

# Smartphone Addiction and Associated Health Outcomes

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Smartphone addiction (SA) is generally conceptualized as a behavioral addiction including mood tolerance, salience, withdrawal, modification, conflict, and relapse. Literature suggests that there are associations between SA and mental health, physical health, and neurological problems. Furthermore, tolerance, salience, withdrawal, and cravings have been associated with excessive smartphone use.

smartphone

addiction

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## 1. Introduction

The 21st century is known as the age of information technology. Wireless communication and the internet are remarkable entities resulting in revolutionary changes in the field of communication <sup>[1]</sup>. In 2007, computer-based phones (smartphones) were introduced <sup>[2]</sup>. Since then, smartphones have become an indispensable part of daily life in all communities and countries. As such, smartphones have become one of the fastest-growing sectors in the technology industry <sup>[3]</sup>. Over the past decade, smartphone ownership and use have been exponentially increased globally. For instance, there were about 2.1 billion smartphone users in 2017 and the number was projected to exceed 2.8 billion by 2020 worldwide <sup>[4]</sup>.

A number of novel problematic behaviors have emerged in the information technology era, such as gambling, internet gaming, and sexual behaviors, which may lead to compulsive engagement <sup>[5]</sup>. Extreme instances may lead to individuals feeling unable to control these behaviors without external influence, and these behaviors may be considered non-substance or behavioral addictions <sup>[6]</sup>. Internet addiction is one of the earliest examined forms of information technology addiction <sup>[7]</sup>. The relatively newer concept of “smartphone addiction” (SA) has also been studied based on previous internet addiction research <sup>[8]</sup>. Smartphones distinguish their use from traditional Internet use on computers or laptops because smartphones allow users to access the internet continuously regardless of time and space. Smartphone addiction is fueled by an Internet overuse problem or Internet addiction disorder <sup>[9]</sup>. The increased use of smartphones has resulted in most in people communicating daily online, as a result of interactive texts and social media, instead of face-to-face human contact. Smartphones fetch a limitless range of cognitive activities for users; smartphones forge opportunities for individuals to engage in a range of online activities such as participating in social network sites, playing video games, and “surfing the web” <sup>[10]</sup>. However, the smartphone poses a negative impact on our ability to think, remember, pay attention, and regulate emotion <sup>[11]</sup>. The increase in popularity and frequency of smartphone use has led to the emergence of clinical cases of people presenting with abuse symptoms <sup>[12]</sup>.

The concept of addiction is not easy to define, and the usage of the term addiction has been considered controversial; however, central to its definition is the dependence on a substance or activity [13].

## 2. Current Insights

Interestingly, studies conducted in different parts of the world showed similar effects on health outcomes as a result of smartphone addiction. Hence, the consistency across the studies strengthens the study findings, emphasizing the association between SA and health outcomes.

The findings suggest that depression and anxiety are significantly linked with smartphone addiction. One national USA survey found that 46% of smartphone owners believed they could not live without their phones [14]. Overuse patterns of smartphones involves a tendency to check notifications all the time, and such behavior patterns can induce “reassurance seeking” which broadly includes symptoms such as depression and anxiety [15]. This “reassurance seeking” pathway corresponds to those individuals whose smartphone use is driven by the necessity to maintain relationships and obtain reassurance from others. Biliieux and colleagues explained this reassurance-seeking behavior with the theoretical model of “problematic mobile phone use” [16]. In addition, this checking behavior is related to the next pathway, the “fear of missing out” (FOMO). One study found that FOMO mediated relations between both depression and anxiety severity with SA [17].

It is evident that musculoskeletal pain and insomnia are the two most common physical problems related to SA. Fingers, cervical, back, and shoulder problems are most commonly linked to excessive smartphone usage. Prolonged use of smartphones can cause defective postures such as forwarding head posture, which can produce injuries to the cervical spine and cause cervical pain [18]. Numerous studies found De Quervain tenosynovitis (characterized by pain in the wrist over the radio styloid process—the thumb side of wrist) was associated with different electronic devices like gaming controllers, tablets, and smartphones [19][20]. Texting and chatting through smartphones have been considered a risk factor for De Quervain tenosynovitis [21].

Poor sleep quality and difficulty in falling asleep or maintaining sleep has been identified as one of the negative consequences of SA, which is similar to our results [22][23]. Moreover, in line with our finding, another systematic review revealed that SA is related to poorer sleep quality [24]. One study found that 75% of the young adults (age < 30 years) take their phones to bed, which may increase the likelihood of poor sleep quality [25]. Smartphone addicts are unsuccessful at controlling their smartphone use, even in bed. Again, fear of missing out could be the reason of taking phones in the beds as they do not want to miss any notification [26][27]. In addition, blue light emitted by smartphones can have a negative effect on circadian rhythms, leading to negative sleep consequences, such as going to sleep later than intended and thus reducing overall sleep time [28].

