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RESEARCH ARTICLE

Effects of Smartphone Addiction on the Physical and Mental Well-being of Indian Students

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Abstract

Objectives: The study aimed to investigate the influence of varying levels of addiction, ranging from no addiction to extremely high addiction, on the physical and mental well-being of Indian students. **Methods:** The study is descriptive and based on the survey method. The six constructs and 15 physical and mental well-being items were assessed on the 5-point Likert scale. The composite scores were computed and classified into five categories. **Findings:** The results revealed that students aged 18-22 and 23-27 heavily rely on smartphones to explore their identity, socialize, and engage in academic and professional endeavours; male and female students and 91% of Professional/vocational training students exhibit the highest frequency of moderate addiction. Students (39%) spend 2-4 hours on smartphones daily based on individual preferences, habits, and lifestyle factors. A positive correlation was found between age and addiction group as well as between addiction group and smartphone usage, and negative correlations were found between smartphone usage and age groups. A significant correlation exists between an inability to control carvings (ICC), dependency (D), Conflict (C), Over-Usage (OU) and Withdrawal and Escape (WE), and all these have the greatest contribution to the first variate. MANOVA Analysis Pillai's Trace (<0.001); Wilks' Lambda (<0.001); Hotelling's Trace (<0.001); Roy's Largest Root (<0.001) revealed substantial disparities among groups stratified by addiction severity spanning from no addiction to extremely high addiction across a spectrum of physical and mental well-being dimensions among Indian students. The discriminant function plot effectively illustrated the discernment achieved in varying levels of smartphone addiction, notably accentuating differences among moderate (0.370), high (1.091), and extremely high (1.803) addiction categories. **Novelty:** This study investigated how varying levels of addiction exert influence on both physical and mental well-being and shed new light on this multifaceted relationship, particularly among students within the context of Indian academia.

Keywords: Smartphone Addiction; Physical and Mental Wellbeing; Usage Patterns; Smartphones; Indians; Students

1 Introduction

ICT integrates several technologies, such as the Internet, wireless networks, cell phones, and other modes of communication, facilitating synchronous communication as we live next door to the recipient of information. The rapid development of media, the internet and cell phones in advanced IT industries has led to addiction. Addictions are substance and behavioural; this may be a chronicle/lifelong with significant effects on physical and mental health and relationships[1,2]. Technology addiction is defined as a dependency on technology use, and addiction develops psychological and physical problems[1]. Smartphone addiction is characterized by substance addiction and behavioural addiction. Smartphone addiction includes mood tolerance, salience, withdrawal, modification, conflict, and relapse; it is related to mental health, physical and neurological problems, and excessive smartphone use[3]. The convenience and effortlessness of accessing smartphone technology are the main factors of smartphone addiction, and research has recently emphasized smartphone addiction. It was observed that cognitive and behavioural disorders are dependent on technology. According to earlier studies, smartphones also develop significant social issues that represent addiction symptoms, including the inability to control cravings, dependency, overuse, conflict, and withdrawal symptoms.

Increased daily smartphone usage is linked to smartphone addiction, leading to psychophysiological issues, including sleep deprivation and mental health issues. Smartphone addiction affects social skills, poses health risks, and impacts the psychological well-being of Korean adults[2]. Furthermore, smartphone use is reported to be excessive, leading to impatience and irritability[4]. The number of smartphone users among youth is increasing drastically, and smartphones are used for academic purposes and maintaining social relations, but excessive use affects mental and physical health. Smartphone addiction is linked to psychological and physiological issues such as mood disorders, depression, loneliness, low self-esteem, and shyness. Students are drawn to smartphones for entertainment, self-expression, and social connectivity, facilitated by affordable internet packages, messaging, and low call rates. It provides academic help and maintains social relations, but excessive use affects mental and physical health. The growth of smartphones is attributed to extensive mobile broadband coverage and competitive pricing. Smartphone use significantly affects higher education students in various social and academic contexts. Excessive smartphone use can adversely affect the psychophysiological well-being of students. College and university students are particularly susceptible to smartphone addiction.

Research is crucial to determine whether smartphone addiction affects college and university students' physical and mental health, particularly in India. Thus, empirical research is needed to investigate smartphone addiction's physiological and psychological effects. Most existing research on smartphone addiction has focused on various demographic groups, leaving a gap in knowledge regarding Indian colleges and university students.

The study's importance is to comprehensively understand how smartphone addiction affects students' physical and mental health and provide an authentic assessment of smartphone addiction. This research could be important for future studies and provide valuable insights for mitigating the effects of smartphone addiction on the physical and mental well-being of Indian students.

