Vol 27 - Issue 3 (2026)

Journal of Dependence

AKADEMiSYEN
KiTABEVi

e - ISSN 3108-7973
DOI: 10.51982/bagimli

Journal of Dependence

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Journal of Dependence

Volume 27, Issue 3, 2026

Owner: Akademisyen Publishing

Publisher: Akademisyen Publishing

Managing Editor: Yasin DİLMEN

Address: Halk Sokak 5 / A Yenişehir / Ankara

E-mail: journalofdependenceeditor@gmail.com

Online Publication Date: Sept 15, 2026

Frequency: Published online four times a year on Mart, June, September and December

Design and Arrangement: Akademisyen Publishing

Typesetting: Akademisyen Publishing

Journal's History (2000-2025)

Journal's Previous Name	Parallel Title	p-ISSN	e-ISSN
Bağımlılık Dergisi	Journal of Dependence	1302-5570	2791-9846

AKADEMISYEN YAYINEVİ

Publisher Contact

Address: Halk Sokak 5 / A
Yenişehir / Ankara

Phone: 0312 431 16 33

E-mail: info@akademisyen.com

Website: akademisyen.com

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Journal of Dependence contains original articles, case reports, editorials, and letters to the editor and review articles in all areas of dependence including behavioral dependence. The publication language of the journal is **English**.

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E-mail: editor@jod.akademisyen.net

- **e – ISSN: 3108-7973**
- **DOI: 10.51982/bagimli**

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JOURNAL OF DEPENDENCE

Research Article

Diagnostic performance of a specific local Turkish large language model in detecting alcohol use disorder across internal medicine practice: A 42-patient pilot study

İlker Boğa, Mete Tuğcan Üçdal

DOI: 10.51982/bagimli.619

Abstract

Objective: Alcohol use disorder (AUD) is underdiagnosed in internal medicine. We evaluated a local large language model (LLM), fine-tuned on a Turkish medical corpus, for detecting AUD across outpatient, emergency and inpatient settings.

Method: We retrospectively analyzed 42 adult patients at a tertiary state hospital (January–May 2024); the de-identified dataset followed the MIMIC-IV schema. The reference standard was the clinician-confirmed DSM-5 diagnosis; comparators were the Alcohol Use Disorders Identification Test–Consumption (AUDIT-C), gamma-glutamyl transferase (GGT), mean corpuscular volume and the AST/ALT ratio. An in-hospital Llama-3-8B-Instruct model fine-tuned via low-rank adaptation produced binary predictions, probabilities and severity categories. Analyses used Wilson 95% confidence intervals, bootstrap AUC, Cohen's κ and paired DeLong tests.

Results: Mean age was 53.0 ± 15.0 years; 50.0% were female. AUD prevalence was 47.6% (20/42). The LLM achieved sensitivity 85.0% (95% CI, 64.0–94.8), specificity 90.9% (72.2–97.5), accuracy 88.1%, area under the curve (AUC) 0.864 (0.720–0.977) and κ = 0.761. In all 17 true positives, severity matched the reference exactly (quadratic-weighted κ = 1.000). In this enriched cohort AUDIT-C and GGT separated perfectly (AUC = 1.000) and the LLM AUC was lower (DeLong p = 0.038), a ceiling effect of this case mix, not a general marker property.

Conclusion: The local LLM achieved clinically acceptable accuracy and exact severity classification within correctly flagged cases; its principal value lies where AUDIT-C is not routine. Because the cohort was enriched for AUD, predictive values and discrimination may differ substantially in routine populations. Multicenter prospective validation is warranted.

Keywords: Alcohol use disorder, DSM-5, Large language model, Artificial intelligence, Internal medicine, Diagnostic performance, Clinical decision support system

İlker Boğa
Department of Internal Medicine, Faculty of Medicine, Ankara Medipol University, Ankara, Türkiye
Email: ilkerboga87@hotmail.com
ORCID iD: 0000-0002-8166-1809

Mete Tuğcan Üçdal
Republic of Türkiye Ministry of Health, Ankara Etimesgut Şehit Sait Ertürk State Hospital, Department of Internal Medicine, Ankara, Türkiye
Hacettepe University Faculty of Medicine, Department of Medical Biochemistry (PhD program), Ankara, Türkiye
Email: mtucdal@gmail.com
ORCID iD: 0009-0002-1763-5857

Received: 2026-05-22
Accepted: 2026-08-05

e-ISSN: 3108-7973

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INTRODUCTION

Alcohol use disorder (AUD) is among the leading public health problems affecting adult populations worldwide, contributing both to direct organ injury and to a broad range of medical and psychiatric comorbidities (Carvalho et al., 2019). Global data from the World Health Organization indicate that more than 3 million annual deaths are attributable to alcohol use and over 5% of the global disease burden is attributable to alcohol consumption (World Health Organization, 2018). In Türkiye, the 2022 Turkish Health Survey reports that 12.1% of individuals aged 15 years and older used alcohol during the previous 12 months, with a higher past-year prevalence among men (18.4%) than among women (5.9%) (Türkiye İstatistik Kurumu, 2023).

Internal medicine practice—encompassing the outpatient clinic, the emergency department, inpatient services, gastroenterology and hepatology units—constitutes one of the most critical contact points for the diagnosis of AUD. Elevations in liver function tests, dyspepsia, macrocytosis, uncontrolled hypertension, unexplained fatigue, alcohol-withdrawal-related tremor and insomnia are among the frequently underrecognized presentations of AUD. A meta-analysis by Mitchell and colleagues reported that primary and secondary care clinicians correctly identify AUD in only 25–50% of cases (Mitchell et al., 2012). Connor and colleagues similarly emphasized that overlooking AUD as an underlying diagnosis substantially increases long-term morbidity and mortality (Connor et al., 2016).

Among structured screening tools, the Alcohol Use Disorders Identification Test (AUDIT) and its three-item abbreviated form, AUDIT-C, are among the most widely used in internal medicine practice (Bush et al., 1998; Saunders et al., 1993). Turkish validation studies have demonstrated acceptable psychometric properties for both instruments (Saatcioğlu et al., 2002). In real-world practice, however, AUDIT/AUDIT-C is not administered in a substantial proportion of encounters owing to physician time constraints, patient reticence, and limited integration with the routine electronic health record (EHR) workflow (Rehm et al., 2016).

Traditional laboratory markers—gamma-glutamyl transferase (GGT), mean corpuscular volume (MCV), carbohydrate-deficient transferrin and the aspartate aminotransferase/alanine aminotransferase (AST/ALT) ratio—offer an alternative for AUD screening, yet their sensitivity and specificity remain moderate, and they can be significantly affected by non-alcohol-related etiologies (Conigrave et al., 2003; Niemelä, 2016).

In recent years, large language models (LLMs) have demonstrated notable results in clinical decision support, reflecting a broader convergence of human and machine intelligence in high-performance medicine (Topol, 2019). Singhal and colleagues showed that LLMs encoding clinical knowledge can achieve performance approaching expert-level evaluation (Singhal et al., 2023). Thirunavukarasu and colleagues highlighted the potential of LLMs in medical diagnosis, patient communication and decision support, as well as their limitations regarding privacy, hallucination and external validity (Thirunavukarasu et al., 2023). Goh and colleagues demonstrated in a randomized trial the contribution of clinician–LLM collaboration to diagnostic reasoning (Goh et al., 2024).

Widespread use of commercial, cloud-based LLM services within healthcare systems raises significant obstacles under data protection regulations including Türkiye's Law No. 6698 on the Protection of Personal Data (KVKK), the European Union General Data Protection Regulation (GDPR) and the United States Health Insurance Portability and Accountability Act (HIPAA). The requirement that patient data not leave the institution motivates healthcare organizations to favor locally deployed, on-premise open-weight LLMs running on in-hospital servers. Fine-tuning open-weight models such as the Llama family on domain-specific medical corpora through low-rank adaptation (LoRA) addresses both privacy and clinical fit (Grattafiori et al., 2024; Hu et al., 2022; Touvron et al., 2023).

In the context of AUD, the capacity of LLMs to perform DSM-5 risk and severity classification from Turkish clinical notes has been evaluated in only a limited number of studies. Most existing studies are based on English text and on general-purpose commercial models accessed through the cloud; data on locally deployed models adapted to the Turkish medical corpus and to clinical practice in Türkiye remain scarce.

In this pilot study, we aimed to evaluate the diagnostic performance of a specific local LLM—fine-tuned on a Turkish medical corpus and deployed on an in-hospital server—in binary AUD classification and severity grading against a DSM-5 reference among adult patients presenting to the internal medicine outpatient clinic, the emergency department and inpatient services. As a secondary aim, the model's comparative performance against AUDIT-C and traditional laboratory markers (GGT, MCV, AST/ALT ratio) and the error patterns of misclassified cases were examined.

METHODS

Study Design

This was a single-center, retrospective, diagnostic-accuracy pilot study conducted at Ankara Etimesgut Şehit Sait Ertürk State Hospital, Ankara, Türkiye. The study protocol was structured in accordance with the Standards for Reporting Diagnostic Accuracy Studies (STARD) 2015 guideline (Bossuyt et al., 2015). The study was conducted in accordance with the ethical principles laid out in the 2013 revision of the Declaration of Helsinki. The flow of records from initial screening to final inclusion is summarized in the STARD participant flow diagram (Supplementary Figure S1).

Patient Population and Data Source

Forty-two adult patients evaluated between January and May 2024 in the internal medicine outpatient clinic (n = 13, 30.9%), the emergency department (n = 11, 26.2%) or inpatient services (n = 18, 42.9%), and who met the following inclusion criteria, were included: (i) age 18 years or older; (ii) availability of a structured history and physical examination record at initial evaluation; (iii) complete blood count, liver function tests (AST, ALT, GGT, total bilirubin, alkaline phosphatase), MCV, albumin and international normalized ratio (INR) results obtained within the preceding 60 days and documented in the EHR; and (iv) completion of a structured clinician-administered DSM-5 evaluation.

Exclusion criteria were (i) pregnancy; (ii) underlying terminal malignancy or enrollment in a palliative care program; (iii) inability to obtain a reliable history because of severe psychiatric comorbidity; (iv) prior hospitalization with a primary hepatobiliary disease diagnosis; and (v) more than 15% missing data in the history or laboratory records. Among the consecutive records screened during the study period, the first 42 patients meeting eligibility criteria and with a completed DSM-5 reference assessment were included. The target of 42 patients was set on a feasibility basis appropriate to a pilot design rather than by a formal power calculation, and it corresponds to all eligible patients accrued within the predefined five-month enrollment window. The structured DSM-5 reference assessment was applied to all consecutively screened patients regardless of clinical suspicion of alcohol use, rather than selectively to patients with suspected alcohol-related pathology, so that the reference standard was not conditioned on clinical suspicion. The resulting enrichment of the cohort and its implications for generalizability are addressed in the Limitations section.

The dataset was structured according to the MIMIC-IV core schema commonly used in multicenter clinical databases and was de-identified (Johnson et al., 2023). All records originated from Ankara Etimesgut Şehit Sait Ertürk State Hospital and were collected specifically for this study. The data have no relationship to and no overlap with the actual MIMIC-IV corpus, which is a separate United States intensive-care database; the reference to MIMIC-IV denotes only a schema design that organizes patient, admission and event information in a comparable

relational structure. Each patient was assigned a unique study identifier (study_id), a surrogate subject identifier (mimic_style_subject_id) and a surrogate admission identifier (mimic_style_hadm_id); links to true identifiers were severed via a one-way hash function. Patient province of origin was recorded for demographic generalization purposes.

Data Collectiv on and Variables

Data were extracted in de-identified form from the hospital's EHR system by one investigator and independently verified by a second investigator. Variables collected included (i) demographics (age, sex, province of origin, body mass index); (ii) care setting and service (outpatient/emergency/inpatient; internal medicine, gastroenterology, hepatology, emergency medicine, psychiatry consultation); (iii) chief complaint, triage acuity and vital signs (systolic and diastolic blood pressure, heart rate, respiratory rate, body temperature, peripheral oxygen saturation); (iv) comorbidities (smoking, diabetes, hypertension, chronic liver disease, depression/anxiety) and the Charlson Comorbidity Index; (v) presence of an alcohol history in the clinical note and AUDIT-C score; (vi) DSM-5 AUD reference, severity category and ICD-10 alcohol-related codes; (vii) laboratory parameters (AST, ALT, GGT, alkaline phosphatase, total bilirubin, albumin, INR, platelet count, MCV, hemoglobin, creatinine, sodium, glucose, C-reactive protein, AST/ALT ratio); (viii) clinical management variables (thiamine administration, benzodiazepine protocol, psychiatry consultation); and (ix) hospital length of stay, in-hospital mortality and discharge disposition.

Identifiers such as names, surnames, national identity numbers, telephone numbers and addresses within clinical notes were removed using a custom named-entity recognition module and subsequently checked manually. The clinical note summary submitted to the LLM for each patient consisted of a field averaging approximately 1,450 characters (notes_prompt_excerpt_tr field). This excerpt was assembled by a fixed extraction script from the same source sections for every patient, namely the structured history of present illness, the past medical and social history, and the physician assessment recorded at the initial evaluation. Free-text addenda, family-witness statements and notes entered after the index evaluation were not included in this field, so that the information available to the model was uniform across patients. A representative de-identified example of this input, together with the full model prompt template, is provided as Supplementary Material S3.

Local Large Language Model Architecture and Deployment

The local LLM evaluated in this study was obtained by fine-tuning the open-weight Llama-3-8B-Instruct base model (Grattafiori et al., 2024) on a Turkish medical corpus using the LoRA method (Hu et al., 2022). The fine-tuning dataset comprised (i) PubMed publications with Turkish abstracts, (ii) official clinical guidelines of the Turkish Ministry of Health, (iii) consensus reports of Turkish Medical Association specialty societies, (iv) the Turkish DSM-5-TR and ICD-10 F10 diagnostic criteria, and (v) Turkish validation studies of the AUDIT, AUDIT-C, CIWA-Ar and CAGE instruments. The corpus contained approximately 4.2 million Turkish medical sentences. LoRA adapters with rank = 16 and alpha = 32 were used, with a learning rate of 2×10^{-4}, a batch size of 8, and training over 3 epochs.

The model was deployed using 4-bit quantization (Q4_K_M) on an in-hospital GPU server equipped with an NVIDIA RTX A6000 (48 GB VRAM) running the vLLM inference engine. All inference operations were performed on the hospital intranet, without Internet access. This configuration was designed to ensure compliance with the KVKK and HIPAA.

A single inference was performed per patient; sampling temperature was set to 0.2 and top-p to 0.9. The model prompt contained the de-identified clinical note summary, vital signs, comorbidities and laboratory values in a structured JSON format. The model output was also structured as a JSON schema comprising (i) the binary AUD prediction (0/1), (ii)

the AUD probability score (0–1), (iii) the DSM-5 severity category (Mild/Moderate/Severe; provided only when probability ≥ 0.5), and (iv) a structured rationale category (explicit alcohol history; no supportive findings; missed alcohol history; over-weighting of laboratory pattern).

Reference Standard

The reference standard consisted of a structured clinician-administered DSM-5 evaluation conducted face-to-face during the outpatient visit or hospitalization. A diagnosis of AUD required the presence of at least two of the eleven DSM-5 criteria within the past 12 months; severity was classified as Mild (2–3 criteria), Moderate (4–5 criteria) or Severe (six or more criteria) (American Psychiatric Association, 2013). In addition, alcohol history documented in the clinical note and the AUDIT-C score were recorded for secondary comparison. The clinician establishing the reference diagnosis did not have access to the local LLM output; conversely, the local LLM had no access to the details of the DSM-5 assessment. We note, however, that several inputs provided to the model, namely the documented alcohol history, the AUDIT-C score and the hepatic laboratory values, are themselves correlates of, or contributors to, individual DSM-5 criteria. The model therefore operated on information that overlaps with the construct measured by the reference standard, as occurs in routine clinical practice. Complete independence between the index test inputs and the reference standard should not be assumed.

Statistical Analysis

Continuous variables were summarized as mean ± standard deviation when normally distributed and as median (interquartile range) otherwise. Categorical variables were reported as frequencies and percentages. Normality was assessed by the Shapiro–Wilk test. Group comparisons used the independent-samples *t* test, the Mann–Whitney *U* test, the chi-square test and Fisher's exact test.

Diagnostic performance indicators included sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), negative likelihood ratio (LR−) and accuracy; 95% Wilson confidence intervals were used for all point estimates (Wilson, 1927). Areas under the receiver operating characteristic (ROC) curve (AUC) were calculated for the LLM probability score and comparator markers, with 95% confidence intervals obtained from 2,000 bootstrap iterations. AUC comparisons were performed using the paired DeLong test (DeLong et al., 1988). When a comparator achieved complete separation between AUD-positive and AUD-negative patients, its bootstrap confidence interval collapsed to a single point (1.000 to 1.000) because every resample reproduced perfect separation. This behavior is the expected consequence of complete separation rather than an artifact of underdispersion. In paired DeLong comparisons against such markers, both the comparator variance and its covariance with the LLM probability score are zero. The test statistic therefore reduces to the standardized distance of the LLM AUC from 1.000 and is identical across all perfectly separating comparators. The standard error of the LLM AUC used in these comparisons was 0.066, and the corresponding variance–covariance terms are reported in Supplementary Table S1. Complete separation for each perfectly separating marker is displayed at the individual-patient level in Supplementary Figure S2. As a post-hoc characterization of precision, the achieved power for the primary AUC against the null value of 0.500 at the two-sided 5% level was greater than 0.90.

Agreement between the local LLM binary output and the DSM-5 reference was assessed with Cohen's κ, and agreement on severity classification with the quadratic-weighted κ. Interpretation followed Landis and Koch's framework (Landis & Koch, 1977). All statistical analyses were performed using Python 3.11 (scikit-learn 1.4, statsmodels 0.14, SciPy 1.13) and R 4.3 (pROC and irr packages). Two-sided $p < 0.05$ was considered the threshold of statistical significance.

Ethics Approval

The study was approved by the Republic of Türkiye Ministry of Health, Ankara Provincial Health Directorate Non-Interventional Ethics Committee (decision dated 24 October 2025, number 2025-10-3). Owing to the retrospective design, the committee waived the requirement for individual informed consent; all patient data were anonymized in accordance with the KVKK. The committee approval encompassed the de-identified reporting of individual misclassified cases. These case descriptions contain no direct identifiers, province of origin is reported only at the cohort level and is not linked to individual cases, and no combination of the reported attributes is sufficient for re-identification.

RESULTS

Patient Characteristics

As shown in **Table 1**, of the 42 patients included in the analysis, 21 (50.0%) were male and 21 (50.0%) were female, with a mean age of 53.0 ± 15.0 years. The mean body mass index was 27.2 ± 4.0 kg/m^2 and the median Charlson Comorbidity Index was 2.0 (1.0–3.0). Hypertension was present in 25 patients (59.5%), diabetes mellitus in 12 (28.6%), chronic liver disease in 11 (26.2%), and depression/anxiety in 23 (54.8%). Active smoking was reported by 12 patients (28.6%).

Distribution by care setting was: inpatient hospitalization 18 (42.9%), internal medicine outpatient clinic 13 (30.9%) and emergency department 11 (26.2%). The distribution by service was led by gastroenterology (n = 14, 33.3%) and internal medicine (n = 13, 30.9%), followed by emergency medicine (n = 9, 21.4%), hepatology (n = 4, 9.5%) and psychiatry consultation (n = 2, 4.8%). The dataset represented 12 provinces of patient origin, with Kayseri (n = 7), Ankara (n = 6) and Adana (n = 6) being the most represented. Care setting and service represent two independent classification axes applied to the same 42 patients. Care setting denotes the physical location of the encounter, namely outpatient clinic, emergency department or inpatient ward, whereas service denotes the responsible clinical

Table 1. Demographic, clinical and care-setting characteristics in the overall sample and stratified by DSM-5 reference (n = 42)

Variable	Overall (n = 42)	DSM-5 AUD (−) (n = 22)	DSM-5 AUD (+) (n = 20)	p
Age, mean ± *SD*, years	53.0 ± 15.0	52.3 ± 16.1	53.8 ± 14.1	0.762
Male sex, *n* (%)	21 (50.0)	9 (40.9)	12 (60.0)	0.215
Body mass index, kg/m²	27.2 ± 4.0	27.2 ± 3.9	27.1 ± 4.2	0.930
Charlson Comorbidity Index	2.0 (1.0–3.0)	1.5 (1.0–2.0)	2.0 (1.0–3.0)	0.282
Hypertension, *n* (%)	25 (59.5)	13 (59.1)	12 (60.0)	0.953
Diabetes mellitus, *n* (%)	12 (28.6)	8 (36.4)	4 (20.0)	0.241
Chronic liver disease, *n* (%)	11 (26.2)	0 (0.0)	11 (55.0)	<0.001
Depression/anxiety, *n* (%)	23 (54.8)	7 (31.8)	16 (80.0)	0.002
Active smoking, *n* (%)	12 (28.6)	5 (22.7)	7 (35.0)	0.378
Alcohol history in note, *n* (%)	20 (47.6)	0 (0.0)	20 (100.0)	<0.001
AUDIT-C score, median (IQR)	3.0 (1.0–9.0)	1.0 (0.3–2.0)	9.0 (7.0–11.3)	<0.001
Outpatient clinic, *n* (%)	13 (30.9)	7 (31.8)	6 (30.0)	1.000
Emergency department, *n* (%)	11 (26.2)	6 (27.3)	5 (25.0)	1.000
Inpatient hospitalization, *n* (%)	18 (42.9)	9 (40.9)	9 (45.0)	0.789

Note. *SD = standard deviation; IQR = interquartile range; AUD = alcohol use disorder; AUDIT-C = Alcohol Use Disorders Identification Test – Consumption. Comparisons between AUD (−) and AUD (+) groups used the independent-samples t test, the Mann–Whitney U test and Fisher's exact test.*

specialty; gastroenterology and hepatology patients are therefore distributed across the outpatient and inpatient settings rather than forming a separate location category.

