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Determinants of Well-Being among University Students in Ethnic Minority Regions of Sichuan Province, China

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Abstract

This study investigates the mediating role of mobile phone addiction in the relationships among physical health, academic performance, academic competence, technology features, and well-being among university students in ethnic minority regions of Sichuan, China. Drawing on data from 852 students across 14 faculties, the research employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to test a hypothesized mediation model. Participants completed validated instruments measuring physical health, academic outcomes, mobile phone use, technology features, and well-being between October and December 2023. Findings indicate that physical health, academic performance, academic competence, and technology features are positively associated with well-being. Moreover, mobile phone addiction is negatively linked to physical health, academic performance, and academic competence, while it is positively associated with technology features. Mediation analysis revealed that mobile phone addiction significantly explains the indirect effects of all predictors on well-being.

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These results underscore the dual influence of individual and technological factors on students' psychological outcomes and highlight mobile phone addiction as a critical mechanism through which these influences operate. The study contributes to the growing literature on digital behavior and student well-being in underrepresented populations.

Keywords: Mobile Phone Addiction; Well-Being; Physical Health; Academic Performance; Technology Features；Ethnic Minority University Students.

1. Introduction

The WHO Special Initiative for Mental Health aims to ensure that individuals attain the highest possible level of mental well-being. Mental health disorders represent a significant global health challenge among adolescents. In 2019, data indicated that approximately one in seven adolescents was affected by mental health conditions, equating to an estimated 166 million cases worldwide—89 million among boys and 77 million among girls[1]. Poor well-being has become a profound problem in higher education. Over the past decade, there has been a noticeable increase in the number of college students exhibiting symptoms of depression and anxiety, drawing significant attention from researchers and educators[2,3]. Globally, over the past year, around 31% of college students were identified as having potential mental health disorders based on screening assessments[4]. Mental disorders have emerged as a significant health concern in contemporary China[5]. Studies demonstrate that young individuals with severe mental illness exhibit a significantly higher risk of suicide-related mortality in comparison to older adults [6]. Moreover, individuals possessing higher educational attainment have been associated with elevated suicide rates[7]. A previous study has shown that the mental health of Chinese teens varies a lot from place to place, mostly depending on the economy and the standard of living. Notably, rates of occurrence are much higher in the western parts of the country[8]. These western regions have the greatest age-standardized mortality rate (ASMR) for all mental illnesses (MD)[5]. Western Chinese adolescents had committed 4.2% non-suicidal self-injury (NSSI) in the past year [9].

The well-being perspective highlights the importance of integrating mental and physical health in a holistic approach to disease prevention and health promotion. This framework emphasizes the connection of different health dimensions, highlighting the need for comprehensive strategies that consider multiple facets of well-being. The impact of mental or physical health issues on an individual's overall well-being is significant[10].

Physical health strongly influences subjective well-being (SWB), according to extensive research. In public health, physical health is crucial for well-being[11]. There is a substantial body of evidence indicating that physical health plays a pivotal role in influencing SWB. In the context of public health, physical health is of paramount importance for overall well-being[11]. There is a positive correlation between better physical health and higher levels of well-being, whereas poorer physical health is associated with lower levels of well-being[12]. Education is frequently acknowledged as a significant predictor of an individual's well-being [13]. It is widely acknowledged by social scientists and policymakers that education improves the standard of living and enhances well-being[14]. Furthermore, academic performance and scholarly abilities, which are closely related to educational achievements, have also been demonstrated to impact SWB. Similarly, excessive smartphone use has been linked to negative academic behavior and poorer academic outcomes [15,16]. A growing body of evidence indicates that positive academic outcomes contribute to an individual's overall sense of well-being[17]. Furthermore, technological characteristics, particularly excessive or problematic smartphone use, have emerged as critical variables affecting SWB [18,19].

Students' well-being in China seems to be insufficiently researched [20]. Research indicates that smartphone addiction can mediate the relationship between online social networking support and addiction, leading to potential negative impacts on well-being [21]. The association between internet addiction and adolescent depression in Sichuan Province has also been confirmed [22]. An online survey conducted among college students in the Chengdu area revealed that 22.8% of participants belonged to the internet-dependent group, while 8.7% fell into the internet-addicted category [23]. Nonetheless, comprehensive research focusing on the prevalence of depression and anxiety symptoms, along with related factors, among adolescents in western China, including Sichuan Province, remains limited [24]. Particularly, a thorough exploration of the correlations involving college students' well-being in Sichuan Province is still needed.Current research on MPA lacks empirical data from ethnic areas of China [25]. Research increasingly highlights the complex relationship between physical health conditions and mental health outcomes [26]. Indeed, the relationship between well-being and health behavior has been found to be robust and applicable to a broad cross-section of the U.S. population [27]. The state of health has been demonstrated to exert an influence on social well-being [28]. This conclusion has been corroborated by subsequent research [29]. Furthermore, the diagnosis of a severe or life-threatening physical illness often leads to considerable psychological distress, which may escalate into clinical depression. In some cases, this distress can become so overwhelming that it increases the risk of suicidal

