

**INVESTIGATING THE ASSOCIATION  
BETWEEN PROBLEMATIC INTERNET USE  
AND CHRONIC PAIN SYNDROMES**

**Theses of the doctoral (PhD) dissertation  
Dr. Ildikó Radványi**

**University of Pécs  
Faculty of Medicine**

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## TABLE OF CONTENTS

|       |                                                                                                    |    |
|-------|----------------------------------------------------------------------------------------------------|----|
| 1     | INTRODUCTION .....                                                                                 | 1  |
| 1.1   | The phenomenon and forms of problematic internet use (PIU).....                                    | 1  |
| 1.2   | Etiological factors underlying problematic internet use .....                                      | 1  |
| 1.2.1 | Genetic and neurobiological background.....                                                        | 1  |
| 1.2.2 | Environmental factors .....                                                                        | 1  |
| 1.3   | Conceptual framework of problematic internet use: the I-PACE model.....                            | 2  |
| 1.4   | Lifestyle and health effects of problematic internet use.....                                      | 2  |
| 1.5   | Measurement, epidemiological, and therapeutic characteristics of problematic internet use.....     | 2  |
| 1.6   | Clinical framework of chronic pain and the pain syndromes investigated .....                       | 3  |
| 1.7   | An integrated interpretation of problematic internet use and chronic pain.....                     | 3  |
| 2     | OBJECTIVES .....                                                                                   | 3  |
| 3     | INVESTIGATING THE ASSOCIATION BETWEEN INTERNET USE AND PRIMARY HEADACHE SEVERITY .....             | 4  |
| 3.1   | Introduction .....                                                                                 | 4  |
| 3.2   | Methods.....                                                                                       | 4  |
| 3.2.1 | Selection of the study population .....                                                            | 4  |
| 3.2.2 | Data collection and instruments used.....                                                          | 5  |
| 3.2.3 | Data processing and statistical analysis .....                                                     | 5  |
| 3.3   | Results .....                                                                                      | 6  |
| 3.3.1 | Main characteristics of the sample and headache prevalence .....                                   | 6  |
| 3.3.2 | Internet use, problematic internet use, and psychological characteristics.....                     | 7  |
| 3.3.3 | Migraine-specific main findings .....                                                              | 7  |
| 3.3.4 | Tension-type headache-specific main findings .....                                                 | 9  |
| 3.4   | Discussion .....                                                                                   | 10 |
| 4     | INVESTIGATING THE ASSOCIATION BETWEEN PROBLEMATIC INTERNET USE AND NEUROPATHIC LOW BACK PAIN ..... | 11 |
| 4.1   | Introduction .....                                                                                 | 11 |
| 4.2   | Methods.....                                                                                       | 12 |
| 4.2.1 | Selection of the study population .....                                                            | 12 |
| 4.2.2 | Data collection and instruments used.....                                                          | 12 |
| 4.2.3 | Data processing and statistical analysis .....                                                     | 13 |
| 4.3   | Results .....                                                                                      | 13 |
| 4.3.1 | Main characteristics of the sample and prevalence of chronic low back pain                         | 13 |
| 4.3.2 | Main factors associated with neuropathic low back pain.....                                        | 13 |

|       |                         |    |
|-------|-------------------------|----|
| 4.3.3 | Mediation analysis..... | 15 |
| 4.4   | Discussion .....        | 16 |
| 5     | CONCLUSION.....         | 17 |
| 6     | PUBLICATIONS .....      | 17 |
| 7     | REFERENCES .....        | 18 |

## **ABBREVIATIONS**

AIS: Athens Insomnia Scale

BDI-SF: Beck Depression Inventory, Short Form

DSM-5: Diagnostic and Statistical Manual of Mental Disorders, 5th Edition

IAT: Internet Addiction Test

ICD-11: International Classification of Diseases, 11th Revision

ICHD-3: International Classification of Headache Disorders, 3rd Edition

I-PACE: Interaction of Person-Affect-Cognition-Execution model

NLBP: Neuropathic Low Back Pain

PIU: Problematic Internet Use

PIUQ: Problematic Internet Use Questionnaire

SPSS: Statistical Package for the Social Sciences

TTH: Tension-type headache

# **1 INTRODUCTION**

## **1.1 The phenomenon and forms of problematic internet use (PIU)**

The widespread adoption of digital technology has fundamentally transformed everyday life, including learning, work, and social interactions. Although internet use offers numerous benefits, excessive, uncontrolled, or maladaptive use may be associated with adverse psychological, social, and functional consequences.

Several terms have been used to describe this phenomenon; however, the term problematic internet use has the advantage of not presuming a uniform nosological background and of accurately reflecting the heterogeneity of the construct. In clinical terms, problematic internet use can be defined as impaired control over internet use that leads to deterioration in psychological, social, academic, occupational, or other areas of functioning, and/or to subjective distress.

Problematic internet use may manifest in various forms, including online gaming and gambling addiction, problematic social media use, online shopping, and other digital behaviors that are difficult to control. These behaviors may involve addictive, impulsive, and compulsive features to varying degrees, suggesting that PIU is not a unitary disorder but rather an umbrella construct encompassing multiple psychopathological mechanisms. Among these forms, internet gaming disorder is the one most closely aligned with the classical model of behavioral addictions; accordingly, it is included in the DSM-5 as a condition warranting further study and in the ICD-11 as an independent diagnosis.

## **1.2 Etiological factors underlying problematic internet use**

The development of problematic internet use is a multifactorial process in which genetic, neurobiological, and environmental factors all play a role.

### **1.2.1 Genetic and neurobiological background**

Twin studies suggest that the heritability of problematic internet use is moderate, indicating that, in addition to genetic vulnerability, environmental factors also make a substantial contribution to the development of the condition. Among neurobiological models, dysfunction of the reward system has particular relevance, especially alterations in dopaminergic regulation, which may increase the propensity to seek activities that provide rapid and intense reward. Neuroimaging findings further suggest that problematic internet use—particularly internet gaming disorder—may be associated with alterations in brain networks involved in reward processing, inhibitory control, and decision-making.

### **1.2.2 Environmental factors**

In addition to genetic vulnerability, environmental factors are also of key importance. Younger age, early exposure to digital devices, an unfavorable family background, excessive and non-goal-directed internet use, as well as impulsivity, low self-control, and difficulties in emotion regulation may all increase the risk of problematic internet use. Problematic internet use is also frequently associated with depression, anxiety symptoms, and other mental disorders, although the causal relationships are not always clear. Taken together, these findings

suggest that problematic internet use is typically not an isolated phenomenon, but rather is embedded in a broader network of psychological and environmental problems.

### **1.3 Conceptual framework of problematic internet use: the I-PACE model**

The I-PACE model (Interaction of Person-Affect-Cognition-Execution) provides a useful conceptual framework for understanding problematic internet use, as it describes the development and maintenance of behavioral addictions within an integrated model.