DSM-5 AUD was confirmed in 20 patients (47.6%); the severity distribution was Mild 5 (25.0%), Moderate 10 (50.0%) and Severe 5 (25.0%). Among the 20 AUD-positive patients, the primary alcohol-related ICD-10 code recorded per patient was K70.10 (alcoholic hepatitis, n = 6), E52 (Wernicke encephalopathy, n = 5), F10.10 (uncomplicated alcohol abuse, n = 4), F10.239 (alcohol withdrawal, n = 3) and F10.20 (alcohol dependence, n = 2). Each patient was assigned a single primary alcohol-related code for this tabulation; secondary F10.x codes documented for some patients are not represented here. Within the AUD-positive group, 17 patients (85.0%) received thiamine administration, 8 (40.0%) were started on a benzodiazepine withdrawal protocol, and 10 (50.0%) had a psychiatry consultation.

Clinical and Laboratory Markers

In the overall population, the median GGT was 118 (62–290) U/L, MCV 94.8 (88.6–101.9) fL, and AST/ALT ratio 1.38 (1.05–2.15).

As shown in **Table 2**, all hepatic markers were significantly elevated in the DSM-5 AUD-positive group: GGT 295.5 (196.5–396.0) versus 83.0 (62.2–107.5) U/L (p < 0.001), AST 176.5 (136.5–282.2) versus 41.5 (30.5–49.8) U/L (p < 0.001), ALT 112.0 (82.8–152.2) versus 33.5 (21.5–44.2) U/L (p < 0.001), MCV 101.9 (97.9–108.5) versus 90.8 (85.1–93.3) fL (p < 0.001) and total bilirubin 1.80 (1.30–2.80) versus 0.70 (0.60–0.90) mg/dL (p < 0.001). Albumin was significantly lower in the AUD-positive group: 2.90 (2.70–3.40) versus 4.20 (3.80–4.50) g/dL (p < 0.001). The AUDIT-C score was 9.0 (7.0–11.3) in the AUD-positive group and 1.0 (0.3–2.0) in the AUD-negative group (p < 0.001).

Binary Diagnostic Performance of the Local LLM

Across the 42-patient series, the local LLM produced 17 true positive (TP), 20 true negative (TN), 2 false positive (FP) and 3 false negative (FN) classifications. Binary classification performance was: sensitivity 85.0% (95% CI, 64.0–94.8), specificity 90.9% (95% CI, 72.2–97.5), PPV 89.5% (95% CI, 68.6–97.1), NPV 87.0% (95% CI, 67.9–95.5), overall accuracy 88.1%, LR+ 9.35 and LR− 0.17 (**Table 3**).

Table 2. Laboratory parameters by DSM-5 reference (n = 42)

Parameter	Overall	DSM-5 AUD (−) (n = 22)	DSM-5 AUD (+) (n = 20)	p
AST, U/L	60.0 (39.0–168.5)	41.5 (30.5–49.8)	176.5 (136.5–282.2)	<0.001
ALT, U/L	57.5 (33.0–110.5)	33.5 (21.5–44.2)	112.0 (82.8–152.2)	<0.001
GGT, U/L	118.0 (62.0–290.0)	83.0 (62.2–107.5)	295.5 (196.5–396.0)	<0.001
ALP, U/L	128.5 (84.5–185.0)	97.0 (76.0–143.0)	170.5 (130.5–211.5)	0.003
Total bilirubin, mg/dL	0.99 (0.66–1.83)	0.70 (0.60–0.90)	1.80 (1.30–2.80)	<0.001
Albumin, g/dL	3.54 (3.05–4.20)	4.20 (3.80–4.50)	2.90 (2.70–3.40)	<0.001
INR	1.09 (1.00–1.20)	1.00 (1.00–1.10)	1.20 (1.10–1.30)	<0.001
Platelets, ×10³/μL	222.0 (180.0–270.5)	247.5 (212.2–297.5)	197.5 (151.8–240.8)	0.006
MCV, fL	94.8 (88.6–101.9)	90.8 (85.1–93.3)	101.9 (97.9–108.5)	<0.001
AST/ALT ratio	1.38 (1.05–2.15)	1.10 (0.90–1.70)	1.80 (1.20–2.20)	0.053
CRP, mg/L	22.0 (12.7–47.0)	12.8 (7.4–25.0)	47.5 (32.0–66.5)	<0.001

Note. *Values are presented as median (interquartile range). ALP = alkaline phosphatase; ALT = alanine aminotransferase; AST = aspartate aminotransferase; CRP = C-reactive protein; GGT = gamma-glutamyl transferase; INR = international normalized ratio; MCV = mean corpuscular volume. Group comparisons used the Mann–Whitney U test.*

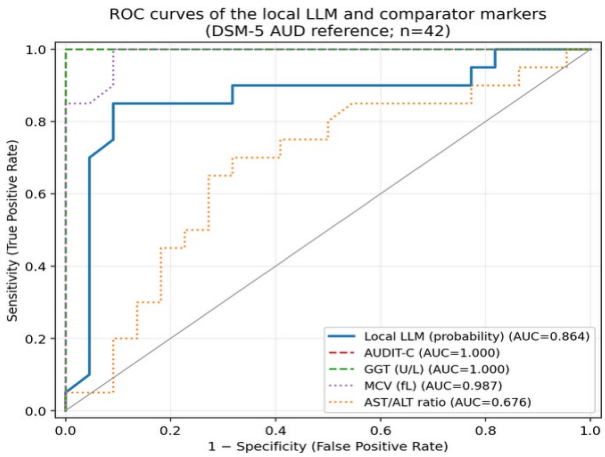

Figure 1. Receiver operating characteristic (ROC) curves of the local LLM and comparator markers against the DSM-5 AUD reference (n = 42). The local LLM probability score yielded AUC = 0.864 (95% CI, 0.720–0.977); AUDIT-C and GGT achieved perfect separation (AUC = 1.000) in this enriched pilot cohort; these values are cohort-specific and are not general estimates of marker performance. MCV (AUC = 0.987) and AST/ALT ratio (AUC = 0.676) are shown as comparators. The diagonal grey line represents a non-discriminating reference (AUC = 0.500).

Table 3. Binary diagnostic performance of the local LLM against the DSM-5 AUD reference (n = 42)

Indicator	Value	95% CI (Wilson)
True positive (TP), *n*	17	—
False positive (FP), *n*	2	—
True negative (TN), *n*	20	—
False negative (FN), *n*	3	—
Sensitivity, %	85.0	64.0–94.8
Specificity, %	90.9	72.2–97.5
Positive predictive value (PPV), %	89.5	68.6–97.1
Negative predictive value (NPV), %	87.0	67.9–95.5
Overall accuracy, %	88.1	75.0–94.8
Positive likelihood ratio (LR+)	9.35	—
Negative likelihood ratio (LR−)	0.17	—
Cohen's κ (binary)	0.761	0.553–0.969
AUC (LLM probability score)	0.864	0.720–0.977

Note. *AUC = area under the curve; CI = confidence interval; LLM = large language model. Confidence intervals were computed with the Wilson method for point proportions and with 2,000 bootstrap iterations for the AUC. All indices describe the present enriched pilot cohort.*

On ROC analysis of the LLM probability score, the AUC was 0.864 (95% CI, 0.720–0.977; **Figure 1**), and the corresponding classification matrix is shown in **Figure 2A**. Cohen's κ between the local LLM and the DSM-5 reference was 0.761 (95% CI, 0.553–0.969), corresponding to substantial agreement on the Landis and Koch scale (Landis & Koch, 1977).

Severity Classification Performance

Of the 19 patients flagged as AUD-positive by the local LLM, 17 had a true AUD diagnosis (true positives) and were assigned a DSM-5 severity category by the model. In all 17 of these cases, the LLM severity category matched the DSM-5 reference exactly (Mild 5/5, Moderate 10/10, Severe 2/2); the remaining 3 severe AUD cases were missed by the model and therefore had no severity prediction. The quadratic-weighted Cohen's κ for severity agreement within true-positive cases was 1.000 (**Figure 2B**). This value was computed only among correctly detected cases, is therefore conditional on correct binary classification, and rests on a small subgroup (n = 17). Because the three missed Severe cases are

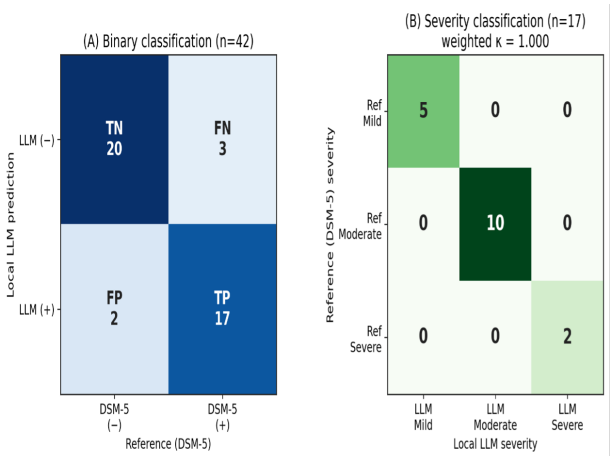

Figure 2. Classification matrices for the local LLM. (A) Binary classification: 17 true positives, 20 true negatives, 2 false positives and 3 false negatives (accuracy 88.1%; Cohen's κ = 0.761). (B) DSM-5 severity classification: in all 17 true-positive cases the LLM severity category matched the reference exactly (quadratic-weighted κ = 1.000). Color intensity is proportional to case counts.

absent from this subgroup, the severity distribution analyzed here (Mild 5, Moderate 10, Severe 2) does not reproduce the full reference distribution (Mild 5, Moderate 10, Severe 5). The value should accordingly be read as a within-cohort observation rather than as an estimate of severity-grading accuracy.

Comparison With Comparator Markers

ROC analyses of comparator markers alone are summarized in **Table 4**. In this enriched pilot cohort, AUDIT-C (AUC = 1.000; 95% CI, 1.000–1.000), GGT (AUC = 1.000; 95% CI, 1.000–1.000) and AST (AUC = 1.000) achieved perfect separation; at the AUDIT-C ≥ 4 threshold, all 20 AUD-positive patients and all 22 AUD-negative patients were correctly classified (sensitivity and specificity both 100%). MCV (AUC = 0.987), albumin (AUC = 0.953) and total bilirubin (AUC = 0.948) demonstrated very high discrimination. By contrast, the AST/ALT ratio showed only moderate discrimination (AUC = 0.676). These perfect and near-perfect values describe discrimination within the present enriched cohort and are not offered as general performance estimates for these markers.

Within this cohort, paired DeLong tests showed that the local LLM probability score (AUC 0.864) had a lower AUC than AUDIT-C, GGT and AST (ΔAUC = −0.136; z = −2.07; p = 0.038 for each comparison). Because each of these comparators achieved complete separation, the comparator variance and its covariance with the LLM probability score were both zero; the DeLong statistic therefore depended only on the standard error of the LLM AUC and was identical across the three comparisons. Differences between the LLM and MCV or ALT were of borderline significance (p = 0.051 and p = 0.078, respectively). No significant difference was detected against the other comparators (albumin, INR, bilirubin, platelets, AST/ALT ratio).

Qualitative Analysis of Misclassification Patterns

Each of the five misclassified cases was examined according to the model's structured rationale category. The three false negatives—a 74-year-old man, a 32-year-old man and a 55-year-old man—were patients clinically classified as Severe AUD by DSM-5, with an explicit alcohol history in the clinical note, AUDIT-C scores ranging from 7 to 12 and GGT values between 352 and 599 U/L. In all three the LLM rationale category was

Table 4. AUC values for the local LLM and comparator markers, with paired DeLong test results (n = 42)

Comparator	AUC	95% CI (bootstrap)	ΔAUC (LLM − comparator)	p (DeLong)
Local LLM (probability)	0.864	0.720–0.977	—	—
AUDIT-C score	1.000	1.000–1.000	−0.136	0.038
GGT, U/L	1.000	1.000–1.000	−0.136	0.038
AST, U/L	1.000	1.000–1.000	−0.136	0.038
MCV, fL	0.987	0.957–1.000	−0.123	0.051
ALT, U/L	0.984	0.945–1.000	−0.120	0.078
Albumin (inverted), g/dL	0.953	0.870–1.000	−0.090	0.234
Total bilirubin, mg/dL	0.948	0.865–1.000	−0.084	0.274
INR	0.909	0.793–0.989	−0.045	0.554
Platelets (inverted)	0.751	0.591–0.880	+0.112	0.292
AST/ALT ratio	0.676	0.494–0.844	+0.188	0.078

Note. *AUC = area under the curve; CI = confidence interval; LLM = large language model. Because higher values of albumin and platelets reduce the probability of AUD, scores were inverted (negated) before AUC calculation. AUC values of 1.000 denote complete separation within this enriched pilot cohort and are not general estimates of marker performance.*

labeled "missed alcohol history"; alcohol use was reported primarily in family-witness accounts or in subsequent notes and was therefore intermittently reflected in the structured portion of the record. The alcohol-history variable summarized in Table 1 records whether an alcohol history was documented anywhere in the complete medical record, whereas the text supplied to the model was limited to the structured initial-evaluation excerpt described in the Methods. In these three cases an alcohol history was present in the record as a whole, and was therefore coded as present in Table 1, but it did not appear in the structured excerpt available to the model, which accounts for the false-negative classifications. The two false positives—a 35-year-old woman and a 59-year-old man—were patients without a documented alcohol history in the clinical note, AUDIT-C scores of 2 and 1, and GGT values of 106 and 88 U/L; in both cases the LLM rationale was labeled "over-weighting of laboratory pattern."

Overall accuracy by care setting was 11/11 (100%) in the emergency department, 12/13 (92.3%) in the internal medicine outpatient clinic and 14/18 (77.8%) in the inpatient group; the accumulation of misclassifications in the inpatient group suggests that the model encountered greater difficulty in cases with advanced hepatic decompensation in whom acute alcohol use could not be unambiguously established.

DISCUSSION

In this pilot study, a specific local LLM fine-tuned on a Turkish medical corpus and deployed on an in-hospital server achieved 88.1% overall accuracy, 85.0% sensitivity, 90.9% specificity and an AUC of 0.864 for AUD detection against a DSM-5 reference in internal medicine practice, and demonstrated exact DSM-5 severity classification in every case it flagged as AUD-positive. Substantial agreement with the clinician diagnosis was observed (κ = 0.761). In this small, enriched cohort AUDIT-C and GGT achieved perfect separation and the local LLM showed a lower AUC than these two markers; this ranking is a characteristic of the present cohort and cannot be transferred to unselected populations.

Our findings are broadly consistent with prior studies demonstrating the potential of LLM-based clinical decision support, but emphasize two important nuances. First, the existence of well-established, low-cost screening instruments (AUDIT, AUDIT-C) with high accuracy makes it inherently difficult for LLMs to establish absolute superiority in this task. Singhal and colleagues had previously emphasized that the ability of LLMs to approach expert-level performance is sensitive to task type and dataset enrichment (Singhal et al., 2023). Second, the ceiling effect observed in our study reflects a cohort in which AUD can largely be predicted from enzyme patterns, macrocytosis and the clinical history, equalizing the discrimination of each method.

The performance of traditional biomarkers in AUD screening has typically been reported as moderate; Conigrave and colleagues described single-marker sensitivities of 30–70% and specificities of 60–90% for GGT and MCV (Conigrave et al., 2003). Niemelä's broad review likewise emphasized that these markers are insufficient as stand-alone tools in real-world samples (Niemelä, 2016). The perfect separation observed in our cohort likely reflects the combined effect of a high AUD prevalence (47.6%), the presence of an AUD subgroup with substantial chronic liver disease burden, and a relatively healthy comparison group. This pattern indicates that, in a test set composed of cases in which the AUD diagnosis is already clinically conspicuous, opportunities for the LLM to display incremental superiority are reduced. We regard this enrichment, together with the spectrum of the cohort, as the primary explanation for the perfect biomarker discrimination observed here, rather than as a secondary observation. A within-sample AUC of 1.000 for single biomarkers such as GGT, AST or MCV is not expected in unselected internal medicine populations, in which these markers typically show only moderate accuracy. The present result should therefore be read as a property of an enriched and clinically conspicuous cohort and not as evidence that these markers outperform the model in general practice. Accordingly, the statement that

the model showed a lower AUC than AUDIT-C and GGT describes this specific cohort and should not be generalized.

Two distinct clinical value axes were nevertheless observed for the local LLM. First, exact DSM-5 severity classification was achieved in all true positives—an output that AUDIT-C cannot structurally generate, bridging screening and triage. Second, the structured rationale categories produced by the model provide an interpretable feedback mechanism for the clinician workflow. Analysis of the misclassification patterns revealed two principal failure modes of the model: (i) missing alcohol histories that appear only in free-text notes or family-witness accounts and not in structured fields (3/3 FN) and (ii) over-weighting of laboratory patterns in cases without an explicit alcohol history (2/2 FP). Both patterns could be addressed in clinical context with additional safeguards (e.g., a dedicated structured alcohol-history prompt or mandatory history confirmation when laboratory evidence is the principal driver of risk).

The choice of local (on-premise) deployment offers a critical advantage for clinical translation. Use of cloud-based commercial LLM services in healthcare is significantly constrained by KVKK and international regulations (HIPAA, GDPR). The LoRA method introduced by Hu and colleagues (Hu et al., 2022) enables domain-specific fine-tuning at relatively low hardware cost without retraining all model parameters, permitting deployment on a single GPU server as in our study. A further favorable finding for practical applicability is the high negative likelihood ratio (0.17): this value reduces the pre-test probability of AUD in a patient flagged as negative by approximately six-fold.

A further point concerns the scope of the model evaluated here. The index test was a single 8-billion-parameter open-weight model, fine-tuned with LoRA on a Turkish medical corpus and served entirely inside the hospital, and the results describe that specific configuration. They are not estimates of what general-purpose commercial large language models would achieve on the same task. Commercial systems are considerably larger, are updated on schedules the deploying institution does not control, and are reached through external application programming interfaces, which is the arrangement that KVKK, GDPR and HIPAA constrain in routine care. A compact locally fine-tuned model makes the opposite trade: less general reasoning capacity, but domain and language fit, auditability, version stability and data residency. The accuracy reported here should therefore be attributed to this locally fine-tuned Turkish model rather than to large language models in general, and head-to-head comparison with general-purpose commercial models remains an open question for future work.

Subgroup analyses indicated that the model achieved its best performance in the emergency department (100% accuracy) and outpatient clinic (92.3% accuracy) settings, with relative difficulty in the inpatient group (77.8% accuracy) because of cases of advanced hepatic decompensation in whom acute alcohol use was unclear. This pattern highlights the need for setting-specific calibration when integrating clinical decision support systems.

Strengths of our study include adherence to the STARD 2015 reporting guideline, use of a DSM-5 reference standard, a de-identified data structure modeled on the MIMIC-IV schema, double-blinding between index test and reference standard, direct comparison with traditional biomarkers and AUDIT-C, robust statistical reporting with paired DeLong tests and bootstrap confidence intervals, an on-premise privacy-compliant architecture, and interpretability afforded by structured error categorization.

Limitations of the Study

Several limitations should be acknowledged. First, the sample size is limited to 42 patients and the study is pilot in nature; confidence intervals are relatively wide, which limits the power for multiple-comparison analyses. Second, the AUD prevalence

of 47.6% far exceeds the prevalence encountered in routine internal medicine practice (typically 5–15%). Because PPV and NPV depend directly on prevalence, both would change substantially in a routine population: at a prevalence of 10%, holding the observed sensitivity and specificity constant, the PPV would fall from 89.5% to approximately 51% while the NPV would rise to approximately 98%. The ROC characteristics reported here are likewise cohort-dependent, because discrimination was estimated over a case mix in which clearly affected and clearly unaffected patients predominate. Every diagnostic index in this report should therefore be read as descriptive of the present enriched cohort rather than as an expected value for routine internal medicine populations. Third, the single-center retrospective design limits external validity. Fourth, model outputs were obtained from a single inference and test–retest reliability was not evaluated; because the sampling temperature was non-zero (0.2), each output is a single realization of a stochastic process, and the paired comparison of this single realization against deterministic laboratory values should be interpreted with that stochasticity in mind. Fifth, the impact of the local LLM on long-term follow-up, treatment guidance and patient outcomes was beyond the scope of this study. Finally, risks arising from hallucination tendencies and out-of-scope clinical information generation were not analyzed in detail. The structured DSM-5 reference assessment was applied to all consecutively screened patients regardless of clinical suspicion, so the study is not subject to selective verification of the reference standard. The eligibility requirements and the case mix of the source services, which were weighted toward gastroenterology and hepatology, nonetheless produced an enriched cohort in which clearly affected and clearly unaffected patients predominate over diagnostically ambiguous cases. This enrichment, rather than selective application of the reference standard, is the most plausible reason that several single biomarkers reached an AUC of 1.000, a result that should not be expected in unselected populations.

Within these limitations, future studies are recommended to focus on (i) multicenter prospective validation, (ii) consecutive sampling that reflects real-world prevalence, (iii) testing the performance of integrated algorithms in which the LLM is combined with AUDIT-C, GGT and clinician evaluation, (iv) measurement of the effect on screening frequency, decisions to administer thiamine and benzodiazepines, and referral rates to psychiatry consultation when the model is integrated into the clinical workflow, and (v) extended validation of the model for other substance use disorders (opioid, benzodiazepine, cannabis).

CONCLUSION

A specific local LLM fine-tuned on a Turkish medical corpus and deployed on an in-hospital server demonstrated, in this 42-patient pilot study, clinically acceptable diagnostic performance (accuracy 88.1%, AUC 0.864) for the detection of AUD against DSM-5 criteria in internal medicine practice, together with exact agreement in severity classification. AUDIT-C and GGT achieved perfect separation in this small, enriched cohort, a result specific to the present case mix rather than a general property of these markers; accordingly, the principal clinical value of the model lies in workflows where AUDIT-C is not routinely administered and where automatic risk flagging, severity grading and interpretable rationale generation from free-text clinical notes are required. Privacy-preserving, locally deployable models thus represent a promising decision support tool for broadening AUD screening across internal medicine practice. These findings apply to this specific locally fine-tuned Turkish model and to this enriched pilot cohort; multicenter prospective validation in unselected populations is essential before they can be translated into clinical practice.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

Financial Support

The Authors report no financial support regarding content of this article.