ideation or behavior[30]. The current research indicates that the extent of the mental health benefits appears to be contingent upon the level of physical fitness [12,29,31,32,33,34]. Therefore, it is hypothesized that:

H1: Physical health has a significant positive effect on well-being.

The authors in[35] showed that poor academic performance in adolescence increases the risk of depressive symptoms in early adulthood. At-risk students with academic achievement have been found to represent a subset of at-risk students with less severe psychological distress, which may partially explain why they perform better academically than symptomatic but satisfied students[36]. Additionally, research by[37] indicated that greater subjective well-being was associated with improved academic outcomes. Among the different aspects of subjective well-being, the Scale of Positive and Negative Experience (SPANE) was identified as having a significant relationship with academic success [37]. Therefore, it is hypothesized that:

H2: Academic performance has a significant positive effect on well-being.

There is compelling evidence to suggest a reciprocal relationship between subjective well-being and academic engagement. Research has consistently demonstrated that perceived academic competence plays a significant role in fostering adaptive academic motivation, increasing student engagement, and enhancing academic performance [38,39]. Studies suggest that elementary school students' perceived academic competence may serve as a crucial explanatory factor in the relationship between peer acceptance, self-reported friendships, life satisfaction, and academic achievement [40]. Furthermore, a growing body of evidence highlights the positive association between perceived academic competence and overall well-being, reinforcing its importance in both educational and psychological domains [36,39,41,42]. Therefore, it is hypothesized that:

H3: Academic competence has a significant positive effect on well-being.

What is the effect of the utilization of digital technology on the state of well-being? In response to a direct question, 31% of American teenagers indicated that the impact is predominantly positive, 45% stated that it is neither positive nor negative, and 24% asserted that it is predominantly negative [43]. The quantity of use is also a significant factor; both low and excessive use have been linked to a decline in well-being, whereas moderate use has been associated with an improvement in well-being [19]. Additionally, their scalability presents a valuable opportunity to extend mental health prevention, early identification, and intervention to a larger

number of young people [44]. Technology can facilitate convenient access to mental health resources, such as mood-enhancing and skill-building applications designed to promote mental well-being [45]. Therefore, it is hypothesized that:

H4: Technology features has a significant positive effect on well-being.

The studies have demonstrated that the more frequent and intense use of smartphones is associated with reduced sleep duration and decreased sleep quality in adolescents [46], disrupted sleep patterns and quality[47], and poorer sleep quality, along with a greater perception of stress[48,49]. Long-term smartphone use is linked, according to emerging studies, to decreased attention, worse digital processing capacity, more impulsivity, more hyperactivity, and more sensitivity to negative social attention [50,51]. These studies demonstrate the cognitive and behavioral harms of excessive smartphone use. Numerous studies have linked excessive smartphone use to psychiatric problems, sleep issues, impaired physical performance, and chronic discomfort [51]. Smartphone use has also been linked to emotional dysregulation, uncontrolled eating, constrained eating, food addiction, and higher body fat in teenagers [52]. Smartphone addicts were more likely to be overweight, sedentary, and sleep less than six hours every night. Additionally, they were more likely to experience musculoskeletal discomfort, including shoulder pain, eye pain, and neck pain [53]. A reduction in physical activity, a decline in muscle mass, and an increase in fat mass are associated with one another [54]. Therefore, it is hypothesized that:

H5: Physical health has a significant negative effect on MPA.

A recent paper in[55] establishes a link between problematic smartphone use and poorer academic performance. The ability to multitask in any of the analyzed technologies (email, text, and Facebook) is negatively correlated with effective learning ability, which is manifested in lower test scores [56]. A review of the literature reveals a correlation between time spent on smartphones and academic performance and time management skills in adolescents [57]. Those who are addicted to smartphones may exhibit poorer time management skills due to the significant amount of time they spend on their devices, which can result in the neglect of other important activities in their daily lives [58]. Secondly, the desire to remain informed about and engaged with the online world, commonly referred to as "FOMO" or "fear of missing out," may result in a student's inability to concentrate, which is essential for optimal academic performance [59]. Moreover, a deficiency in motivation to learn can result in students becoming disinterested and disengaged, and smartphone applications can offer a

swift and alluring avenue for evading the demands of reality [60]. Therefore, it is hypothesized that:

H6: Academic competence performance has a significant negative effect on MPA.