2 Literature Review and Theoretical Framework

Various national and international studies have explored the emergence of smartphone addiction among Indian students, smartphone usage patterns, different types of smartphone activities contributing to smartphone addiction that contribute to addiction, and the repercussions of this addiction on students' physical and mental health. Reviewing the literature has provided insights into global and national trends in smartphone usage patterns, increasing addiction tendencies among students, the negative consequences of smartphone addiction and strategies to mitigate them. The variables of inability to control cravings, dependency, conflict, over-usage, withdrawal symptoms, and the desire to escape were identified through a literature review:

2.1 Smartphone Addiction

There are detrimental repercussions of excessive smartphone and internet use [5], and several factors contribute to smartphone addiction. Students of health sciences frequently replace smartphones, have increasing anxiety levels, and use them for longer periods [6]. The high screen usage and rising smartphone addiction among teenagers and young adults assessed smartphone addiction risk using the SARR score, which studied smartphone addiction in Bangladeshi young adults and identified predictors of smartphone addiction as social networking services and instant messaging [7]. The study regarding the relationships between personal environment variables indicated that high SNS intensity is linked to heavy SNSs. Social app interactions are strongly correlated with smartphone addiction for female users [8]. The unwarranted use of smartphones and psychological stress are associated, but there is no association between using DEBs and sleep quality [9]. Certain psychological factors directly contribute to the likelihood of smartphone addiction [10]. Depression as a consistent consequence of adolescent smartphone addiction [11]. Zhou, Zhu, and Chen introduced an improved model of smartphone addiction, addressing previous biases and accurately representing compulsive smartphone use [12]. Harris et al. [13] addressed the research gap in assessing smartphone addiction among college/university students in the US by considering variations related to gender, age, and education. Due to frequent and varied use, smartphones have become troublesome devices and have contributed to smartphone addiction [14].

2.2 Physical and mental well-being

Alageel et al. [15] explored the associations relating to smartphone addiction in postgraduate students and various conditions, including major depressive and attention deficit hyperactive disorder, insomnia, and nicotine dependence. Women are more addicted than men, and the family's annual income, monthly allowance, and father's job significantly correlate with smartphone addiction; using cell phones harms students' well-being [16]. Mehmood et al. [17] described the adverse effects of smartphone addiction on behaviour and mental health, making international students particularly susceptible to it. Kim's research reported that their self-esteem and FoMO moderate the impact of parental support on teenagers' problematic smartphone use. Parental support influences teens' problematic smartphone uses through a series of mediations involving (FoMO); specifically, parental support boosts teens' self-esteem and concurrently reduces their FoMO [18]. The pressure to be constantly connected to social networks leads to perceived isolation, reduced daily stress, and excessive use of smartphones, which may increase anxiety and depression [19]. Heavy smartphone use lowers people's emotional well-being and leads to low self-esteem [20]. The issue of anxiety due to smartphone addiction in Korean youth was studied using the "Revised Children's Manifest Anxiety Scale (RCMAS) and the Korean Smartphone Addiction Proneness Scale Index (KSAPSI)" [21]. Smartphone addiction impacts the mental health of university students and concurrently affects interpersonal sensitivity, self-esteem, social anxiety, stress, and happiness [22]. The behavioural inhibition system has a strong connection with smartphones and mental health. Smartphone addiction impacts adolescent mental health, affecting anxiety and sadness, as well as social connections. There is consistent evidence linking smartphone addiction to mental health issues, issues with cognitive-emotional regulation, impulsivity, diminished cognitive function, addiction to social networking sites, shyness, and low self-esteem [22–25]. A positive link exists between daily routines, quality health, smartphone addiction and insomnia among students [26]. There are associations with musculoskeletal problems, upper limb issues, ocular discomfort, and sleep complications [27]. Kwak's research proposed an emotion dysregulation model for problematic smartphone use mediated by psychological distress [28].

2.3 Summary of the Literature Review and Research Gap

The literature review revealed several attributes of smartphone addiction, smartphone usage, physical and mental well-being, etc., studied in countries such as the USA, Saudi Arabia, China, Malaysia, Switzerland, Germany, France, Korea, the Philippines, Saudi Arabia, and Bangladesh. Moreover, some of the studies are related to smartphone addiction among adults and college and university students. However, the literature review revealed a need for evidence from college and university students of various genders, ages, education, and addiction groups in India. It showed that all smartphone-related factors, i.e. inability to

control cravings, dependency, conflict, withdrawal and escape, must be studied. Other study gaps include exploring the impact of different levels of smartphone addiction on the physical and mental health of Indian students.

The study will contribute new values to the previous studies because various national and international studies have explored the emergence of smartphone addiction among various age groups of society, smartphone usage patterns, and different types of smartphone activities contributing to smartphone addiction that contribute to addiction. The study emphasized the repercussions of addiction on students' physical and mental health.

2.4 Research Questions

"Is Smartphone Addiction Affecting the Physical and Mental Well-being of Indian Students?"