Ethical Declaration

Ethical permission was obtained from the Republic of Türkiye Ministry of Health, Ankara Provincial Health Directorate Non-Interventional Ethics Committee for this study with date 24 October 2025 and number 2025-10-3, and Helsinki Declaration rules were followed to conduct this study. Owing to the retrospective design, the requirement for individual informed consent was waived by the Ethics Committee; all patient data were anonymized in accordance with Law No. 6698 on the Protection of Personal Data (KVKK).

Author Contributions

Concept: İ.B., M.T.Ü.; Design: İ.B., M.T.Ü.; Supervising: M.T.Ü.; Financing and equipment: İ.B., M.T.Ü.; Data collection and entry: İ.B., M.T.Ü.; Analysis and interpretation: İ.B., M.T.Ü.; Literature search: İ.B., M.T.Ü.; Writing: M.T.Ü.; Critical review: İ.B., M.T.Ü. **else:** Development and deployment of the local large language model — M.T.Ü.

Thanks

The authors thank the Information Technology Unit of Ankara Etimesgut Şehit Sait Ertürk State Hospital for support with data extraction, and the Department of Medical Biochemistry, Hacettepe University Faculty of Medicine, for statistical analysis consultation

Corresponding Author

Mete Tuğcan Üçdal

Specialist in Internal Medicine. Republic of Türkiye Ministry of Health, Ankara Etimesgut Şehit Sait Ertürk State Hospital, Department of Internal Medicine, Ankara, Türkiye.

Email: mtucdal@gmail.com

ORCID iD: 0009-0002-1763-5857

Journal of Dependence, 2026; 27(3):130-141

JOURNAL OF DEPENDENCE

Research Article

Smartphone addiction and partner surveillance: The indirect role of cognitive jealousy among Turkish young adults

M. Selenga Gürmen

DOI: 10.51982/bagimli.620

Abstract

Objective: This study examined whether cognitive jealousy functions as an indirect pathway linking smartphone addiction to partner surveillance among Turkish young adults in romantic relationships. Drawing on the behavioral addiction framework and uncertainty reduction perspective, the study focused on how smartphone addiction may be associated with relationship-specific suspicious and ruminative cognitions and digitally enabled monitoring behaviors.

Methods: The sample consisted of 174 Turkish young adults (18 to 30 years) who were currently involved in a romantic relationship. Participants completed self-report measures of smartphone addiction, interpersonal electronic surveillance, and cognitive jealousy. Data were analyzed using Pearson correlations and an indirect effect analysis. The indirect effect was tested using 5,000 bootstrap resamples and 95% confidence intervals.

Results: Smartphone addiction was positively associated with partner surveillance ($r = .34$, $p < .001$) and cognitive jealousy ($r = .40$, $p < .001$). Cognitive jealousy was also positively associated with partner surveillance ($r = .38$, $p < .001$). The indirect effect of smartphone addiction on partner surveillance through cognitive jealousy was significant, $B = 0.126$, $BootSE = 0.053$, 95% CI [0.034, 0.240]. The direct effect remained significant after cognitive jealousy was included in the model.

Conclusion: Findings suggest that cognitive jealousy represents one significant pathway through which smartphone addiction is associated with partner surveillance. Smartphone addiction may be linked to digitally enabled monitoring behaviors not only through increased digital engagement, but also through suspicion, rumination, and perceived relational uncertainty.

Keywords: Smartphone addiction; Behavioral addiction; Jealousy; Romantic relationships; Interpersonal electronic surveillance; Young adults

M. Selenga Gürmen
Özyeğin University, Department of Psychology, Istanbul, Türkiye
Email: selenga.gurmen@ozyegin.edu.tr
ORCID iD: 0000-0003-0109-6051

Received: 2026-05-22
Accepted: 2026-08-05

e-ISSN: 3108-7973

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INTRODUCTION

Smartphones have become deeply embedded in everyday life, shaping not only individual routines but also the organization of romantic relationships. For many couples, smartphones facilitate connection, availability, and relationship maintenance through instant messaging, social networking platforms, and location-based communication. At the same time, these same affordances may create new opportunities for intrusive monitoring (Tokunaga, 2011). The constant accessibility of digital information can blur the boundary between relational transparency and partner surveillance, particularly when checking, tracking, or monitoring a partner's online presence becomes normalized as an expression of care, curiosity, or relational investment.

Interpersonal electronic surveillance (IES) refers to the use of digital technologies to monitor a romantic partner's behaviors, communications, or social interactions (Tokunaga, 2011). Such behaviors may include repeatedly checking a partner's online activity, monitoring social media interactions, seeking indirect information through digital platforms, or using digital tools to track a partner's whereabouts. Although some forms of digital checking may be perceived as relatively normative within contemporary romantic relationships, frequent or intrusive surveillance may carry important relational costs (Tokunaga, 2011; Imperato et al., 2023). Existing literature has linked technology-facilitated monitoring with relationship distress, anxiety, reduced autonomy, and broader patterns of control and digital abuse (Harris & Woodlock, 2019; Messing et al., 2020; Southworth et al., 2007). Further, recent dyadic research suggests that electronic surveillance may become a relational dynamic in which both partners engage in IES and relational trust may be undermined (Litt & Rodriguez, 2022). Thus, understanding the psychological conditions under which digital access becomes partner-directed surveillance is increasingly important for both addiction research and relationship science.

One factor that may contribute to such behaviors is smartphone addiction. Although the term smartphone addiction is widely used in the behavioral addiction literature, it is important to note that smartphone addiction is not currently recognized as a formal diagnostic category in major classification systems (American Psychiatric Association, 2022). Within the behavioral addiction framework, smartphone addiction is not defined simply by time spent using a device, but rather by a pattern of compulsive engagement characterized by salience, mood modification, tolerance, withdrawal, conflict, and relapse (Griffiths, 2005; Demetrovics et al., 2026). Therefore, smartphone addiction is conceptually distinct from high-frequency smartphone use alone; the emphasis is on dysregulated use and functional or relational impairment.

Individuals with higher levels of smartphone addiction may experience stronger urges to check, greater difficulty disengaging from digital environments, and heightened reliance on smartphones for emotional regulation (Csibi et al., 2021; Kuss et al., 2018; Orsolini et al., 2025). In romantic relationships, these features may have interpersonal consequences. Such dysregulated smartphone use may increase not only access to digital relational information, but also the tendency to attend to, revisit, and cognitively monitor relationship-relevant cues such as delayed responses, visible online activity, or ambiguous social media interactions.

A key psychological process that may help explain the link between smartphone addiction and partner surveillance is cognitive jealousy. Romantic jealousy is commonly conceptualized as a multidimensional construct that includes cognitive, emotional, and behavioral components (Pfeiffer & Wong, 1989). Cognitive jealousy refers specifically to suspicious, intrusive, and ruminative thoughts regarding a partner's fidelity, interest in alternatives, or hidden interactions. In digitally mediated romantic contexts, ambiguous online cues may become especially salient when interpreted through jealous cognitions (Gubler et al., 2023). Smartphone addiction may therefore not simply increase digital exposure; it

may also intensify the cognitive monitoring of the relationship (Borrajo et al., 2015; Quiroz et al., 2024). Cognitive jealousy may function as one interpretive mechanism through which ambiguous digital cues are transformed into suspicion and perceived relational threat.

From an uncertainty reduction perspective, individuals who experience relational ambiguity may engage in information-seeking behaviors to reduce distress or restore a sense of predictability (Berger & Calabrese, 1975). In contemporary romantic relationships, smartphones provide immediate and low-effort access to information about a partner's activities, communications, and social connections. As a result, partner surveillance may appear to serve a regulatory or uncertainty-reduction function, offering a seemingly direct way to seek reassurance or verify suspicions. However, such monitoring may ultimately expose individuals to additional ambiguous information, thereby reinforcing suspicion, jealous rumination, and relational insecurity over time. This interpretation is consistent with prior research linking problematic technology use, jealous cognitions, and surveillance behaviors in romantic relationships (Aloia, 2023; Elphinston & Noller, 2011; Elphinston et al., 2013; Quiroz et al., 2024).

Although existing research provides support for several parts of this pathway, cognitive jealousy as a potential explanatory mechanism linking smartphone addiction with partner surveillance remains underexamined. Prior studies have shown that social media intrusion is associated with romantic jealousy and relationship difficulties (Elphinston & Noller, 2011; Elphinston et al., 2013; Gubler et al., 2023), and that jealousy is linked to cyber dating abuse, intrusive monitoring, and interpersonal electronic surveillance (Aloia, 2023; Borrajo et al., 2015; De Cristofaro et al., 2023). However, much of this work has focused on social media use, attachment insecurity, or broader technology-related behaviors rather than addiction-like smartphone use patterns, compulsivity, salience, and conflict. Therefore, the integrated pathway from smartphone addiction to cognitive jealousy and, in turn, to partner surveillance requires direct empirical attention.

Examining this pathway in a Turkish sample is also important. Much of the literature on digital surveillance, jealousy, and technology-related relationship difficulties has been conducted in Western, Educated, Industrialized, Rich, and Democratic (WEIRD) populations. Turkey provides a relevant context for examining partner surveillance because rapid digital adoption coexists with culturally shaped expectations regarding closeness, responsiveness, privacy, and relational accountability. Previous research has documented problematic smartphone and social media use in Turkish samples (Altın & Üzgü, 2024; Altundağ et al., 2019; Simsek et al., 2019), suggesting that digital behaviors are deeply embedded in young adults' everyday relational lives. In this context, monitoring a partner's digital activity may be interpreted in multiple ways—as care, transparency, mistrust, or control—making it especially important to examine the psychological processes that underlie surveillance behaviors. Investigating these dynamics in a Turkish sample may therefore help clarify whether models developed largely in Western samples are relevant in contexts where digital availability, privacy, and relational closeness may be negotiated differently.

The present study addresses these gaps by examining whether cognitive jealousy represents a significant indirect pathway linking smartphone addiction and interpersonal electronic surveillance among Turkish young adults in romantic relationships. Drawing on the behavioral addiction framework and uncertainty reduction perspective, it is proposed that smartphone addiction may increase sensitivity to and engagement with digital relational cues, while cognitive jealousy may represent one pathway through which these cues are interpreted as suspicious or threatening. In turn, partner surveillance may emerge as an attempt to reduce uncertainty or regulate relational insecurity. Based on this theoretical model, the following hypotheses were tested:

H1: Smartphone addiction will be positively associated with partner surveillance.

H2: Smartphone addiction will be positively associated with cognitive jealousy.

H3: Cognitive jealousy will be positively associated with partner surveillance.

H4: Smartphone addiction will be indirectly associated with partner surveillance through cognitive jealousy.

METHODS

Participants

Participants were 174 Turkish young adults who were currently involved in a romantic relationship. The original sample consisted of 180 participants; however, six multivariate outliers were excluded during data screening procedures, resulting in a final analytic sample of 174 participants. Participants ranged in age from 18 to 30 years ($M = 21.61$, $SD = 1.88$). The majority of the sample identified as female (71.8%), and most participants reported being in an unmarried romantic relationship (95.4%). Smaller proportions reported being engaged (3.4%) or married (1.1%). The sample primarily consisted of undergraduate students (89.7%).

Eligibility criteria required participants to be between 18 and 30 years old, fluent in Turkish, and currently involved in a romantic relationship. The upper age limit of 30 was selected because the study focused on young adults, a developmental period in which smartphone use, digital communication, and romantic relationship formation are particularly salient (Arnett, 2007; Munshi et al., 2024). Restricting the sample to this age range also helped reduce developmental heterogeneity in relationship experience and digital media use.

Participants were not recruited from a clinical population. Psychiatric diagnoses were not assessed, and no clinical interviews were conducted. Therefore, the findings should be interpreted as reflecting a non-clinical young adult sample rather than a clinically assessed sample.

Measures

Demographic Information Form

Participants completed a brief demographic form assessing age, sex, relationship status, and educational level. Eligibility criteria required participants to be between 18 and 30 years old and currently involved in a romantic relationship.

Smartphone Addiction Scale (SAS)

Smartphone addiction was assessed using the Smartphone Addiction Scale (SAS; Kwon et al., 2013). The SAS is a 33-item self-report measure designed to assess addictive patterns of smartphone use, including daily-life disturbance, withdrawal, cyberspace-oriented relationship, overuse, tolerance, and positive anticipation. Items are rated on a 6-point Likert-type scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*), with higher scores indicating higher levels of smartphone addiction. The Turkish adaptation of the scale developed by Demirci et al. (2014) was used in the present study. Internal consistency in the current sample was excellent ($\alpha = .94$).

Interpersonal Electronic Surveillance Scale for Social Network Sites (IESS)

Partner surveillance behaviors were assessed using the Interpersonal Electronic Surveillance Scale for Social Network Sites (IESS; Tokunaga, 2011). The IESS is a 13-item self-report measure designed to assess the extent to which individuals monitor a romantic partner's online activities and social interactions through social networking sites and other digital platforms. Items are rated on a 7-point Likert-type scale ranging from 1 (*never*) to 7 (*always*), with higher scores indicating greater engagement in partner-directed electronic surveillance. For the present study, the scale was translated into Turkish using a forward–back translation procedure. Internal consistency was excellent in the current sample (Cronbach's $\alpha = .94$; McDonald's $\omega = .94$).

To examine the construct validity of the Turkish version of the IESS, a confirmatory factor analysis

(CFA) was conducted to test the original one-factor structure. The model demonstrated excellent fit to the data, $\chi^2(65) = 50.40$, $p = .908$, Comparative Fit Index (CFI) = 1.00, Tucker–Lewis Index (TLI) = 1.01, Incremental Fit Index (IFI) = 1.00, Normed Fit Index (NFI) = .99, Root Mean Square Error of Approximation (RMSEA) = .00, 90% CI [.00, .02], and Standardized Root Mean Square Residual (SRMR) = .057. Collectively, these indices indicate an excellent fit between the hypothesized one-factor model and the observed data.

All factor loadings were statistically significant (*ps* < .001) and substantial in magnitude, ranging from .68 to .80. Specifically, standardized factor loadings varied from .681 (Item 4) to .795 (Item 10), indicating that each item contributed meaningfully to the latent construct of interpersonal electronic surveillance. The strong factor loadings, combined with the excellent model fit indices and high internal consistency estimates, provide preliminary support for the hypothesized one-factor structure and internal consistency of the Turkish version in the current sample.

Multidimensional Jealousy Scale (MJS)

Cognitive jealousy was assessed using the cognitive subscale of the Multidimensional Jealousy Scale (MJS; Pfeiffer & Wong, 1989). This subscale measures suspicious, ruminative, and intrusive thoughts concerning a romantic partner's fidelity, involvement with alternative partners, or concealed interactions. The cognitive subscale comprises five items rated on a 7-point Likert-type scale ranging from 1 (*never*) to 7 (*always*), with higher scores indicating greater levels of cognitive jealousy. For the present study, the scale was translated into Turkish using forward–back translation procedures. Internal consistency was excellent in the current sample (Cronbach's $\alpha = .92$; McDonald's $\omega = .92$).

To evaluate the factorial validity of the Turkish version of the cognitive jealousy subscale, a confirmatory factor analysis (CFA) was conducted to test the hypothesized one-factor structure. Results indicated an excellent fit to the data, $\chi^2(5) = 0.35$, $p = .997$, Comparative Fit Index (CFI) = 1.00, Tucker–Lewis Index (TLI) = 1.05, Incremental Fit Index (IFI) = 1.02, Normed Fit Index (NFI) = .998, Root Mean Square Error of Approximation (RMSEA) = .00, 90% CI [.00, .00], and Standardized Root Mean Square Residual (SRMR) = .022. Collectively, these indices provide strong evidence that the unidimensional model adequately represented the data.

All five items loaded significantly on the latent cognitive jealousy factor (*ps* < .001). Standardized factor loadings ranged from .73 to .90, indicating strong associations between the observed items and the underlying construct. Specifically, loadings ranged from .734 (Item 5) to .904 (Item 1), suggesting that the items were robust indicators of cognitive jealousy. Furthermore, no modification indices exceeded the recommended cutoff values, indicating that no substantial model misspecification was evident. Taken together, the excellent model fit, strong factor loadings, and high reliability coefficients support the construct validity and internal consistency of the Turkish version of the cognitive jealousy subscale in the present sample.

Procedure

Data were collected through Qualtrics as part of a broader research project examining digital behaviors and relationship functioning among young adults. The present analyses focus on a distinct relational outcome, partner surveillance, and a theoretically specific mechanism, cognitive jealousy. Participants were recruited through convenience and snowball sampling via social media networks. To improve gender balance in the sample, an additional recruitment phase included undergraduate students who were offered optional course credit for participation. Participation was voluntary across all recruitment methods.

After providing informed consent, participants completed the questionnaire battery anonymously. Measures were presented in a fixed order: smartphone addiction, interpersonal electronic surveillance, cognitive jealousy, and demographic

information. Ethical approval was obtained from the Özyeğin University Human Research Ethics Committee (Date: 30 December 2016; Decision No. 16), and the study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

Primary analyses were conducted using SPSS. Confirmatory factor analyses were conducted using IBM SPSS AMOS and Monte Carlo analyses were implemented in Python (version 3.x). Prior to hypothesis testing, the data were screened for missing values, multivariate outliers, and statistical assumptions. No missing data were identified. Six multivariate outliers were detected using Mahalanobis distance criteria and excluded from the analyses, resulting in a final sample of 174 participants.

Descriptive statistics and Pearson correlation coefficients were calculated for all study variables. Assumptions of linearity, homoscedasticity, and multicollinearity were examined and found to be acceptable. Given some non-normality in cognitive jealousy scores, the indirect effect was evaluated using bootstrapped confidence intervals. To test the hypothesized indirect association between smartphone addiction and partner surveillance through cognitive jealousy, indirect effect analysis was conducted using the PROCESS macro for SPSS (Model 4; Hayes, 2022). The indirect effect was estimated using 5,000 bootstrap resamples and 95% confidence intervals.

RESULTS

Descriptive Statistics and Bivariate Correlations

Descriptive statistics for the primary study variables are presented in **Table 1**, and bivariate correlations are presented in **Table 2**. Smartphone addiction was positively associated with partner surveillance, $r = .34$, $p < .001$, supporting Hypothesis 1. Smartphone addiction was also positively associated with cognitive jealousy, $r = .40$, $p < .001$, supporting Hypothesis 2. In addition, cognitive jealousy was positively associated with partner surveillance, $r = .38$, $p < .001$, supporting Hypothesis 3. Participant sex was significantly associated with cognitive jealousy, $r = -.20$, $p < .01$.

Table 1: Descriptive Statistics for Age and Primary Study Variables (N = 174)

Scales	M	SD	Range		Skewness	Kurtosis
			Min.	Max.		
Age	21.61	1.88	18	30	1.26	3.46
Smartphone Addiction	2.68	0.78	1.15	5.30	0.69	0.75
Partner Surveillance	3.70	1.35	1	7	0.32	−0.32
Cognitive Jealousy	1.60	0.97	1	5.40	2.31	5.15

Table 2: Bivariate Pearson Correlations Among Study Variables

Variables	1	2	3	4	5
1. Age	-				
2. Sex	.18*	-			
3. Smartphone Addiction	−.05	−.13	-		
4. Partner Surveillance	−.04	−.11	.34***	-	
5. Cognitive Jealousy	−.02	−.20**	.40***	.38***	-

Note. Sex (1 = Female, 2 = Male).
*$p < .05$, **$p < .01$, ***$p < .001$ (two-tailed).

Gender Differences in Study Variables

Independent-samples t tests were conducted to examine gender differences in smartphone addiction, partner surveillance, and cognitive jealousy. Results indicated that women ($M = 2.71$, $SD = 0.75$) and men ($M = 2.55$, $SD = 0.66$) did not differ significantly in smartphone addiction, $t(172) = 1.34$, $p = .182$, Cohen's $d = 0.22$, 95% CI [−0.11, 0.55]. Similarly, no significant gender difference emerged for partner surveillance. Women ($M = 3.75$, $SD = 1.38$) reported slightly higher levels of partner surveillance than men ($M = 3.46$, $SD = 1.22$), but this difference was not statistically

significant, $t(172) = 1.30$, $p = .195$, Cohen's $d = 0.22$, 95% CI [−0.11, 0.55].

In contrast, women reported significantly higher levels of cognitive jealousy ($M = 1.60$, $SD = 0.92$) than men ($M = 1.28$, $SD = 0.42$). Because Levene's test indicated unequal variances, $F(1, 172) = 14.55$, $p < .001$, Welch's t test was interpreted. The analysis revealed a significant gender difference, $t(169.88) = 3.22$, $p = .002$, Cohen's $d = 0.40$, 95% CI [0.07, 0.73], indicating a small-to-medium effect size. Thus, women exhibited greater cognitive jealousy than men, whereas no significant gender differences were observed for smartphone addiction or partner surveillance.

Indirect Effect Analysis

To test Hypothesis 4, an indirect effect analysis was conducted using PROCESS Macro for SPSS (Model 4; Hayes, 2022) with 5,000 bootstrap resamples. Smartphone addiction was positively associated with cognitive jealousy, $B = 0.329$, $SE = 0.083$, $t(172) = 3.98$, $p < .001$, indicating that higher levels of smartphone addiction were associated with greater cognitive jealousy. Cognitive jealousy, in turn, was positively associated with partner surveillance while controlling for smartphone addiction, $B = 0.383$, $SE = 0.120$, $t(171) = 3.18$, $p = .002$.

The total effect of smartphone addiction on partner surveillance was significant, $B = 0.562$, $SE = 0.134$, $t(172) = 4.20$, $p < .001$. When cognitive jealousy was included in the model, the direct effect of smartphone addiction on partner surveillance remained significant, $B = 0.436$, $SE = 0.136$, $t(171) = 3.20$, $p = .002$. Thus, smartphone addiction continued to predict partner surveillance even after accounting for cognitive jealousy.