Perceived competence is typically understood through two primary dimensions: academic competence and social competence [61]. Researchers have found a link between putting things off and becoming addicted to smartphones. Academic procrastination is especially interesting [62]. A major obstacle to both academic achievement and student well-being is procrastination [63]. Long-term benefits connected with timely completion of complex academic tasks include reaching both professional and educational goals [64]. Moreover, studies imply that teenagers' opinions about their academic competency have a major influence on social media addiction [65]. In particular, people who believe they are academically competent are less likely to rely too much on social media [66]. Notably, students are far less likely to develop a social media addiction when they report lower levels of smartphone addiction and fear of missing out (FoMO) while still feeling highly competent academically [67]. Therefore, it is hypothesized that:

H7: Academic competence has a significant negative effect on MPA.

Technology features encompass the capabilities, resources, and characteristics of digital platforms and devices that affect user engagement. Several studies investigate the impact of specific smartphone applications on users' usage behaviors [68,69]. Studies show that people become addicted to social media because they are emotionally and functionally attached to these sites. These attachments are shaped by a mix of technical and motivational factors. A big part of what motivates people to use technology is how much they enjoy it and how connected they feel to others. Technical factors such as system quality, data support, and personalization contribute significantly [70]. The authors in [71] found that those who rely too heavily on online communication tools are more likely to experience boredom and struggle with impulse control. According to[72] suggested those who used their smartphones the most frequently were those that participated in social applications frequently. In the findings of [70,73,74] the extensive use of applications such as social networking services, instant messaging, mobile gaming, and various entertainment platforms is a major contributor to problematic smartphone use. Therefore, it is hypothesized that:

H8: Technological features have a significant negative effect on MPA.

There is evidence linking excessive smartphone use to increased susceptibility to social anxiety, anxiety disorders, and depression. Numerous research studies have provided copious documentation of the association Reference [75,76,77]. Subsequent studies, such as those conducted by [46], have identified possible links between smartphone usage and various mental health issues. Excessive smartphone use is associated with several psychological issues, including shyness and low self-esteem [54,76,78,79,80], impaired mental health Reference [81], and reduced overall well-being [82]. Substantial evidence also suggests that problematic smartphone use frequently coexists with other psychiatric conditions [83]. Furthermore, excessive engagement with smartphones has been associated with heightened feelings of loneliness, stress, and other negative emotional states [84].

However, some studies have presented opposing viewpoints on this matter. There are some situations in which using a smartphone can improve one's mental and physical health [85]. Students report high levels of tension, anxiety, and stress throughout their time at university. This makes it an ideal setting to study how AI could affect mental health. Recent studies investigate the dual role of AI in potentially worsening or mitigating these emotional states [86,87]. Recent research [88] has identified various methods by which AI can aid mental health, such as offering emotional support, alleviating stress, promoting self-reflection, and providing tailored interventions. The construction of rich, immersive environments through the use of augmented reality and virtual reality, driven by artificial intelligence, has been empirically proven to contribute to relaxation, stress reduction, and improved mental health [89]. Therefore, it is hypothesized that:

H9: Mobile phone addiction has a significant negative effect on well-being.Hayes'process macro revealed that internet addiction and sleep quality played multiple mediation roles in the relationship between bullying victimization and depression [90]. The present study examined whether fear of missing out (FoMO) (trait-FoMO and state-FoMO) and smartphone addiction mediated the relationship between positive affect (PA)/negative affect (NA) and sleep quality [91]. In addition, the results of the analysis showed that self-control in Internet usage directly mediated the relationship between physical exertion and SWB. MPA mediated the interaction between physical exercise and SWB in reverse [92]. Findings suggested that adolescents with inadequate health literacy (HL) (both HL and six domains) are more likely to have problematic mobile phone use [91]. A substantial body of research indicates that individuals who engage in regular physical exercise are better able to regulate their internet usage and exhibit lower levels of dependence on mobile phones [92].

Therefore, it is hypothesized that:

H10: MPA mediates in the relationship between physical health and well-being.