3 Methodology

3.1 Methods

This study adopts a pragmatic paradigm and utilizes a mixed-methods approach, providing a descriptive analysis. This comprehensive approach employs empirical research and systematic analysis to evaluate and quantify the impact of smartphone addiction on the physical and mental health of Indian students, aiming to generalize the results of the study. The objective is to understand the extent of smartphone addiction, observe physical and mental health changes, and analyze smartphone usage patterns. The questionnaire was meticulously crafted to address the research objectives, featuring questions about the prevalence of smartphone addiction, methods for assessing the level of addiction, the pattern of smartphone usage, physical and mental health issues, and approaches to decrease smartphone use. The study included 446 students from various locations across India, all enrolled in the 2023-24 academic session. A preliminary pilot study was conducted via Google Forms involving 25 students. The Google Form was distributed to 500 students via email, WhatsApp, and other online channels using purposive and selective multistage sampling. Of these, 460 responses were collected, and 446 were found valid. Faculty mediators assisted in identifying students and distributing the questionnaires.

3.2 The difference between the proposed method and the existing method

The study aimed to investigate the influence of varying levels of addiction, ranging from no addiction to extremely high addiction, on the physical and mental well-being of Indian students. It specifically examined factors such as the inability to control cravings (ICC), dependency (D), conflict (C), over-usage (OU), and withdrawal and escape (WE), utilizing the SAS Scale established by Kwon et al. [8].

The existing study revealed several significant correlations, notably between age and addiction group, between addiction group and smartphone usage, as well as between inability to control cravings (ICC), dependency (D), conflict (C), over-usage (OU), and withdrawal and escape (WE). Additionally, a non-significant correlation was observed between smartphone usage and age group. Moreover, MANOVA analysis revealed significant differences among groups of Indian students categorized by addiction level—ranging from no addiction to extremely high addiction—across various physical and mental well-being constructs. Furthermore, the established discriminant function plot visually highlighted the successful discrimination between different levels of smartphone addiction, particularly emphasizing distinctions among moderate, high, and extremely high addiction groups based on their variate scores. Overall, these findings underscore the nuanced relationship between smartphone addiction and the diverse dimensions of physical and mental well-being.

Among the participants, 49% were aged 8-22 Years, 28% were aged 23-27 Years, 9% were aged 28-32 Years, 2% were aged 33-37 Years 13 and 10% were aged 37 Years & Above. Also, 50.6 % of students were male, while 49.4% were female. The participants' educational levels ranged from professional/vocational training to doctoral degrees, and all owned smartphones. In the present study, a smartphone addiction scale was used to calculate smartphone addiction levels among students. The composite score for each physical and mental construct was calculated. A score with a value of 0.00 is considered as no addiction; a score between 0.01 to 1.00 is regarded as a low addict; a score between 1.01 to 2.00 is considered a moderate addict; a score between 2.01 to 3.00 is viewed as a high addict; and the score between 3.01 to 4.00 is considered as very high addict. Table 1 offers an analysis of addiction status among Indian students. Among the participants, 40% of males and 46% of females exhibit moderate levels of addiction, 29% of males and 35% of females exhibit the second-highest frequency of low addiction, whereas 3% of males and 2% of females exhibit an exceptionally low percentage of high addiction. The table further breaks down the level of addiction among different age groups. Students aged 18-22 and 23-27 years had the highest frequencies of moderate addiction. Students aged 28-32 years exhibit moderate addiction, and students aged 33-37 years demonstrate mild addiction. Table 1 also explores addiction status based on students' educational levels. Professional/vocational training students show the highest frequency of

moderate addiction, followed by bachelor's degree students. Students pursuing master's degrees exhibit a notable frequency of mild addiction, while those in doctorate programs primarily display low addiction tendencies. Finally, the table highlights the addiction status concerning students' smartphone ownership; 170 students were moderately addicted to smartphones, while 136 students were less addicted.

Notably, students who own three smartphones tend to have a greater likelihood of having moderate addiction (Table 1).

Table 1. Smartphone Addiction Level among Indian Students

Descriptive Statistics	Characteristics	No addiction	Low addiction	Moderate addiction	High addiction	Extremely high addiction	Total
Gender	Male	19	67	92	42	6	226
	%	8.00	29.00	40.00	18.00	3.00	100.00
	Female	12	78	100	25	5	220
	%	6.00	35.00	46.00	11.00	2.00	100.00
Age	18-22 Years	16	76	101	23	5	221
	23-27 Years	8	36	53	26	2	125
	28-32 Years	5	13	13	8	2	41
	33-37 Years	0	4	8	1	0	13
	37 Years & Above	3	16	18	8	1	46
Education	Professional/Vocational Training	18	56	91	23	4	192
	Bachelor's Degree	9	70	71	32	5	187
	Master's Degree	0	3	12	3	0	18
	Doctorate	5	14	11	5	0	35
	No Answer	0	2	8	3	1	14
Smartphone Ownership	1	30	136	170	62	7	405
	2	1	7	20	4	2	34
	3	1	2	3	0	1	7
Total		**32**	**145**	**193**	**66**	**10**	**446**

Table 2 shows that users use smartphones for diverse purposes. Among all students, communication and information acquisition 379 (9.6%) was the highest in smartphone usage activity and tracking expenses and saving on smartphones 125 (3.2%) was the least common. According to Table 2, 172 (38.6%) students spend 2-4 hours per day, which is the highest in the series, and 7 (1.6%) students use smartphones 12 hours daily, which is the lowest value of the series.