According to the model, the development of the condition involves the interplay of individual vulnerability factors, affective processes, cognitive distortions, and impaired executive functioning. Increased impulsivity, low self-control, and depressive and anxiety symptoms may increase the likelihood that an individual will use the internet for emotion regulation or escapism. In the short term, online activities may reduce negative emotions and enhance positive experiences, thereby reinforcing use. At the same time, dysfunctional beliefs and weakened control functions may further impair the regulation of behavior. The I-PACE model therefore highlights that problematic internet use develops and is maintained through the mutually reinforcing interaction of individual vulnerability, emotional states, cognitive distortions, and reinforcement-based learning.

### **1.4 Lifestyle and health effects of problematic internet use**

Problematic internet use (PIU) may adversely affect several domains of a healthy lifestyle. The literature indicates associations between problematic internet use and unhealthy dietary patterns, physical inactivity, sleep disturbance, psychological distress, social withdrawal, and the more frequent occurrence of other addictive behaviors.

The association between PIU and poorer sleep quality, insomnia, as well as depressive and anxiety symptoms appears to be particularly consistent across studies. Excessive internet use is also often associated with a sedentary lifestyle and reduced physical activity, which may, over the longer term, increase the risk of chronic non-communicable diseases.

Overall, PIU should not be regarded merely as a behavioral characteristic, but rather as a complex risk condition that may adversely affect both physical and mental health.

### **1.5 Measurement, epidemiological, and therapeutic characteristics of problematic internet use**

Research on problematic internet use (PIU) is complicated by the lack of a uniformly accepted definition of the phenomenon; nevertheless, several instruments are available for its assessment. Among the early questionnaires, the Internet Addiction Test (IAT) should be highlighted, while in Hungarian research particular importance has been attributed to the Problematic Internet Use Questionnaire (PIUQ), which assesses the dimensions of impaired control, obsession, and neglect.

Prevalence estimates vary considerably across studies; however, international data suggest that the prevalence of PIU is approximately 6–7%, with higher rates observed particularly among adolescents, young adults, and university students. Hungarian findings likewise indicate that the phenomenon is substantial, although its frequency varies across age groups.

At present, treatment approaches are not standardized; however, lifestyle interventions, sleep regulation, and psychotherapy—particularly cognitive behavioral therapy—may be considered

promising approaches. Evidence for pharmacological and neuromodulatory interventions remains limited at this stage.

## **1.6 Clinical framework of chronic pain and the pain syndromes investigated**

Chronic pain is defined as pain that persists or recurs for at least three months and represents a substantial individual, societal, and healthcare burden. In the ICD-11, chronic pain is addressed within a distinct diagnostic framework, which differentiates between primary and secondary chronic pain syndromes.

Contemporary pain typology distinguishes three main mechanisms of pain: nociceptive, neuropathic, and nociplastic pain. This classification is clinically important because the symptom profile, psychological characteristics, and therapeutic implications of these pain types may differ substantially.

Of particular relevance to my research are primary headache disorders, especially migraine and tension-type headache, as well as primary chronic low back pain. The persistence of these conditions is influenced by neurobiological, psychosocial, and lifestyle-related factors, and their management requires a biopsychosocial approach.

## **1.7 An integrated interpretation of problematic internet use and chronic pain**

Research in recent years suggests that problematic internet use (PIU) and chronic pain syndromes may be linked through a multidirectional, mutually reinforcing relationship. In individuals living with chronic pain, internet use may become a coping strategy or a means of distraction, while physical inactivity, prolonged sitting, and poor ergonomics associated with excessive internet use may contribute to the persistence or worsening of musculoskeletal complaints.

Important mediating factors in this relationship may include sleep disturbance, stress, depression, and anxiety. PIU is often associated with poorer sleep quality and increased psychological burden, which in turn may enhance pain sensitivity and contribute to the chronification of pain.

The I-PACE model offers an integrated explanatory framework for this relationship, as personal vulnerability factors, affective and cognitive processes, and impaired self-regulation may play a role not only in PIU, but also in the persistence of nociplastic pain and, to some extent, neuropathic pain. Overall, the relationship between PIU and chronic pain can be understood within a network of biopsychosocial mechanisms, which justifies its targeted investigation.

## **2 OBJECTIVES**

1. Our first objective was to examine the association between problematic internet use and the severity of primary headache disorders, particularly migraine and tension-type headache, and to explore the role of internet use habits, depression, insomnia, and other sociodemographic factors in the persistence and worsening of headache.
2. Our second objective was to investigate the associations between problematic internet use and chronic neuropathic low back pain, with particular emphasis on the role of

psychological factors—primarily depression and sleep disturbance—in the mechanisms underlying pain severity and persistence.

### **3 INVESTIGATING THE ASSOCIATION BETWEEN PROBLEMATIC INTERNET USE AND PRIMARY HEADACHE SEVERITY**

#### **3.1 Introduction**

In addition to the traditionally recognized triggers of primary headache disorders—such as stress, sleep disturbances, an unfavorable lifestyle, and persistent psychological burden—the spread of digitalization and excessive internet use have also emerged in recent years as potential risk factors. Problematic internet use may adversely affect physical health and has been associated with various somatic symptoms, including headache.

Previous studies suggest that time spent using computers and smartphones may be associated with a higher frequency and greater severity of headaches. At the same time, findings regarding the relationship between problematic internet use and primary headache disorders remain inconsistent. Some studies have not demonstrated a clear association, whereas others have reported a positive relationship between problematic internet use and the occurrence or severity of headache. These discrepancies may be attributable to differences in the populations studied, the measurement instruments used, and the diagnostic approaches applied.

The aim of our study was to analyze, by means of an online questionnaire survey, the relationship of online activities and problematic internet use with the severity of primary headache disorders. In the analysis, we also took into account demographic characteristics, comorbidities, depressive symptoms, sleep disturbance, the purpose of internet use, and the severity of problematic internet use.

#### **3.2 Methods**

##### **3.2.1 Selection of the study population**

Our cross-sectional online questionnaire study was conducted between February and May 2023 among part-time students at Gál Ferenc University. This target population was selected because, compared with full-time students, this adult student group is more heterogeneous in terms of age, family status, and employment, and was therefore considered suitable for investigating problematic internet use, psychological factors, and complaints related to chronic pain syndromes.

Eligible participants were students aged 18 to 64 years with active student status who responded voluntarily and anonymously. Exclusion criteria were age under 18 years, an incomplete or non-evaluable questionnaire, and lack of informed consent to participate. The questionnaire was distributed through institutional electronic channels to approximately 2,000 part-time students. A total of 550 complete, non-excluded questionnaires were included in the final analysis, corresponding to an estimated response rate of approximately 27–28%. The research protocol was approved by the Hungarian Medical Research Council (ETT) (approval number: BMEÜ/1732–3/2022/EKU).

### **3.2.2 Data collection and instruments used**

Data were collected using an online self-administered questionnaire. The full questionnaire consisted partly of self-developed items and partly of validated question blocks. The core module, completed by all participants, included questions on sociodemographic characteristics, lifestyle, health status, and internet use habits, whereas the headache-specific section was completed only by those who reported headache complaints within the previous 3 months. Validated questionnaires were used to assess problematic internet use, depressive symptoms, and insomnia.