Bootstrap analyses further revealed a significant indirect effect of smartphone addiction on partner surveillance through cognitive jealousy, $B = 0.126$, $BootSE = 0.053$, 95% CI [0.034, 0.240]. Because the confidence interval did not include zero, the indirect effect was considered statistically significant. Standardized estimates indicated that smartphone addiction was positively associated with cognitive jealousy ($\beta = .29$), and cognitive jealousy was positively associated with partner surveillance ($\beta = .24$). The standardized indirect effect was approximately $\beta = .07$.

Taken together, these findings support Hypothesis 4 and indicate that cognitive jealousy represents a significant indirect pathway linking smartphone addiction and partner surveillance. Specifically, greater smartphone addiction was associated with higher levels of cognitive jealousy, which in turn were associated with increased partner surveillance, while the direct association between smartphone addiction and partner surveillance remained statistically significant.

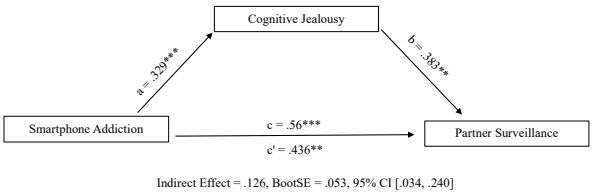

Figure 1. Indirect effect model examining the association between smartphone addiction and partner surveillance through cognitive jealousy. **p < .01; *** p < .001.

Sensitivity Analysis

To further evaluate the robustness of the mediation effect, a Monte Carlo simulation was conducted using the unstandardized path coefficients and standard errors obtained from the PROCESS mediation model (Preacher & Selig, 2012). Following recommendations for Monte Carlo estimation of indirect effects, 200,000 replications were generated to estimate the sampling distribution of the indirect effect. The estimated indirect effect was 0.126, and the Monte Carlo 95% confidence interval ranged from 0.039 to 0.239. Because the confidence interval did not include zero, the results provided additional support for the statistical significance and stability of the indirect effect. The Monte Carlo confidence interval closely matched the bootstrap confidence interval obtained from PROCESS (95% CI [0.034, 0.240]), suggesting that the mediation effect was robust and that the sample size ($N = 174$) provided adequate sensitivity to detect the observed

indirect association between smartphone addiction and partner surveillance through cognitive jealousy. Monte Carlo confidence intervals were estimated using a simulation-based approach implemented in Python (version 3.x), with 200,000 replications based on the parameter estimates and standard errors from the fitted mediation model.

As a sensitivity analysis, a post hoc Monte Carlo power analysis was conducted to evaluate whether the sample size was sufficient to detect the observed indirect effect in the mediation model. Following Schoemann et al. (2017), the simulation was based on the observed standardized path coefficients from the final model (a = .29, b = .24), yielding a standardized indirect effect of approximately ab = .07, with a sample size of N = 174. A total of 5,000 Monte Carlo replications were generated assuming a significance level of α = .05. Results indicated an estimated statistical power of .88 to detect the observed indirect effect. This value exceeds the conventional .80 criterion for adequate statistical power (Cohen, 1988), suggesting that the study had adequate sensitivity to detect the indirect effect observed in the data.

DISCUSSION

The present study examined whether cognitive jealousy functions as an indirect pathway linking smartphone addiction to partner surveillance among Turkish young adults in romantic relationships. Consistent with the hypotheses, smartphone addiction was positively associated with cognitive jealousy and partner surveillance, and cognitive jealousy was positively associated with partner surveillance. The indirect effect was also significant, while the direct association between smartphone addiction and partner surveillance remained significant. Because the data are cross-sectional, these findings should not be interpreted causally. However, they suggest that cognitive jealousy may be one relationship-specific cognitive process through which smartphone addiction is associated with digitally enabled partner monitoring.

These findings are consistent with behavioral addiction perspectives suggesting that addiction-like smartphone use may have interpersonal implications beyond the amount of time spent using a device (Griffiths, 2005; Csibi et al., 2021; Kuss et al., 2018). In romantic relationships, features such as compulsive checking, difficulty disengaging, and reliance on smartphones for emotion regulation may increase engagement with ambiguous digital cues, including delayed responses, online visibility, or social media interactions. The present findings extend this literature by suggesting that such smartphone-related dysregulation may be linked not only to individual functioning, but also to relationship-specific cognitions and behaviors.

The association between smartphone addiction and cognitive jealousy is also consistent with research showing that digitally mediated romantic contexts can intensify jealousy-related thoughts and concerns (Elphinston & Noller, 2011; Elphinston et al., 2013; Gubler et al., 2023; Quiroz et al., 2024). Rather than suggesting that smartphone use itself produces jealousy, the present findings point to a more modest interpretation: individuals with higher levels of smartphone addiction may be more likely to encounter, revisit, or interpret digital relational cues through suspicious or ruminative cognitions. In turn, cognitive jealousy was associated with partner surveillance, which aligns with prior studies linking jealousy, digital monitoring, interpersonal electronic surveillance, and cyber dating abuse (Tokunaga, 2011; Borrajo et al., 2015; Aloia, 2023; Quiroz et al., 2024).

From an uncertainty reduction perspective, partner surveillance may function as an attempt to seek reassurance or reduce ambiguity in the face of perceived relational threat (Berger & Calabrese, 1975). However, surveillance may also expose individuals to further ambiguous information and may be associated with lower trust, reduced autonomy, and more controlling relational dynamics when it becomes frequent or intrusive (Harris & Woodlock, 2019; Messing et al., 2020; Litt & Rodriguez, 2022). Therefore, cognitive jealousy may

help explain why smartphone addiction is linked to surveillance behaviors, but it is unlikely to be the only mechanism involved. The remaining direct effect suggests that other processes, such as habitual checking, fear of missing out, attachment insecurity, low trust, or emotion regulation difficulties, may also contribute to partner-directed monitoring.

The gender-related findings should also be interpreted cautiously. Women reported higher levels of cognitive jealousy than men, whereas gender differences in smartphone addiction and partner surveillance were not statistically significant. This pattern may suggest that gender was more closely related to jealous cognitions than to smartphone addiction or surveillance behavior in the present sample. However, the sample was predominantly female, and gender differences were not a central focus of the present study. Future studies with more gender-balanced samples should examine whether gender is differently associated with cognitive, emotional, and behavioral components of jealousy in digital relationship contexts (Pfeiffer & Wong, 1989; De Cristofaro et al., 2023).

The study also contributes to the literature by examining these associations in a Turkish young adult sample. Much of the research on electronic surveillance, digital jealousy, and technology-facilitated partner monitoring has been conducted in Western samples (Tokunaga, 2011; Elphinston & Noller, 2011; Aloia, 2023). Although the present study did not directly test cultural values, the findings suggest that the links among smartphone addiction, cognitive jealousy, and partner surveillance may also be relevant in a non-WEIRD context. Future research should examine how cultural expectations regarding privacy, closeness, responsiveness, trust, and relational accountability may shape the meaning and consequences of partner surveillance.

Limitations and Future Directions

Several limitations should be considered. First, the cross-sectional design prevents conclusions about temporal ordering or causality. Although the proposed model examined smartphone addiction as associated with cognitive jealousy and partner surveillance, alternative and bidirectional pathways are possible. For example, cognitive jealousy may increase smartphone checking, and partner surveillance may increase exposure to ambiguous relational information, which may further intensify jealousy or smartphone-related dysregulation over time. Longitudinal research is needed to examine these possible reciprocal processes.

Second, all variables were assessed using self-report measures, which may have introduced shared method variance and socially desirable responding, particularly because partner surveillance may be perceived as sensitive or intrusive. Future studies would benefit from partner reports, behavioral indicators of smartphone use, app-based usage data, or ecological momentary assessment.

Third, the sample primarily consisted of young, unmarried university students, most of whom were female. Participants were not recruited from a clinical population, psychiatric diagnoses were not assessed, and no clinical interviews were conducted. Therefore, the findings should be interpreted as reflecting a non-clinical young adult sample rather than a clinically assessed population. The results may not generalize to older adults, married couples, clinical samples, more diverse educational groups, or gender-balanced samples.

Another limitation concerns the potential selection bias introduced by the use of multiple recruitment strategies. Participants were recruited through convenience and snowball sampling via social media and personal networks, and an additional recruitment phase included undergraduate students who were offered optional course credit. These recruitment channels may have attracted participants with different characteristics, such as student status, motivation for participation, comfort with online surveys, digital engagement, or willingness to disclose jealousy and surveillance behaviors. Because recruitment source was not controlled in the analyses, it is not possible to determine whether responses differed across recruitment channels or whether recruitment method influenced the observed associations.

Measurement-related limitations should also be noted. The IESS and the cognitive jealousy subscale of the MJS were translated into Turkish for the present study using forward–back translation procedures. Additional analyses provided preliminary support for their one-factor structure and internal consistency in the present sample. However, the current study was not designed as a formal Turkish adaptation or validation study. Future research should conduct full-scale adaptation studies of the IESS and MJS in Turkish samples, including expert review, pilot testing, convergent and discriminant validity, test–retest reliability, and measurement invariance across gender and other relevant groups.

Despite these limitations, the study contributes to the literature by linking smartphone addiction with partner surveillance through cognitive jealousy. These findings may have implications for prevention, relationship education, and clinical practice. Interventions with young adults and couples may benefit from addressing not only smartphone-related dysregulation, but also the suspicious and ruminative interpretations that give digital cues relational meaning. Relationship education programs may also help young adults distinguish between mutual transparency and monitoring behaviors that undermine autonomy, trust, or safety, particularly given the overlap between partner surveillance, digital coercive control, and cyber dating abuse (Borrajo et al., 2015; Harris & Woodlock, 2019; Messing et al., 2020).

CONCLUSION

In conclusion, the present study suggests that cognitive jealousy may be one pathway linking smartphone addiction and partner surveillance among Turkish young adults in romantic relationships. The findings contribute to a relational understanding of smartphone addiction by showing that addiction-like smartphone use may be associated with digitally enabled monitoring behaviors through suspicion and rumination. At the same time, the cross-sectional, self-report, and non-clinical nature of the data requires caution. Future longitudinal, dyadic, and culturally informed research is needed to clarify the direction, mechanisms, and relational consequences of these associations.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

Financial Support

The Authors report no financial support regarding content of this article.

Ethical Declaration

Ethical permission was obtained from the Özyeğin University, Human Research Ethics Committee for this study with date 30/12/2016 and number 16, and Helsinki Declaration rules were followed to conduct this study.

Author Contributions

Concept: MSG, Design: MSG, Supervising: MSG, Financing and equipment: MSG, Data collection and entry: MSG, Analysis and interpretation: MSG, Literature search: MSG, Writing: MSG, Critical review: MSG.

Corresponding Author

M. Selenga Gürmen: Özyeğin University, Department of Psychology, Istanbul, Türkiye

Email: selenga.gurmen@ozyegin.edu.tr

ORCID iD: 0000-0003-0109-6051

Journal of Dependence, 2026; 27(3):142-154

JOURNAL OF DEPENDENCE

Research Article

Childhood physical neglect and lower peripheral inflammatory indices in hospitalized male patients with substance use disorder: Associations with lifetime suicide attempts

Mustafa Kurt, Ali Taşdemir, Samet Öksüz, Merve Gök

DOI: 10.51982/bagimli.621

Abstract

Objective: Childhood trauma is a major risk factor for suicidality and long-term biological stress alterations. Although suicidal behavior is commonly linked to systemic inflammation, it may also be associated with attenuated peripheral inflammatory responses. This study examined associations between childhood trauma subtypes, hemogram-derived inflammatory indices, and lifetime suicide attempts in hospitalized male patients with substance use disorder (SUD).

Methods: Childhood trauma, hemogram-derived inflammatory indices—including monocyte-to-lymphocyte ratio (MLR) and systemic inflammation response index (SIRI)—a composite Cumulative Inflammation Score (CIS), and lifetime suicide attempts were assessed in 186 hospitalized men with SUD. Hierarchical multiple linear regression analyses were performed after adjustment for relevant clinical covariates.

Results: Fifty-three patients (28.5%) had a history of suicide attempts and showed lower inflammatory indices (CIS: $p = .006$; MLR: $p = .001$). Physical neglect emerged as the trauma subtype most consistently associated with lower inflammation. In adjusted models, higher physical neglect scores remained independently associated with lower CIS ($\beta = -.258$, $p = .007$), MLR ($\beta = -.248$, $p = .013$), and SIRI ($\beta = -.252$, $p = .009$). These associations persisted after excluding hepatitis-positive participants.

Conclusion: Childhood physical neglect may be associated with relatively lower peripheral inflammatory indices in hospitalized men with SUD, highlighting heterogeneity in inflammatory profiles within this population. Because the underlying mechanisms were not directly examined and the regression models explained only modest variance, these findings should be considered hypothesis-generating. Prospective longitudinal studies are needed to determine whether hemogram-derived inflammatory indices have clinical utility for understanding suicidality in SUD.

Keywords: Childhood Trauma; Physical Neglect; Peripheral Inflammation; Substance-Related Disorders; Suicide Attempt

Mustafa Kurt
Karadeniz Technical University, Faculty of Medicine, Department of Mental Health and Diseases, Trabzon, Türkiye
Email: drmustafakurt61@gmail.com
ORCID iD: 0000-0002-2666-7087

Ali Taşdemir
Adana Dr. Ekrem Tok Mental Health and Diseases Hospital, Adana, Türkiye
Email: drali4020@gmail.com
ORCID iD: 0000-0001-5014-9725

Samet Öksüz
Rize Training and Research Hospital, Rize, Türkiye
Email: sametoksuz@yahoo.com
ORCID iD: 0000-0001-8502-0980

Merve Gök
Karadeniz Technical University, Faculty of Medicine, Department of Mental Health and Diseases, Trabzon, Türkiye
Email: mrvtulu17@gmail.com
ORCID iD: 0009-0007-6893-8504

Received: 2026-06-11
Accepted: 2026-08-19

e-ISSN: 3108-7973

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INTRODUCTION

Systemic inflammation and immune dysregulation are increasingly implicated in the neurobiology of psychiatric disorders and suicidal behavior (Baldini et al., 2025; Zeng et al., 2024). However, the specific trajectory of these immune alterations remains complex, particularly in high-risk clinical populations exposed to chronic allostatic load, such as individuals with Substance Use Disorders (SUD). Current evidence suggests that psychoactive substance use is associated with significant alterations in both central and peripheral inflammatory signaling, involving microglial activation, cytokine release, and neuroinflammatory processes detectable via neuroimaging (Kohno et al., 2019; Namba et al., 2021).

A single biomarker may fail to adequately capture the complexity of systemic inflammation. Recent evidence suggests that hematology-derived composite inflammatory indices— including neutrophil-to-lymphocyte ratio (NLR), monocyte-to-lymphocyte ratio (MLR), and platelet-to-lymphocyte ratio (PLR)—may be associated with psychiatric and addiction-related processes (Baykara et al., 2022; Gürbüzer et al., 2024). These indices offer a more comprehensive inflammatory profile by simultaneously capturing multiple cellular components of immune activity. Notably, newer systemic indices such as systemic immune-inflammation index (SII) and systemic inflammation response index (SIRI) may demonstrate greater sensitivity than classical parameters in predicting suicide attempts (Ninla-Aesong et al., 2024). These hematology-derived inflammatory indices may be particularly informative in clinical populations where multiple biological and psychosocial vulnerabilities coexist, such as individuals with SUD and histories of childhood trauma.

Childhood trauma is highly prevalent among individuals with SUD, reflecting a complex bidirectional relationship between early adversity and substance use (Zhang et al., 2020). Childhood trauma may disrupt neurodevelopmental processes and contribute to persistent dysregulation in stress-response systems (Teicher & Samson, 2016) while also substantially increasing the risk of suicidal behavior (Rizk et al., 2021). In the broader literature, childhood adversity has most consistently been associated with immune activation and elevated proinflammatory mediators in adulthood (Baumeister et al., 2016).

Emerging evidence, however, suggests that the inflammatory consequences of childhood adversity may not follow a uniform proinflammatory trajectory, particularly when chronic deprivation rather than acute threat constitutes the predominant form of early stress (McLaughlin et al., 2014; Miller et al., 2007). Consistent with the threat–deprivation framework, deprivation-related adversities such as physical neglect may exert neurobiological effects that differ substantially from those associated with abuse-related trauma (Sheridan & McLaughlin, 2014). Childhood physical neglect has been associated with atypical inflammatory signaling patterns and altered adaptation to repeated psychosocial stress, although the direction of these responses may vary depending on the clinical context and measurement approach (Schreier et al., 2020). Relatedly, blunted hypothalamic-pituitary-adrenal (HPA) axis reactivity has been reported in suicidal populations with chronic stress histories (Melhem et al., 2016; Young et al., 2021), raising the possibility that prolonged adversity may, in some individuals, be associated with attenuated peripheral inflammatory responses over time.

This issue may be particularly relevant in SUD populations, where psychoactive substances themselves exert heterogeneous immunomodulatory effects. While stimulant and opioid exposure have been associated with elevated inflammatory indices in some studies (Lara-Apolinario et al., 2026), chronic opioid dependence has also been linked to reduced monocyte-related inflammatory activity (Quraishi et al., 2022), and cannabis use has been associated with heterogeneous and context-dependent immune effects (Moshfeghinia et al., 2024). These findings suggest that inflammatory

patterns in trauma-exposed individuals with SUD may be more heterogeneous than the predominantly proinflammatory profiles commonly reported in general psychiatric populations.

Childhood trauma is among the strongest predictors of suicide attempts in individuals with SUD (Armoon & SoleimanvandiAzar, 2021; Baekkerud et al., 2023). Although suicidal behavior has repeatedly been linked to immune dysregulation (Baldini et al., 2025), the biological pathways through which early trauma—particularly deprivation-related experiences—contributes to suicide vulnerability in SUD populations remain poorly understood (Turecki et al., 2019). While elevated inflammatory indices have been reported in some suicidal populations (Peth et al., 2024), it remains unclear whether trauma-exposed individuals with prolonged substance use exhibit predominantly proinflammatory or relatively attenuated inflammatory profiles. Accordingly, the present study aimed to examine the relationship between childhood trauma, systemic inflammatory markers, and suicide attempts in individuals with SUD. We hypothesized that a history of suicide attempts would be associated with alterations in systemic inflammatory markers. Furthermore, we hypothesized that childhood trauma subtypes would show distinct patterns of association with these markers, with deprivation-related adversities demonstrating a different inflammatory profile from threat-related adversities. Finally, we hypothesized that childhood trauma dimensions would remain independently associated with systemic inflammatory indices after adjustment for relevant clinical covariates.

METHODS

Sample and Design

This cross-sectional study was conducted at the addiction center of Adana Dr. Ekrem Tok Mental Health and Diseases Hospital (January 2026–April 2026), including 186 male inpatients (aged 18–65) diagnosed with SUD (Diagnostic and Statistical Manual of Mental Disorders (DSM-5)). Individuals with psychotic, bipolar, organic brain disorders, or comorbid Alcohol Use Disorder (AUD) were excluded. Participants who reported alcohol consumption but did not meet DSM-5 diagnostic criteria for AUD remained eligible for inclusion. Medical histories and eligibility criteria were verified through retrospective medical record review and structured psychiatric interviews. To minimize biological confounding, individuals with malignancy, chronic systemic diseases, acute infection, Body Mass Index > 30 kg/m^2, recent use of inflammation-altering medications (e.g., antibiotics or corticosteroids within the previous three months), or clinically significant hematological abnormalities (e.g., anemia or leukocytosis) were excluded.

The study protocol was reviewed and formally approved by the Adana City Training and Research Hospital Scientific Research Ethics Committee (Date of Approval: December 18, 2025; Meeting No: 20; Decision No: 967). All procedures were conducted in strict accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments.

Sample size estimation was performed using G*Power 3.1 for between-group comparisons with unequal group allocation. Assuming a medium effect size (Cohen's d = 0.50), α = .05, and 80% statistical power, the minimum required sample size was estimated at 155 participants. The final sample consisted of 186 individuals.

Measurement and Assessment Tools

Sociodemographic and Clinical Data Form

Basic demographic and clinical characteristics were recorded. For patients reporting multiple routes of substance administration, classification was based on the primary route of use. Concomitant alcohol use was defined as self-reported alcohol consumption that did not meet DSM-5 criteria for AUD. Participants with occasional or non-disordered alcohol use were therefore retained, whereas those meeting criteria for current AUD were excluded. To minimize

acute inflammatory confounding, only serologically confirmed chronic Hepatitis B/C infection was considered as an infection-related clinical variable. A history of suicide attempt was defined as at least one lifetime suicide attempt requiring emergency medical and/or surgical intervention, as documented in hospital medical records and confirmed during the psychiatric interview. Suicidal ideation and preparatory behaviors in the absence of an actual suicide attempt were not classified as suicide attempts. For statistical analyses, suicide attempt history was coded as a dichotomous lifetime variable (present/absent).

Childhood Trauma Questionnaire (CTQ)

The CTQ, developed by Bernstein et al. (1994) and adapted into Turkish by Şar et al. (2012) (Cronbach α = .93), was used to assess individuals' traumatic experiences prior to the age of 18. High scores on the 28-item 5-point Likert-type scale, consisting of five subscales (emotional, physical, and sexual abuse; emotional and physical neglect), indicate increased trauma severity. In this study, Cronbach α was calculated as .83.

Psychometric assessments, including the Barratt Impulsiveness Scale Short Form (BIS-SF; α = .78) and the Buss-Perry Aggression Questionnaire (BPAQ; α = .90), were conducted on hospitalization day 21 to ensure cognitive stability and exclude acute withdrawal. These scores characterized the clinical profile and supported sample homogeneity.

