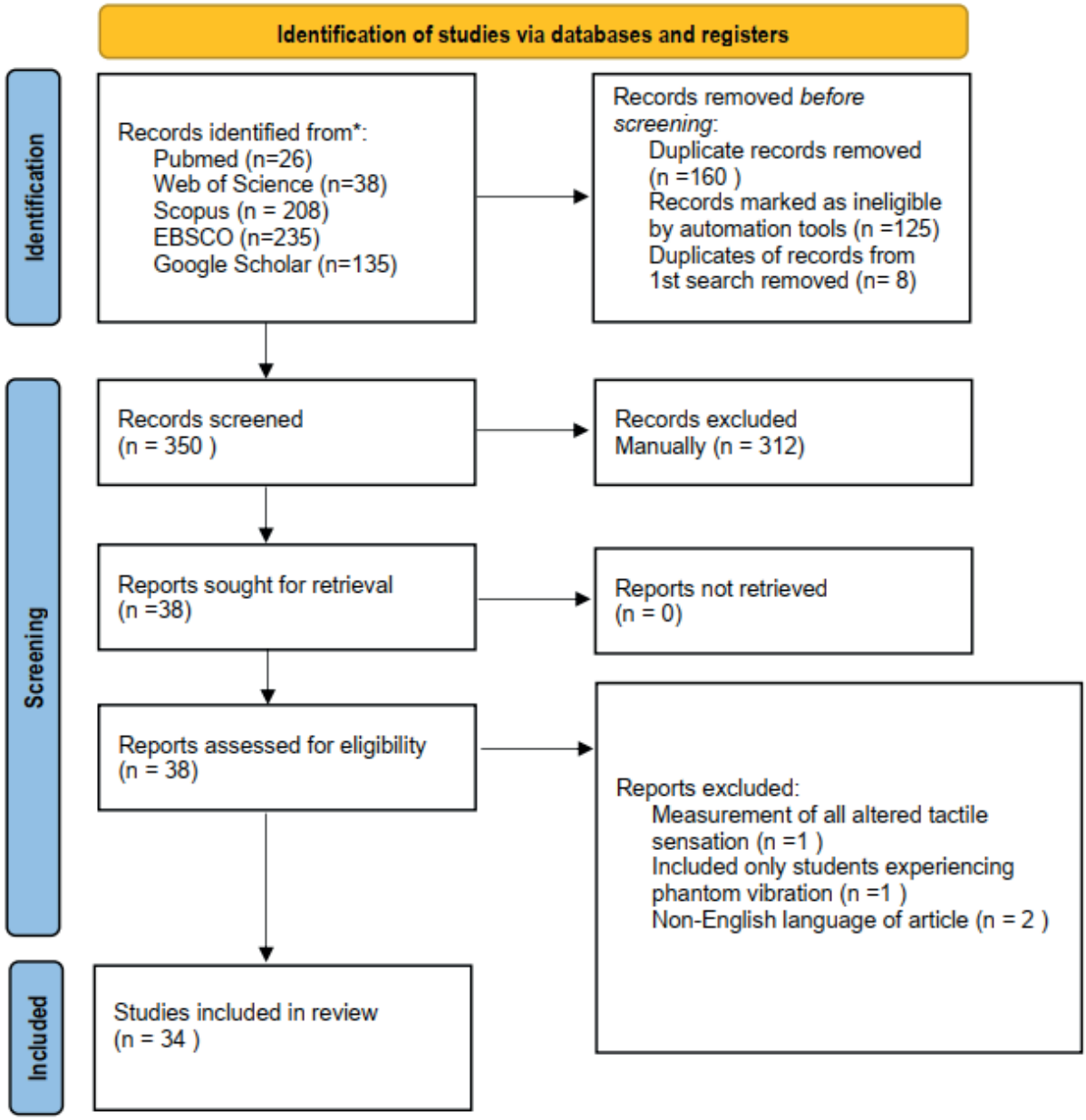

Fig. 1. PRISMA Flow diagram

Epidemiology

Due to the diversity of approaches, PV, PR, or overall PPS sensations were measured. The prevalence of PPS, defined as the perception of any false phone signal, ranged from 26.1% [13] to 95% for Goyal – it should be noted that 74% perceived both PR and PV symptoms and only 17% and 4% PV or PR, respectively [14]. In the case of the longitudinal study performed by Lin et al. on a group of 74 medical interns during internship, baseline prevalence of 78.1% increased and was 95.9%, 93.2%, 80.8%, 50% in third, sixth, twelfth month and two weeks after the internship respectively for PV and for PR increased from 27.4% to 84.9%, 87.7%, 86.3%, 54.2% at third, sixth, twelfth month and two weeks after the internship respectively [12]. Most of the work was conducted on non-generic populations such as university students, school children, high-tech company workers, and medical workers. Only two studies were conducted as online surveys of the general population [15,16]. Analysis of all findings is summarized in Table 1.

Table 1. Studied population and prevalence of PV, PR and PPS

Author, Country, Year	Number of participants	Type of population	PV(%)	PR (%)	PPS (%)
Al-Ani et al. Iraq, 2009 [17]	200	Students	47	77	-
Rothberg et al. United Kingdom, 2010 [3]	176	Medical professionals	68	-	-
Drouin et al. USA, 2012 [18]	290	Students	89	-	-
Subba et al. India, 2013 [19]	336	Students	-	34.6	-
