

# Association Between Smartphone Addiction and Restless Hand Disorder: A Cross-Sectional Study on the Ergonomic and Behavioral Impact of Prolonged Mobile Phone Use

Ashfaq-ul-Hassan<sup>1</sup>, Saba Qaiser<sup>2</sup>, Sajad Hamid<sup>3</sup>

<sup>1</sup>Associate Professor and Head, Department of Anatomy, SKIMS Medical College & Hospital, Bemina. <sup>2</sup>Senior Resident Department of Anatomy, SKIMS Medical College & Hospital, Bemina. <sup>3</sup>Associate Professor, Department of Anatomy, SKIMS Medical College & Hospital, Bemina

## Abstract

**Background:** With the widespread use of smartphones, emerging evidence indicates an increase in musculoskeletal and sensory symptoms linked to prolonged and compulsive device use. This study investigated the association between smartphone usage patterns, addiction levels, and the development of Restless Hand Disorder (RHD) symptoms among frequent users. **Material and Methods:** A cross-sectional analytical study was conducted among smartphone users to assess hand-related symptoms and their relationships with phone usage duration, years of ownership, and addiction level, as measured by the Mobile Phone Addiction Index (MPAI). Statistical analyses included chi-square tests and Pearson's correlation to evaluate associations and correlations between variables. **Results:** Restless-hand symptoms were common, with thumb or wrist pain reported by 69.2%, tingling or numbness by 61.7%, and hand restlessness by 56.7% of participants. Those using smartphones  $\geq 6$  hours/day had a markedly higher prevalence of RHD (78.9%) than those with  $< 6$  hours/day (33.3%) ( $\chi^2 = 25.15$ ,  $p < 0.001$ ). Participants with  $\geq 5$  years of smartphone use had a higher RHD frequency (67.1%) than those with  $< 5$  years (31.7%) ( $\chi^2 = 13.65$ ,  $p < 0.001$ ). The prevalence increased with addiction level—23.5% (low), 61.0% (moderate), and 73.3% (high) ( $\chi^2 = 20.3$ ,  $p < 0.001$ ). Strong positive correlations were found between daily phone use and symptom severity ( $r = 0.62$ ,  $p < 0.001$ ), addiction score and hand restlessness ( $r = 0.58$ ,  $p < 0.001$ ), and addiction score and total symptom burden ( $r = 0.65$ ,  $p < 0.001$ ). **Conclusion:** The findings indicated that both the intensity and chronicity of smartphone use significantly contribute to the development and severity of RHD. The results suggest a combined ergonomic and behavioral etiology, emphasizing the importance of awareness, ergonomic education, and moderation in smartphone use to prevent emerging technology-related musculoskeletal issues.

**Keywords:** Smartphone addiction; Restless Hand Disorder (RHD); Musculoskeletal symptoms; Ergonomic strain; Behavioral dependence; Mobile Phone Addiction Index (MPAI); Screen time; Hand pain; Digital overuse; Upper limb discomfort.

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## INTRODUCTION

Smartphones are woven into daily life: they serve as portals for social contact, information, entertainment, and work, and are carried and checked many times per hour by large segments of the population. For a sizeable minority, this pattern of use becomes compulsive, producing clinically relevant symptoms that resemble behavioural addictions, persistent, poorly controlled use despite harm, strong cravings, and functional impairment.<sup>[1]</sup> Contemporary reviews conceptualize problematic mobile phone use (mobile phone addiction, smartphone addiction, nomophobia) within behavioural-addiction and impulse-control frameworks, noting converging evidence for altered reward-control circuits and for psychological comorbidity such as anxiety and impaired sleep.<sup>[2]</sup> These models place compulsive checking and habitual device engagement at the core of the disorder rather than pure peripheral pathology.<sup>[3]</sup> Behavioral mechanisms explain how brief and unpredictable rewards from phones, such as notifications, social feedback, or new content, lead to habit formation and compulsive checking. Digital platforms use variable-ratio or variable-interval

reinforcement schedules, which are known to produce persistent behaviors. Over time, these intermittent rewards activate dopaminergic pathways in the brain's reward system and reduce conscious control, shifting phone use from purposeful to automatic. This explains why users often check their phones without thinking, as frequent small interactions evolve into a powerful habitual drive.<sup>[4]</sup> Clinically useful measurement tools have been developed to quantify this behavioural phenotype. The Smartphone Addiction Scales, like the Mobile Phone Addiction Index (MPAI) and the Smartphone Addiction Scale (SAS), are widely validated self-report instruments that operationalize core

**Address for correspondence:** Dr. Saba Qaiser,  
Senior Resident Department of Anatomy, SKIMS Medical College & Hospital,  
Bemina.