Cumulative Inflammation Score (CIS) Calculation and Laboratory Analyses

Fasting venous blood samples were collected as part of the routine admission assessment between 08:00 and 10:00 a.m. on the morning of hospitalization, before initiation of pharmacological detoxification or other inpatient treatment procedures. Because this was a naturalistic clinical study, the exact interval since last substance use, withdrawal severity, and acute physiological status were not systematically recorded. Hemogram-derived indices included NLR (neutrophil/lymphocyte count ratio), MLR (monocyte/lymphocyte count ratio), SII (platelet × neutrophil/lymphocyte count), and SIRI (neutrophil × monocyte/lymphocyte count). To comprehensively summarize systemic inflammatory activity while reducing multiple testing, the four hemogram-derived indices (NLR, MLR, SII, and SIRI) were entered into an unrotated principal component analysis (PCA). Sampling adequacy was confirmed using the Kaiser–Meyer–Olkin statistic (KMO = .738) and Bartlett's test of sphericity ($\chi^2 = 626.741$, $p < .001$). A single component with an eigenvalue > 1 was retained, explaining 78.7% of the total variance, with factor loadings ranging from .82 to .93. Individual factor scores were generated using the regression method in SPSS and saved as standardized continuous scores (M = 0, SD = 1), which were termed the CIS.

Statistical Analysis

Data analysis was performed using SPSS 27.0. The primary outcome was systemic inflammation, operationalized using the PCA-derived Cumulative Inflammation Score (CIS). Hierarchical multiple linear regression was the primary analytical approach for evaluating the independent associations between childhood trauma dimensions and systemic inflammation after adjustment for relevant clinical covariates. Analyses of individual inflammatory indices (MLR, SIRI, NLR, and SII), group comparisons, bivariate correlations, and substance-specific subgroup analyses were performed as secondary or sensitivity analyses.

The normality of continuous variables was examined using the Kolmogorov-Smirnov test, supplemented by inspection of skewness and kurtosis values. Depending on distribution characteristics, the Independent Samples t-test, Mann-Whitney U test, and Chi-square test were used for group comparisons. Bivariate relationships were evaluated using Spearman rank correlations with Benjamini-Hochberg False Discovery Rate (FDR) corrections for multiple comparisons. Hierarchical linear regression analyses were conducted to evaluate independent predictors of systemic inflammation,

including the CIS and specific inflammatory indices (e.g., MLR, SIRI). Clinical covariates entered in the first step included age, duration of substance use, number of hospitalizations, chronic viral infection (Hepatitis B/C), concomitant alcohol use (present/absent), and suicide attempt history. Childhood trauma subdimensions were entered in the second step. To evaluate whether the observed associations were independent of substance-type heterogeneity, primary substance category (dummy coded) was entered as an additional third block in supplementary hierarchical regression analyses. Multicollinearity was assessed using variance inflation factors (VIF), with all values remaining well below 3. Statistical significance was evaluated at the $p < .05$ level.

RESULTS

Sociodemographic and Clinical Characteristics

Of the 186 SUD patients included in the study, 53 (28.5%) had a history of suicide attempts. The groups with and without suicide attempts showed similar distributions in terms of age, marital status, and education level ($p > .05$). However, unemployment was significantly higher among suicide attempters ($\chi^2 = 6.435$, $p = .011$).

Suicide attempters had longer substance use durations ($Z = -2.317$, $p = .021$), more hospitalizations ($Z = -3.014$, $p = .003$), and a more prevalent family history of substance use ($\chi^2 = 7.553$, $p = .006$). Among patients with a history of suicide attempts, chronic viral infection (Hepatitis B/C) positivity ($\chi^2 = 9.534$, $p = .002$) and concomitant alcohol use ($\chi^2 = 5.244$, $p = .022$) were found to be significantly higher than in the group without a history of suicide attempts **(Table 1)**.

Childhood Trauma Scores, Behavioral Characteristics, and Hematological Findings

In the comparison of traumatic experiences, CTQ total scores as well as the emotional abuse, emotional neglect, and physical neglect subscale scores were significantly higher among patients

Table 1: Comparison of Sociodemographic and Clinical Characteristics

Variables	Suicide attempt: No (n = 133)		Suicide attempt: Yes (n = 53)		Test Value $t/Z/\chi^2$	p
Age (Years) $M \pm SD$	31.14 ± 8.18		31.83 ± 8.27		t = -0.521	.603
	n	%	n	%		
Marital Status						
Married	46	34.6	16	30.2	χ^2 = 1.239	.538
Single	69	51.9	32	60.4		
Divorced	18	13.5	5	9.4		
Education Level						
Elementary School	71	53.4	32	60.4	χ^2 = 1.263	.532
High School	52	39.1	19	35.8		
University	10	7.5	2	3.8		
Employment Status						
Yes	80	60.2	21	39.6	χ^2 = 6.435	.011*
No	53	39.8	32	60.4		
History of incarceration						
Yes	95	71.4	31	58.5	χ^2 = 2.903	.088
No	38	28.6	22	41.5		
Diagnosis						
Opioid	7	5.3	7	13.2	χ^2 = 7.941	.094
Cannabis	54	40.6	17	32.1		
Sedative	14	10.5	2	3.8		
Amphetamine	34	25.6	12	22.6		
Mixed	24	18.0	15	28.3		
Route of administration						
IV	14	10.5	8	15.1	χ^2 = 3.911	.141
Oral	74	55.6	21	39.6		
Inhaler	45	33.8	24	45.3		
Chronic viral infection (Hepatitis B/C)						
Yes	12	9.0	14	26.4	χ^2 = 9.534	.002**
No	121	91.0	39	73.6		
Substance use in the family						
Yes	112	84.2	35	66.0	χ^2 = 7.553	.006**
No	21	15.8	18	34.0		
Alcohol use						
Yes	96	72.2	29	54.7	χ^2 = 5.244	.022*
No	37	27.8	24	45.3		
Age of first substance use (Years)	18.00 (5.00)		17.00 (4.00)		Z = -1.529	.126
Duration of substance use (Years)	6.00 (9.00)		8.00 (10.00)		Z = -2.317	.021*
Number of hospitalizations	1.00 (1.00)		2.00 (2.00)		Z = -3.014	.003**

Note: Categorical variables are presented as frequencies (n) and percentages (%), and compared using the Chi-square test (χ^2). Continuous variables that met the assumption of normal distribution (Age) are presented as $M \pm SD$ and analyzed using the Independent Samples t-test (t); those that did not show normal distribution are presented as Median (Interquartile Range-IQR) and analyzed using the Mann-Whitney U test (Z). Statistical significance: * $p < .05$, ** $p < .01$.

with a history of suicide attempts than among those without such a history (all p < .05). Behavioral characteristics assessed by the BIS-SF and BPAQ did not differ significantly between groups (both p > .05). Among the raw hematological parameters, only monocyte counts were significantly lower in the suicide attempt group (p = .038), whereas white blood cell, neutrophil, lymphocyte, and platelet counts were comparable between groups (all p > .05). Regarding hemogram-derived inflammatory indices, NLR (p = .031), MLR (p = .001), SII (p = .015), SIRI (p = .011), and the CIS (p = .006) were all significantly lower among patients with a history of suicide attempts **(Table 2)**.

Table 2: Comparison of Childhood Trauma, Behavioral Characteristics, and Hemogram-Derived Inflammatory Indices

Variables	Suicide attempt: No (*n* = 133)	Suicide attempt:Yes (*n* = 53)	Test Value	Effect Size	
Childhood Traumas			Z	r	*p*
Emotional Abuse [a]	7.00 (5.00)	9.00 (8.50)	-2.725	.200	.006**
Physical Abuse [a]	5.00 (5.00)	6.00 (8.00)	-1.395	.102	.163
Sexual Abuse [a]	5.00 (2.00)	5.00 (3.50)	-0.939	.069	.348
Emotional Neglect [a]	12.00 (7.00)	16.00 (8.50)	-3.864	.283	< .001**
Physical Neglect [a]	10.00 (5.00)	12.00 (4.00)	-2.351	.172	.019*
CTQ-Total [a]	42.00 (18.50)	52.00 (22.00)	-3.720	.273	< .001**
Behavioral Characteristics			t	*d*	
BIS-SF [b]	29.93 ± 7.40	31.86 ± 5.80	-1.705	0.276	.090
BPAQ [b]	74.92 ± 18.54	80.45 ± 21.96	-1.739	0.283	.084
Raw Hematological Parameters			Z	*r*	
WBC(×10³/µL) [a]	9.30 (3.50)	8.70 (3.20)	−0.994	.073	.321
Neutrophil (×10³/µL) [a]	6.10 (3.10)	5.40 (2.80)	−1.343	.098	.180
Lymphocyte (×10³/µL) [a]	2.40 (1.10)	2.55 (0.90)	1.021	.075	.308
Monocyte (×10³/µL) [a]	0.58 (0.30)	0.52 (0.22)	−2.074	.152	.038*
Platelet (×10³/µL) [a]	278.00 (95.00)	275.00 (105.00)	−0.431	.032	.667
Inflammatory Markers			Z	*r*	
NLR [a]	2.45 (1.36)	2.13 (1.18)	-2.160	.158	.031*
MLR [a]	0.24 (0.10)	0.20 (0.09)	-3.183	.233	.001**
SII [a]	663.80 (474.56)	560.62 (384.62)	-2.429	.178	.015*
SIRI [a]	1.32 (1.09)	1.08 (0.81)	-2.534	.186	.011*
CIS [a]	-0.06 (1.18)	-0.35 (0.89)	-2.734	.200	.006**

Note: Superscript a indicates variables analyzed using the Mann–Whitney *U* test (reported as median [IQR], *Z* statistic, and effect size *r*). Superscript b indicates variables analyzed using the Independent Samples *t*-test (reported as *M* ± *SD*, *t* statistic, and Cohen's *d*). CTQ: Childhood Trauma Questionnaire; BIS: Barratt Impulsivity Scale; BPAQ: Buss-Perry Aggression Questionnaire; CIS: Cumulative Inflammation Score; NLR: Neutrophil/Lymphocyte Ratio; MLR: Monocyte/Lymphocyte Ratio; SII: Systemic Immune-Inflammatory Index; SIRI: Systemic Inflammation Response Index. Significance: * $p < .05$, ** $p < .01$.

Bivariate Correlations

Bivariate correlation analyses were conducted between childhood trauma dimensions and inflammatory indices **(Table 3)**. Based on FDR-adjusted significance levels, CTQ abuse-related subscales (emotional, physical, and sexual abuse) did not show statistically significant correlations with inflammatory markers (all FDR-adjusted $p > .05$). Initial weak correlations between emotional neglect and inflammatory indices did not remain significant after FDR adjustment. In contrast, higher physical neglect scores remained significantly associated with lower MLR ($r = -.231$, FDR-p = .018), SIRI ($r = -.213$, FDR-p = .029), and CIS ($r = -.239$, FDR-p = .018).

Table 3: Bivariate Spearman Correlation Matrix of Childhood Trauma Dimensions and Inflammatory Indices

Variables	1	2	3	4	5	6	7	8	9	10
1. Emotional Abuse	-									
2. Physical Abuse	.704**	-								
3. Sexual Abuse	.491**	.534**	-							
4. Emotional Neglect	.283**	.269**	.198**	-						
5. Physical Neglect	.433**	.418**	.421**	.532**	-					
6. NLR	.013	.038	.020	-.159	-.143	-				
7. MLR	-.035	-.018	.033	-.188	-.231*	.627**	-			
8. SII	-.025	-.026	-.045	-.150	-.169	.849**	.541**	-		
9. SIRI	-.034	-.021	.027	-.176	-.213*	.796**	.827**	.736**	-	
10. CIS	-.066	-.034	-.018	-.178	-.239*	.845**	.849**	.880**	.913**	-

Note: *Data represent Spearman's rho (ρ) correlation coefficients. CTQ: Childhood Trauma Questionnaire; CIS: Cumulative Inflammation Score; NLR: Neutrophil-to-Lymphocyte Ratio; MLR: Monocyte-to-Lymphocyte Ratio; SII: Systemic Immune-Inflammatory Index; SIRI: Systemic Inflammation Response Index. Statistical significance for correlations between trauma dimensions and inflammatory indices (columns 6-10) was adjusted using the Benjamini-Hochberg False Discovery Rate (FDR) method. * p < .05 (FDR-adjusted), ** p < .01.*

Factors Associated with Systemic Inflammation

Hierarchical multiple linear regression analyses were conducted to identify independent predictors of systemic inflammation **(Table 4)**. Clinical and trauma-related variables were entered hierarchically, with demographic and clinical covariates entered in the first step and childhood trauma dimensions added in the second step. In step one, a history of suicide attempts was significantly associated with lower CIS scores ($\beta = -.187$, $p = .015$). In step two, the inclusion of childhood trauma subdimensions significantly improved model fit ($\Delta R^2 = .059$, $p = .043$), and physical neglect showed independent association with lower CIS scores ($\beta = -.258$, $p = .007$).

After adjustment for the same clinical covariates, physical neglect remained negatively associated with MLR ($\beta = -.248$, $p = .013$), SIRI ($\beta = -.252$, $p = .009$), SII ($\beta = -.214$, $p = .028$), and NLR ($\beta = -.197$, $p = .041$). No independent associations were observed between abuse-related trauma dimensions and inflammatory indices (all $p > .05$).

To further evaluate whether the observed associations were independent of substance-type heterogeneity, additional hierarchical regression analyses were performed in which primary substance category (dummy coded) was entered as a third block. The associations remained statistically significant after additional adjustment for primary substance category, with childhood physical neglect continuing to independently predict lower MLR ($\beta = -.175$, $p = .019$) and SIRI ($\beta = -.166$, $p = .022$) (maximum VIF = 1.06).

Table 4: Hierarchical Multiple Linear Regression Analysis of Clinical and Traumatic Factors Predicting Cumulative Inflammation Score

Variables	B	SE	β	95% CI for *B*	t	p	VIF
Step 1: Clinical Covariates							
Age	0.005	0.003	.110	[−0.001, 0.010]	1.326	.187	1.350
Duration of substance use	−0.001	0.003	−.045	[−0.007, 0.006]	−0.528	.598	1.510
Number of hospitalizations	0.006	0.006	.105	[−0.005, 0.018]	1.359	.176	1.201
Chronic viral infection (Hep B/C)	−0.058	0.036	−.161	[−0.130, 0.013]	−1.925	.056	1.416
Alcohol Use	0.005	0.043	.024	[−0.080, 0.090]	0.325	.746	1.118
Suicide attempt history	−0.101	0.046	−.187*	[−0.193, −0.010]	−2.459	.015*	1.225
Step 2: Childhood Trauma Subdimensions							
Age	0.005	0.003	.112	[−0.001, 0.010]	1.361	.175	1.350
Duration of substance use	0.001	0.003	.012	[−0.006, 0.006]	0.137	.892	1.510
Number of hospitalizations	0.005	0.006	.085	[−0.006, 0.017]	1.098	.274	1.201
Chronic viral infection (Hep B/C)	−0.057	0.037	−.145	[−0.130, 0.015]	−1.724	.086	1.416
Alcohol Use	0.002	0.043	.004	[−0.083, 0.087]	0.049	.961	1.118
Suicide attempt history	−0.097	0.047	−.169*	[−0.190, −0.003]	−2.164	.032*	1.225
Emotional Abuse	0.007	0.007	.100	[−0.006, 0.020]	0.875	.383	2.629
Physical Abuse	−0.003	0.007	−.022	[−0.018, 0.012]	−0.201	.841	2.444
Sexual Abuse	0.015	0.008	.137	[−0.001, 0.030]	1.541	.125	1.575
Emotional Neglect	−0.001	0.005	−.027	[−0.009, 0.008]	−0.299	.766	1.644
Physical Neglect	−0.024	0.008	-.258**	[−0.040, −0.009]	−2.714	.007**	1.806

Note: *B* = unstandardized regression coefficient; SE = standard error; *β* = standardized regression coefficient; CI = confidence interval; *VIF* = variance inflation factor. Model Summary: Model 1 (Clinical Covariates): $R^2 = .071$, Adjusted $R^2 = .040$, $F(6,179) = 2.291$, $p = .037$. Model 2 (Trauma Subdimensions Added): $R^2 = .130$, $\Delta R^2 = .059$, $\Delta F(5,174) = 2.343$, $p = .043$. Statistical Significance: * $p < .05$, ** $p < .01$.

Sensitivity and Supplementary Analyses

Sensitivity analyses excluding 26 hepatitis-positive participants (n = 160) yielded comparable findings, with physical neglect remaining negatively correlated with CIS (r = −.227, p = .004) and individual inflammatory indices, including MLR (r = −.200, p = .011), SIRI (r = −.200, p = .011), and SII (r = −.165, p = .037).

Supplementary subgroup analyses by primary substance diagnosis revealed significant between-group differences in CIS levels (Kruskal–Wallis H = 11.734, p = .019). Post-hoc analyses indicated that the opioid group had significantly lower CIS levels compared with the cannabis (p = .003), amphetamine (p = .024), and mixed-use (p = .013) groups.

DISCUSSION

This study is one of a limited number of studies examining the possible role of systemic inflammation markers in the relationship between childhood trauma and suicide attempts in SUD patients receiving inpatient treatment. The findings suggest that childhood physical neglect was associated with relatively lower peripheral inflammatory indices among hospitalized male patients with

SUD, a pattern that may reflect heterogeneity in inflammatory responses within this specific clinical population.

Our findings can be interpreted within the framework of the time-dependent stress response model, which proposes that while acute stressors often trigger immune activation, early and chronic stressors such as childhood physical neglect have been proposed to contribute to long-term alterations in stress-response systems, potentially resulting in blunted biological responses in adulthood (Kuhlman et al., 2020; Miller et al., 2007). Consistent with this perspective, blunted hypothalamic-pituitary-adrenal (HPA) axis reactivity has been reported in suicide attempters with chronic stress histories (Melhem et al., 2016; Young et al., 2021), and prolonged adversity may be associated with a non-linear attenuation of peripheral inflammatory activity over time (Danese & McEwen, 2012). Previous theoretical models have suggested that chronic early deprivation may influence glucocorticoid signaling and stress-response regulation, leading to attenuated peripheral immune responsiveness in adulthood (Danese & Lewis, 2017). Because these mechanisms were not directly examined in the present study, this interpretation should be considered speculative. Inflammatory markers were measured at hospital admission rather than during an acute suicidal crisis; therefore, the observed profile is more likely to reflect systemic inflammatory status at admission than acute physiological changes associated with an active suicidal event.

In multiple regression analyses, the finding that physical neglect—rather than abuse-related trauma subtypes—was independently associated with lower inflammatory indices may be interpreted within the threat–deprivation model of childhood adversity (Sheridan & McLaughlin, 2014). According to the threat–deprivation framework, abuse-related adversities have more commonly been linked to acute immune activation, whereas deprivation-related experiences have been hypothesized to be associated with relatively attenuated inflammatory responses. Emerging clinical evidence is broadly consistent with this interpretation, as histories of childhood maltreatment and neglect have been associated with alterations in peripheral inflammatory biomarkers and psychiatric symptom profiles across both clinical and population-based samples (Cuñat et al., 2024; Jiang et al., 2025). In addition, inflammatory alterations related to neglect exposure may be relevant to suicidal behavior specifically (García-Fernández et al., 2025). Although emotional neglect initially demonstrated weak bivariate correlations with inflammatory indices, these associations lost significance after FDR correction. Physical neglect was the only trauma dimension that consistently remained associated with lower inflammatory indices after multivariable adjustment. Moreover, the overall explained variance of the regression models was modest, suggesting that additional biological, behavioral, and environmental factors likely contribute to variability in peripheral inflammatory indices.

Childhood physical neglect encompasses not only psychosocial deprivation but also inadequate fulfillment of basic physical needs, including nutrition. One possible explanation for the present findings is that prolonged deprivation during critical developmental periods may influence the maturation of stress-response and immune regulatory systems. Although this hypothesis is biologically plausible, the present study did not directly assess nutritional history or neuroimmune function. Future longitudinal studies incorporating nutritional, immunological, and neuroendocrine assessments are therefore needed to clarify these pathways.

While suicidal behavior has frequently been associated with elevated inflammatory markers in general psychiatric populations (Elbay et al., 2025; Moshfeghinia et al., 2025), recent evidence suggests that immune alterations in individuals with suicidal behavior are heterogeneous and vary by psychiatric diagnosis and symptom severity (Grendas et al., 2024). Similarly, findings across trauma-exposed and substance-using cohorts remain inconsistent, with both increased and attenuated inflammatory profiles being reported (Velasco et al., 2023). Populations

characterized by chronic adversity, prolonged substance exposure, or severe allostatic burden may demonstrate relatively attenuated inflammatory responses over time rather than persistent immune activation—a pattern broadly consistent with the profile observed in the present sample.

The interpretation of these findings should also consider the heterogeneous immunomodulatory effects of chronic substance exposure itself. Opioid dependence has been associated with reduced monocyte activity and lower inflammatory indices, whereas stimulant-related substances may produce more variable inflammatory profiles (Lara-Apolinario et al., 2026; Quraishi et al., 2022). In addition, direct comparisons across SUD diagnoses indicate that NLR and MLR levels may differ substantially by primary substance, with alcohol use disorder associated with higher inflammatory indices than cocaine use disorder (Ruwel et al., 2025). Although patients with primary opioid use demonstrated lower CIS levels in subgroup analyses, the association between childhood physical neglect and inflammatory indices remained evident after adjustment for substance category, suggesting that the observed associations were not fully explained by differences in primary substance category.

The heterogeneity of inflammatory findings across studies may reflect important moderating factors, including the type, timing, and chronicity of trauma exposure, as well as characteristics of the study population. Studies conducted in general population samples or acute clinical settings have predominantly reported elevated inflammatory markers following childhood adversity, with abuse-related adversities showing more consistent associations with proinflammatory profiles than deprivation-related adversities such as neglect (Baumeister et al., 2016; Coelho et al., 2014; Danese et al., 2007). However, attenuated, modest, or inconsistent inflammatory associations have also been documented, particularly in studies examining specific trauma subtypes or populations characterized by chronic allostatic burden (Chiang et al., 2022; Cornman et al., 2023; Velasco et al., 2023). Taken together, these discrepancies underscore the importance of considering trauma subtype, population context, and biological measurement approach when interpreting inflammatory findings in high-risk clinical populations.

The present findings are based on hemogram-derived peripheral inflammatory indices rather than direct cytokine or neuroimmune measurements. Although such peripheral alterations may indirectly relate to neuroimmune processes implicated in stress responsivity and addiction (Hu et al., 2022; Namba et al., 2021; Wohleb et al., 2015), direct mechanistic inferences cannot be drawn from the present data. Therefore, the observed associations should not be interpreted as evidence of neuroinflammatory mechanisms or causal biological pathways.