Lin et al. Taiwan, 2013 [10]	74	Medical interns	78.1*	27.4*	-
Alam et al. Pakistan, 2014 [20]	150	Students	93	-	-
Chen et al. Taiwan, 2014 [13]	384	High-tech company workers	21.1	16.1	26.1
Gupta et al. India, 2015 [21]	1000	Students	-	-	55.6
Tanis et al. USA, 2015 [16]	403	USA population	71.2	63.5	82.6
Sauer et al. Germany, 2015 [15]	249	Germany population	-	-	83.5
Goyal, India, 2015 [14]	300	Students	91	78	95
Krueger et al. USA, 2016 [22]	168	Students	82	45	-
Kruger et al. USA, 2017 [23]	776	Students	77	37	-
Masthi et al. India, 2017 [24]	566	Students	-	-	38.1
Mohammadbeigim et al. Iran, 2017 [25]	363	Students	54.3	49.3	70.1
Masthi et al. India, 2018 [26]	1389	Students	-	-	66**
Mangot et al. India, 2018 [27]	93	Medical interns	60	42	-
Gemeay et al. Egypt, 2018 [28]	300	Students	77	77	-
Mohammed et al. Iraq, 2018 [29]	600	Medical professionals	57.7	61.5	-
Pisano et al. Italy, 2019 [30]	2859	School children	-	-	58.9
Dang et al. Vietnam, 2019 [31]	384	Students	75.6	-	-
Choudhury et al. India, 2019 [32]	252	Students	-	-	21.1**
Sebastian et al. India, 2020 [33]	487	Students	59.1	61	-
Srivastava et al. India, 2020 [34]	120	Students	70.8	46.7	-
Charulatha et al. India, 2021 [35]	200	Students	76	-	-
Kumar et al. India, 2022 [36]	169	Students	-	-	49.1
Lasanthika et al. Sri Lanka, 2022 [37]	372	Students	61.6	53.5	-
Riaz et al. Pakistan, 2022 [38]	190	Medical professionals	72.2	-	-
Ramasubramani et al. India, 2022 [39]	383	Students	27.9	21.1	44.9
Mali. India, 2023 [40]	204	Medical students	68	-	-