Studies have demonstrated that academic performance is a positive predictor of SWB at a later stage of the educational process [93]. Findings indicated that as mobile phone use (MPU) increases, stress and anxiety levels rise, while academic performance declines. Consequently, elevated stress and anxiety levels are associated with diminished academic performance and reduced SWB [94]. The authors in [53] indicated that individuals with a proclivity for smartphone use are less likely to demonstrate exemplary academic performance, as defined by the categories of excellent, very good, or excellent, in comparison to those who do not exhibit such a tendency [53]. The authors in [95] confirmed that excessive mobile phone use is associated with negative academic behaviors among Malaysian tertiary education students. Therefore, it is hypothesized that:

H11: MPA mediates in the relationship between academic performance and well-being.

It has been shown that life satisfaction is associated with heightened intrinsic motivation [96]. These findings suggest that students who experience higher life satisfaction not only perceive academic activities as more meaningful and fulfilling but also tend to have greater confidence in their ability to perform academic tasks effectively [96]. The manner in which individuals utilize social media for academic advantage is contingent upon their personality and intrinsic motivation. Students who demonstrate proficiency in self-regulation are more likely to integrate their engagement with social media into a harmonious balance with their academic responsibilities, which ultimately contributes to their success [97,98]. Therefore, it is hypothesized that:

H12: MPA mediates in the relationship between academic competence and well-being.

In contemporary settings, a significant portion of adolescents' interaction with digital technology occurs through mobile devices [43]. However, university students utilize the Internet for purposes that extend beyond academic and educational objectives. It is common for them to use it for retrieving information, casual browsing, entertainment, communication, gaming, social networking, online shopping, and, in some cases, activities like gambling and seeking sexual content [99,100,101,102,103]. Technological solutions can facilitate convenient access to mental health resources. For example, they can be utilized to promote emotional well-being and develop competencies for psychological well-being [45]. Digital mental health programs can play an

instrumental role in disseminating large-scale mental health education in educational settings [44,104]. As a consequence, this addiction may further affect an individual's well-being and quality of life (QoL) [105]. Therefore, it is hypothesized that:

H13: MPA mediates in the relationship between technology features and well-being.

2. Purpose of the study

With support from actual data, this study will further substantiate the role of mobile phone addiction in influencing well-being. This will help expand and refine the theoretical framework concerning the mechanisms through which mobile phone addiction affects well-being, providing a deeper explanation and understanding within this field. Furthermore, given the prevalence of mobile phone addiction among university students, the findings provide empirical support for the prevention and mitigation of mobile phone addiction. The result offers valuable insights for promoting the health and well-being of university students.

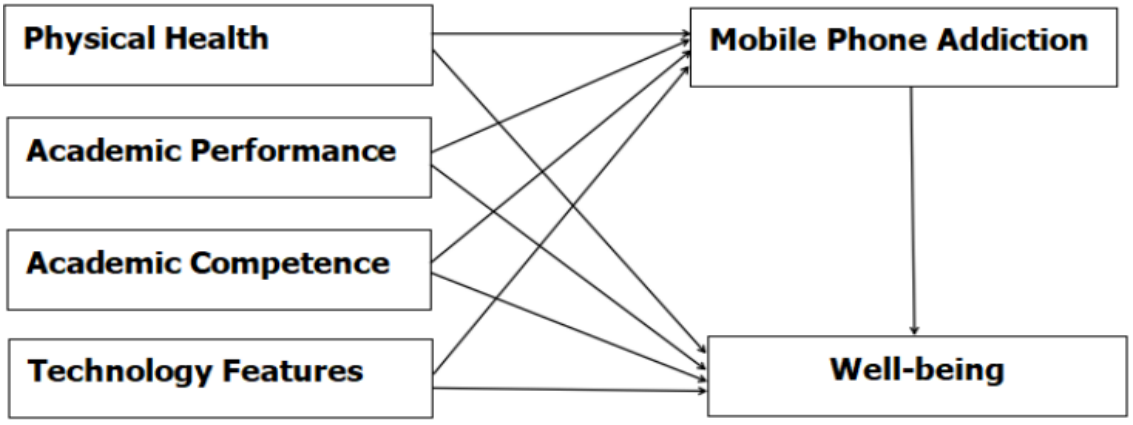

Figure 1: Conceptual Research model

3. Method

This study employed a cross-sectional quantitative research design to explore the mediating effect of mobile phone addiction on the relationship between physical health, academic performance, academic competence, technology features, and well-being. Data were collected from 852 university students across 14 faculties at a higher education institution located in an ethnic minority region of Sichuan Province, China. The survey was conducted between October and December 2023 using a structured questionnaire that included validated scales:

10 items assess the Physical Health Questionnaire [106], 10 items of the Academic Performance Questionnaire[107], 10 items evaluate Academic Competence (https://www.wjx.cn/vj/r4hUEy3.aspx), 10 items estimate Technology Features[108], 5 items of the Well-being Index[109], and 10 items measure the mobile phone addiction scale [110]. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to test the hypothesized mediation model, given its suitability for analyzing complex relationships among latent variables and its robustness in social science research.