Table 2. Smartphone Usage and Times Utilized

Smartphone Usage and Time Utilized on Smartphone		Frequency	%	Cumulative Percent
Smartphone Usage	Communication and Information Acquisition	379	9.6%	85.2%
	Messenger Services	264	6.7%	59.3%
	Gaming	135	3.4%	30.3%
	Book tickets	219	5.5%	49.2%
	Mobile Banking	300	7.6%	67.4%
	Photo, Video and Music	314	7.9%	70.6%
	Learning	334	8.4%	75.1%
	Entertainment	294	7.4%	66.1%
	Web Surfing	186	4.7%	41.8%
	Email	310	7.8%	69.7%
	Location-based Services	186	4.7%	41.8%
	Purchase and Sell of Products and Services	186	4.7%	41.8%
	Track expenses and savings	125	3.2%	28.1%
	Schedule Activities on the Calendar	159	4.0%	35.7%
	Commute with Virtual Communities and Social Networks	195	4.9%	43.8%

Continued on next page

Table 2 continued

	Interact with friends and make new friends	214	5.4%	48.1%
	Food Service	160	4.0%	36.0%
	Total	3960	100.0%	889.9%
Time Spent on Smartphones (in hours)	0-2 hours	81	18.2	18.2
	2-4 hours	172	38.6	38.6
	4-6 hours	127	28.5	28.5
	8-10 hours	51	11.4	11.4
	10-12 hours	8	1.8	1.8
	Above 12 hours	7	1.6	1.6
	Total	446	100.0	100.0

3.3 Measures

The Smartphone Addiction Scale (SAS) developed by Kwon et al.[4] was utilized to assess the six variables, i.e., the physical and mental well-being constructs - Inability to control cravings (ICC), dependency (D), conflict (C), over usage (OU), and withdrawal and escape (WE) on 15 items of the smartphone addiction scale (SAS). The items were evaluated using a 5-point Likert scale ranging from Strongly Disagree (1) to Agree (5) Strongly. These items are aimed at measuring smartphone addiction. The composite scores were computed from the Likert scale and classified into five categories: A score with a value of 0.00 is considered as no addiction; a score between 0.01 to 1.00 is regarded as a low addict; a score between 1.01 to 2.00 is considered as moderate addict; the score between 2.01 to 3.00 is considered as high addict; and the score between 3.01 to 4.00 is considered as very high addict. The scale assesses the degree of smartphone addiction across the student population. The combined reliability of Cronbach's alpha score for 47 items was 0. 884. Cronbach's alpha reliability score was acceptable for all items except gender. The Shapiro–Wilk and Kolmogorov–Smirnov tests assess p-values for all factors less than 0.05, as the sample data did not conform to a normal distribution. Hence, a nonparametric test was employed.

4 Data Analysis

In the present study, Multivariate Analysis of Variance (MANOVA) and Pearson correlation coefficients were conducted to analyze the impact of different levels of addiction (no addiction, low addiction, moderate addiction, high addiction, and extremely high addiction) on the physical and mental health (Inability to control cravings (ICC), dependency (D), conflict (C), over usage (OU), and withdrawal and escape (WE)) of Indian students. A correlation matrix of the variables was examined, and Multivariate Analysis of Variance (MANOVA) was conducted with four statistical measures (i.e., Pillai's criterion, Wilk's lambda, Hotelling's trace, and Roy's Largest Root) to explore the impact of different levels of addiction on the physical and mental health of Indian students. The discrimination function measures different physical and psychological well-being constructs to determine the discrimination at varying levels of smartphone addiction. The data were analyzed using SPSS version 20.

5 Results and Discussion

Before using MANOVA, the relationship between the variables age, addiction groups, and smartphone usage was ascertained using bivariate Pearson's correlation coefficients (see Table 3). Also, correlation was examined among factors such as inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE) among Indian Students (See Table 4).

Table 3. Correlation between Age, Addiction Group and Smartphone Usage

		Age	Addiction groups	Smartphone Usage (In hours)
Age	Pearson Correlation	1	.035	-.072
	Sig. (2-tailed)		.460	.128
	N	446	446	446
Addiction Group	Pearson Correlation	.035	1	.187**
	Sig. (2-tailed)	.460		.000
	N	446	446	446
Smartphone Usage (In hours)	Pearson Correlation	-.072	.187**	1
	Sig. (2-tailed)	.128	.000	

Continued on next page

Table 3 continued

N	446	446	446

****. Correlation is statistically significant at the 0.01 level (two-tailed)**

Table 4. Correlation between Inability to control cravings (ICC), dependency (D), conflict (C), over-usage (OU), and withdrawal and escape (WE)