**Baseline prevalence*
*** Stated only for high dependent on phone participants*

Age

In all cases, younger age was significantly associated with phantom sensations. Models tested by Sauer et al. have shown that younger age was a predictor of PPS [15]. Similar findings were present in the Polish study comparing PPS with hallucinatory-like experiences (HLE) [41]. A study in Pakistan reported a significant association between the group of 21-40-year-olds and the older medical staff [38]. Tanis et al. also showed that PPS is more frequent in the group 18-44 years old compared to the age between 45-64. Additionally, the correlational analysis showed that age is negatively correlated with the intensity of using the phone [16]. Those findings were supported by showing that cell phone dependency mediates the relationship between age and phantom experiences [23]. A British survey conducted among healthcare professionals

also found that PV is more frequent in younger ages [3]. Surprisingly, in the Iran study, age was only a determining factor for PV, with no correlation between age and PR [25], although it was not confirmed by Gemeay et al., who found a correlation both for PV and PR [28]. Both groups were recruited from medical universities and were similar in terms of the number; thus, further studies should elucidate whether there is a difference in perception of more specific sensations. Lastly, an Italian study showed that in children aged 10-14, PPS sensations increase with age [30]. Contrary to the findings mentioned, Dang et al. did not find a significant difference between age and PV or PR among medical university students in Vietnam31. Nonetheless, an online survey posted on groups connected with the university could lead to bias caused by multiple repeats by the same participant after spotting the study on a different group.

Gender

Only one paper reported that females more often experience PPS [30]. The large sample size was one of the factors. Another possibility is that cultural differences and country development which is linked to cell phones and Internet availability. Behavioral factors not measured in this study may also have had an impact on such outcomes. Interestingly, three studies found that males experienced PV more often than women [16,17,25], but only one confirmed that PR is more often in women [25]. One of the proposed explanations was the way the phone is carried, where men are more likely to have their phone in their pocket and women to place it on the table or keep it in a purse [16]. Gender differences were not noticed by other authors [15,19,28,31,38,39].

Occupation

Only a few studies have investigated the role of occupation. However, Rothberg found that in PV, one of the most vulnerable groups was residents [3]. Pakistan study showed that PV was more prevalent among surgeons and nurses [38]. USA survey found higher rates of experiencing PV between students and people working in sales and offices compared to the unemployed [16]. It is plausible that those groups, due to working conditions, have had higher call anticipation. Sauer found that PPS in a social context, understood as awaiting contact or the need to be available on call, is a predictor of frequency PPS [15]. Contrary to this, an Iranian study on nurses showed no correlation between PV or PR and levels of job-related stress [29]. Additionally, two studies on students showed that staying at a hostel/dormitory during the study was a significant determinant for experiencing PV and PR [39] or PR [25].

Relation to phone use

Fourteen studies searched for external factors such as i.e. location of the phone, duration of use, and mode of phone (vibration/ringing).

Increased time of usage was positively correlated with PPS [16,27,29,30,37], PR [17,39], and PV [3,35,38,40]. On the contrary, Dang et al. did not find any association between intensity of usage and PV [31]. Similarly, in an Indian study on 336 medical students, there were no significant differences between students who reported or did not PR and the duration of their phone calls [19]. In addition, Rothberg found that the location of the phone (breast pocket) and vibration mode are correlated with experiencing PV [3]. Those findings were supported by Charulatha et al., where pockets/hands, as a usual site of mobile phones, were associated with PV [35]. For Pakistani healthcare workers, PV was more prevalent while carrying the phone in the breast or back pocket; it was also connected with vibration mode [38]. In the case of Iraqi nurses, shirt pockets were also significantly related to PPS experience [29]. Ramasubramani et al. reported that in adjusted analysis, vibration mode and location in shirt or pants were associated with PV [39]. Studies conducted on medical interns showed that vibration mode increases the odds of PV [12,27]. In an Indian study by Mali medical students who experienced PR, they reported usage of vibration mode and mainly carrying a phone in Jean's front pocket [40]. In contrast, Dang et al. failed to confirm the association between the mode of setting and the location of the device [31]. Similarly, Lin et al. did not find a relation between PPS and location [12].

Patterns of usage were also considered to be one of the factors that correlate with the PPS experience. PR was strongly related to the frequency of phone calls and PV to phone messages, respectively [16]. Those findings were supported by Mahammadbeigim et al., who found that the use of mobile apps such as Viber, WhatsApp, and Line, which are used for communication, relates to a higher occurrence of PV. It is consistent with his second finding that phone usage for friend-finding, chatting, and entertainment was also correlated to PV [25]. These data were confirmed by Mohammed et al., who found that mobile usage for education, communication, and entertainment is associated with PPS [29]. Also, in an Indian study of 204 medical students, PV was more frequently reported by respondents whose primary purpose for mobile phone usage was social media [40].