4. Participants

Between October and December 2023, a sample survey was conducted among undergraduate students at a university in an ethnic minority region of Sichuan Province. A total of 852 participants were included in the final analysis, of whom 18.08% (154) were male and 81.92% (698) were female. Han students accounted for 64.2% (547), Tibetan students 14.44% (123), Yi students 17.49% (149), Qiang students 3.17% (27), and Hui students 0.7% (6). In terms of academic year distribution, first-year students comprised 67.25% (573), second-year students 27.11% (231), while third- and fourth-year students accounted for 4.81% and 0.82%, respectively. The questionnaire collected detailed demographic information, including gender, faculty, year of study, ethnicity, and data on core study variables.

5. Data Collection and Analysis

The output data were exported in Microsoft Office Excel and IBM SPSS 28.0 statistical formats for analysis. In both Excel and SPSS files, Likert scale responses were automatically numerically coded. Descriptive analyses of basic demographic information were conducted using SPSS. Out of 852 responses, 840 responses were usable, which made up a 93.3 percent usable rate. The core variables of this study were analyzed using Structural Equation Modeling (SEM) version 4.1.0.3, which was employed to construct the structural model, test variables, and assess model fit, outer loadings, and local fit indices. Mediation effects were analyzed using the maximum likelihood estimation method for parameter estimation, while the bootstrap method was applied to test path coefficients, with statistical significance set at $p < 0.05$.

6. The Scale

Reliability refers to the consistency or dependability of a measure. It indicates the extent to which the same

results can be obtained using the same method under similar conditions. Convergent validity refers to how closely a test is related to other tests that measure the same (or similar) constructs[111].

Table1: Reliability and Convergent Validity

Variables	Items	Outer Loadings	Cronbach's Alpha	Average variance extracted (AVE)
Physical Health	PH1	0.709	0.728	0.552
	PH4	0.820		
	PH5	0.805		
	PH8	0.618		
Academic Performance	AP1	0.805	0.727	0.647
	AP2	0.838		
	AP7	0.77		
Academic Competence	AC4	0.826	0.818	0.731
	AC5	0.896		
	AC9	0.841		
Technology Features	TF1	0.900	0.861	0.780
	TF2	0.887		
	TF3	0.862		
Mobile Phone Addiction	MPA2	0.823	0.713	0.635
	MPA3	0.780		
	MPA9	0.787		
Well-being	WB1	0.873	0.869	0.792
	WB3	0.911		
	WB5	0.886		

According to Table 1, the AVE[112], outer loading[113], and Cronbach's alpha [114] for all the constructs are within the acceptable range; the constructs in this study demonstrate strong reliability and convergent validity.

Discriminant validity is demonstrated by evidence that measures of constructs that theoretically should not be highly related to each other are, in fact, not found to be highly correlated to each other. Practically speaking, discriminant validity coefficients should be noticeably smaller in magnitude than convergent validity coefficients[116].

Table2: HTMT for Discriminant Validity

Variables	AC	AP	MPA	PH	TF	WB
AC	-					
AP	0.716	-				
MPA	0.428	0.504	-			
PH	0.264	0.452	0.487	-		
TF	0.451	0.393	0.082	0.091	-	
WB	0.425	0.580	0.217	0.520	0.330	-

Note: PH = Physical Health; AP= Academic performance; AC = Academic competence; TF=Technology Features;MPA=Mobile Phone Addiction;WB=Well being ; Mindfulness=Mindfulness

The HTMT values below 0.90 indicate good discriminant validity among the constructs [116]. This is suitable for further causal analysis and hypothesis testing, as values below this threshold generally demonstrate that constructs are distinct from each other and there are no issues of discriminant validity in the study.