The self-developed background questionnaire recorded participants' sex, age, marital status, number of children, educational attainment, and whether they were employed alongside their studies. The survey also considered smoking, alcohol consumption, diabetes mellitus, hypertension, cardiovascular disease, chronic low back pain, previous depression, and the main characteristics of internet use, including daily duration of use, the digital device used, the time of day of use, and the purpose of internet use.

The headache questionnaire assessed the onset, localization, character, intensity, duration, accompanying symptoms, aura, number of headache days, triggering and relieving factors, as well as medical consultation and medication use related to headaches occurring within the previous 3 months. Headache diagnoses were established in accordance with the guidelines of the International Headache Society, and the questionnaires were evaluated by two independent physicians. Based on the ICHD-3 criteria and the validated Hungarian version of the ID-Migraine questionnaire, primary headaches were classified as migraine, tension-type headache, or unclassifiable primary headache. Headache severity was categorized as mild, moderate, or severe according to symptom frequency.

Problematic internet use was assessed using the Problematic Internet Use Questionnaire (PIUQ), an 18-item instrument that measures the dimensions of obsession, neglect, and impaired control. Responses were recorded on a five-point Likert scale; a total score above 41 indicated problematic internet use. The internal consistency of the questionnaire was excellent (Cronbach's  $\alpha = 0.889$ ).

Depressive symptoms were assessed using the shortened 9-item version of the Beck Depression Inventory (BDI-SF). A total score above 9 indicated the presence of depression; scores of 10–18 indicated mild depression, 19–25 moderate depression, and scores above 26 severe depression. The Hungarian version of the questionnaire had been validated and showed good internal consistency (Cronbach's  $\alpha = 0.830$ ).

Sleep disturbances were assessed using the Athens Insomnia Scale, which evaluates sleep quality and related daytime symptoms. A total score above 6 indicated the presence of insomnia. The Hungarian version had been validated and showed excellent internal consistency (Cronbach's  $\alpha = 0.834$ ).

### **3.2.3 Data processing and statistical analysis**

Results were presented as mean  $\pm$  standard deviation (SD), as well as absolute and relative frequencies. Differences between categorical variables were examined using the chi-square test. To jointly analyze the sociodemographic, lifestyle-related, and psychological factors associated with headache severity, a multivariate analysis of variance approach was applied. To explore

the potential relationships among problematic internet use, psychological factors, and headache severity, a regression-based analysis with a mediation framework was performed. All analyses were conducted using SPSS 11.0 software, and the level of statistical significance was set at  $p < 0.05$ .

### 3.3 Results

#### 3.3.1 Main characteristics of the sample and headache prevalence

A total of 550 participants completed the online questionnaire in full, including 480 women and 70 men. Most participants were between 19 and 40 years of age, 74.9% were married or living in a relationship, 44.2% had no children, and 84.2% were also engaged in secondary employment. Detailed sociodemographic characteristics are presented in Table 3.1.

In the total sample, 202 participants (36.7%) reported headaches. The prevalence of migraine was 13.5%, while that of tension-type headache was 21.6%. Among participants reporting headache, 36.6% were classified as having migraine, 58.9% as having tension-type headache, and 4.5% as having unclassifiable primary headache. Over the previous 3 months, participants reported an average of 13.8 headache days. The proportion of severe cases was higher in the migraine group, whereas mild forms were more common among those with tension-type headache.

**Table 3.1.** Sociodemographic characteristics of the study population according to headache type and headache occurrence.

|                            | Participants | Occurrence and type of headache |            |           |            |
|----------------------------|--------------|---------------------------------|------------|-----------|------------|
|                            | Total        | No headache                     | Headache   | Migraine  | TTH        |
|                            | N=550 (%)    | N=348 (%)                       | N=202 (%)  | N=74 (%)  | N=119 (%)  |
| <b>Gender</b>              |              |                                 |            |           |            |
| male                       | 70 (12.7)    | 55 (15.8)                       | 15 (7.4)   | 3 (4.1)   | 11 (9.2)   |
| female                     | 480 (87.3)   | 293 (84.2)                      | 187 (92.6) | 69 (95.9) | 108 (90.8) |
| <b>Age</b>                 |              |                                 |            |           |            |
| 19 years                   | 19 (3.5)     | 13 (3.8)                        | 6 (3.0)    | 1 (1.3)   | 5 (4.2)    |
| 20-29 years                | 172 (31.3)   | 93 (26.7)                       | 79 (39.1)  | 27(36.5)  | 49 (41.2)  |
| 31-40 years                | 133 (24.2)   | 79 (22.7)                       | 54 (26.7)  | 20(27.0)  | 29 (24.4)  |
| 41-50 years                | 169 (30.7)   | 116 (33.3)                      | 53 (26.2)  | 23(31.1)  | 29 (24.4)  |
| 51-60 years                | 54 (9.8)     | 44 (12.6)                       | 10 (5.0)   | 3 (4.1)   | 7 (5.9)    |
| 61-65 years                | 3 (0.5)      | 3 (0.9)                         | 0          | 0         | 0          |
| <b>Marital status</b>      |              |                                 |            |           |            |
| single                     | 138 (25.1)   | 87 (25.0)                       | 51 (25.3)  | 15 (20.3) | 34 (28.6)  |
| in a relationship          | 176 (32.0)   | 97 (27.9)                       | 79 (39.1)  | 32 (43.2) | 46 (38.7)  |
| married                    | 236 (42.9)   | 164 (47.1)                      | 72 (35.6)  | 27 (36.5) | 39 (32.7)  |
| <b>Number of children</b>  |              |                                 |            |           |            |
| have no child              | 243 (44.2)   | 137 (39.4)                      | 106(52.5)  | 34 (45.9) | 67 (56.3)  |
| 1 child                    | 91 (16.5)    | 65 (18.7)                       | 26 (12.9)  | 11 (14.9) | 12 (10.1)  |
| 2 children                 | 131 (23.8)   | 82 (23.5)                       | 49 (24.2)  | 19 (25.7) | 29 (24.4)  |
| 3, or more than 3 children | 85 (15.5)    | 64 (18.4)                       | 21 (10.4)  | 10 (13.5) | 11 (9.2)   |

### **3.3.2 Internet use, problematic internet use, and psychological characteristics**

In the total study population, the mean age at first digital device use was 17.6 years, and 77.6% of participants spent at least two hours per day using the internet. The most frequently reported time period of internet use was between 18:00 and 21:00, and the most common purpose of internet use was studying or work. Detailed data on internet use are presented in Table 3.2.

According to the PIUQ, the prevalence of problematic internet use in the total sample was 8.4%. This proportion was 2.9% among participants without headache, compared with 17.8% among those reporting headache; within the headache subgroups, a higher rate of PIU was found among participants with tension-type headache than among those with migraine. Depressive symptoms and sleep disturbance were also more frequent among participants reporting headache than in the headache-free group.