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inference regarding the temporal relationships among childhood trauma, systemic inflammation, and suicide attempt history. Peripheral inflammatory markers were measured only once at hospital admission before treatment initiation, and acute factors such as recent substance use, withdrawal severity, sleep disturbance, dehydration, or nutritional status may have influenced these indices. Second, the heterogeneity of substance use diagnoses represents an important limitation, as different psychoactive substances exert distinct immunomodulatory effects. Although additional analyses adjusting for primary substance category yielded comparable findings, relatively small subgroup sizes limited substance-specific inference. Third, although major biological confounders (e.g., obesity, acute infection, chronic systemic disease, hematological disorders, and recent anti-inflammatory medication use) were excluded, detailed information regarding smoking intensity, psychiatric symptom severity, nutritional status, and medication exposure was unavailable. Although sensitivity analyses excluding hepatitis-positive participants supported the robustness of the findings, detailed virological and liver disease characteristics were unavailable. Fourth, childhood

trauma subdimensions frequently co-occur, and the independent contribution of each trauma domain should therefore be interpreted cautiously. Fifth, suicide attempt history was assessed as a lifetime dichotomous variable without information regarding timing, frequency, method, or medical lethality. Although post-hoc power analyses indicated adequate statistical power, the unequal group sizes may have reduced sensitivity for detecting smaller effects. Finally, the single-center sample consisting exclusively of hospitalized male patients limits the generalizability of these findings to female patients, outpatient populations, and other clinical settings.

CONCLUSION

The present findings suggest that childhood physical neglect in hospitalized male patients with SUD is associated with relatively lower hemogram-derived inflammatory indices, highlighting the heterogeneity of peripheral inflammatory profiles in this high-risk clinical population. These findings should not be interpreted as evidence of reduced suicide risk or generalized immune suppression but rather as reflecting one possible pattern of peripheral inflammatory dysregulation. The underlying biological mechanisms remain to be clarified, and these observations should therefore be considered hypothesis-generating. Future prospective longitudinal studies incorporating comprehensive immune profiling are warranted to determine the clinical relevance of hemogram-derived inflammatory indices in suicidality among individuals with SUD.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

Financial Support

The Authors report no financial support regarding content of this article.

Ethical Declaration

The study protocol was approved by the Adana City Training and Research Hospital Scientific Research Ethics Committee (Date: December 18, 2025; Meeting No: 20; Decision No: 967).

Consent to Participate: Written informed consent was obtained from all individual participants included in the study.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process:

During the preparation of this work, the authors used DeepL in order to improve the language quality and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Data Availability Statement:

The datasets generated and/or analysed during the current study are not publicly available due to the sensitive nature of the data and patient privacy restrictions but are available from the corresponding author on reasonable request.

Author Contributions

Conceptualization: MK, Methodology: MK, Formal Analysis: MK, SÖ, Resources: MK, AT,MG Writing – Original Draft: MK, Writing – Review, Editing: MK, MG, AT, Supervision: MK, Visualization: SÖ, Software: SÖ, Investigation: AT, MG, Data Curation: AT,MG, All authors read and approved the final manuscript.

Thanks

We would like to express our sincere gratitude to all the patients who voluntarily participated in this study

Corresponding Author

Mustafa Kurt

Karadeniz Technical University, Faculty of Medicine, Department of Mental Health and Diseases, 61080, Ortahisar, Trabzon, Türkiye

Email: drmustafakurt61@gmail.com

ORCID iD: 0000-0002-2666-7087

Journal of Dependence, 2026; 27(3):155-164

JOURNAL OF DEPENDENCE

Research Article

Hematological profiles and complete blood count alterations in smokers

Şule Şirin Berk, Hatice Şahin

DOI: 10.51982/bagimli.622

Abstract

Objective: The aim of this study was to evaluate the associations between cigarette smoking and hematological parameters in otherwise healthy individuals.

Methods: A total of 109 individuals were included in the study, comprising 49 active smokers and 60 never-smokers. Complete blood count parameters along with related hematological indices were retrospectively evaluated.

Results: A total of 109 participants (49 smokers, 60 non-smokers) were evaluated. In unadjusted analyses, smokers exhibited significantly higher white blood cell (WBC), neutrophil, lymphocyte, eosinophil, and hemoglobin levels ($p<0.05$). However, after adjusting for sex, only WBC ($p=0.002$) and lymphocyte ($p=0.033$) levels remained significantly higher in the smoker group. Correlation analyses showed that cumulative smoking exposure was positively associated with WBC, lymphocyte, and RDW levels ($p<0.05$). Multivariable linear regression further revealed that cumulative smoking exposure was an independent factor associated with higher leukocyte levels ($B=0.004$, $p=0.009$), whereas sex was the primary factor independently associated with red cell distribution width (RDW-SD) ($B=-2.555$, $p<0.001$). The inclusion of smoking exposure improved the adjusted R 2 for the WBC model from 0.015 to 0.113.

Conclusion: This study indicates that smoking is significantly associated with variations in hematological parameters and inflammatory markers. After adjusting for confounding factors such as sex, leukocyte and lymphocyte counts remained significantly elevated in smokers. Notably, cumulative smoking exposure was identified as an independent factor of higher leukocyte levels, increasing the adjusted R^2 of the model from 0.015 to 0.113. These findings suggest that chronic tobacco exposure may contribute to systemic inflammation and alterations in the leukocyte profile.

Keywords: Blood cell count, Hemoglobin, Smoking, Inflammation

Şule Şirin Berk
Kahramanmaraş Sütçü İmam University Faculty of Medicine, Department of Psychiatry, Kahramammaraş, Türkiye
Email: sulesirinberk@hotmail.com
ORCID iD: 0000-0001-8445-2394

Hatice Şahin
Kahramanmaraş Sütçü İmam University Faculty of Medicine , Department of Pulmonary Diseases, Kahramanmaraş, Türkiye
Email: drh.sahin@hotmail.com
ORCID iD: 0000-0002-3317-3640

Received: 2026-06-11
Accepted: 2026-08-05

e-ISSN: 3108-7973

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INTRODUCTION

Tobacco use is one of the most important global public health challenges and is associated with numerous causes of morbidity and mortality, particularly chronic obstructive pulmonary disease (COPD), cardiovascular diseases, and various malignancies (Gartner & Hall, 2024). Cigarette smoke contains thousands of toxic, mutagenic, and carcinogenic compounds that directly induce cellular damage. Inhalation of these substances triggers oxidative stress pathways at the cellular level, resulting in the development of persistent low-grade systemic inflammation (Khanna et al., 2013).

The hematopoietic system shows highly sensitive variations in relation to the chronic inflammatory processes and bone marrow stimulation induced by tobacco smoke exposure (Siggins et al., 2014). Previous studies have demonstrated that cigarette smoking is associated with a variety of hematological alterations, most notably leukocytosis (Malenica et al., 2017). However, the relationships between tobacco exposure and hematological/inflammatory markers-such as acute-phase reactants C-reactive protein (CRP) and complete blood count parameters such as white blood cell (WBC), neutrophil, lymphocyte, eosinophil, hemoglobin (Hb), red cell distribution width (RDW-SD), and plateletcrit (PCT) are complex and involve multiple underlying mechanisms (Sharafi et al., 2025). Furthermore, distinguishing the potential confounding effects of demographic factors such as age and sex on these parameters and determining the role of cumulative smoking exposure (pack-years) as an independent predictor are crucial for understanding the extent of tobacco-related systemic damage (Lee et al., 2025).

The present study aimed to evaluate the associations of active smoking and cumulative tobacco exposure on routine hematological parameters and inflammatory markers among healthy individuals attending an occupational health outpatient clinic. In addition, the study sought to investigate the influence of sex on these associations and to determine the independent relationship between cumulative smoking exposure and laboratory parameters using multivariable analytical models.

METHODS

This retrospective study was conducted between September 2025 and March 2026 and included a total of 109 volunteers who attended the Occupational Health Outpatient Clinic of xxx University Faculty of Medicine Hospital for routine health examinations or periodic medical surveillance. The study protocol was approved by the Ethics Committee of xxx University (Approval Date: 13.04.2026, Decision No: 11). Due to the retrospective nature of the study and the complete anonymization of patient data, the requirement for informed consent was officially waived by the ethics committee.

The inclusion criteria were: being between 18 and 65 years of age, having undergone periodic occupational health surveillance at the outpatient clinic during the study period, and having complete laboratory data available. Based on tobacco use status, participants were classified into two groups: active smokers,

defined as individuals who smoked at least one cigarette per day (n = 49), and never-smokers, defined as individuals who had never used cigarettes throughout their lifetime (n = 60). Following final database validation, the cohort sizes were confirmed as n = 49 for smokers and n = 60 for non-smokers (total N = 109), and all subsequent statistical analyses, including ANCOVA models, were executed using these verified cohort sizes.

The exclusion criteria included a history of acute or chronic infection, malignancy, autoimmune or chronic inflammatory systemic disease, hematological malignancy or disorders affecting bone marrow function, use of immunomodulatory medications (e.g., systemic corticosteroids) within the previous month, chronic medication use for major systemic diseases, regular or heavy alcohol consumption and pregnancy, all of which could directly influence hematological parameters and inflammatory processes.

Information regarding tobacco use status, type of exposure, and smoking characteristics, including the number of cigarettes smoked per day, duration of smoking, and cumulative exposure expressed as cumulative smoking exposure, was obtained from medical records. Specifically, these detailed smoking histories were extracted from the standardized medical anamnesis records documented by the examining physicians during face-to-face clinical interviews at the time of the outpatient clinic visit. Complete blood count parameters routinely assessed during occupational health surveillance, including WBC, neutrophil count, lymphocyte count, eosinophil count, Hb, platelet count (PLT), RDW, PCT, and immature granulocyte (IG) count, were retrospectively retrieved from the hospital electronic medical record system.

Statistical analyses

Statistical analyses were performed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA), and graphs were generated using GraphPad Prism version 10.4.1 (GraphPad Software, LLC, San Diego, CA, USA). Data distribution was assessed using the Kolmogorov–Smirnov test and visual inspection methods. Normally distributed continuous variables were presented as mean ± standard deviation, whereas non-normally distributed variables were expressed as median (25th–75th percentile). Categorical variables were presented as n (%).

Independent samples t-test was used for comparisons of normally distributed continuous variables, while Pearson's chi-square test was used for categorical variables according to expected cell frequencies. Since the proportion of females differed significantly between groups, sex was considered a potential confounding factor in the comparison of hematological parameters, and analysis of covariance (ANCOVA) was performed.

Spearman correlation analysis was used to evaluate the relationships between smoking-related variables and hematological parameters.

Multiple linear regression analyses were performed to determine the association of

smoking exposure with WBC and RDW levels, as these parameters showed significant unadjusted correlations with cumulative smoking exposure. Because lymphocyte count is a component of the total WBC count and was moderately to strongly correlated with WBC, WBC was selected as the representative leukocyte parameter to avoid redundancy in the regression model. Two regression models were constructed: Model 1 included age and sex, whereas Model 2 additionally included cumulative smoking exposure. Assumptions of linear regression analyses, including linearity, normality of residuals, homoscedasticity, independence of errors, and absence of multicollinearity, were evaluated and confirmed before analysis. A two-tailed p value < 0.05 was considered statistically significant.

RESULTS

A total of 109 participants were included in the study, consisting of 49 active smokers and 60 non-smokers. As shown in **Table 1**, the proportion of females was significantly higher in the non-smoker group compared to the smoker group (p = 0.020). No significant between-group differences were observed in age. Among smokers, the median number of cigarettes smoked per day was 10.0 (7.0–20.0), median smoking duration was 10.0 (5.0–13.8) years, and median cumulative smoking exposure was 100.0 (42.0–195.0).

As presented in **Table 2**, smokers had significantly higher WBC ($p < 0.001$), neutrophil ($p = 0.044$) lymphocyte ($p = 0.007$), eosinophil ($p < 0.001$), and Hb ($p = 0.004$) levels, whereas PCT ($p = 0.042$) levels were significantly lower

Table 1. Comparison of demographic characteristics, comorbidities, and smoking-related variables between active smokers and non-smokers

	Active smokers N=49	Non-smokers N=60	Effect size	p-value
Age, years[a]	32.0±6.3	31.7±7.7	NA	0.807
Sex, F[b]	16 (32.7)	33 (55.0)	0.220	**0.020**
Comorbidity HT DM Asthma COPD CAD Other	None	None	NA	NA
Cigarettes/day[c]	10.0 (7.0 ,20.0)	NA	NA	NA
Smoking duration,years[c]	10.0 (5.0 ,13.8)	NA	NA	NA
Exposure* [c]	100.0 (42.0 ,195.0)	NA	NA	NA

(*): Cigarettes/day x Smoking duration/years, a: mean ± standard deviation, b: n (%), c: median (25% - 75%)
Abbreviations: F, Female; HT, Hypertension; DM, Diabetes Mellitus; COPD, Chronic Obstructive Pulmonary Disease; CAD, Coronary Artery Disease

compared to non-smokers in the unadjusted analyses. However, after adjustment for sex, only WBC (p = 0.002, partial η^2= 0.09, moderate effect size) and lymphocyte levels (p = 0.033, partial eta squared = 0.04, low-effect size) remained significantly higher in smokers. No significant between-group differences were observed for neutrophil, RDW, HB, PLT, and IG levels after sex adjustment.

As shown in **Table 3**, cigarettes/day showed significant positive correlations with WBC (rho = 0.493, p < 0.001) and neutrophil levels (rho = 0.309, p = 0.033). Smoking duration was positively correlated with Hb levels (rho = 0.297, p = 0.042). In addition, cumulative smoking exposure was significantly correlated with WBC (rho = 0.391, p = 0.007), lymphocyte (rho = 0.311, p = 0.033), and RDW levels (rho = 0.315, p = 0.031). No other significant correlations were observed between smoking-related variables and hematological parameters.

Table 2. Comparison of hematological parameters between active smokers and non-smokers

	Active smokers N=49	Non-smokers N= 60	Effect size (Partial Eta Squared)	p-value[c]	p-value (adjusted for sex)[d]
WBC (×10³/µL)[a]	8.55 ± 1.84	7.34 ± 1.71	0.090	<0.001	0.002
Neutrophil (×10³/µL)[a]	4.82 ± 1.59	4.27 ± 1.49	0.030	0.044	0.064
Lymphocyte (×10³/µL)[a]	2.74 ± 0.74	2.35 ± 0.74	0.040	0.007	0.033
Eosinophil (×10³/µL)[b]	0.22 (0.13, 0.36)	0.13 (0.07 – 0.24)	0.030	<0.001	0.093
PCT (%)[a]	0.25 ± 0.05	0.27 ± 0.05	0.030	0.042	0.096
RDW-SD (fL)[a]	40.96 ± 2.59	41.16 ± 3.10	0.000	0.724	0.569
HB (g/dL)[a]	14.98 ± 1.59	14.09 ± 1.54	0.030	0.004	0.081
PLT (×10³/µL)[a]	253.63 ± 45.60	268.93 ± 54.11	0.020	0.118	0.197
IG (%)[b]	0.02 (0.01, 0.03)	0.02 (0.01,0.03)	0.020	0.138	0.221

a: mean ± standard deviation, b: median (25% - 75%), (c): Independent samples t test or Mann Whitney – U test, (d): ANCOVA
Abbreviations: SD, standard deviation; WBC, white blood cell count; PCT, plateletcrit; RDW, red cell distribution width; HB, hemoglobin; PLT, platelet count; IG, immature granulocyte

Table 3. Correlations between smoking exposure variables and hematological parameters in active smokers

	Cigarettes/day			Smoking duration			Exposure		
	rho	p-value	BH-FDR adjusted p-value	rho	p-value	BH-FDR adjusted p-value	rho	p-value	BH-FDR adjusted p-value
WBC	0.493	<0.001	0.009	-0.055	0.712	0.745	0.391	0.007	0.063
Neutrophil	0.309	0.033	0.149	-0.241	0.102	0.459	0.095	0.527	0.716
Lymphocyte	0.158	0.283	0.637	0.125	0.401	0.745	0.311	0.033	0.149
Eosinophil	0.129	0.381	0.668	0.178	0.231	0.693	0.281	0.056	0.168
PCT	0.113	0.445	0.668	-0.049	0.745	0.745	0.088	0.557	0.716
RDW	0.251	0.085	0.255	0.078	0.604	0.745	0.315	0.031	0.149
HB	0.051	0.728	0.728	0.297	0.042	0.378	0.199	0.180	0.405
PLT	0.067	0.651	0.728	-0.096	0.519	0.745	-0.004	0.978	0.978
IG	0.079	0.591	0.728	0.088	0.557	0.745	0.175	0.240	0.432

Abbreviations: WBC, white blood cell count; PCT, plateletcrit; RDW, red cell distribution width; HB, hemoglobin; PLT, platelet count; IG, immature granulocyte; BH-FDR, Benjamini–Hochberg False Discovery Rate.

After applying the Benjamini–Hochberg false discovery rate (BH-FDR) correction, only the positive correlation between cigarettes/day and WBC remained statistically significant (rho = 0.009). None of the other correlations remained significant after correction for multiple comparisons (all rho > 0.05).

As presented in **Table 4**, multivariable linear regression analyses were performed to determine the independent associations of age, sex, and cumulative smoking exposure with WBC and RDW levels in active smokers. In Model 1, which included only age and sex, neither age nor sex was significantly associated with WBC levels. However, sex was independently associated with RDW levels (B = -2.278, p = 0.003). In Model 2, after adding cumulative smoking exposure to the model, smoking exposure was found to be independently associated with higher WBC levels (B = 0.004, 95% CI: 0.001 to 0.008, p = 0.009), whereas age and sex remained non-significant . For RDW,

Table 4. Multiple linear regression analysis of factors associated with WBC and RDW levels in active smokers adjusted for age and sex

	WBC		RDW	
Model 1	B (95% CI)	p-value	B (95% CI)	p-value
Age	-0.045 (-0.134 to 0.044)	0.318	0.179 (0.071 to 0.288)	0.002
Sex*	0.457 (-0.731 to 1.646)	0.442	-2.278 (-3.726 to -0.830)	0.003
Adjusted R^2	0.015		0.242	
Model 2	B (95% CI)	p-value	B (95% CI)	p-value
Age	-0.060 (-0.144 to 0.024)	0.159	0.167 (0.060 to 0.274)	**0.003**
Sex*	0.115 (-1.025 to 1.255)	0.839	-2.555 (-4.009 to -1.102)	**<0.001**
Exposure	0.004 (0.001 to 0.008)	**0.009**	0.004 (-0.001 to 0.008)	0.089
Adjusted R^2	0.113		0.275	

(*): Sex was coded as 1 = female and 2 = male.
Abbreviations: B, Unstandardized Coefficients; WBC, white blood cell count; RDW, red cell distribution width

sex remained a significant independent factor (B = -2.555, $p < 0.001$), while cumulative smoking exposure was not independently associated with RDW levels ($p = 0.089$). The adjusted R^2 value increased from 0.015 to 0.113 for WBC and from 0.242 to 0.275 for RDW after inclusion of cumulative smoking exposure in the models. All predictors showed acceptable collinearity, with tolerance values ranging from 0.897 to 0.926 and VIF values ranging from 1.080 to 1.115, indicating no evidence of multicollinearity.

DISCUSSION

In the present study, hematological parameters were compared between healthy active smokers and healthy non-smoking controls, and the independent effects of tobacco smoke exposure on leukocyte profiles and erythrocyte indices were investigated using multivariate analyses. The principal finding of our study was that, in unadjusted analyses, smokers exhibited significantly higher WBC, neutrophil, lymphocyte, eosinophil, and Hb levels, whereas PCT levels were significantly lower. However, after controlling for sex—a factor frequently overlooked in the literature despite its substantial influence on hematological parameters-via ANCOVA, the independent effect of smoking on WBC and lymphocyte counts remained significant, whereas the significance of differences observed in other parameters disappeared. These findings highlight the importance of considering sex distribution as a potential confounding factor in studies investigating the relationship between smoking and hematological indices (Campesi et al., 2020; Zhao et al., 2026).

Previous studies have consistently reported that cigarette smoking increases peripheral total WBC counts (Chee et al., 2025). Inhalation of tobacco smoke activates alveolar macrophages in the lungs, leading to the release of pro-inflammatory cytokines such as IL-1, IL-6, and TNF-α, which subsequently stimulate leukocyte mobilization from the bone marrow (Sehlikoğlu et al., 2024). Our findings are consistent with this pathophysiological mechanism, as WBC and lymphocyte levels remained significantly elevated among smokers even after adjustment for sex ($p = 0.002$ and $p = 0.033$, respectively).

Furthermore, unadjusted correlation analyses revealed a significant positive association between the number of cigarettes smoked per day and WBC count. In our multivariable linear regression model (Model 2), cumulative smoking exposure was independently associated with higher WBC levels after adjustment for age and sex. Notably, inclusion of cumulative smoking exposure substantially improved the model's explanatory power, increasing the adjusted R^2 value for WBC from 0.015 to 0.113 (representing an increase in explained variance from 1.5% to 11.3%). It should be noted that this dose-response linear regression analysis evaluating pack-years was conducted exclusively within the active smoking subgroup (n = 49), rather than the overall study population. Consistent with these findings, Smith et al. (2021) also demonstrated a significant association between tobacco use and asymptomatic leukocytosis, while Higuchi et al. (2016) highlighted the substantial impact of smoking status on mathematical models of leukocyte variance. These results further suggest the association between increasing chronic tobacco exposure and greater degrees of subclinical systemic inflammation.

Although neutrophil, eosinophil, and Hb levels were significantly higher in smokers in unadjusted analyses, these differences lost statistical significance after adjustment for sex. Cigarette smoking is known to induce tissue hypoxia, stimulating erythropoietin production and thereby increasing hemoglobin levels. However, our findings suggest that the observed difference in Hb levels was largely attributable to sex-related variation, as males physiologically exhibit higher Hb concentrations and were overrepresented in the smoking group (Beleslin-Cokic et al., 2004). Nevertheless, the positive correlation observed in unadjusted analyses between smoking duration and Hb levels (rho = 0.297, p = 0.042) suggests that prolonged exposure to tobacco smoke may be linked to a hypoxia-driven stimulatory pattern in erythrocyte mass. However, because the between-group difference in Hb disappeared after sex adjustment and the correlation was no longer significant after BH-FDR correction, this finding should be interpreted with caution.