The neurological effect of SA is not clear yet from this review. However, currently neuroimaging studies play an important role in understanding the complexity of addictive behavior [29], as they can assess any pathological change in the brain. Two studies in this review reported the negative changes in grey matter and white matter integrity in the brain with the assistance of neuroimaging (**Table 1**), which is similar to the neuropathy caused by

substance abuse [30][31] and Internet addiction [32][33]. However, the modest sample size and the lack of a clinical evaluation are the potential limitations of these studies [34][35].

**Table 1.** Summary of outcomes.

Author and Reference	Outcomes	Specific Outcome Quality
HYE-JIN KIM [36]	<ul style="list-style-type: none"> <li>Smartphone addiction was significantly associated with total accidents, falling/slipping, and bumps/collisions</li> </ul>	Accident Fair
Yeon-Jin Kim [37]	<ul style="list-style-type: none"> <li>SA had a stronger relationship with depression and anxiety, stronger than IA</li> </ul>	Depression and anxiety Fair
DEOKJONG LEE [34]	<ul style="list-style-type: none"> <li>Small GMV in the lateral orbitofrontal cortex (OFC) was correlated with an increasing tendency to be immersed in smartphone use</li> </ul>	Gray matter abnormalities Fair
JeonHyeong Lee [38]	<ul style="list-style-type: none"> <li>Significant differences in the cervical repositioning errors of flexion, extension, and right and left lateral flexion were found among the Normal Group, Moderate Addiction Group, and Severe Addiction Group</li> </ul>	Musculoskeletal problems Fair
Kyung Eun Lee [39]	<ul style="list-style-type: none"> <li>For both men and women, increases in smartphone dependency were associated with increased anxiety scores</li> </ul>	Anxiety Fair
Yeon-Seop Lee [40]	<ul style="list-style-type: none"> <li>Using smartphones continuously over long periods raises pressure on the median nerve and increases the probability of occurrence of CTS</li> </ul>	Carpal tunnel syndrome Poor
Mi Jung Rho [41]	Mental health problems were related to problematic smartphone use: (1) self-control (66%), (2) anxiety (25%), (3) depression (7%), and (4) dysfunctional impulsivities (3%)	Psychiatric symptoms Fair

Author and Reference	Outcomes	Specific Outcome Quality
Aljohara A. Alhassan <a href="#">[42]</a>	<ul style="list-style-type: none"> <li>Significantly higher smartphone addiction scores were associated with younger aged users.</li> </ul> <p>Factors associated with higher depression scores were high school-educated users (<math>\beta = -2.03</math>, adj. <math>p = 0.01</math>) compared to the university educated group and users with higher smart phone addiction scores (<math>\beta = 0.194</math>, adj. <math>p &lt; 0.001</math>).</p>	Depression Fair
Alosaimi, F. D. <a href="#">[43]</a>	<ul style="list-style-type: none"> <li>At least 43% had decreased sleeping hours and experienced a lack of energy the next day, 30% had an unhealthy lifestyle (ate more fast food, gained weight, and exercised less)</li> </ul>	Risk of sedentary behavior Fair
Dalia El-Sayed <a href="#">[44]</a>	<ul style="list-style-type: none"> <li>A significant positive correlation was found between PUMP score and depression and trait anxiety scores, duration of owning a smartphone, and average duration of each daily call.</li> </ul>	Depression and trait anxiety Good
Jon D. Elhai <a href="#">[45]</a>	<ul style="list-style-type: none"> <li>35.9% of our sample reported that they felt tired during day due to late-night smartphone use,</li> <li>38.1% of them acknowledged that their sleep quality decreased, and</li> <li>35.8% admitted that they slept less than four hours due to smartphone use more than once</li> </ul>	Anxiety Good
Yuanming Hu <a href="#">[35]</a>	<ul style="list-style-type: none"> <li>A primary understanding of white matter characteristics in SPD indicated that the structural deficits might link to behavioral impairments</li> </ul>	Lower white matter integrity Fair
Jon D. Elhai <a href="#">[46]</a>	<ul style="list-style-type: none"> <li>COVID-19 anxiety correlated with severity of PSU, depression, and anxiety</li> </ul>	COVID-19 anxiety Good