7.Findings

Table3. Structural Model Results, R2 and f 2

No	Hypothesis	Std.Beta Coefficient	Std. Error	Standard deviation (STDEV)	T values	P values	2.5%	97.5%	R2	f2	Decision
H1	PH -> WB	0.317	0.318	0.033	9.666*	0.000**	0.251	0.381	0.325	0.133	supported
H2	AP -> WB	0.272	0.272	0.040	6.873*	0.000**	0.193	0.350	0.325	0.068	supported
H3	AC -> WB	0.129	0.130	0.036	3.594*	0.000**	0.055	0.197	0.325	0.010	supported
H4	TF -> WB	0.134	0.135	0.033	4.088*	0.000**	0.198	0.198	0.325	0.023	supported
H5	PH -> MPA	-0.259	-0.259	0.037	7.037*	0.000**	-0.328	-0.185	0.228	0.078	supported
H6	AP -> MPA	-0.202	-0.202	0.042	4.781*	0.000**	-0.280	-0.115	0.228	0.032	supported
H7	AC -> MPA	-0.209	-0.210	0.043	4.893*	0.000**	-0.292	-0.123	0.228	0.033	supported
H8	TF -> MPA	0.118	0.118	0.037	3.202*	0.001*	0.045	0.189	0.228	0.011	supported
H9	MPA ->WB	0.091	0.091	0.034	2.677*	0.007*	0.026	0.157		0.007	rejected

*Note: PH = Physical Health; AP= Academic performance; AC = Academic competence; TF=Technology Features;MPA=Mobile Phone Addiction;WB=Well being ; Mindfulness=Mindfulness; *p< 0.05,**p<0.01.*

Based on the results presented in Table 3, most hypothesized paths were significantly supported ($p < 0.05$)[114], indicating that the examined variables effectively predict both well-being and mobile phone addiction. Physical health, academic performance, academic competence, and technology features exhibited significant positive effects on well-being. Additionally, physical health, academic performance, and academic competence significantly negatively predicted mobile phone addiction, while technology features positively predicted mobile phone addiction. However, the original hypothesis that mobile phone addiction negatively predicts well-being was not supported. Surprisingly, mobile phone addiction demonstrated a significant positive effect on well-being. Well-being showed strong explanatory power, while mobile phone addiction had a moderate explanatory effect[117]. According to the f^2[117] indicator, physical health (PH) had the strongest impact on well-being, whereas the effect of mobile phone addiction (MPA) on well-being, although significant, was relatively small, suggesting the potential involvement of other moderating factors in this relationship.

Table 4: Hypothesis Testing on Mediation

No	Hypothesis	Std. Beta	Std. Error	p-value	Confidence Interval		Decision
					LL	UL	
H10	PH -> MPA -> WB	-0.024	0.010	0.015*	-0.044	-0.007	supported
H11	AP -> MPA -> WB	-0.018	0.008	0.021*	-0.036	-0.005	supported
H12	AC -> MPA -> WB	-0.019	0.008	0.016*	-0.036	-0.005	supported
H13	TF -> MPA -> WB	0.011	0.005	0.041*	0.002	0.022	supported

*Note: *p< 0.05, UL = Upper Level, LL = Lower Level.*

The table presented the mediating effect of mobile phone addiction in the relationship between physical health, academic performance, academic competence, technology features, and well-being. The p-values ($p < 0.05$) and confidence intervals not contained in zero confirmed the significance of the mediation effect, highlighting the critical role of mobile phone addiction in the determinants of well-being. Physical health, academic performance, and academic competence negatively influenced mobile phone addiction, as indicated by standardized coefficients (Std. Beta). This reduction in mobile phone addiction subsequently enhanced well-being. This underscored the beneficial influence of physical health, academic performance, and academic competence attributes on well-being. Conversely, technology features influenced well-being indirectly via mobile phone addiction, as evidenced by a standardized beta coefficient of 0.011. This indicates that particular technological features may enhance mobile phone dependency, which in turn affects overall well-being. The findings highlight the necessity of acknowledging and addressing the potential negative consequences linked to over dependence on technology.

This brought attention to the fact that both academic success and good physical health can improve well-being and emphasized how important they are. A standardized beta value of 0.011, on the other hand, showed that technology traits had a secondary effect on well-being through mobile phone addiction. This shows that technology features may be making people more dependent on mobile phones, which in turn has an impact on

their overall health. These results are important because they show how important it is to find and reduce the bad effects that might come from using technology too much.

8.Discussion and Conclusion

First, physical health emerged as a central determinant of well-being, reinforcing its positive contribution to individuals' overall quality of life [26,27,32]. This finding underscores the distinct role health plays in shaping subjective well-being, particularly among specific demographic groups such as ethnic minorities and university students, where health-related disparities may be more pronounced. Prior research also highlights that the quality of health and social relationships during adolescence strongly influences well-being outcomes in early adulthood[12]. Similarly, the authors in[31]reported that a higher incidence of social and health problems is associated with greater depressive symptoms and reduced life satisfaction, further confirming the importance of health status in psychological outcomes. Chronic health conditions, therefore, represent critical challenges that can substantially reduce well-being [29]. On the other hand, proactive health behaviors, such as regular physical activity, have been consistently linked to improvements in mental health and subjective well-being. Evidence demonstrates that low- and moderate-intensity aerobic exercise effectively reduces depression and stress among university students[33,34]. These findings suggest that maintaining good health not only enhances individuals' perceptions of their ability to accomplish goals but also facilitates greater participation in social interactions and stronger interpersonal relationships, both of which further reinforce overall well-being[28].