RDW has recently gained attention not only as a marker for differential diagnosis of anemia but also as a biomarker of chronic inflammation and cardiovascular risk (Marzouk et al., 2020). In our study, no significant difference in RDW was observed between smokers and non-smokers. However, among smokers, cumulative smoking exposure demonstrated a significant positive correlation in unadjusted analysis with RDW (rho = 0.315, p = 0.031). Further investigation using multivariable regression analysis yielded an interesting finding: although cumulative smoking exposure showed a borderline association with RDW after adjustment (p = 0.089), sex emerged as the strongest and most significant independent factor related to RDW-SD ($B = -2.555$, $p < 0.001$). These results suggest that the potential adverse effects of smoking on erythropoiesis, such as inflammation-induced anisocytosis, may be overshadowed by physiological variations associated with biological sex (Erik et al., 2025).

Regarding platelet indices, unadjusted analyses demonstrated significantly lower PCT levels among smokers (p = 0.042). PCT reflects total platelet mass as the proportion of platelet volume within the total blood volume. Similar to the findings observed for leukocyte-related parameters, the significance of this difference disappeared after adjustment for sex (p = 0.096) (Yuan et al., 2026). Furthermore, no significant differences were identified in PLT or IG-percentages between groups, nor were any significant correlations observed with smoking exposure variables. These findings suggest that, within the study population, the systemic inflammatory response associated with smoking is primarily mediated through lymphoid and myeloid leukocyte pathways, whereas the megakaryocytic lineage may not yet be substantially involved in the early subclinical inflammatory process (El-Mahdy et al., 2020).

One of the major strengths of our study is the rigorous methodological control of key confounding variables, particularly age and sex, through both ANCOVA and multivariable linear regression analyses. This approach helps clarify some of the inconsistencies reported in previous studies. Nevertheless, several limitations should be acknowledged. First, the study was conducted at a single center with a relatively small sample size (n = 109), and the study population consisted of relatively young, healthy individuals attending an occupational health outpatient clinic, which may limit the generalizability of our findings to broader or clinical populations. Second, a key limitation of our study is the potential for residual confounding due to unmeasured lifestyle and physiological variables. Specifically, parameters such as body mass index (BMI), dietary habits, alcohol consumption, and physical activity levels were unavailable for adjustment. BMI and nutritional status are well-established modulators of low-grade systemic inflammation and leukocyte counts, while physical activity and chronic alcohol exposure can independently influence subclinical inflammatory markers and hematological profiles. The inability to control for these potential confounders means that residual confounding cannot be completely ruled out, and part of the observed associations could be influenced by unmeasured baseline differences between smokers and non-smokers. Third, the correlation and dose-response regression analyses evaluating smoking exposure parameters were performed exclusively within the subgroup of active smokers (n = 49), rather than the general cohort, and therefore should be considered exploratory. Fourth, major acute-phase reactants such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) could not be comprehensively analyzed due to insufficient data availability, limiting our ability to establish the direct relationship between humoral inflammatory responses and cellular inflammatory markers such as WBC and lymphocyte counts (Elisia et al., 2020). Future prospective studies with larger sample sizes and comprehensive adjustment for lifestyle confounders are warranted to validate these findings.

CONCLUSION

This study suggests that chronic tobacco use is associated with alterations in hematological parameters and markers of systemic inflammation. Even after controlling for potential confounding factors such as sex, WBC and lymphocyte counts remained significantly higher in smokers, aligning with the strong associations between cigarette smoking on immune function and inflammatory processes. While sex emerged as the primary factor independently associated with RDW-SD in the overall cohort, cumulative smoking exposure (pack-years) was identified as a strong independent factor associated with elevated WBC levels strictly within the active smoking subgroup (n = 49), increasing the proportion of explained variance for leukocyte profiles from 1.5% to 11.3%.

In clinical practice, smoking history and cumulative tobacco exposure should be carefully considered when interpreting complete blood count results in smokers. The physiological and pathological tendency toward increased leukocyte and lymphocyte counts may reflect chronic low-grade subclinical inflammation; failing to account for this exposure may otherwise lead to unnecessary diagnostic evaluations and investigations in otherwise healthy individuals.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

Financial Support

The Authors report no financial support regarding content of this article.

Ethical Declaration

This study was conducted with the decision of Kahramanmaraş Sütçü İmam University Faculty of Medicine Ethics Committee dated 13.04.2026 and numbered 2026/11. As this was a retrospective study, the requirement for written informed consent was waived by the committee. The study was conducted in accordance with the principles of the Declaration of Helsinki and all patient data were anonymized prior to analysis to ensure confidentiality

Author Contributions

Concept: ŞŞB,HŞ Design: ŞŞB,HŞ, Supervising: ŞŞB,HŞ, Financing and equipment: ŞŞB, HŞ, Data collection and entry:ŞŞB, HŞ, Analysis and interpretation:ŞŞB, HŞ, Literature search: ŞŞB,HŞ, Writing: ŞŞB,HŞ, Critical review: ŞŞB, HŞ

Corresponding Author

Hatice Şahin: Kahramanmaraş Sütçü İmam University
Faculty of Medicine , Department of Pulmonary Diseases,
Kahramanmaraş, Türkiye

ORCID iD: 0000-0002-3317-3640

Email: drh.sahin@hotmail.com

Journal of Dependence, 2026; 27(3):165-182

JOURNAL OF DEPENDENCE

Research Article

Behavioral addiction tendencies and associated psychosocial factors in faculty members

Esma Akpinar Aslan, Figen Ünal Demir

DOI: 10.51982/bagimli.623

Abstract

Objective: Behavioral addictions may be associated with psychological symptoms and work-related factors. However, studies evaluating multiple behavioral addiction domains among faculty members remain limited. This study aimed to investigate behavioral addiction tendencies and associated psychosocial factors among faculty members.

Methods: This cross-sectional online study included 202 faculty members. Participants completed an online survey consisting of a sociodemographic questionnaire, the Depression Anxiety Stress Scale-21 (DASS-21), Pittsburgh Sleep Quality Index (PSQI), Bergen Work Addiction Scale (BWAS), Smartphone Addiction Scale–Short Version (SAS-SV), Bergen Social Media Addiction Scale (BSMAS), Internet Gaming Disorder Scale–Short Form (IGDS9-SF), Modified Yale Food Addiction Scale (mYFAS 2.0), and Online Gambling Addiction Scale (OGAS). Group comparisons and correlation analyses were performed.

Results: Behavioral addiction tendencies were observed at varying levels among faculty members, with work addiction, smartphone addiction, and social media addiction showing the highest scores. Depression, anxiety, and stress were positively associated with work addiction, smartphone addiction, social media addiction, and internet gaming disorder scores. Faculty members working more than 40 hours per week had significantly higher work addiction scores. Smartphone use, social media use, and gaming-related behaviors were positively associated with one another, whereas online gambling/betting tendencies demonstrated a distinct pattern.

Conclusion: Behavioral addiction tendencies in faculty members appear to be associated with psychological symptoms and selected work-related characteristics. These findings contribute to the limited literature examining multiple behavioral addiction domains among faculty members and highlight the importance of considering behavioral addictions within a broader psychosocial context.

Keywords: Behavioral addictions, Faculty members, Work addiction, Psychological symptoms

Esma Akpinar Aslan
Department of Psychiatry, School of Medicine, Tokat Gaziosmanpasa University, Tokat, Türkiye.
E-mail: esma.akpinaraslan@gop.edu.tr
ORCID iD: 0000-0003-4714-6894

Figen Ünal Demir
Department of Psychiatry, School of Medicine, Tokat Gaziosmanpasa University, Tokat, Türkiye.
E-mail: funal86@hotmail.com
ORCID iD: 0000-0002-8258-2600

Received: 2026-06-12
Accepted: 2026-08-26

e-ISSN: 3108-7973

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INTRODUCTION

Although addiction has traditionally been conceptualized within the framework of substance use disorders, increasing evidence suggests that certain repetitive behaviors share neurobiological, cognitive, and behavioral mechanisms similar to those involved in addictive processes. Both substance-related and behavioral addictions have been associated with dysregulation of the mesolimbic reward system, particularly dopaminergic pathways involved in reward processing and reinforcement, as well as alterations in prefrontal brain regions responsible for inhibitory control and decision-making. Repeated engagement in rewarding behaviors may strengthen craving, reinforce maladaptive learning processes, and ultimately promote compulsive behavioral patterns despite adverse consequences. These shared mechanisms provide a neurobiological rationale for conceptualizing behavioral addictions within the addiction spectrum (Brand et al., 2019; Hunt et al., 2024; Volkow et al., 2016). Consequently, increasing attention has been directed toward behavioral addictions, particularly in the context of rapid technological advances and evolving social environments. Various behavioral addiction domains, including internet gaming disorder, compulsive buying, pornography- and sex-related behaviors, and food-related behaviors, have attracted growing research interest. Internet gaming disorder remains one of the most extensively investigated technology-related behavioral addictions, with a rapidly expanding body of evidence over the past decade (Kuss & Griffiths, 2012; Zhuang et al., 2023). The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) recognized gambling disorder as a non-substance-related addictive disorder under the broader category of substance-related and addictive disorders, providing an important indication of the clinical relevance of behavioral addictions (APA, 2013). Internet gaming disorder was included as a condition requiring further investigation, whereas other behavioral patterns were not incorporated because of insufficient evidence regarding diagnostic criteria and disease course (APA, 2013).

Behavioral addiction is generally defined as the persistent and repetitive engagement in a specific activity despite adverse consequences and impaired control over the behavior (Grant et al., 2010). One of the most widely accepted frameworks for conceptualizing behavioral addictions is Griffiths' components model, which proposes six core dimensions: salience, mood modification, tolerance, withdrawal, conflict, and relapse (Griffiths, 2005). Behavioral patterns such as work addiction, social media addiction, internet gaming disorder, and problematic smartphone use have been evaluated within this framework (Fournier et al., 2023). More recently, the Interaction of Person–Affect–Cognition–Execution (I-PACE) model, originally proposed by Brand et al. (2016) and subsequently updated and generalized to behavioral addictions beyond internet-use disorders (Brand et al., 2019), has provided a broader neurocognitive framework in which individual predispositions (e.g., personality traits and psychopathology) interact with affective and cognitive responses to influence inhibitory control, decision-making, and the development of addictive behaviors. This framework also provides a theoretical basis for understanding the development and maintenance of behavioral addictions, as well as their associations with psychosocial factors such as depression, anxiety, stress, and sleep quality (Brand et al., 2019). This perspective suggests that examining multiple behavioral addiction domains together may provide a more comprehensive understanding, particularly in populations in which several risk behaviors may co-occur.

The social and psychological consequences of behavioral addictions have led to growing research interest. Meta-analyses indicate prevalence estimates ranging from approximately 10–14% for internet addiction, 24–27% for smartphone addiction, 6–17% for social media addiction, 10–21% for food addiction, and 3–7% for gambling-related problems (Alimoradi et al., 2022; Meng et al., 2022). Similar findings have also been reported in Turkish and regional studies (Akpinar Aslan et al., 2021; Gürbüzer & Gürcan Yıldırım, 2025).

However, most existing studies have focused on the general population or student samples, whereas occupational groups, particularly faculty members, remain comparatively underinvestigated.

The I-PACE framework proposes that affective processes and individual characteristics contribute substantially to the development of problematic behaviors (Brand et al., 2016, 2019). Increased levels of depression, anxiety, and stress may lead individuals to engage in specific behaviors as a means of emotional regulation, avoidance, or temporary relief, whereas behavioral addiction patterns themselves may contribute to psychological distress over time (Brand et al., 2014). Previous studies have reported bidirectional associations between psychological symptoms and behavioral addiction domains such as internet addiction and food addiction (Lin et al., 2025; Sun et al., 2025). Accordingly, evaluating behavioral addiction tendencies together with depression, anxiety, and stress may contribute to a more comprehensive understanding of these relationships.

Sleep quality represents another psychosocial factor potentially associated with behavioral addiction tendencies. Impaired sleep may negatively affect executive functioning and reduce inhibitory control, thereby increasing vulnerability to problematic behavioral patterns. Previous studies have reported associations between poor sleep quality and internet addiction, internet gaming disorder, and social media addiction. Existing evidence suggests a potentially bidirectional relationship in which sleep disturbances and behavioral addiction tendencies may mutually reinforce one another (Alimoradi et al., 2019; Han et al., 2024).

Behavioral addictions have generally been examined as isolated constructs rather than multidimensional patterns. Considering multiple behavioral addiction domains together may provide a broader perspective on shared mechanisms and overlapping behavioral profiles. Although previous studies have primarily focused on individual behavioral addiction domains, studies simultaneously examining multiple behavioral addiction tendencies together with their associated psychosocial factors among faculty members remain scarce. The increasing digitalization of academic life and growing occupational demands may place faculty members at risk for both technology-related behavioral addiction tendencies and psychological difficulties, including depression, anxiety, and stress. In Turkey, faculty members commonly undertake multiple academic responsibilities, including teaching, research, academic advancement, and administrative duties, often extending beyond regular working hours, resulting in a substantial workload (Çelik et al., 2023). These occupational characteristics make faculty members a theoretically relevant and practically important population for investigating behavioral addiction tendencies. Accordingly, the present study simultaneously examines multiple behavioral addiction domains together with depression, anxiety, stress, and sleep quality among faculty members, aiming to provide a multidimensional understanding of behavioral addiction tendencies and their psychosocial correlates in this occupational group. The present study aimed to investigate behavioral addiction tendencies and associated psychosocial factors among faculty members and tested the following hypotheses:

H1. Behavioral addiction tendencies are expected to be observed across multiple behavioral domains among faculty members, including social media use, smartphone use, internet gaming, work-related behaviors, online gambling/betting, and eating behaviors.

H2a. Higher weekly working hours will be positively associated with work addiction tendencies.

H2b. Longer daily internet use will be positively associated with technology-related behavioral addiction domains, including problematic smartphone use, social media addiction, and internet gaming disorder.

H3. Depression, anxiety, and stress levels are expected to be positively associated with each behavioral addiction domain examined, including work addiction, problematic smartphone use, social

media addiction, internet gaming disorder, online gambling/betting, and food addiction.

H4. Poor sleep quality is positively associated with behavioral addiction scale scores.

H5. Positive associations exist among digital behavioral addiction domains, including social media use, smartphone use, internet gaming, and online gambling/betting.

METHODS

Participants

The study included 202 faculty members aged 18 years and older who were actively employed at a university. No specific university or geographical region in Türkiye was targeted during recruitment. The online survey was disseminated through academic networks, and faculty members from universities across Türkiye were invited to participate on a voluntary basis. Electronic informed consent was obtained from all participants before participation. As the study aimed to evaluate behavioral addiction tendencies among actively employed faculty members, no additional exclusion criteria were applied.

Procedure

All participants completed an online survey developed by the researchers using the Google Forms platform. Data were collected between January and April 2026. Survey links were distributed through e-mail and social media platforms (e.g., Facebook professional groups and WhatsApp groups), and participants were recruited using convenience sampling, supplemented by snowball dissemination, whereby initial recipients were encouraged to share the survey link with other eligible faculty members. The first page of the survey contained an informed consent form, and participants were required to provide electronic informed consent before proceeding. The survey was conducted anonymously, and no personally identifiable information (e.g., names or e-mail addresses) was collected. An a priori power analysis was conducted for the planned correlation analyses. Assuming an expected correlation coefficient of r = .20, a statistical power of 80%, and a two-sided significance level of .05, the minimum required sample size was calculated as 194 participants. The final sample exceeded this requirement. The survey included, in sequence, a sociodemographic questionnaire, Depression Anxiety Stress Scale-21 (DASS-21), Pittsburgh Sleep Quality Index (PSQI), Bergen Work Addiction Scale (BWAS), Smartphone Addiction Scale–Short Version (SAS-SV), Bergen Social Media Addiction Scale (BSMAS), Internet Gaming Disorder Scale–Short Form (IGDS9-SF), Modified Yale Food Addiction Scale (mYFAS 2.0), and Online Gambling Addiction Scale (OGAS).

The survey was configured to prevent unanswered items. Completion of all questionnaires required approximately 15 minutes.

Data Collection Tools

Sociodemographic Questionnaire

The questionnaire was developed by the researchers and included items regarding age, gender, work-related characteristics, and internet-use behaviors.

Depression Anxiety Stress Scale-21 (DASS-21)

The DASS-21 (Henry & Crawford, 2005) is a 21-item, four-point Likert-type scale designed to assess symptoms of depression, anxiety, and stress. Each subscale consists of seven items, and higher scores indicate greater symptom severity. The Turkish version validated by Sarıcam (2018) was used. In the current sample, Cronbach's α coefficients for the depression, anxiety, and stress subscales of the DASS-21 were .793, .830, and .835, respectively.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI (Buysse et al., 1989) is a widely used instrument assessing sleep quality across seven components, including sleep duration, sleep latency, habitual sleep efficiency, sleep disturbances, use of sleep medication, daytime dysfunction, and subjective sleep quality. Total scores above 5 indicate poor sleep quality. The Turkish version validated by Agargun et al. (1996) was used. In the current sample, Cronbach's α coefficient was .709.

Bergen Work Addiction Scale (BWAS)

The BWAS (Andreassen et al., 2012) is a seven-item, five-point Likert-type scale assessing work addiction tendencies. Higher scores indicate greater work addiction tendency. The Turkish version validated by Ozsoy (2020) was used. In the current sample, Cronbach's α coefficient was .820.

Smartphone Addiction Scale–Short Version (SAS-SV)

The SAS-SV (Kwon et al., 2013) is a 10-item, six-point Likert-type scale assessing problematic smartphone use risk. Higher scores indicate greater smartphone addiction tendency. The Turkish version validated by Noyan et al. (2015) was used. In the current sample, Cronbach's α coefficient was .920

Bergen Social Media Addiction Scale (BSMAS)

The BSMAS (Andreassen et al., 2016) is a six-item, five-point Likert-type scale evaluating social media addiction tendency. Higher scores indicate greater risk. The Turkish version validated by Demirci (2019) was used. In the current sample, Cronbach's α coefficient was .901.

Internet Gaming Disorder Scale–Short Form (IGDS9-SF)

The IGDS9-SF (Pontes & Griffiths, 2015) was developed according to DSM-5 diagnostic criteria and consists of nine items assessing internet gaming disorder symptoms. Higher scores indicate greater gaming-related problems. The Turkish version validated by Aricak et al. (2018) was used. In the current sample, Cronbach's α coefficient was .916.

Modified Yale Food Addiction Scale Version 2.0 (mYFAS 2.0)

The mYFAS (Schulte & Gearhardt, 2017) 2.0 is a 13-item instrument based on DSM-5 symptom criteria for food addiction. Higher scores indicate greater food addiction tendency. The Turkish version validated by Tok et al. (2023) was used. In the current sample, Cronbach's α coefficient was .930.

Online Gambling Addiction Scale (OGAS)

The OGAS was developed by Karaibrahimoglu et al. (2022) and consists of 21 items across three dimensions: motivation, addiction, and negative psychology. Scores range from 21 to 105, with higher scores indicating greater online gambling/betting addiction tendency. A cut-off score of 27 has been proposed, with higher values indicating risk status. In the current sample, Cronbach's α coefficient was .998.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). Data distribution was assessed using histograms, Q–Q plots, and Shapiro–Wilk tests. Because scale scores did not meet the assumption of normality, nonparametric tests were applied.

Descriptive statistics included medians, interquartile ranges (Q1–Q3), minimum–maximum values, mean ranks, frequencies (n), and percentages (%), as appropriate. Missing data were identified for PSQI-derived variables ($n = 9$, 4.5%; valid $n = 193$) and academic experience duration in months ($n = 3$, 1.5%; valid $n = 199$). No imputation procedures were performed, and analyses were conducted using available data.

The Mann–Whitney U test was used for comparisons between two independent groups, whereas the Kruskal–Wallis H test was applied for comparisons involving three or more groups. Bonferroni correction was used for post hoc pairwise analyses following significant Kruskal–Wallis tests. Because the analyses were hypothesis-driven and based on prespecified comparisons, no global adjustment for multiple testing was applied. Associations between variables were examined using Spearman's rank correlation analysis. Statistical significance was set at $p < .05$.

Ethical approval

This study was conducted in accordance with the Declaration of Helsinki and approved by the Non-Interventional Scientific Research Ethics Committee of Tokat Gaziosmanpaşa University (Approval No: 25-MOBAEK-455; Date: December 12, 2025).

RESULTS

Participant Characteristics

The mean age of participants was 42.15 ± 6.70 years, and 58.9% were female (n = 119). Detailed demographic, lifestyle, clinical, internet-use, and sleep-related characteristics are presented in **Tables 1 and 2**.

Descriptive Characteristics of Scale Scores

The mean DASS-21 depression, anxiety, and stress subscale scores were 9.37 ± 6.76, 8.54 ± 6.32, and 8.68 ± 6.93, respectively. According to PSQI scores, 58.0% of participants had good sleep quality. Based on OGAS scores, 23.8% of participants were classified as being at risk. Descriptive statistics for behavioral addiction scales are presented in **Table 3**.

Comparisons of Behavioral Addiction Scores According to Participant Characteristics

Comparisons of behavioral addiction scores according to participant characteristics are presented in **Table 4.** Male participants had significantly higher IGDS9-SF scores than female participants (Z = −2.513, p = .012). Although median scores were similar, the wider interquartile range among males suggested a greater distribution of elevated gaming-related scores. No gender differences were observed for BWAS, SAS-SV, BSMAS, mYFAS, or OGAS scores.

Participants older than 40 years tended to have higher OGAS scores than those aged 40 years or younger (Z = −1.962, p = .050). No significant age-related differences were found for BWAS, SAS-SV, BSMAS, IGDS9-SF, or mYFAS scores.