Author and Reference	Outcomes	Specific Outcome Quality	
	<ul style="list-style-type: none"> <li>12% of participants were identified with at least moderate depression, and 24% with moderate anxiety</li> </ul>		
Linbo Zhuang <a href="#">[47]</a>	<ul style="list-style-type: none"> <li>Cervical disc degeneration may be associated with excessive smartphone use</li> </ul>	cervical disc degeneration	Good
Yasemin P. Demir <a href="#">[48]</a>	<ul style="list-style-type: none"> <li>There was a negative correlation between MPPUS and PSQI (<math>r = -0.367</math>, <math>p</math> less than 0.05); a strong positive correlation between MPPUS and ESS (<math>r = 0.675</math>, <math>p</math> less than 0.05); and a negative correlation between MPPUS and 24-h MQoLQ (<math>r = -0.508</math>, <math>p</math> less than 0.05)</li> </ul>	Increased headache duration, poor sleep quality	Fair
KADİR DEMİRCİ <a href="#">[49]</a>	<ul style="list-style-type: none"> <li>Smartphone Addiction Scale scores of females were significantly higher than those of males</li> <li>Depression, anxiety, and daytime dysfunction scores were higher in the high smartphone use group than in the low smartphone use group</li> </ul>	Depression, anxiety, and daytime dysfunction	Fair
Ayse Gokce <a href="#">[50]</a>	<ul style="list-style-type: none"> <li>There is a mild, significant, positive correlation between the PU and LSAS scores of the students who participated in the study</li> <li>No significant relationship was found between the PU and EAT scores in the study group</li> <li>Problematic Mobile Phone Use Scale total scores showed a significant correlation with smoking</li> </ul>	Increased smoking	Fair
Betul Ozcan <a href="#">[51]</a>	<ul style="list-style-type: none"> <li>Frequency of poor sleep quality was significantly higher in students with smartphone addiction compared to others</li> </ul>	Poor sleep quality	Good

Author and Reference	Outcomes	Specific Outcome Quality
S HariPriya <a href="#">[52]</a>	<ul style="list-style-type: none"> <li>A moderately positive significant correlation between smartphone addiction and sleep quality was shown</li> </ul>	Poor sleep quality, less physical activity Good
Hsien-Yuan Lane <a href="#">[53]</a>	<ul style="list-style-type: none"> <li>With addiction to smartphones, higher risk of psychological distress and poor sleep quality was found, which is inconsistent with a previous report that more and more young adults report poor sleep quality in a higher percentage when they become addicted to smartphones</li> </ul>	Psychological distress, poor sleep quality Good
Anna Maria <a href="#">[54]</a>	<ul style="list-style-type: none"> <li>Social anxiety was significantly and positively related to PSU</li> </ul>	Social anxiety Fair
Jon D. Elhai <a href="#">[55]</a>	<ul style="list-style-type: none"> <li>Worry and anger may be helpful constructs in understanding the phenomenology of PSU, and psychological interventions for worry and anger may offset PSU</li> </ul>	Worry and anger Good
Matteo Megna <a href="#">[56]</a>	<ul style="list-style-type: none"> <li>Smartphone overuse was found to be linked with higher signs of inflammation</li> </ul>	Psoriatic arthritis Fair
Arunrat Tangmunkongvorakull <a href="#">[57]</a>	<ul style="list-style-type: none"> <li>Female students had scores for psychological well-being that were, on average, 1.24 points higher than the scores of male students (<math>p &lt; 0.001</math>)</li> </ul>	Psychological well-being Fair
Zaheer Hussain <a href="#">[58]</a>	<ul style="list-style-type: none"> <li>The average time spent on a smartphone per day was 190.6 min (SD = 138.6)</li> </ul>	Anxiety Good

Author and Reference	Outcomes	Specific Outcome Quality
	<ul style="list-style-type: none"> <li>Problematic smartphone use was positively related to time spent on the smartphone and anxiety</li> </ul>	
MILES RICHARDSON [59]	<ul style="list-style-type: none"> <li>PSUS was not found to have diagnostic ability for high levels of anxiety</li> </ul>	Connectedness with nature and anxiety Fair
Asem A. Alageel [60]	<ul style="list-style-type: none"> <li>65.9% of the participants who were identified as having high smartphone use had no depression, whereas 10.3% had severe depression, 16.1% had moderately severe depression, and 7.7% had moderate depression</li> <li>A significant correlation between the severity of insomnia and smartphone use</li> <li>47.8% of the participants with high smartphone use had ADHD symptoms</li> </ul>	Insomnia, depression, adult

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