### **3.3.3 Migraine-specific main findings**

In examining the factors influencing migraine severity, significant differences were observed across severity categories for several sociodemographic and psychological variables. Based on the age distribution, the proportion of participants aged 20–29 years was higher in the severe migraine group than in the mild and moderate groups (46.7% vs. 31.8% and 27.3%, respectively;  $p = 0.035$ ). The proportion of single participants was also higher in the severe group than among those with mild or moderate migraine (26.7% vs. 13.6% and 18.2%, respectively;  $p = 0.022$ ), and the proportion of participants without children was likewise greater in the severe migraine group (60.0% vs. 31.8% and 40.9%, respectively;  $p = 0.044$ ).

The analysis of psychological factors also revealed significant differences in the distribution of depressive symptoms across migraine severity groups ( $p = 0.032$ ). The prevalence of sleep disturbance was significantly higher in the severe migraine group than among participants with mild and moderate migraine (23.3% vs. 0.0% and 4.5%, respectively;  $p = 0.020$ ).

In summary, migraine severity showed significant associations with the 20–29-year age group, single marital status, childlessness, the distribution of depressive symptoms, and insomnia.

According to the mediation-oriented analysis, more severe migraine was associated with higher headache frequency, depressive symptoms, and worsening sleep quality. These findings suggest that depressive symptoms may constitute an important component of the symptom pattern accompanying more severe migraine and sleep disturbance, and that this network of associations also reflects a pattern consistent with a possible mediating role. However, due to the cross-sectional study design, causal mediation cannot be established. The pattern of associations is illustrated in Figure 3.1.

**Table 3.2.** Internet use and problematic internet use characteristics in the study population according to headache type and headache occurrence.

|                                                               | Participants | Occurrence and type of headache |            |           |            |
|---------------------------------------------------------------|--------------|---------------------------------|------------|-----------|------------|
|                                                               | Total        | No headache                     | Headache   | Migraine  | TTH        |
|                                                               | N=550 (%)    | N=348 (%)                       | N=202(%)   | N=74 (%)  | N=119 (%)  |
| <b>Daily internet use</b>                                     |              |                                 |            |           |            |
| < 1 hour                                                      | 23 (4.2)     | 19 (5.5)                        | 4 (2.0)    | 0         | 4 (3.4)    |
| 1 hour                                                        | 100 (18.2)   | 66 (18.9)                       | 34 (16.8)  | 16 (21.6) | 16 (13.4)  |
| 2 hours                                                       | 164 (29.8)   | 110 (31.6)                      | 54 (26.7)  | 19 (25.7) | 33 (27.7)  |
| 3 hours                                                       | 115 (20.9)   | 75 (21.6)                       | 40 (19.8)  | 14 (18.9) | 24 (20.2)  |
| 4 hours                                                       | 62 (11.3)    | 33 (9.5)                        | 29 (14.4)  | 10 (13.5) | 18 (15.1)  |
| 5 hours                                                       | 39 (7.1)     | 21 (6.0)                        | 18 (8.9)   | 9 (12.2)  | 8 (6.7)    |
| 6 hours                                                       | 16 (2.9)     | 5 (1.4)                         | 11 (5.5)   | 4 (5.4)   | 6 (5.0)    |
| > 6 hours                                                     | 31 (5.6)     | 19 (5.5)                        | 12 (5.9)   | 2 (2.7)   | 10 (8.5)   |
| <b>Daily time interval of internet use (multiple answers)</b> |              |                                 |            |           |            |
| between 24:00-03:00                                           | 63 (11.5)    | 30 (8.6)                        | 33 (16.3)  | 9 (12.2)  | 12 (10.1)  |
| between 03:00-06:00                                           | 49 (8.9)     | 30 (8.6)                        | 19 (9.4)   | 8 (10.8)  | 11 (9.2)   |
| between 06:00-09:00                                           | 99 (18.0)    | 64 (18.4)                       | 35 (17.3)  | 11 (14.9) | 22 (18.5)  |
| between 09:00-12:00                                           | 106 (19.3)   | 77 (22.1)                       | 29 (14.4)  | 8 (10.8)  | 20 (16.8)  |
| between 12:00-15:00                                           | 101 (18.4)   | 63 (18.1)                       | 38 (18.8)  | 15 (20.3) | 22 (18.5)  |
| between 15:00-18:00                                           | 160 (29.1)   | 103 (29.6)                      | 57 (28.2)  | 20 (27.0) | 34 (28.6)  |
| between 18:00-21:00                                           | 314 (57.1)   | 200 (57.5)                      | 114 (56.4) | 42 (56.8) | 64 (53.8)  |
| between 21:00-24:00*                                          | 115 (20.9)   | 67 (19.3)                       | 48 (23.8)  | 12 (16.2) | 32 (26.9)* |
| <b>Goal of internet use (multiple answers)</b>                |              |                                 |            |           |            |
| learning/working                                              | 531 (96.5)   | 339 (97.4)                      | 192 (95.1) | 71 (95.9) | 112(94.1)  |
| online gaming                                                 | 75 (13.6)    | 52 (14.9)                       | 23 (11.4)  | 5 (6.8)   | 18 (15.1)  |
| chat                                                          | 316 (57.5)   | 195 (56.0)                      | 121 (59.9) | 43 (58.1) | 75 (63.0)  |
| social media                                                  | 336 (61.1)   | 212 (60.9)                      | 124 (61.4) | 47 (63.5) | 71 (59.7)  |
| partner search                                                | 13 (2.4)     | 9 (2.6)                         | 4 (2.0)    | 1 (1.4)   | 3 (2.5)    |
| movies                                                        | 252 (45.8)   | 147 (42.2)                      | 105 (52.0) | 36 (48.6) | 63 (52.9)  |
| music                                                         | 262 (47.6)   | 154 (44.3)                      | 108 (53.5) | 39 (52.7) | 64 (53.8)  |
| video streaming                                               | 64 (11.6)    | 43 (12.4)                       | 21 (10.4)  | 7 (9.5)   | 13 (10.9)  |
| <b>Problematic internet use</b>                               | 46(8.4)      | 10(2.9)                         | 36 (17.8)  | 9 (12.2)  | 26 (21.8)  |

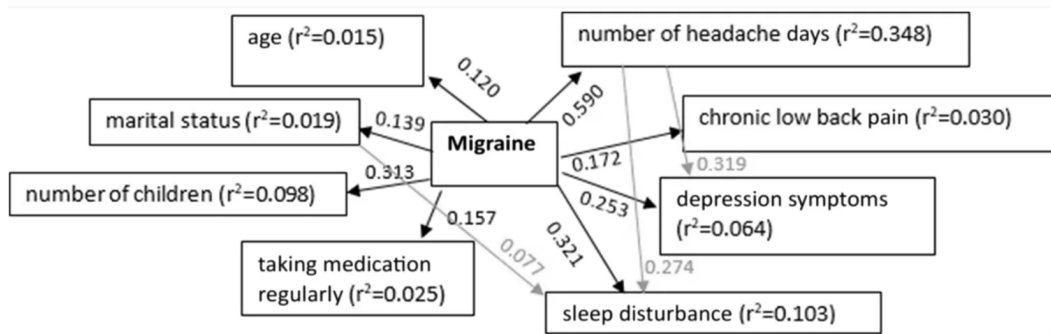


**Figure 3.1.** Association between migraine and demographic characteristics, comorbidities, headache-related medical history, and online activities ( $p < 0,05$ ).