E-mail: [sabawani1192@gmail.com](mailto:sabawani1192@gmail.com)

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features of problematic use: daily-life disturbance, withdrawal, tolerance, and inability to control use.<sup>[5,6]</sup> Complementary measures (nomophobia scales, objective screen-time logs, and app-usage metrics) permit triangulation between subjective dependence and real-world behaviour. Using such instruments permits observational studies to relate the degree of habitual/addictive use to downstream outcomes. Problematic smartphone habits manifest through both observable behaviors and bodily sensations. Common examples include phantom vibrations or ringing, where users mistakenly sense phone cues that do not occur.<sup>[7]</sup> These experiences are linked with frequent phone checking and higher levels of problematic use. Repeated sensorimotor interaction with the device alters attention, expectation, and body awareness, creating conditioned perceptual experiences and automatic hand movements. Over time, these conditioned actions, such as reaching, unlocking, or swiping, can become habitual routines that persist even in the absence of the phone.<sup>[8]</sup>

Conceptualizing “restless hand” as a behavioral or compulsive phenomenon, rather than a primary neurological disorder, is both plausible and clinically significant. From this perspective, the restlessness of the hand may represent conditioned motor urges arising from repetitive, device-linked actions; compulsive microbehaviors reinforced by prior digital rewards; and heightened bodily awareness or tension triggered by craving or anxiety during phone unavailability. Additionally, factors such as sleep disturbance and psychological stress may intensify these urges. Although peripheral musculoskeletal strain or nerve irritation may coexist, an addiction-centered model suggests that behavioral indicators such as elevated MPAI scores, frequent phone checking, and nomophobia, along with psychosocial influences, are more strongly correlated with restless-hand symptoms than isolated neuropathic findings.<sup>[3,9,10]</sup> Research on “restless hand” as a behavioral outcome of smartphone addiction is limited. Most existing studies emphasize pain, sleep, or mental health, without standardized tools linking hand restlessness to addiction metrics. The objective of this study was to assess the association between habitual or addictive smartphone use and restless-hand symptoms among frequent users. It aimed to evaluate the prevalence and severity of symptoms such as tingling, numbness, and thumb or wrist pain, and to determine whether higher addiction scores, longer daily use, and extended years of phone use were significantly correlated with increased symptom severity. The study further sought to identify behavioral patterns, including

excessive social media use and frequent checking, that contribute to hand restlessness, thereby exploring restless-hand manifestations as potential behavioral outcomes of smartphone addiction rather than purely ergonomic or neurological effects.

## MATERIALS AND METHODS

This observational cross-sectional study examined the association between habitual smartphone use and the development of restless-hand symptoms among adult mobile phone users. A total of 120 participants aged 18 years and above were enrolled through convenience sampling from university students, office workers, healthcare professionals, and other occupational groups. Inclusion criteria included individuals who had used smartphones for at least 1 year and provided informed consent. Those with pre-existing neurological or musculoskeletal disorders affecting the upper limbs were excluded to minimize confounding effects.

Data were collected using a structured, pretested questionnaire administered via Google Forms that assessed demographic characteristics, mobile phone usage patterns, and hand-related symptoms. The questionnaire included items from the Mobile Phone Addiction Index (MPAI) to determine the degree of behavioral dependence, along with self-reported measures of daily phone use, the purpose of use, and the duration of smartphone ownership. Participants were asked about common symptoms, such as tingling, numbness, thumb or wrist pain, cramps, and hand restlessness, and rated them on a 0–10 severity scale. Restless-hand disorder (RHD) was operationally defined as the presence of one or more hand restlessness symptoms associated with frequent smartphone use.