		ICC	D	OU	C	WE
ICC	Pearson Correlation	1	.607**	.484**	.475**	.594**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	446	446	446	446	446
D	Pearson Correlation	.607**	1	.615**	.689**	.805**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	446	446	446	446	446
OU	Pearson Correlation	.484**	.615**	1	.826**	.624**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	446	446	446	446	446
C	Pearson Correlation	.475**	.689**	.826**	1	.709**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	446	446	446	446	446
WE	Pearson Correlation	.594**	.805**	.624**	.709**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	446	446	446	446	446

****. Correlation is significant at the 0.01 level (2-tailed). Note:** ICC-Inability to Control Carving, D-Dependency, C-Conflict, OU-Over Usage, WE-Withdrawal and Escape

H_1: Null hypothesis(H_O): There is no significant relationship between age, smartphone addiction and smartphone usage among Indian students.

H_2: Null hypothesis(H_O): There is no significant relationship between inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE) among Indian Students.

The results revealed for Hypothesis (H_1), a significant correlation (p<0.05<=0.01, r= 0.035) exists among inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OV) and Withdrawal and Escape (WE). In contrast, another considerable correlation (p<0.05<=0.01, r= 0.187) exists between the addiction group and smartphone usage. Also, a non-significant correlation exists between smartphone usage and the age group where (p>0.05>==0.01, r= -.072). Students of different age groups are impacted by smartphone addiction and smartphone usage. Hence, the Null hypothesis was rejected.

The results revealed for Hypothesis (H_2), significant correlations (p<0.05<=0.01) exist between an inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE) among Indian Students. The Indian Students who have difficulty controlling their cravings are likely to experience dependency, conflict, overuse, and engage in withdrawal and escape behaviours. Hence, the Null hypothesis was rejected.

To assess the correlations between the students' physical and mental health and their addiction degree, an independent MANOVA was conducted. The hypothesis formulated is as follows:

H_3: Null hypothesis(H_O): There is no significant relationship between the effect of addiction level on the physical and mental well-being of Indian students.

Table 5 shows the F statistic and P values of the analysis; tests of between-subjects effects were utilized to evaluate the difference between dependent variables, inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE). More specifically, the results revealed significant differences in ICC (F= 21.985, P= 0.000), D (F= 32.920, P= 0.000), OU (F= 24.481, P= 0.000), C (F= 30.832, P= 0.000), WE (F= 32.089, P= 0.000). The result showed significant differences among all levels of smartphone addiction in all Physical and mental well-being variables. Thus, the model is efficient. The results showed that varying levels of addiction significantly affect the physical and mental health of Indian students. Pillai's trace (F=5.886, p<0.001), Wilks' Lambda (F=5.054, p<0.001), Hotelling Lawley Trace (F=6,861, p<0.001) and Roy's Largest Root (F=23.356, p<0.001). Since the p-value was less than .05. Therefore, the null hypothesis was rejected. It was concluded that the effects of different levels of addiction impact the physical and mental well-being of Indian Students.

A Discriminant Function Analysis (DFA) was conducted to perform a multivariate test of differences between an inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE). The canonical correlations for the dimensions are 0.649, 0.202, 0.085 and 0.022, respectively. The Wilk's Lamda test for DFA result reveals

Table 5. F statistics, P values, means and SD of the variables (MANOVA)

Physical and Mental Well-being (Variables)	No addiction (n=32)	Low addiction (n=145)	Moderate addiction (n=193)	High addiction (n=66)	Extremely high addiction (n=10)	F-Statistics	P-Value
	Mean SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
ICC	1.57(0.92)	2.25(1.11)	2.97(1.03)	3.18(1.04)	3.50(1.24)	21.985	0.000
D	1.25(0.60)	2.12(1.03)	2.77(0.97)	3.19(1.04)	3.43(1.43)	32.920	0.000
OU	1.59(1.02)	2.22(1.14)	2.82(1.09)	3.36(1.18)	3.93(1.38)	24.481	0.000
C	1.42(0.93)	2.02(1.03)	2.68(1.04)	3.26(1.12)	3.87(1.36)	30.832	0.000
WE	1.45(1.00)	2.06(1.03)	2.79(0.98)	3.24(1.14)	3.96(1.42)	32.089	0.000

Note: ICC-Inability to Control Carving, D-Dependency, C-Conflict, OU-Over Usage, WE-Withdrawal & Escape **Pillai's Trace (<0.001); Wilks' Lambda (<0.001) ; Hotelling's Trace (<0.001); Roy's Largest Root (<0.001); MANOVA (Multivariate Analysis of Variance);SD-Standard Deviation**

functions 1 through 4 have (p=0.000) and functions 2 through 4 have significance (p<0.05) Whereas, functions 3 through 4 and 4 have significance (p>0.05). Table 6 reveals the functions have a greater capacity for discrimination. The associated chi-square statistic tests the hypothesis that the mean values of the specified functions are equivalent across 1 through 4 and 2 through 4. The standardized canonical discriminant function coefficients (Table 7) demonstrate the importance of independent variables in predicting the dependent variable, facilitating comparisons across variables measured on various scales. Large absolute value coefficients are associated with variables that have greater discriminating power. Inability to Control Carving (ICC), Dependency (D), Conflict (C) and Withdrawal and Escape (WE) have the greatest contributions to the first variate. For the first variable, Inability to Control Carving (ICC), Dependency (D), Conflict (C) and Withdrawal and Escape (WE) have positive weights, whereas OU (Over usage) has negative weights, which implies that variations in Inability to Control Carving (ICC), Dependency (D), Conflict (C) and Withdrawal and Escape (WE) concerning other measures of physical and mental well-being account for group disparities.