### 3.3.4 Tension-type headache specific main findings

In examining the factors influencing the severity of tension-type headache, significant differences were observed across severity categories for several sociodemographic, psychological, and internet use variables. Based on the age distribution, the proportion of participants aged 20–29 years was higher in the severe TTH group than in the mild and moderate groups (50.0% vs. 33.9% and 44.4%, respectively;  $p = 0.048$ ). The proportion of participants without children was higher in both the moderate and severe groups than in the mild TTH group (66.7% and 58.3% vs. 50.0%, respectively;  $p = 0.013$ ).

The analysis of psychological factors showed that the proportion of participants reporting mild depressive symptoms was higher in the moderate and severe groups than in the mild group (85.2% and 77.8% vs. 55.4%, respectively;  $p = 0.040$ ), and the proportion of moderate depressive symptoms was also greater in these groups (7.4% and 8.3% vs. 3.6%, respectively;  $p = 0.024$ ). Among the internet use characteristics, the proportion of internet use between 21:00 and 24:00 was higher in the moderate and severe TTH groups than in the mild group (29.6% and 30.6% vs. 23.2%, respectively;  $p = 0.043$ ). The prevalence of problematic internet use was highest in the severe group (33.3% vs. 21.4% and 7.4%, respectively;  $p = 0.003$ ).

In summary, TTH severity showed significant associations with younger age, particularly the 20–29-year age group, childlessness, mild and moderate depressive symptoms, as well as evening internet use and problematic internet use.

According to the mediation-oriented analysis, more severe TTH was associated with higher headache frequency, poorer mental health status, worsening sleep quality, and certain internet use patterns. These findings suggest that depressive symptoms and problematic internet use may constitute important components of the symptom pattern accompanying more severe TTH and sleep disturbance, and that this network of associations also reflects a pattern consistent with a possible mediating role. However, due to the cross-sectional study design, causal mediation cannot be established. The pattern of associations is illustrated in Figure 3.2.

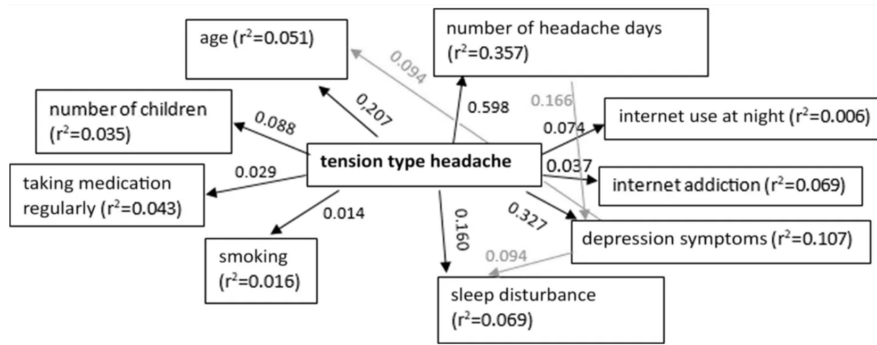


**Figure 3.2.** Association between tension-type headache and demographic characteristics, comorbidities, headache-related medical history, and online activities ( $p < 0,05$ ).

### 3.4 Discussion

According to the literature, the spread of digitalization may act as an emerging risk factor that can adversely affect physical health, including the development and persistence of headache. Although investigating the relationship between problematic internet use and primary headache disorders is of clear clinical relevance, the available findings remain limited and often inconsistent; therefore, the question has remained open. The aim of our study was to explore this relationship, with particular emphasis on the statistical association between problematic internet use and the severity of migraine and tension-type headache. As our analysis was based on a cross-sectional design, our findings describe associations only and do not permit causal or temporal conclusions.

In our sample, the combined prevalence of primary headache disorders was 36.7%; the prevalence of migraine was 13.5%, while that of tension-type headache was 21.6%. This is consistent with previous epidemiological observations indicating that tension-type headache is generally more common than migraine.

Our findings showed that younger age was associated with more severe forms of headache in both migraine and tension-type headache. In both the severe migraine and severe TTH groups, the proportion of participants aged 20–29 years was higher than in the less severe groups. One possible explanation is the greater psychological burden, sleep deprivation, and other lifestyle-related stressors characteristic of young adulthood. Previous studies likewise suggest that stress is associated with more frequent and more intense headache attacks.

Childlessness was associated with more severe headache forms in both migraine and tension-type headache. One possible explanation is that, according to the literature on headache disorders, more frequent or more severe attacks may influence decisions regarding childbearing, although more detailed evidence on this issue is primarily available for migraine. The relationship between family status and headache severity appeared to differ by headache type. In migraine, the distribution of family status differed across severity groups; descriptively, it may be noted that within the severe migraine group, the combined proportion of those who were in a relationship or married exceeded that of single participants. In tension-type headache, family status did not show a significant association with severity categories; however, at a descriptive level, the combined proportion of those who were in a relationship or married was also higher than that of single participants in the severe TTH group. According to the literature, this may be related to the psychological burden associated with partnership and family roles, as

well as to differences in the recognition of emotional stress and the coping strategies used in response to it.

The importance of psychological factors was clearly reflected in our findings. Depressive symptoms were more common among participants with headache than in the headache-free group, and their distribution differed across severity groups in both migraine and tension-type headache. In migraine, the overall distribution of depressive symptoms differed across severity categories, whereas in TTH, mild and moderate depressive symptoms in particular were more frequent in the more severe groups. Insomnia was also more common among participants with headache and showed a more pronounced association with severity, particularly in migraine. In tension-type headache, sleep disturbance was numerically more frequent in the more severe group, but the difference did not reach statistical significance. These observations are consistent with previous evidence indicating that depression and sleep disturbance are more common in primary headache disorders and may also be associated with symptom intensity and frequency.

The prevalence of problematic internet use in our study was 8.4%, which is consistent with Hungarian and international data. Based on our findings, significant associations with internet use characteristics emerged primarily in relation to tension-type headache: internet use between 21:00 and 24:00, as well as problematic internet use, was more frequent in the more severe TTH groups. By contrast, no similar pattern was observed in the migraine subgroup. Previous studies have also reported different internet use patterns between the two primary headache types. It may be hypothesized that, in migraine, increased sensitivity to digital stimuli is accompanied by a conscious or unconscious restriction of online activity.