Data were analyzed using SPSS version 26.0. Descriptive statistics (frequencies, percentages, means, and standard deviations) summarized participant characteristics and symptom patterns. The Chi-square test assessed associations between mobile phone use variables and restless-hand symptoms. In contrast, Pearson’s correlation coefficient (r) was used to evaluate the relationship between addiction scores, duration of use, and symptom severity. A p-value < 0.05 was considered statistically significant.

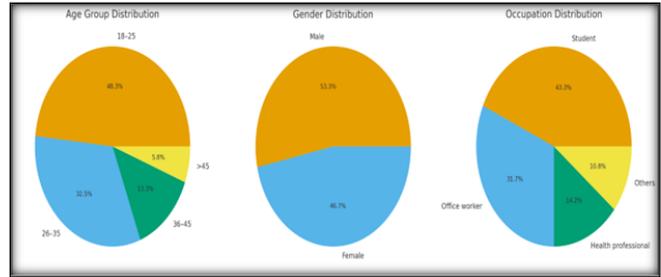
## RESULTS

A total of 120 participants were included in the study. The majority of respondents (48.3%) belonged to the 18–25-year age group, followed by 32.5% in the 26–35-year range, 13.3% between 36–45 years, and only 5.9% were above 45 years of age, indicating that younger adults constituted the predominant population in this study.

**Table 1: Demographic Characteristics of Participants (n = 120)**

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	18–25	58	48.3
	26–35	39	32.5
	36–45	16	13.3
	>45	7	5.9
Gender	Male	64	53.3
	Female	56	46.7
Occupation	Student	52	43.3
	Office worker	38	31.7
	Health professional	17	14.2
	Others	13	10.8

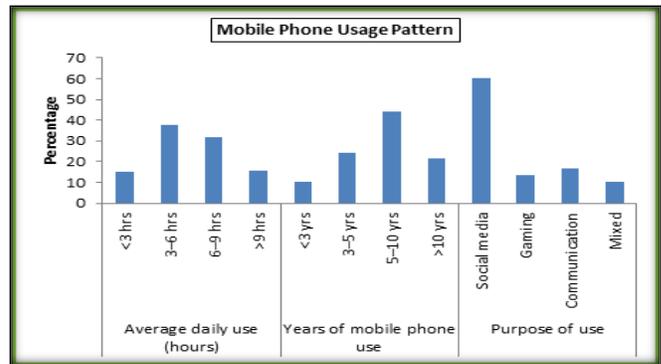
Males accounted for 53.3% of participants, while females comprised 46.7%, reflecting a nearly balanced gender distribution. Regarding occupation, students formed the largest subgroup (43.3%), followed by office workers (31.7%), health professionals (14.2%), and others (10.8%). This distribution highlights that the study primarily represented young, active smartphone users, particularly students and working professionals, who are typically more engaged with mobile devices in daily activities.



**Table 2: Mobile Phone Usage Pattern**

Parameter	Category	Frequency (n)	Percentage (%)
Average daily use (hours)	<3 hrs	18	15.0
	3–6 hrs	45	37.5
	6–9 hrs	38	31.7
	>9 hrs	19	15.8
Years of mobile phone use	<3 yrs	12	10.0
	3–5 yrs	29	24.2
	5–10 yrs	53	44.2
	>10 yrs	26	21.6
Purpose of use	Social media	72	60.0
	Gaming	16	13.3
	Communication	20	16.7
	Mixed	12	10.0

Analysis of mobile phone usage patterns revealed that the majority of participants (37.5%) used their phones for 3–6 hours daily, while 31.7% reported usage between 6–9 hours, and 15.8% exceeded 9 hours per day. Only 15% of users reported using their phones for less than 3 hours daily, indicating that prolonged daily phone use was common among participants. Regarding duration of ownership, 44.2% had used smartphones for 5–10 years, 24.2% for 3–5 years, and 21.6% for more than 10 years, suggesting sustained long-term exposure to smartphones. Regarding purpose, social media emerged as the predominant activity (60%), followed by communication (16.7%), gaming (13.3%), and mixed purposes (10%).