Table 6. Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 4	.550	262.828	20	.000
2 through 4	.952	21.761	12	.040
3 through 4	.992	3.424	6	.754
4	1.000	.214	2	.899

a. Initially, four canonical discriminant functions were employed in the analysis Canonical Correlation-Function 1: 0.649, Function 2: 0.202, Function 3: 0.085, Function 4: 0.022

Table 7. Standardized Canonical Discriminant Function Coefficients

	Function			
	1	2	3	4
ICC	.382	-.159	.606	-.669
D	.343	-1.322	-.390	.310
OU	-.002	.037	-.401	.996
C	.418	.488	-.596	-1.295
WE	.142	1.026	.802	.718

The average scores of the discriminant functions for each group represent the centroids (Table 8). A combined group plot effectively demonstrated the relationships between the variables and the groups. Variable 1 has positive values on the initial variations for moderate, high, and extremely high addiction. In contrast, no addiction and low addiction have negative values, according to the variate centroids for each group. Figure 1, a combined group plot, representation indicates that Variate 1 discriminates between moderate, high, and extremely high addiction.

Table 8. Functions at Group Centroids

Addiction groups	Function			
	1	2	3	4
No Addiction	-1.886	.503	.017	-.031
Low Addiction	-.697	-.137	-.052	.017
Moderate Addiction	.370	-.045	.086	-.005
High Addiction	1.091	.059	-.145	-.023
Very High addiction	1.803	.855	.000	.102

Note: Unstandardized canonical discriminant functions evaluated at group means

Overall, we conclude that among all students, different levels of addiction—moderately, high, and very high—had relatively good and canonical significance, with Inability to Control Carving (ICC), Dependency (D), Conflict (C) and Withdrawal and Escape (WE). Hence, different constructs of physical and mental well-being discriminate the various levels of smartphone addiction.

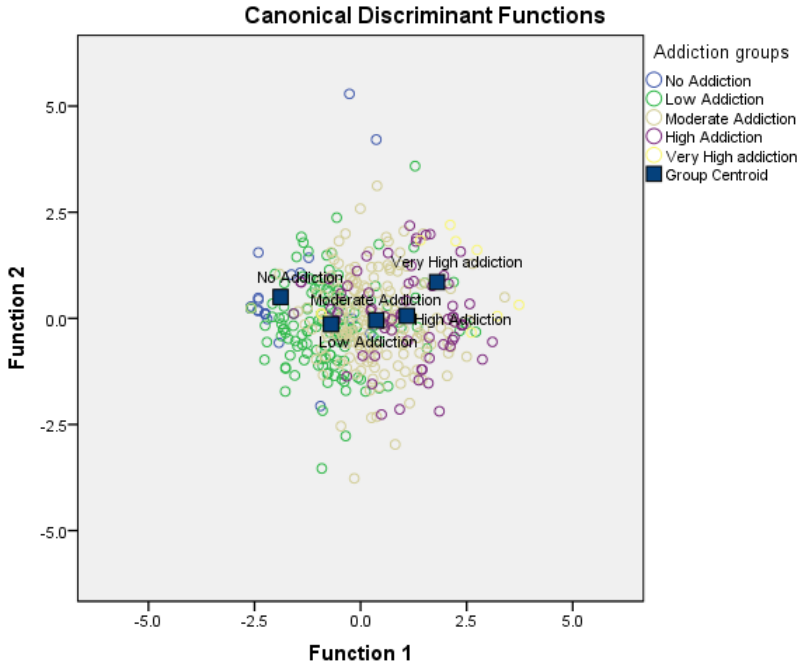

Fig 1. Level of Smartphone Addiction

Discussion

The main goal of the current study was to investigate how smartphone addiction affects Indian students' physical and mental health. The study also looked at the associations between age, addiction categories, and smartphone usage by using correlation analysis.