According to the mediation-oriented analysis, the severity of both migraine and tension-type headache was associated with multiple interrelated demographic, psychological, and lifestyle-related factors. In migraine, psychological and sleep-related factors appeared to be more prominent, whereas in tension-type headache the role of internet use characteristics also seemed more pronounced. However, these patterns cannot be regarded as evidence of causal mediation.

Overall, our findings showed that the severity of primary headache types was associated with several sociodemographic, psychological, and lifestyle-related factors. Younger age, childlessness, and depressive symptoms were related to differences in severity in both migraine and tension-type headache. Sleep disturbance appeared to be particularly prominent in migraine, whereas internet use characteristics were associated primarily with the severity of tension-type headache. From a clinical perspective, it therefore seems justified to routinely inquire about the duration and nature of internet use, as well as depressive symptoms and sleep quality, during patient history taking, as this may contribute to a more comprehensive understanding of the lifestyle-related and psychological factors accompanying headache.

## **4 INVESTIGATING THE ASSOCIATION BETWEEN PROBLEMATIC INTERNET USE AND NEUROPATHIC LOW BACK PAIN**

### **4.1 Introduction**

With the widespread adoption of digital technologies, increasing attention has been directed toward the associations between problematic internet use and chronic pain syndromes. Low back pain is one of the most common forms of chronic pain and represents a substantial social and healthcare burden. According to contemporary perspectives, chronic low back pain may

involve not only structural abnormalities but also neuropathic and nociplastic mechanisms, in which disturbances of central pain processing, as well as psychological and lifestyle-related factors, may all play an important role.

A growing body of evidence suggests that problematic internet use may indirectly contribute to the persistence or worsening of chronic low back pain. Possible pathways include prolonged sedentary behavior, reduced physical activity, adverse ergonomic strain, and increasing sleep disturbances and psychological distress. Previous studies have also drawn attention to the possible relationship between problematic internet use, physical inactivity, and musculoskeletal complaints.

Although an increasing number of studies have examined the relationship between problematic internet use and chronic pain, relatively little is still known about how this association manifests in neuropathic-type low back pain. A particularly important question is the role that psychological factors—primarily depressive symptoms and sleep disturbance—may play in this relationship.

Therefore, the aim of our study was to explore the relationship between problematic internet use and chronic low back pain with neuropathic features, with particular emphasis on the possible role of depression and sleep disturbance.

## **4.2 Methods**

### **4.2.1 Selection of the study population**

The target population of the study presented in this chapter was identical to the sample described in Chapter 3; a detailed description of the inclusion and exclusion criteria is provided in Section 3.2.1. The cross-sectional online questionnaire study was conducted between February and May 2023 among part-time students at Gál Ferenc University. A total of 550 complete, non-excluded questionnaires were included in the final analysis. The research protocol was approved by the Hungarian Medical Research Council (ETT) (approval number: BMEÜ/1732–3/2022/EKU).

### **4.2.2 Data collection and instruments used**

Data were collected using an online self-administered questionnaire. A detailed description of the questionnaires used to assess sociodemographic characteristics, lifestyle factors, comorbidities, internet use habits, as well as problematic internet use, depression, and insomnia is provided in Section 3.2.2. In the present study, the novel elements were the low back pain-specific question block and the painDETECT questionnaire used to identify neuropathic pain.

The low back pain-specific question block was completed only by participants who reported low back pain within the previous 3 months. To screen for neuropathic pain, we used the validated self-administered painDETECT questionnaire, which assesses the qualitative characteristics, temporal course, and radiation of pain on the basis of 9 items. Based on the total score, three categories were distinguished: a score of  $\leq 12$  indicated that neuropathic pain was unlikely, a score of 13–18 was considered uncertain, and a score of  $\geq 19$  suggested probable neuropathic pain.

### 4.2.3 Data processing and statistical analysis

Descriptive statistics (mean  $\pm$  standard deviation or percentages) were calculated for all variables. Associations between categorical variables were examined using the chi-square test, while relationships between continuous variables were assessed using Pearson correlation coefficients. Possible predictors of neuropathic pain (painDETECT scores) were analyzed by hierarchical linear regression in three successive models: the first model included sociodemographic characteristics, the second included health-related risk factors and comorbidities, and the third included psychosocial and lifestyle-related variables (depression, problematic internet use, and insomnia). This was followed by mediation analysis to explore the indirect ways in which problematic internet use might contribute to neuropathic pain through depression and insomnia. Statistical significance was set at  $p < 0.05$  for all analyses.

## 4.3 Results

### 4.3.1 Main characteristics of the sample and prevalence of chronic low back pain

A total of 550 participants completed the online questionnaire, and the vast majority of respondents were female (87.3%). Detailed descriptive statistics on demographic characteristics, risk factors, comorbidities, and patterns of internet use are presented in Tables 4.1 and 4.2. The prevalence of problematic internet use was 8.4% ( $n = 46$ ). Mild depressive symptoms were reported by 64.4% of participants, whereas moderate and severe depression were much less frequent (5.1% and 0.2%, respectively). Insomnia was reported by 5.8% of respondents ( $n = 32$ ). The overall prevalence of chronic low back pain was 46.2% ( $n = 254$ ), and within this subgroup, 72.8% had nociceptive pain, 15.0% mixed-type pain, and 12.2% neuropathic pain.

### 4.3.2 Main factors associated with neuropathic low back pain

According to the univariable analyses, no significant association was found between neuropathic pain and the sociodemographic variables examined. In contrast, among health-related risk factors and comorbidities, drug use ( $p = 0.027$ ), diabetes mellitus ( $p = 0.048$ ), and headache/migraine ( $p = 0.033$ ) showed significant associations with neuropathic pain. Bivariate correlation analysis indicated that higher painDETECT scores were significantly associated with problematic internet use ( $r = 0.126$ ;  $p < 0.05$ ), depression scores ( $r = 0.44$ ;  $p < 0.001$ ), and insomnia scores ( $r = 0.33$ ;  $p = 0.009$ ). In the first model of the hierarchical linear regression, none of the sociodemographic factors proved to be significant. In the second model, headache/migraine was a significant predictor ( $p = 0.002$ ), whereas in the third model smoking ( $p = 0.030$ ), cardiovascular disease ( $p = 0.045$ ), and particularly depressive symptoms ( $p = 0.001$ ) showed significant associations with higher painDETECT scores. The final model explained 13.6% of the variance, with depression emerging as the strongest predictor. Detailed regression results are presented in Table 4.3.