Lastly, the study by Subba et al. revealed that using a mobile phone in the classroom or library while eating or driving is more common in students with PR than in those without it. Additionally, individuals affected by PR are more likely to borrow money for phone use without their parent's knowledge and more often cut their sleep

time to talk on mobile [19]. Those findings were partially confirmed by Lasanthika et al. and Charulatha et al., who reported that students who use their phones at night were more likely affected by PV and PR [37] or PV [35].

Psychological aspects of PPS

Looking for personality traits that may be associated with PPS Kruger et al. used Experiences in Close Relationship Scale-Short Form (ECR-S) and found that higher attachment anxiety was positively correlated with PR frequency and these experiences happened more likely when they were expecting contact. On contrary, those with attachment avoidance were less likely to report PPS when expecting a call or message [22].

Two papers used the Big-Five Inventory (BFI) to search for possible correlations. Drouin et al. used 44-item BFI and Sauer et al. German 10-item version [15,18]. Although an American study found a significant negative effect between conscientiousness and the frequency of PV [18], such a relation was not found by Germans [15]. Both groups were similar; thus, the possibility of a lack of statistical power should be considered. However, in 2017, Kruger et al., with the use of the Ten Item Personality Inventory (TIPI) and Mobile Phone Problem Use Scale (MPPUS), did not find a correlation between conscientiousness identified by Drouin in a similar but larger population [23].

Indian study performed on college students with a questionnaire constructed originally by authors showed that 339 (66%) of smartphone addicts had PPS, suggesting that it may be an independent risk factor for developing social media addiction [26]. Ramasubramani et al. found that self-reported overuse of mobile phones was a determinant for the frequency of both PV and PR experiences; however, a higher score on the Smartphone Addiction Scale-Short Version (SAS-SV) was a determinant only for PV [39]. Similar results were obtained in a study on Indian interns, where PV and PR-experiencing individuals had higher scores than those who did not experience it [27]. Lastly, the SAS-SV scale was used by Sebastian et al. PV and PR experience were positively correlated with higher scores on a scale [33]. Similarly, Tanis et al., based on the Bianchi and Phillips survey, found a positive relation between phone addiction and PPS [16]. A study in Sri Lanka where the Problematic Use of Mobile Phone Scale (PUMP) presented only a weak association between the level of addiction and self-reported PV [37]. On the contrary, in the evaluation of the Smartphone Addiction Inventory (SPAI), Lin et al. reported that there was low or no correlation between subscales and PV/PR, suggesting that those phenomena might be independent [42]. There is also a possibility that differences in SAS-SV and SPAI were responsible for such outcomes. Additionally, Choudhury et al. did not find a relation between the score on the Mobile Phone Dependence Questionnaire (MDPQ) and experiencing PPS [32].

Considering PPS as one of the possible outcomes of stress, studies compared score on the Perceived Stress Scale (PSS) with the experience of PV. In both cases, there was an association between PV and the level of stress [27,35]. The same results were also obtained by Sebastian et al. which found a correlation between PSS score and PV but also between PSS and PR [33].

Depression and anxiety were also considered factors related to PPS. Chen et al. used the Hospital Anxiety and Depression Scale (HADS) and the Chinese Occupational Burnout Inventory. Although the HADS scores did not differ significantly, those experiencing PV had a higher score in OBI for personal fatigue, job fatigue, and job overcommitment. Personal fatigue and job fatigue scores were higher in those with either PV or PR [13].

Studies on Taiwanese medical interns with Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI) showed that stress-induced PV and PR experiences may be reflected by a change in the BDI and BAI scores. Interns with severe PV/PR, defined as bothersome or very bothersome, had higher scores in both inventories compared to the subclinical group [10].