**Table 3: Prevalence and Severity of Restless Hand Symptoms**

Symptom	Present (n, %)	Absent (n, %)	Mean Severity Score (0–10) ± SD
Tingling / numbness	74 (61.7%)	46 (38.3%)	4.8 ± 1.7
Hand restlessness (urge to move / stretch)	68 (56.7%)	52 (43.3%)	4.3 ± 2.0
Thumb or wrist pain	83 (69.2%)	37 (30.8%)	5.6 ± 2.1
Cramps after prolonged use	57 (47.5%)	63 (52.5%)	4.1 ± 1.9
Decreased grip strength	31 (25.8%)	89 (74.2%)	3.3 ± 1.5

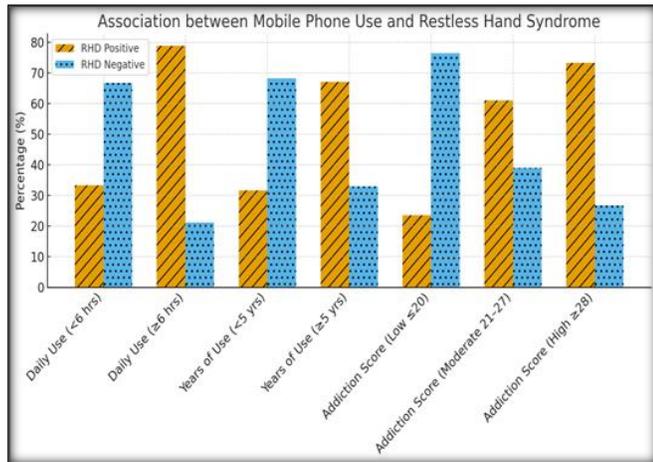
As shown in [Table 3], restless-hand symptoms were common among participants, ranging in severity. Thumb or wrist pain was the most frequently reported complaint, affecting 69.2% of individuals with a mean severity score of 5.6 ± 2.1. Tingling or numbness was present in 61.7% of participants, with a mean score of 4.8 ± 1.7, while hand restlessness, characterized by an urge to move or stretch, was reported by 56.7%, showing a mean severity of 4.3 ± 2.0.

Cramps after prolonged smartphone use were noted in 47.5% of participants (4.1 ± 1.9), and decreased grip strength was the least common symptom, observed in 25.8% (3.3 ± 1.5). These findings indicate that sensory and motor discomforts, particularly pain and restlessness, were prevalent among frequent smartphone users, suggesting possible behavioral or ergonomic strain associated with extended device use.

**Table 4: Association between Mobile Phone Use and Restless Hand Syndrome**

Parameter	Group	RHD Positive (n,%)	RHD Negative (n, %)	χ <sup>2</sup> (Chi-square)	p-value
Daily use (hours)	<6 hrs (n = 63)	21 (33.3%)	42 (66.7%)	25.15	<0.001
	≥6 hrs (n = 57)	45 (78.9%)	12 (21.1%)		
Years of use	<5 yrs (n = 41)	13 (31.7%)	28 (68.3%)	13.65	<0.001
	≥5 yrs (n = 79)	53 (67.1%)	26 (32.9%)		

Addiction score (MPAI)	Low ( $\leq 20$ ) (n = 34)	8 (23.5%)	26 (76.5%)	20.3	<0.001
	Moderate (21–27) (n = 41)	25 (61.0%)	16 (39.0%)		
	High ( $\geq 28$ ) (n = 45)	33 (73.3%)	12 (26.7%)		



As shown in [Table 4], there was a strong and statistically significant association between mobile phone usage patterns, addiction levels, and the presence of Restless Hand Disorder