The Six constructs of the Smartphone Addiction Scale (SAS), inability to control carvings, dependency, overuse, conflict, withdrawal and escape, were derived from Kwon et al.[4], which measures 15 items of physical and mental well-being of the student on a 5-point Likert scale. The composite scores computed from the Likert scale assess the degree of smartphone addiction across the student population into five categories: a score with a value of 0.00 is considered as no addiction; a score between 0.01 to 1.00 is considered as low addict; the score between 1.01 to 2.00 is considered as moderate addict; the score

between 2.01 to 3.00 is considered as high addict; and the score between 3.01 to 4.00 is considered as very high addict. The analysis revealed that 40% of male and 46% of female students exhibited moderate levels of addiction. Students aged 18-22, 23-27, and 37 years and older showed the highest level of moderate addiction as they heavily rely on smartphones to explore their identity and family responsibilities, navigate for careers and social connections, and engage in academic and professional endeavours, smartphone usage is deeply rooted in their daily routine lives that may impact their dependence and usage patterns [8]. Physical symptoms such as headaches, eye strain, and musculoskeletal issues affect individuals of all ages, with younger individuals being more susceptible to these symptoms due to smartphone usage and a lack of ergonomic awareness.

With growing age, students are influenced by psychological symptoms such as emptiness, loneliness, and stress and may rely more on smartphones [11]. Students who entered professional and vocational training showed the highest frequency of moderate addiction. They use smartphones to engage in networking activities and career development and excel in demanding courses, which leads them to use smartphones excessively. Additionally, peer influence and social norms within the community may perpetuate smartphone dependency, which may lead to higher frequencies of moderate addiction among students. Higher education demands increased academic and work-related responsibilities, leading to increased smartphone usage and frequent notification checking among students pursuing advanced degrees or demanding academic programs [29]. Higher education levels can enhance students' time management skills, potentially influencing their frequency of checking their smartphones for notifications. The study also explores the area of smartphone addiction that is impacted by smartphone ownership. Students with one smartphone are moderate to slightly less addicted, as they are prone to excessive use. Students with one smartphone can regulate their usage habits, allocate their time, and prioritize their activities over excessive smartphone use, which leads to a balanced lifestyle and lower levels of addiction and prevents the development of addictive behaviour in Students [26]. Students spend 2-4 hours per day, which is the highest in the series, and use smartphones 12 hours daily, which is the lowest value of the series, as it varies based on individual preferences, habits, and lifestyle factors. Three hypotheses were developed based on the research questions and objectives. According to the investigation, significant correlations were identified: a positive correlation between age and addiction group, addiction group and smartphone usage, and a negative correlation between smartphone usage and different age groups, and a significant correlation exists between inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE). Younger students are more accustomed to rapid technological advancements than older students. Increased smartphone usage may lead to greater dependence on or addiction to smartphones. Additionally, the students prioritized other activities related to smartphone use.

Multivariate test statistics (MANOVA) Wilks' Lambda, Pillai's Trace, Lawley-Hotelling Trace, and Roy's Largest Root showed significant differences between no addiction, low addiction, moderate addiction, high addiction, and extremely high addiction with all the physical and mental well-being constructs of Indian students. The model was found to be efficient, and it was concluded that varying levels of addiction significantly affect the physical and mental health of Indian students. Tests of the between-subjects effects model efficiently discern variations across the dataset, effectively capturing the influence of the addiction group on the constructs of physical and mental well-being. According to the non-significant results from the univariate tests, a discriminant function analysis was utilized to examine the interactions between the physical and mental well-being constructs.

The discriminant function significantly analyzes the differences between the groups across the measured variables.

The finding implies that the differences between groups are primarily driven by variances in Inability to Control Carving (ICC), Dependency (D), Conflict (C) and Withdrawal and Escape (WE) compared to other physical and mental well-being constructs. Therefore, these variables are crucial in distinguishing between the groups and significantly predict the physical and mental well-being constructs based on the addiction group.

The variate centroids provide insight into how diverse groups are positioned relative to each other along the axes of discriminant functions. The first variable reveals that individuals with moderate, high, and extremely high addiction tend to have higher scores on discriminant function variables, indicating higher addiction levels and related well-being. Conversely, those with no or low addiction tended to have lower scores, indicating less addiction and related well-being. The established discriminant function plot provides visual evidence that variate 1 successfully discriminates between diverse levels of smartphone addiction, particularly highlighting distinctions between groups categorized as moderate addiction, high addiction, and extremely high addiction based on their variate scores.

The findings of this study contribute significantly in several ways. Firstly, identifying significant correlations between age, addiction group, and smartphone usage adds depth to our understanding of the complex interplay between demographic factors and smartphone addiction. Additionally, the discovery of significant differences in physical and mental well-being constructs across addiction levels provides valuable insights into the multifaceted impact of smartphone addiction on Indian students. Furthermore, using discriminant function analysis to represent and distinguish between varying addiction levels visually adds a novel methodological approach to the field.

Overall, the results demonstrate that diverse levels of smartphone addiction are associated with unique patterns of physical and mental well-being. This highlights the importance of considering various well-being dimensions when examining the impact of smartphone addiction on individuals' health and functioning. Excessive smartphone usage among students can lead to addiction and cyberloafing, negatively impacting their academic achievements. Universities should establish policy regulations regarding the use of smartphones in the classroom. Elevated levels of contact with lifestyle apps are correlated with user smartphone addiction. Similarly, scholars have suggested that excessive smartphones impact physical and mental health.