The Basic prevalence of severe PV was 5.5% before and 6.8% after the internship, respectively, while PR was 4.1% and 11%, respectively. During the internship, both prevalences increased in the third, sixth, and twelfth months: PV 38.4%, 28.8%, and 37%, respectively, and PR 39.7%, 23.3%, and 34.2%, respectively [11].

Both PV and PR-experiencing interns had a higher score on the somatic depression subscale, whereas those with PR additionally had higher cognitive/affective scores. Somatic anxiety levels were highly elevated in both groups but not in panic scores [10].

Mediation analysis showed that stress-induced PV and PR may be explained by the change in depression and anxiety scores. Anxiety explained 8% of PV and 8% of PR, respectively, while depression was 15% and 22%, respectively [11].

Similar results were obtained with the use of the Hamilton Anxiety Scale (HAM-A) and Hamilton Depression Scale (HAM-D) with an association between experiencing PV and levels of anxiety and depression [35]. Those findings confirmed previously reported associations between the severity of anxiety determined on the HAM-A scale and experiencing PPS [28].

Assuming that PV is related to mental health factors beyond depression and anxiety, Dang et al. used the Self-Reporting Questionnaire (SQR-20) developed by the World Health Organization and also confirmed that psychiatric disturbance was significantly associated with PV, and a

higher score was a positive predictor [31].

An Italian study on children with Strength and Difficulties Questionnaire (SDQ) showed that in all subscales PPS experiencing kids had higher scores than those who did not. Additionally, in the regression model, emotional problems and tantrums were associated with the presence of PPS [30]. Surprisingly, the Polish study, which was determined to compare PPS and HLE, did not find any relation between the score in Symptom Checklist 27 Plus (SCL-27-plus) and PPS [41]. Such findings are opposite to those of previous studies suggesting an association with emotional burden [10–12,30]. They did, however, find that there are differences between PPS and HLE. Although both were related to younger age, the strongest predictor for PPS was MPPUS, contrary to HLE, whose most essential predictors were the SCL-27-plus score, Multi-Modality Unusual Sensory Experiences Questionnaire score, and The Beliefs about Perception Questionnaire (BAPQ) prepared by authors [41]. One of the subscales of BAPQ, top-down influences – a scale that reflects beliefs about how cognition and mindset may influence perception was a significant predictor for both PPS and HLE, which may indicate a shared mechanism [41].

The mechanism underlying those conditions still needs to be better understood. Lin [11] suggested that those hallucinations are caused by Hypothalamus-Pituitary-Adrenal (HPA) axis changes induced by stress, which further stimulate the development of stress-induced PVS and PRS. For Kruger, PPS were types of pareidolia and, as such, are influenced by individual differences in personality, condition, and context [22].

Rothberg et al. suggested that those phenomena are the results of the misinterpretation of incoming sensory signals by the cerebral cortex. Anticipation of the call by the brain causes misinterpretations of the sensory stimulus, such as muscle contractions or pressure from clothing [3]. Those theories suggest that with frequent basis exposure to sensations such as vibration, the brain can be accustomed to them. Those with excessive phone use, a long history of conditioning, and associated neural changes seem more prone to such sensations. PPS is considered a part of regular interaction between humans and mobile phones [43]. Most surveyed considered PPS episodes as not at all or little bothersome [3,18]. These perceptions were also mediated by other factors, such as stress, considering the percentage of severe PPS in interns surveyed by Lin et al. [10-12].

Conclusions

The PPS is a phenomenon that is related to addiction. Unfortunately, most studies are cross-sectional, and the samples are non-generic. More diverse and more extensive studies may resolve the problem of inconsistent results. Also, there was no standardized way to assess the relationship between PPS, psychopathology, and social factors. More studies, including patients with psychiatric disorders, may provide a better understanding of PPS mechanisms. There is also a scarcity of works related to adolescents who are more exposed to technology nowadays. Only one of the presented studies was longitudinal. More similar studies could show the trend of PPS over time, providing a better understanding of its possible impact on health and everyday life.

Conflict of interest

The authors have declared no conflict of interest.

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