Furthermore, the structural model further demonstrated that academic performance positively predicted well-being. This contrasts with much of the earlier literature, which often positioned well-being as an antecedent of academic achievement. By reversing this direction, the current study highlights academic performance as a unidirectional factor influencing mental health outcomes. Consistent with[42], higher levels of academic performance at baseline were associated with more favorable mental health trajectories, supporting the idea that academic success contributes to psychological resilience over time. Importantly, academic performance emerged as more than a mere indicator of educational attainment; it also functioned as a protective element for adolescents' mental health. The results suggest that students considered at risk, yet demonstrating strong academic achievement, form a distinctive subgroup with reduced psychological distress. Such findings offer insight into why these students perform better than their at-risk peers who do not attain similar levels of achievement, even when both groups report satisfaction with their academic progress[36]. Taken together, these results clarify the role of academic performance as a stabilizing resource that not only fosters educational outcomes but also enhances well-being through its impact on mental health.

Additionally, Academic competence was identified as a strong positive predictor of university students' well-being, suggesting that those with higher levels of competence are more likely to experience improved psychological outcomes. This result validates the third hypothesis of the study and aligns with prior research, which similarly emphasized the beneficial impact of academic competence on students' overall adjustment and life satisfaction [17,37,117]. Beyond its indirect influence through academic success, competence appears to function as an independent factor shaping social relationships and fostering a sense of personal achievement. These qualities contribute to students' resilience and ability to cope with stress, thereby reinforcing the positive

association between competence and well-being. The present findings advance current knowledge by highlighting not only the direct role of competence but also its practical implications for designing targeted educational and psychological programs. Fourth, aligned with earlier studies, the present findings suggest that the positive dimensions of technological features—including convenience, opportunities for communication, access to learning resources, and psychological counseling—can play an important role in promoting well-being. Rather than contradicting previous research, these results strengthen existing theoretical claims by offering additional empirical support. Evidence also indicates that moderate and purposeful engagement with technology is linked to greater levels of well-being[19]. Furthermore, digital platforms provide individuals with accessible mental health resources, ranging from mobile applications for mood regulation and skill development[45] to innovative systems for early detection and timely intervention in mental health concerns [44]. Beyond these benefits, e-mental health initiatives have been shown to extend the reach of psychological services, thereby expanding opportunities for mental health promotion in diverse populations.

The present findings highlight the central role of health in shaping patterns of mobile phone addiction, thereby extending earlier research. Consistent with prior studies, a clear negative association between overall health status and problematic mobile phone use was observed[47,49,51,52,53,54]. Notably, recent evidence illustrates that various health-related conditions, including chronic physical discomfort[54] and sedentary lifestyles[73], may act as antecedents that elevate the risk of addictive phone behaviors. This shift in perspective—from viewing health problems solely as outcomes of mobile phone addiction to considering them as potential causal factors—marks a meaningful advancement in the understanding of the reciprocal links between physical health and technology use. Such findings also suggest the need for integrated interventions that simultaneously address health promotion and responsible mobile phone use.

The results revealed a significant negative relationship between academic performance and mobile phone addiction. Consistent with earlier findings, students with stronger dependence on smartphones often neglect essential academic tasks, largely due to inadequate time management [57,58]. Moreover, the fear of missing out has been shown to divert attention and disrupt study behaviors, further undermining academic achievement[59]. Importantly, this study advances the discussion by emphasizing the reverse perspective: rather than only viewing MPA as a threat to academic outcomes, it suggests that high levels of academic achievement may serve as a protective factor against problematic phone use. Students who consistently excel academically are more likely to demonstrate effective time management, self-discipline, and structured daily routines, all of which reduce the susceptibility to excessive mobile phone engagement.

The present findings highlight that higher levels of academic competence substantially reduce the likelihood of mobile phone addiction[63]. Prior studies have also emphasized that fulfilling competence requirements can serve as an important predictor in understanding problematic mobile phone use[67]. According to self-determination theory [118], competence needs reflect a basic psychological drive to feel capable, effective, and in control of one’s environment. When such needs remain unmet, adolescents are more prone to compensate by seeking gratification through mobile devices. Consistent with this perspective, perceived academic competence has been shown to lower susceptibility to social media addiction[66]. Students with greater confidence in their academic skills are less likely to use mobile phones for distraction or social reassurance, thereby reducing the

risk of developing maladaptive usage patterns.