(RHD) symptoms. Participants who used mobile phones for 6 hours or more daily had a markedly higher prevalence of RHD (78.9%) than those with less than 6 hours of daily use (33.3%), with this difference highly significant ( $\chi^2 = 25.15, p < 0.001$ ). Similarly, individuals with a longer duration of phone use ( $\geq 5$  years) exhibited a significantly higher frequency of RHD symptoms (67.1%) than those with less than 5 years of phone use (31.7%) ( $\chi^2 = 13.65, p < 0.001$ ). A clear gradient was also observed across addiction levels measured by the Mobile Phone Addiction Index (MPAI). The prevalence of RHD increased progressively from 23.5% among low addiction users ( $\leq 20$ ) to 61.0% among moderate users (21–27) and 73.3% among high addiction users ( $\geq 28$ ), with the association being statistically significant ( $\chi^2 = 20.3, p < 0.001$ ). These findings indicate that both the intensity and chronicity of smartphone use are strongly correlated with the development of restless-hand symptoms, supporting the behavioral addiction model over purely ergonomic explanations.

**Table 5: Correlation between Mobile Addiction and Symptom Severity**

Variable	r (Correlation Coefficient)	p-value	Interpretation
Daily phone use duration vs. symptom severity	0.62	<0.001	Strong positive correlation
Addiction score vs. hand restlessness score	0.58	<0.001	Strong positive correlation
Addiction score vs. total symptom burden	0.65	<0.001	Strong positive correlation

As presented in [Table 5], there was a strong and statistically significant positive correlation between measures of smartphone addiction and the severity of restless-hand symptoms. Daily phone use duration showed a strong positive correlation with overall symptom severity ( $r = 0.62, p < 0.001$ ), indicating that longer daily use was associated with more severe complaints. Similarly, the addiction score demonstrated a strong positive correlation with both the hand restlessness score ( $r = 0.58, p < 0.001$ ) and the total symptom burden ( $r = 0.65, p < 0.001$ ). These findings suggest that higher levels of smartphone dependence are closely linked to greater intensity and frequency of restless-hand symptoms.

## DISCUSSION

The present study included 120 participants, of whom nearly half (48.3 %) were aged 18–25 years, 32.5 % were aged 26–35, 13.3 % were aged 36–45, and only 5.9 % were aged 46 or older. This age distribution indicates that the sample was heavily weighted toward younger adults—a demographic known to engage most intensively with smartphones and to be at increased risk of behavioural forms of device overuse. For instance, a cross-sectional study of 440 young adults in Bangladesh found a 61.4 % prevalence of smartphone addiction among participants aged  $\leq 25$  years.<sup>[12]</sup> Similarly, in a UK sample of university students, younger age was associated with higher smartphone-addiction scores.<sup>[13]</sup> Thus, our study’s emphasis on younger users is aligned with the wider trend in the literature of younger age groups being more vulnerable to problematic smartphone use. The gender

distribution in our study was slightly male-dominated, with males representing 53.3% and females 46.7% of participants. Many previous reports also note only modest or variable gender differences in smartphone addiction and related behavioural outcomes. This finding is consistent with several previous studies.<sup>[14,15]</sup> A possible explanation for this observation is that males tend to engage more frequently in activities such as online gaming, which may contribute to higher levels of smartphone addiction.<sup>16</sup> However, contrasting evidence exists in the literature, with some studies reporting no significant gender differences in smartphone addiction prevalence, while others have found a higher predisposition among females.<sup>[17,18]</sup> Occupationally, the largest subgroup was students (43.3 %), followed by office workers (31.7 %), health professionals (14.2 %), and others (10.8 %). This occupational profile reinforces the interpretation that our participants were largely young, active smartphone users engaged in daily digital activities, whether for study, work, or leisure. Prior research has similarly shown elevated smartphone use and addiction indicators among university and working populations. For instance, a study of university students in Kerala found significant relationships between excessive smartphone use and entertainment-driven habits.<sup>[19]</sup>