**Table 4.1.** Prevalence of demographic characteristics, risk factors, and comorbidities.

| Entire population                     | N=550 (%)  |
|---------------------------------------|------------|
| <b>Gender</b>                         |            |
| male                                  | 70 (12.7)  |
| female                                | 480 (87.3) |
| <b>Age</b>                            |            |
| 19 years                              | 19 (3.5)   |
| 20-29 years                           | 172 (31.3) |
| 31-40 years                           | 133 (24.2) |
| 41-50 years                           | 169 (30.7) |
| 51-60 years                           | 54 (9.8)   |
| 61-65 years                           | 3 (0.5)    |
| <b>Marital status</b>                 |            |
| single                                | 138 (25.1) |
| in a relationship                     | 176 (32.0) |
| married                               | 236 (42.9) |
| <b>Number of children</b>             |            |
| have no child                         | 243 (44.2) |
| 1 child                               | 91 (16.5)  |
| 2 children                            | 131 (23.8) |
| 3, or more than 3 children            | 85 (15.5)  |
| <b>Secondary employment</b>           |            |
| no                                    | 87 (15.8)  |
| yes                                   | 463 (84.2) |
| <b>Risk Factors and Comorbidities</b> |            |
| On regular medication                 | 185 (33.6) |
| Smoker                                | 97 (17.6)  |
| Alcohol consumption                   | 13 (2.4)   |
| Drug consumption                      | 2 (0.4)    |
| Diabetes                              | 30 (5.5)   |
| Hypertension                          | 59 (10.7)  |
| Cardiovascular problems               | 37 (6.7)   |
| History of depression                 | 61 (11.1)  |

**Table 4.2.** Internet use habits and the prevalence of PIU.

| Entire population                                             | N=550 (%)  |
|---------------------------------------------------------------|------------|
| <b>Daily internet use</b>                                     |            |
| < 1 hour                                                      | 23 (4.2)   |
| 1 hour                                                        | 100 (18.2) |
| 2 hours                                                       | 164 (29.8) |
| 3 hours                                                       | 115 (20.9) |
| 4 hours                                                       | 62 (11.3)  |
| 5 hours                                                       | 39 (7.1)   |
| 6 hours                                                       | 16 (2.9)   |
| > 6 hours                                                     | 31 (5.6)   |
| <b>Daily time interval of internet use (multiple answers)</b> |            |
| between 12:00 a.m. and 3:00 a.m.                              | 63 (11.5)  |
| between 3:00 a.m. and 6:00 a.m.                               | 49 (8.9)   |
| between 6:00 a.m. and 9:00 a.m.                               | 99 (18)    |
| between 9:00 a.m. and 12:00 a.m.                              | 106 (19.3) |
| between 12:00 a.m. and 3:00 p.m.                              | 101 (18.4) |
| between 3:00 p.m. and 6:00 p.m.                               | 160 (29.1) |
| between 6:00 p.m. and 9:00 p.m.                               | 314 (57.1) |
| between 9:00 p.m. and 12:00 p.m.*                             | 115 (20.9) |
| <b>Goal of internet use (multiple answers)</b>                |            |
| learning/working                                              | 531 (96.5) |
| online gaming                                                 | 75 (13.6)  |
| chat                                                          | 316 (57.5) |
| social media                                                  | 336 (61.1) |
| partner search                                                | 13 (2.4)   |
| movies                                                        | 252 (45.8) |
| music                                                         | 262 (47.6) |
| video streaming                                               | 64 (11.6)  |
| <b>Problematic internet use</b>                               |            |
| no                                                            | 504 (91.6) |
| yes                                                           | 46 (8.4)   |

**Table 4.3.** A Hierarchical linear regression analysis examining the possible predictors of neuropathic low back pain (\* $p < 0.05$  in all cases).

| Dependent: sum of low back pain scores | Model I |       |        | Model II |       |        | Model III |       |        |       |       |       |
|----------------------------------------|---------|-------|--------|----------|-------|--------|-----------|-------|--------|-------|-------|-------|
|                                        | B       | SE B  | β      | B        | SE B  | β      | B         | SE B  | β      |       |       |       |
| Gender                                 | -0.716  | 1.278 | -0.037 | -1.126   | 1.378 | -0.058 | -0.776    | 1.318 | -0.040 |       |       |       |
| Age                                    | -0.054  | 0.049 | -0.093 | -0.046   | 0.051 | -0.079 | -0.081    | 0.071 | -0.138 |       |       |       |
| Marital status                         | -1.155  | 0.985 | -0.077 | -0.881   | 0.978 | -0.059 | -0.966    | 0.947 | -0.065 |       |       |       |
| Number of children                     | 0.222   | 0.451 | 0.041  | 0.113    | 0.458 | 0.021  | 0.372     | 0.442 | 0.069  |       |       |       |
| Employment while                       | -0.393  | 1.211 | -0.022 | -0.151   | 1.195 | -0.008 | 0.069     | 1.140 | 0.004  |       |       |       |
| On regular medication                  |         |       |        | -0.160   | 0.950 | -0.012 | -0.325    | 0.920 | -0.025 |       |       |       |
| Smoker                                 |         |       |        | 1.777    | 0.996 | 0.114  | 2.100     | 0.962 | 0.135  |       |       |       |
| Alcohol consumption                    |         |       |        | -1.905   | 2.457 | -0.054 | -1.999    | 2.374 | -0.057 |       |       |       |
| Drug consumption                       |         |       |        | 11.347   | 6.643 | 0.116  | 7.473     | 6.409 | 0.076  |       |       |       |
| Diabetes                               |         |       |        | 2.099    | 1.611 | 0.086  | 2.248     | 1.551 | 0.092  |       |       |       |
| Hypertension                           |         |       |        | 0.886    | 1.444 | 0.045  | 0.582     | 1.387 | 0.029  |       |       |       |
| Cardiovascular problems                |         |       |        | 2.863    | 1.632 | 0.117  | 3.170     | 1.574 | 0.129  |       |       |       |
| Headache, migraine                     |         |       |        | 2.672    | 0.873 | 0.200* | 2.420     | 0.856 | 0.181  |       |       |       |
| History of depression                  |         |       |        | 0.163    | 1.081 | 0.010  | -2.078    | 1.131 | -0.125 |       |       |       |
| Time spent online per day              |         |       |        |          |       |        |           |       |        | 0.055 | 0.258 | 0.015 |
| Age of starting with a                 |         |       |        |          |       |        |           |       |        | 0.096 | 0.082 | 0.121 |
| Internet addiction                     |         |       |        |          |       |        |           |       |        | 1.672 | 1.406 | 0.080 |
| Sum of depression scores               |         |       |        |          |       |        |           |       |        | 0.433 | 0.131 | 0.256 |
| Sum of sleep disturbance               |         |       |        |          |       |        |           |       |        | 0.159 | 0.145 | 0.087 |
| Adjusted R <sup>2</sup>                | -0.009  |       |        | 0.050    |       |        | 0.136     |       |        |       |       |       |
| F                                      | 0.574   |       |        | 1.927*   |       |        | 3.048*    |       |        |       |       |       |

### 4.3.3 Mediation analysis

The results of the mediation analysis showed that problematic internet use was significantly associated with both higher depression scores ( $b = 0.189$ ;  $p < 0.001$ ) and sleep disturbance ( $b = 0.162$ ;  $p < 0.001$ ). At the same time, depression ( $b = 0.441$ ;  $p < 0.001$ ) and sleep disturbance ( $b = 0.328$ ;  $p = 0.009$ ) were each independently and significantly associated with higher painDETECT scores. These findings suggest that problematic internet use may be associated with neuropathic pain primarily through indirect pathways, via depressive symptoms and worsening sleep quality. Detailed mediation results are presented in Table 4.4.