6 Conclusion

This study significantly advances the theoretical and methodological understanding by exploring the dynamic interplay between addiction levels and the Physical and mental well-being of Indian Students. A rigorous MANOVA through Wilks' Lambda, Pillai's Trace, Lawley-Hotelling Trace, and Roy's Largest Root showed significant differences between no addiction, low addiction, moderate addiction, high addiction, and very high addiction with all the physical and mental well-being constructs of Indian students.

The discriminant function significantly analyzes the differences between groups primarily driven by physical and mental well-being constructs. The established discriminant function plot provides visual evidence that variate 1 successfully discriminates between diverse levels of smartphone addiction, particularly highlighting distinctions between groups categorized as moderate addiction, high addiction, and extremely high addiction based on their variate scores. The students with mild, high, and extremely high addiction tend to have higher scores on discriminant function variables, indicating higher addiction levels and related well-being. Conversely, those with no or low addiction tended to have lower scores, indicating less addiction and related well-being.

Furthermore, correlation analysis found that smartphone addiction and smartphone usage impact students of different age groups. This integrated approach provides valuable insights into the nuanced associations between addiction severity, well-being, and demographic factors, thereby contributing to a deeper comprehension of the complex phenomenon of smartphone addiction in contemporary society. These empirical data add depth to the literature and aid in furthering knowledge in this area. The findings may have implications for public health, psychology, and education. Identifying the factors linked to smartphone addiction and its effects on well-being could guide the development of interventions and policies that encourage healthier technology use among students.

Also, a significant correlation exists between an inability to control carvings (ICC), dependency (D), Conflict (C), Over Usage (OU) and Withdrawal and Escape (WE). Students who have difficulty controlling their cravings (ICC) are likely to develop dependencies (D), experience conflicts (C), engage in overuse (OU), and use these behaviours or substances as a form of withdrawal and escape (WE).

Through discriminant function analysis, this study provides insightful information about smartphone addiction, spanning from moderate to extremely high levels. The visual representation of the plot (Figure 1) helps researchers, practitioners, and policymakers to understand these differences between groups. The higher scores on discriminant function variables among students with varying addiction levels not only show the extent of addiction but also its impact on well-being. Furthermore, the correlation analysis across different age groups and the correlation between inability to control cravings (ICC), dependency (D), conflict (C), over-usage (OU), and withdrawal and escape (WE) underscores the widespread nature of smartphone addiction. These findings can inform targeted interventions to reduce smartphone usage, encourage healthier digital habits, and address underlying factors contributing to addiction across diverse demographic groups. The study enhances our ability to comprehend the nuances of smartphone addiction and provides a framework for future research and intervention strategies.

7 Implications of the Study

7.1 Theoretical Implications

The study extends existing addiction theories by investigating the interaction between addiction levels and well-being constructs. This study contributes to the understanding of addiction as a multifaceted phenomenon influenced by the interaction of physical and mental well-being. This study bridges the gap identified in the literature review by examining the effects of addiction on both physical and mental well-being simultaneously. The study also provides insights into refining measurement tools for assessing addiction and well-being.

7.2 Managerial implications

Educational institutions and policymakers can utilize the study's insights to design programs to raise awareness about the potential consequences of excessive smartphone usage among students and promote healthier digital habits. Employers can incorporate the study findings into workplace well programs, such as tech-free breaks or offering resources for managing screen time, which can help mitigate the negative effects of addiction on productivity and job satisfaction. Policymakers can use findings to formulate regulations and guidelines related to smartphone usage. By integrating the findings into theoretical frameworks and practical interventions, researchers and stakeholders can work toward promoting healthier technology usage habits.

8 Limitations of the Study and Directions for Future Research

The study was based on 446 participants and focused on gender, age, education, frequency of smartphone usage, smartphone ownership, smartphone usage in activities, and time spent on smartphones, limiting the generalizability of the study to the broader scope. Reliance on self-reported data for the level of addiction, smartphone usage, physical and mental well-being and other variables may lead to response biases and affect the accuracy of the data. The cross-sectional nature of the research limits the determination of causal relationships between the studied variables. This study focused on Indian students, but addiction patterns and well-being may be different in other cultural contexts. There may be other variables that influence addiction level and well-being, such as personality traits and family dynamics.

Longitudinal studies could provide insights into the causal relationships between addiction, demographic factors, and well-being over time. Exploring interventions or preventive measures to mitigate smartphone addiction and its adverse effects on well-being will promote healthier smartphone usage habits. Exploring the influence of familial attitudes toward technology use and social norms on individual behaviours could guide comprehensive intervention strategies.

The study also offers a guide for future research in areas such as the author's development of physical and mental well-being measurement scales to assess individual responses to addiction. The cultural specificity of addiction patterns and their impacts on well-being facilitate cross-cultural learning. For example, exploring interventions or preventive measures to mitigate smartphone addiction and its adverse effects on well-being could be a fruitful avenue for future research.

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