Our analysis revealed that a large portion of participants reported substantial daily smartphone use. Specifically, 37.5% used their phones for 3–6 hours daily, 31.7% for 6–9 hours, and 15.8% for more than 9 hours daily, with only 15% reporting less than 3 hours. In addition, 44.2% had used smartphones for 5–10 years, 24.2% for 3–5 years, and 21.6% for more than 10 years, indicative

of sustained long-term exposure. The predominant purpose of use was social media (60%), followed by communication (16.7%), gaming (13.3%), and mixed activities (10%). These findings align with the published literature on smartphone use patterns. For example, in a review, it was noted that globally people spend on average 3-5 hours per day on their phones, with younger adults tending toward higher usage.<sup>[20,21]</sup> Similarly, a study on smartphone addiction found that among students, daily use often extended into more than 4–10 hours, and ownership duration was frequently in the 5–8 year range.<sup>[22]</sup> Our finding that social-media use dominates is also consistent with other reports, which show that social communication and internet-surfing constitute a large share of smartphone activity.<sup>[22,23]</sup> The high proportion of long-term users (5 years or more) in our sample is notable, as sustained exposure is often linked in other studies to higher risk of problematic use and its sequelae. The concentration of social media use may further amplify risk, given that such platforms employ features designed to encourage extended engagement.

In our cross-sectional sample of 120 smartphone users, we observed a notably high prevalence of upper-limb sensorimotor symptoms. Thumb or wrist pain affected 69.2% of participants (mean severity score  $5.6 \pm 2.1$ ), tingling or numbness was reported by 61.7% ( $4.8 \pm 1.7$ ), and hand restlessness (urge to move or stretch) by 56.7% ( $4.3 \pm 2.0$ ). Additional complaints included cramps after prolonged smartphone use (47.5%,  $4.1 \pm 1.9$ ) and decreased grip strength (25.8%,  $3.3 \pm 1.5$ ). These findings align with and extend the existing literature. For example, in a large Saudi Arabian cohort of 811 smartphone users, Hassaan et al. reported a 39.7% prevalence of wrist or thumb pain. They found that exceeding 5 hours of daily use significantly increased the risk ( $P = 0.045$ ).<sup>[24]</sup> In a Chinese study, 43.4% of participants experienced thumb/wrist pain attributed to electronic-device use, and a Pakistani study found that 42% of adolescents reported thumb/wrist pain due to smartphone use.<sup>[25,26]</sup> While their prevalence figures are lower than ours, the discrepancy may reflect our sample's heavier usage and higher severity scores. Our higher rate of tingling or numbness (61.7%) also resonates with studies of phantom or conditioned sensorimotor phenomena associated with device dependence. Padyal et al. found phantom vibration and ringing in approximately 40% and 39.5% of medical students, respectively, with significant associations to smartphone addiction scores.<sup>[27]</sup> Eapen et al. reported that 53% of subjects complained of thumb discomfort and 13% of wrist discomfort from smartphone use, noting that symptoms of repetitive strain injury, especially pain followed by tingling, were common, consistent with our data.<sup>[28]</sup> The subjective hand-restlessness in our cohort (56.7%) may represent the behavioural-motor analogue of these phenomena, suggesting that habitual device checking and conditioned hand movements may generate urges to move the hand even at rest. The comparatively lower prevalence of decreased grip strength (25.8%) may indicate that functional weakness or measurable strength loss is a later or less common manifestation of overuse or behavioural strain. For instance, Singh et al. reported no immediate adverse effect

on grip force in young adults despite heavy smartphone use, but did find weakening in wrist extensor and flexor muscles.<sup>[29]</sup> This suggests that while pain, tingling, and restlessness appear early in the spectrum, measurable strength compromise may follow only after prolonged exposure. Collectively, our findings support a mixed peripheral/behavioural model for upper-limb complaints in heavy smartphone users: mechanical overuse and repetitive micro-movements (peripheral) coexist with conditioned behavioural processes (habitual checking, sensorimotor expectation, bodily awareness) to drive symptoms.