**Table 4.4.** Mediation analysis of the indirect effects of PIU on neuropathic pain.

| Mediator   | a-path<br>(X→M) | b-path<br>(M→Y) | Indirect<br>effect | 95% CI      | p value |
|------------|-----------------|-----------------|--------------------|-------------|---------|
| Depression | 0.189           | 0.441           | 0.08               | 0.04 – 0.14 | <0.001  |
| Insomnia   | 0.162           | 0.328           | 0.05               | 0.01 – 0.10 | 0.009   |

**(Y) Dependent variable:** sum of low back pain scores,

**(X) Independent variable:** sum of PIU scores,

**(M) Mediator:** sum of depression scores, sum of sleep disturbance scores

## 4.4 Discussion

The aim of our study was to explore the relationship between problematic internet use and chronic low back pain with neuropathic features, taking into account sociodemographic, health-related, and psychological factors, with particular emphasis on depressive symptoms and sleep disturbance.

Our findings did not demonstrate a clear association between the sociodemographic variables examined and low back pain with neuropathic features. This partly differs from some previous observations, and one possible explanation may be the relatively small size of the neuropathic subgroup.

According to the univariable analyses, drug use, diabetes mellitus, and headache/migraine showed significant associations with neuropathic pain. The relationship between substance use disorders and chronic low back pain has also been reported in previous studies, while the emergence of headache or migraine as a predictor may suggest that these chronic pain conditions partly share common pathophysiological mechanisms.

Higher painDETECT scores were significantly associated with problematic internet use, depression, and insomnia. This suggests that, in low back pain with a neuropathic component, not only health-related but also psychological and behavioral factors may play a role. At the same time, it is important to emphasize that the neuropathic component was identified on the basis of the painDETECT questionnaire; therefore, our findings do not refer to a clinically confirmed diagnosis of neuropathic pain, but rather to the likelihood of neuropathic features.

The hierarchical regression analysis provided a more nuanced picture of these associations. In the final model, headache/migraine, smoking, cardiovascular disease, and particularly depressive symptoms showed significant associations with higher painDETECT scores. Depression emerged as the strongest predictor, which is consistent with previous findings emphasizing the close relationship between mood disorders and chronic pain. At the same time, the explanatory power of the model remained modest, suggesting that only part of the variance in neuropathic pain was captured by the variables included.

In contrast to the univariable associations, problematic internet use showed no significant direct relationship with low back pain with neuropathic features in the fully adjusted regression model. However, the mediation analysis indicated that problematic internet use was significantly associated with higher depression scores and sleep disturbances, and that these factors were themselves associated with higher painDETECT values. This suggests that the effect of problematic internet use may be expressed primarily through indirect pathways, via increased psychological burden and worsening sleep quality. The relationship between depression and pain, as well as the bidirectional association between sleep disturbances and chronic pain, is also supported by the literature.

Overall, our findings indicate that higher painDETECT scores—that is, a greater likelihood of a neuropathic component—are associated primarily with psychological factors, particularly depression and sleep disturbance, as well as with certain health-related and lifestyle-related risks. Problematic internet use is likely linked to this pattern indirectly, mainly through its associations with depression and sleep disturbances. From a clinical perspective, these findings emphasize the importance of regular screening for psychological and sleep-related problems, particularly in individuals with problematic internet use.

## 5 CONCLUSION

Our findings showed that the relationship between problematic internet use and chronic pain syndromes displays distinct patterns depending on the type of pain involved. In the investigation of primary headache disorders, headache severity was associated with several sociodemographic, psychological, and lifestyle-related factors. The 20–29-year age group, childlessness, and depressive symptoms were related to differences in severity in both migraine and tension-type headache. Sleep disturbance appeared to be particularly prominent in migraine, whereas internet use patterns—especially evening internet use and problematic internet use—showed a closer association with tension-type headache. Taken together, these findings suggest that psychological and sleep-related factors may be more prominent in migraine, whereas internet use patterns may play a more marked role in tension-type headache.

In the investigation of chronic low back pain with neuropathic features, our findings suggested that problematic internet use was associated not primarily through a direct relationship, but rather through an indirect pathway involving depression and sleep disturbance, with a greater likelihood of a neuropathic component. This indicates that the relationship between digital behavior and chronic pain is not homogeneous, but differs across the pain types examined.

Our findings are consistent with the core principles of the biopsychosocial model of pain and the I-PACE framework. Based on our results, problematic internet use may be understood in relation to psychological vulnerability, sleep problems, and certain lifestyle-related characteristics. From a clinical perspective, this highlights the potential value of targeted assessment of internet use, sleep quality, and depressive symptoms in patients with primary headache disorders or chronic low back pain.

The novelty of our research lies in examining the relationship between problematic internet use, psychological factors, and two distinct chronic pain phenotypes in an adult sample of part-time university students. At the same time, the cross-sectional design does not allow causal conclusions to be drawn; therefore, future studies should involve longitudinal designs and more heterogeneous populations. From a preventive perspective, our findings suggest that the early identification of problematic internet use, together with the screening of psychological and sleep-related problems, may contribute to more favorable outcomes in chronic pain syndromes.

## 6 PUBLICATIONS

### Publications closely related to the thesis

**Radványi I,** Tibold A, Fejes E, Mak K, Beke S, Fehér G, Nyulas R, Gaal V. Association between internet use and primary headache severity among Hungarian university students: A cross-sectional study. *Front Public Health*. 2024;12:1445856. doi:10.3389/fpubh.2024.1445856. (IF: 3,4; Q1)

**Radványi I,** Tibold A, Fehér G. A digitális viselkedés és az életmódbeli egyensúly klinikai metszéspontjai: a problémás internethasználat komplex hatása az egészségre. *Orv Hetil*.

2025;166(24):922-9. doi:10.1556/650.2025.33328. (IF: 0,9; Q4)

**Radvanyi I**, Tibold A, Herczeg V, Paphazi V, Beke S, Mák K, Fehér G et al. Depression and insomnia mediate the link between problematic internet use and neuropathic low back pain: evidence from a cross-sectional survey. *J Multidiscip Healthc.* 2025;18:7895–7905. doi:10.2147/JMDH.S571188. (IF: 2,4; Q1)

#### **Additional publications on the topic:**

Csáti A, Horváth F, Szok D, Tibold A, **Radványi I**, Fejes É, Tajti J, Fehér G. Internet use may be associated with the severity of headache in migraine patients: Results from a Hungarian tertiary headache center. *BMC Public Health.* 2025;25(1):1036. (IF: 3,6; Q1)

Szapáry Á, Fehér G, **Radványi I**, Fejes É, Nagy GD, Jancsák C, Horváth L, Bankó Z, Berke Gy, Kapus K. Problematic usage of the internet among Hungarian elementary school children: A cross-sectional study. *BMC Public Health.* 2024;24(1):1073. (IF: 3,6; Q1)

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