The findings provide further evidence of a strong positive association between technological features and mobile phone addiction, consistent with earlier research [68,69,70]. This suggests that the design and characteristics of digital technologies are critical to understanding the mechanisms underlying excessive smartphone use. Prior studies have shown that social media addiction is shaped not only by individual motivations, such as enjoyment and the pursuit of social interaction, but also by technological aspects including system quality and personalized functions[70]. The widespread availability of social networking platforms, instant messaging services, online games, and entertainment applications has been recognized as a central factor contributing to problematic usage patterns [73,74]. For university students in particular, while these tools may facilitate academic activities, they simultaneously increase exposure to distracting non-academic content, thereby intensifying the risk of mobile phone overuse.

The structural equation modeling results demonstrated an unexpected finding: mobile phone addiction exerted a significant positive effect on well-being, contradicting the initial assumption that such addiction would be detrimental. In this sample, students with higher levels of mobile phone addiction reported greater well-being. This outcome suggests that, under certain circumstances, smartphone engagement may offer benefits that extend to both physical and psychological health [85]. Cultural differences may partially explain this pattern, as prior studies have shown variations in smartphone use across countries, with higher levels reported in China and Germany and comparatively lower levels observed in Scandinavian contexts[119]. Moreover, emerging evidence highlights how advanced technologies, such as artificial intelligence, may play a constructive role in mental health by offering emotional support, stress relief, opportunities for self-reflection, and tailored interventions[88].The structural equation model (SEM) analysis confirmed a significant mediating role of mobile phone addiction. In line with the hypotheses, the negative mediation pathways (H10–H12) suggest that physical health, academic performance, and academic competence can buffer the negative consequences of mobile phone addiction on well-being. This highlights the protective value of good health and strong academic skills in sustaining psychological functioning. For instance, maintaining physical fitness has been shown to reduce reliance on smartphones and thereby enhance overall well-being[62,92]. Similarly, students with stronger academic performance and higher academic competence tend to display more effective time management[57] and are less prone to problematic social media use[66], which in turn reduces excessive smartphone engagement and supports well-being[93]. By contrast, the positive mediation effect (H13) indicates that technological features, while beneficial for communication, learning, and entertainment, may also amplify mobile phone addiction and indirectly harm well-being[105]. This dual pattern challenges earlier perspectives that emphasized only the positive contributions of technology. The present study advances the discussion by presenting a double-edged view, showing that the rational use of technology can support well-being, whereas excessive use undermines it, thereby offering a more comprehensive framework for understanding technology's role in students' well-being [28,33]

9.Limitations

This study has several limitations that should be acknowledged. First, the sample was restricted to university students from ethnic minority regions of Sichuan Province, which may limit the generalizability of the findings

to other populations or cultural contexts. Second, the cross-sectional design does not allow for causal inferences, and longitudinal or experimental approaches would be needed to establish directionality in the observed relationships. Third, the reliance on self-reported questionnaires introduces the possibility of recall bias and social desirability effects, which may affect the accuracy of the data. Finally, the study focused on specific variables within a structural equation model framework, and other potentially relevant factors, such as family environment, personality traits, or socioeconomic conditions, were not included. These limitations should be considered when interpreting the results, and future studies are encouraged to adopt more diverse samples, employ longitudinal designs, and integrate additional variables to provide a more comprehensive understanding of the determinants of well-being.

10.Conclusion

The survey of 852 undergraduates demonstrated that well-being is shaped by several key determinants, including physical health, academic achievement, academic competence, and technological attributes. Notably, strong health status, higher academic performance, and stronger academic competence were linked with reduced vulnerability to excessive smartphone use, highlighting their protective role in maintaining balanced digital behaviors. Interestingly, technology features presented a dual influence: while generally considered facilitators of communication and learning, their availability was also associated with heightened levels of smartphone engagement, which could evolve into addictive patterns. Furthermore, the mediation analysis underscored that mobile phone addiction plays a pivotal role in connecting these variables with well-being. On one hand, good health and academic resources attenuated the negative influence of smartphone overuse; on the other hand, technology features appeared to amplify dependency, thereby undermining overall well-being. These findings suggest that the relationship between technology and well-being is complex and context-dependent, requiring nuanced interpretations rather than uniform assumptions.

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