Our findings revealed a robust, dose-dependent relationship between smartphone usage and the development of Restless Hand Disorder (RHD), reinforcing a combined ergonomic and behavioural framework. Individuals reporting daily smartphone use of 6 hours or more had a significantly higher prevalence of RHD (78.9%) than those using their devices for fewer than 6 hours (33.3%) ( $\chi^2 = 25.15$ ,  $p < 0.001$ ). In addition, the data demonstrated strong, significant positive correlations: daily use duration correlated with overall symptom severity ( $r = 0.62$ ,  $p < 0.001$ ); smartphone addiction score correlated with hand-restlessness ( $r = 0.58$ ,  $p < 0.001$ ) and with total symptom burden ( $r = 0.65$ ,  $p < 0.001$ ). These effect sizes underscore the conclusion that it is not only the volume of use but also the behavioural dimension of dependence that amplifies sensory and motor complaints in the upper limbs. This strong relationship between usage intensity and symptom occurrence aligns with findings by Yang et al., who reported that students using smartphones for more than 3 hours daily had significantly higher odds of developing upper-back and limb discomfort.<sup>[30]</sup> Similarly, Kim et al., observed that device screen time exceeding 5 hours/day was associated with increased musculoskeletal pain, highlighting that prolonged exposure substantially elevates physical strain.<sup>[31]</sup> Chronicity of use also emerged as an important determinant in our study—participants with  $\geq 5$  years of smartphone ownership had a significantly higher prevalence of RHD (67.1%) than those with  $< 5$  years (31.7%) ( $\chi^2 = 13.65$ ,  $p < 0.001$ ). This observation corroborates the findings of Alghadir et al. (2021), who reported that longer smartphone use was associated with higher levels of pain, disability, and functional impairment among university students, suggesting cumulative physiological effects of habitual device use over time.<sup>[32]</sup> Furthermore, our results demonstrated a progressive rise in RHD prevalence across addiction levels measured by the Mobile Phone Addiction Index (MPAI) from 23.5% among low-addiction users to 61.0% in moderate and 73.3% in high-addiction groups ( $\chi^2 = 20.3$ ,  $p < 0.001$ ). This gradient strongly supports an addiction-centered mechanism, consistent with reports by Ahmed et al. and Mustafaoglu et al., who found significant positive correlations between smartphone addiction scores and musculoskeletal complaints, particularly neck and hand pain.<sup>[33,34]</sup> Beyond physical strain, behavioral dependence and conditioned sensorimotor responses may amplify symptom perception. Mangot et al. and Dang et al. demonstrated significant associations between smartphone addiction, phantom vibration/ringing, and psychological distress in student cohorts; Dang et al. notably found that emotional and attachment factors increased the odds of phantom vibration ( $OR = 2.15$ , 95% CI: 1.21–3.81,  $p = 0.009$ ).<sup>[35,36]</sup> These parallels reinforce that compulsive checking behavior, in addition to repetitive mechanical loading, contributes to sensorimotor

restlessness and perceived discomfort. Mechanistically, our findings support a mixed peripheral-behavioral model. Prolonged, repetitive thumb and wrist movements combined with sustained awkward postures induce tendon loading, soft-tissue strain, and transient nerve irritation mechanisms described in ergonomic studies by Khan et al. and Kim et al.<sup>[37,38]</sup> Concurrently, behavioral reinforcement from intermittent notifications and habitual checking fosters heightened bodily awareness and conditioned restlessness, as supported by addiction-oriented research. The convergence of these pathways provides a comprehensive explanation for the strong, statistically significant associations between smartphone exposure, addiction severity, and RHD observed in our cohort.

## CONCLUSION

This study revealed that restless-hand symptoms were prevalent among smartphone users, with pain, tingling, and restlessness being the most commonly reported complaints. The findings demonstrated a clear and consistent pattern linking both the duration and intensity of smartphone use with the occurrence and severity of Restless Hand Disorder (RHD). Individuals with longer daily screen exposure, extended years of usage, and higher addiction scores exhibited a markedly greater likelihood of experiencing RHD-related symptoms. The progressive increase in symptom burden with higher addiction levels underscores that behavioral dependency plays a substantial role alongside ergonomic strain. Moreover, the strong positive correlations between smartphone addiction measures and symptom severity suggest a dose-response relationship, reinforcing that both mechanical overuse and compulsive behavioral engagement contribute to symptom development. Collectively, these results support a multifactorial model of RHD and highlight the need for ergonomic awareness, moderated device use, and behavioral interventions to mitigate emerging health risks associated with emerging technologies.

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## Conflicts of interest

There are no conflicts of interest.

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