BWAS scores differed significantly across weekly working-hour groups (H(2, n = 202) = 11.98, p = .002). Post-hoc pairwise comparisons with Bonferroni correction indicated that BWAS scores were significantly higher among participants working 41–49 hours and ≥50 hours per week compared with those working ≤40 hours per week (adjusted p = .010 and p = .020, respectively). No significant difference was observed between the 41–49 and ≥50 hours groups (adjusted p = 1.000). No significant differences were found for SAS-SV, BSMAS, IGDS9-SF, mYFAS, or OGAS scores.

Table 1. Sociodemographic characteristics (N = 202)

Variable	Mean ± SD	Median (Min–Max)	n	%
Age, years	42.15 ± 6.70	41 (27–63)		
Academic experience, months	145.74 ± 103.03	132 (2–540)		
Age group				
≤40 years			94	46.5
>40 years			108	53.5
Gender				
Female			119	58.9
Male			83	41.1
Marital status				
Single			31	15.3
Married			158	78.2
Divorced/Widowed			13	6.4
Has children				
No			46	22.8
Yes			156	77.2
Academic title				
Research assistant			17	8.4
Lecturer			16	7.9
Assistant professor			74	36.6
Associate professor			52	25.7
Professor			43	21.3
Faculty group				
Medicine			96	47.5
Non-health faculties			65	32.2
Other health-related faculties			25	12.4
Vocational school/School/ Conservatory			16	7.9
Weekly working hours				
≤40 hours			100	49.5
41–49 hours			63	31.2
≥50 hours			39	19.3
Administrative duty				
No			64	31.7
Yes			138	68.3

Note: Categorical variables are presented as frequencies (n) and percentages (%). Continuous variables are presented as mean ± standard deviation (SD) and median (minimum–maximum).

Table 2. Lifestyle, clinical, internet-use, and sleep-related characteristicss (N = 202)

Variable	n	%
Smoking status		
Never	147	72.8
Former	11	5.4
Occasional	21	10.4
Daily	23	11.4
Alcohol use		
Never	151	74.8
Former	2	1.0
Occasional	47	23.3
Daily	2	1.0
Psychiatric history		
No	174	86.1
Yes	28	13.9
Psychiatric medication use		
No	165	81.7
Yes	37	18.3
Daily internet use		
<2 hours	28	13.9
2–4 hours	88	43.6
>4 hours	86	42.6
Internet use purpose		
Academic/work-related	200	99.0
Social media	166	82.2
Shopping	110	54.5
Gaming	14	6.9
News	5	2.5
Entertainment	4	2.0

Table 2. (Continued)

Variable	n	%
Education	4	2.0
Sleep duration		
≤5 hours	13	6.4
6–7 hours	158	78.2
≥8 hours	31	15.3
Screen use before bed		
No	32	15.8
Yes	170	84.2
Perceived sleep problem		
No	119	58.9
Yes	83	41.1
General stress		
No	36	17.8
Partly/Somewhat	86	42.6
Yes	80	39.6
Academic workload affects quality of life		
No	70	34.7
Yes	132	65.3
PSQI sleep quality group*		
Good sleep quality	112	58.0
Poor sleep quality	81	42.0
OGAS risk status		
No risk (≤27)	154	76.2
Risk (>27)	48	23.8

Note: Values are presented as frequencies (n) and percentages (%). OGAS = Online Gambling Addiction Scale; PSQI = Pittsburgh Sleep Quality Index.
*Multiple responses were allowed for internet use purpose.
† Percentages for PSQI sleep quality group were calculated based on valid cases (n = 193).

Table 3. Descriptive statistics of behavioral addiction scale scores and online gambling/betting risk status (n = 202)

Behavioral addiction	Scale	Median (Q1–Q3)	Min.–Max.	Risk classification
Work addiction	BWAS	19.00 (14.00–23.00)	7.00–33.00	Not classified
Smartphone addiction	SAS-SV	21.00 (14.00–28.00)	10.00–53.00	Not classified
Social media addiction	BSMAS	11.00 (7.00–15.00)	6.00–28.00	Not classified
Gaming disorder	IGDS9-SF	9.00 (9.00–11.00)	9.00–31.00	Not classified
Food addiction	mYFAS	0.00 (0.00–0.00)	0.00–13.00	Not classified
Online gambling/betting	OGAS	21.00 (21.00–25.25)	21.00–105.00	No risk: 154 (76.2%) Risk: 48 (23.8%)

Note: BSMAS = Bergen Social Media Addiction Scale; BWAS = Bergen Work Addition Scale; IGDS9-SF = Internet Gaming Disorder Scale-Short Form; mYFAS = Modified Yale Food Addiction Scale; OGAS = Online Gambling Addiction Scale; SAS-SV = Smartphone Addiction Scale-Short Version. Values are presented as median (Q1–Q3) and minimum–maximum. Q1 and Q3 indicate the first and third quartiles, respectively. Risk classification was reported only for OGAS because it has a predefined cut-off score.

Behavioral addiction scores were also compared according to daily internet use duration. Significant differences were observed for SAS-SV ($H(2, n = 202) = 15.54$, $p < .001$) and BSMAS scores ($H(2, n = 202) = 9.06$, $p = .011$). Post-hoc analyses revealed that participants reporting high daily internet use (>4 h) had significantly higher BSMAS scores than those reporting low daily internet use (<2 h). For SAS-SV, both moderate (2–4 h) and high (>4 h) internet-use groups scored significantly higher than the low-use group. No significant differences were observed for BWAS, IGDS9-SF, mYFAS, or OGAS scores. The observed effect sizes for the significant group differences ranged from small to moderate (rank-biserial r = .128–.176; ε^2 = .045–.077), indicating generally modest practical significance.

Behavioral addiction scores were also examined according to academic title and administrative duty status. Although an overall difference was found across academic title groups for SAS-SV scores ($H(4, n = 202) = 9.56$, $p = .048$), Bonferroni-adjusted post-hoc analyses did not reveal significant pairwise differences. Behavioral addiction scores also did not differ according to administrative duty status.

Associations Between Behavioral Addiction Scores and Psychological Symptoms and Sleep Characteristics

As shown in **Table 5**, BWAS, SAS-SV, BSMAS, IGDS9-SF, and mYFAS scores showed significant positive correlations with DASS-21 depression, anxiety, and stress scores. In contrast, OGAS scores were not significantly associated with psychological symptom levels. Regarding sleep quality, BWAS and IGDS9-SF scores showed positive correlations with PSQI scores, whereas OGAS scores demonstrated a weak negative correlation. No significant associations were observed between PSQI scores and SAS-SV, BSMAS, or mYFAS scores.

Correlations Among Behavioral Addiction Domains

Correlations among digital behavioral addiction domains are presented in **Table 6**. Significant positive associations were observed among SAS-SV, BSMAS, and IGDS9-SF scores. However, OGAS scores were not significantly associated with any other digital behavioral addiction domains.

Associations between work addiction and other behavioral addiction domains were also examined. BWAS scores showed weak but significant positive correlations with SAS-SV ($\rho = .255$, $p < .001$), BSMAS ($\rho = .222$, $p < .01$), and mYFAS 2.0 scores ($\rho = .211$, $p < .01$). No significant correlations were observed between BWAS scores and IGDS9-SF ($\rho = .043$, $p > .05$) or OGAS scores ($\rho = -.130$, $p > .05$).

Table 4. Comparison of behavioral addiction scores according to participant characteristics (N = 202)

Variable	Group	BWAS Median (Q1–Q3)	SAS-SV Median (Q1–Q3)	BSMAS Median (Q1–Q3)	IGDS9-SF Median (Q1–Q3)	mYFAS Median (Q1–Q3)	OGAS Median (Q1–Q3)
Gender	**Female (119)**	19.0 (14.0–23.0)	22.0 (15.0–28.0)	12.0 (7.0–16.0)	9.0 (9.0–10.0)	0.0 (0.0–0.0)	21.0 (21.0–25.0)
	Male (83)	19.0 (15.0–22.0)	20.0 (13.0–28.0)	11.0 (6.0–15.0)	9.0 (9.0–14.0)	0.0 (0.0–0.0)	21.0 (21.0–27.0)
	p	.847	.247	.567	.012*	.588	.954
	Effect size (r)	-.016	-.096	-.047	.176	.030	.004
Age group	**≤40 years (94)**	19.0 (15.0–22.0)	21.0 (14.0–30.0)	11.0 (6.0–16.0)	9.0 (9.0–11.25)	0.0 (0.0–0.0)	21.0 (21.0–21.0)
	>40 years (108)	18.0 (14.0–23.0)	20.5 (14.0–26.75)	11.0 (7.0–15.0)	9.0 (9.0–10.0)	0.0 (0.0–0.0)	21.0 (21.0–33.0)
	p	.700	.674	.950	.214	.490	.050
	Effect size (r)	-.031	-.034	.005	-.086	.038	.128
Weekly working hours	**≤40 h (100)**	17.0 (12.25–22.0)a	19.0 (13.0–27.0)	11.0 (6.25–15.0)	9.0 (9.0–11.0)	0.0 (0.0–0.0)	21.0 (21.0–23.5)
	41–49 h (63)	19.0 (16.0–24.0)b	21.0 (17.0–30.0)	11.0 (7.0–16.0)	9.0 (9.0–11.0)	0.0 (0.0–0.0)	21.0 (21.0–33.0)
	≥50 h (39)	20.0 (16.0–24.0)b	23.0 (14.0–29.0)	11.0 (6.0–15.0)	9.0 (9.0–15.0)	0.0 (0.0–0.0)	21.0 (21.0–33.0)
	p	.002*	.138	.771	.583	.377	.769
	Effect size (ε^2)	.060	.020	.003	.005	.010	.003
Daily internet use	**<2 h (28)**	19.0 (12.5–22.75)	15.5 (10.0–20.0)a	7.5 (6.0–10.75)a	9.0 (9.0–9.75)	0.0 (0.0–0.0)	21.0 (21.0–42.25)
	2–4 h (88)	19.0 (15.0–23.0)	21.5 (16.25–29.75)b	11.0 (7.0–15.0)ab	9.0 (9.0–10.0)	0.0 (0.0–0.0)	21.0 (21.0–24.75)
	>4 h (86)	18.5 (13.75–23.0)	22.0 (14.0–29.25)b	12.5 (7.0–17.0)b	9.0 (9.0–12.25)	0.0 (0.0–0.0)	21.0 (21.0–29.25)
	p	.798	<.001*	.011*	.173	.920	.935
	Effect size (ε^2)	.002	.077	.045	.017	.001	.001

Note: BSMAS = Bergen Social Media Addiction Scale; BWAS = Bergen Work Addiction Scale; IGDS9-SF = Internet Gaming Disorder Scale–Short Form; mYFAS = Modified Yale Food Addiction Scale; OGAS = Online Gambling Addiction Scale; SAS-SV = Smartphone Addiction Scale–Short Version. Values are presented as median (Q1–Q3). Gender and age-group comparisons were performed using the Mann–Whitney U test. Weekly working hours and daily internet use groups were compared using the Kruskal–Wallis H test with Bonferroni-adjusted post-hoc comparisons. Effect sizes are reported as rank-biserial correlation (r) for Mann–Whitney U tests and epsilon squared (ε^2) for Kruskal–Wallis H tests. Different superscript letters indicate significant post-hoc differences. *p < .05.

Table 5. Spearman correlation analysis of behavioral addiction scores with DASS-21 depression, anxiety, stress, and PSQI scores (n = 202)

Behavioral addiction score	DASS-21 depression	DASS-21 anxiety	DASS-21 stress	PSQI
BWAS	.496***	.463***	.491***	.387***
SAS	.359***	.354***	.283***	.127
BSMAS	.338***	.375***	.275***	.107
IGDS9-SF	.240**	.232**	.188**	.174*
mYFAS	.286***	.323***	.289***	.140
OGAS	-.060	-.070	-.016	-.147*

Note: BSMAS = Bergen Social Media Addiction Scale; BWAS = Bergen Work Addition Scale; DASS-21 = Depression Anxiety Stress Scale-21- Short Form; IGDS9-SF = Internet Gaming Disorder Scale-Short Form; mYFAS = Modified Yale Food Addiction Scale; OGAS = Online Gambling Addiction Scale; PSQI = The Pittsburgh Sleep Quality Index; SAS-SV = Smartphone Addiction Scale-Short Version. Values are Spearman's rho coefficients. *p < .05, **p < .01, ***p < .001.

Table 6. Spearman correlation coefficients among digital behavioral addiction scores (n = 202)

Variable	SAS-SV	BSMAS	IGDS9-SF	OGAS
SAS-SV	1	.696***	.255***	-.012
BSMAS	.696***	1	.327***	-.015
IGDS9-SF	.255***	.327***	1	-.028
OGAS	-.012	-.015	-.028	1

Note: BSMAS = Bergen Social Media Addiction Scale; IGDS9-SF = Internet Gaming Disorder Scale-Short Form; OGAS = Online Gambling Addiction Scale; SAS-SV = Smartphone Addiction Scale-Short Version. Values are Spearman's rho coefficients. *p < .05, **p < .01, ***p < .001.

DISCUSSION

The present study examined behavioral addiction tendencies and associated psychosocial factors among faculty members across multiple behavioral domains. Behavioral addiction tendencies were observed at varying levels, particularly in work addiction, smartphone use, and social media use. By examining multiple behavioral addiction domains within the same sample, this study provides a broader perspective on behavioral addiction tendencies and their associated psychosocial characteristics among faculty members. Taken together, these findings underscore the value of adopting a multidomain approach when investigating behavioral addiction tendencies in academic populations.

General Characteristics and Sociodemographic Distribution of Behavioral Addiction Tendencies

Wide score distributions were observed across several behavioral addiction domains, particularly work addiction, smartphone use, and social media use, suggesting varying levels of behavioral addiction tendencies among faculty members. The demanding nature of academic work, continuous digital engagement, and increasing integration of technology into professional life may contribute to these patterns. These observations are also consistent with the I-PACE model, which emphasizes the interaction of individual characteristics with affective, cognitive, and environmental factors in the development and maintenance of problematic

behaviors (Brand et al., 2019). Within the academic environment, persistent occupational demands and extensive technology use may increase vulnerability to different forms of behavioral addiction.

The finding that nearly one-quarter of participants were classified as being at risk for online gambling/betting is noteworthy. Recent evidence suggests increasing rates of online gambling behaviors worldwide (Tran, 2024). Although faculty members represent a highly educated population, the accessibility of online betting platforms, mobile availability, and increasing popularity of sports betting may contribute to these behaviors. Academic stress and occupational burden may also contribute to the use of online betting as a maladaptive coping strategy. However, it should be emphasized that OGAS assesses risk tendency rather than clinical diagnosis. Moreover, because relatively few studies have specifically examined online gambling behaviors among university faculty members, direct comparisons with previous occupational studies remain limited, highlighting the need for further research in this population.

Behavioral addiction scores did not differ according to most sociodemographic variables. However, male participants demonstrated higher internet gaming disorder scores, which is consistent with previous studies reporting greater prevalence of gaming-related problems among males (Stevens et al., 2021; Su et al., 2020). A systematic review and meta-analysis reported that internet gaming disorder prevalence is approximately 2.5 times higher among males than females (Stevens et al., 2021). Previous studies have suggested that this difference may reflect sex-related differences in gaming motivations, reward responsiveness, impulsivity, and gender-related socialization patterns that encourage gaming engagement among males (Brand et al., 2019; Dong & Potenza, 2022; Wang & Cheng, 2022). These mechanisms are consistent with the interaction between individual predispositions and affective-cognitive processes described in the I-PACE model (Brand et al., 2019). Although previous studies have suggested that problematic social media and smartphone use may be more common among females (Su et al., 2020; Varchetta et al., 2024), no gender differences were identified in these domains in the present study. Similar occupational responsibilities and technology-use patterns among faculty members may partly explain this finding. Alternatively, the relatively homogeneous educational and occupational characteristics of the present sample may have attenuated gender-related differences reported in more heterogeneous populations.

Although online gambling behaviors are frequently reported among younger individuals, previous reviews suggest heterogeneous age-related patterns (Dellosa & Browne, 2024). In the present study, participants older than 40 years showed higher OGAS scores. Greater financial resources, sustained interest in sports betting, and easier access to online platforms may contribute to this pattern. The discrepancy between our findings and studies reporting higher gambling involvement among younger individuals may reflect differences in study populations, gambling modalities, or cultural and regulatory contexts. Given that the association observed in our study was borderline significant, this finding should be interpreted cautiously and confirmed in future studies.

Digital Behavioral Addiction Tendencies and Internet-Use Characteristics

Participants reporting longer daily internet use demonstrated higher smartphone addiction and social media addiction scores. Previous studies and meta-analytic findings across different populations suggest that greater digital engagement and internet use are associated with problematic smartphone and social media behaviors (Meng et al., 2022; Tomczyk & Lizde, 2023). The present findings are generally consistent with this literature. However, the strength of this association may vary according to the purpose of internet use, and work-related digital engagement may differ from recreational use. Within academic settings, continuous access to information and increasing reliance on digital

communication may further strengthen this relationship. This interpretation is also compatible with the I-PACE model, which proposes that repeated interactions between individual predispositions and environmental demands contribute to the development and maintenance of problematic technology use (Brand et al., 2019).

Behavioral Addiction Tendencies and Work-Related Characteristics

Participants with longer weekly working hours demonstrated higher work addiction scores. This finding is consistent with previous studies reporting positive associations between work addiction tendencies and increasing workload or total working hours (Dutheil et al., 2020; Morkevičiūtė et al., 2021). Existing workaholism literature suggests that publication pressure, workload, bureaucratic demands, and role overload contribute substantially to excessive work behaviors among academics (Clark et al., 2016). These findings are also consistent with Griffiths' components model of addiction, particularly the concepts of salience and conflict, whereby work gradually becomes a dominant activity that interferes with other aspects of daily life (Griffiths, 2005). Nevertheless, high occupational commitment and long working hours should not automatically be interpreted as work addiction, as excessive work becomes clinically relevant only when it is characterized by impaired control, compulsive engagement, and negative consequences for well-being and daily functioning (Clark et al., 2016; Griffiths, 2005). In academic settings, performance expectations and the pressure to balance teaching, research, and administrative responsibilities may further reinforce these behavioral patterns (Clark et al., 2016). Consistent with this perspective, academic title and administrative responsibilities were not associated with behavioral addiction scores in the present study. Similar expectations regarding teaching, research productivity, publication, and administrative duties across academic roles may contribute to these relatively comparable behavioral patterns among faculty members.

Associations Between Behavioral Addiction Tendencies and Psychological Symptoms

Depression, anxiety, and stress scores showed positive associations with work addiction, smartphone addiction, social media addiction, and gaming-related behaviors. Food addiction scores were also positively associated with psychological symptoms. However, given the substantial clustering of mYFAS scores at zero, this finding may reflect a limited subgroup rather than a broadly distributed pattern within the sample. The generally low mYFAS scores observed in the present sample may reflect occupational or lifestyle characteristics specific to university faculty members. Because factors that might explain this finding, such as dietary habits, nutritional awareness, or other lifestyle characteristics, were not assessed, the reasons for these low mYFAS scores remain unclear. Future studies should examine these factors to better understand food addiction tendencies among university faculty members.

Previous research has consistently reported associations between behavioral addictions and psychological symptoms. Meta-analytic findings suggest significant relationships between problematic smartphone or internet use and depression and anxiety symptoms (Pham et al., 2025). More broadly, recent reviews indicate that digital addiction behaviors and depressive symptoms frequently co-occur and may share overlapping psychological mechanisms (Karakose et al., 2023). Similar associations have also been observed for gaming-related behaviors and work addiction tendencies (Clark et al., 2016; Gao et al., 2022; Ropovik et al., 2023). Collectively, these findings suggest that individuals experiencing psychological distress may engage in behaviors such as excessive smartphone use, social media use, gaming, or overworking as coping strategies. Although these behaviors may temporarily reduce distress, they may evolve into problematic patterns over time. This interpretation is also consistent with the I-PACE model, which proposes that repeated engagement in specific behaviors as a means of regulating negative

affect may contribute to the development and maintenance of behavioral addictions (Brand et al., 2019). However, because of the cross-sectional design, the direction of these relationships cannot be determined.

Unlike other behavioral domains, online gambling/betting scores were not associated with depression, anxiety, or stress. Previous studies generally report positive relationships between gambling-related problems and psychological distress (Lorains et al., 2011). One possible explanation for this discrepancy is that online gambling/betting behaviors may be influenced by different motivational and psychological mechanisms, including reward sensitivity, sensation seeking, and risk-taking tendencies (Sztainert et al., 2014). Alternatively, the absence of an association may reflect the skewed distribution of gambling-related behaviors in the present sample, which may have reduced the statistical power to detect such associations. Therefore, this finding should be interpreted cautiously and replicated in future studies before firm conclusions can be drawn.

Behavioral Addiction Tendencies and Sleep Quality

Work addiction and internet gaming disorder scores were positively associated with poor sleep quality. This finding is consistent with previous studies reporting associations between problematic gaming behaviors and impaired sleep outcomes (Alimoradi et al., 2019; Han et al., 2024; Kristensen et al., 2021). Gaming-related sleep problems may be explained by delayed sleep timing and increased physiological arousal associated with gaming, particularly when gaming occurs during the evening hours (Han et al., 2024). Similarly, work addiction tendencies have previously been linked to poor sleep quality and daytime sleepiness (Spagnoli et al., 2019). Among individuals with work addiction, difficulty disengaging from work-related thoughts and insufficient opportunities for psychological recovery may further contribute to sleep disturbances (Spagnoli et al., 2019).

In contrast, smartphone use, social media use, and several other digital behavioral addiction domains were not associated with sleep quality in the present study. Although previous meta-analyses have reported small-to-moderate relationships between problematic technology use and sleep disturbances (Alimoradi et al., 2019; Han et al., 2024), the absence of significant findings may be related to sample-specific characteristics or relatively small effect sizes. It is also possible that the predominantly work-related nature of smartphone and internet use among faculty members differs from recreational technology use, thereby attenuating the association with sleep quality observed in more heterogeneous populations.

The weak negative association observed between online gambling/betting scores and sleep quality was inconsistent with previous findings suggesting relationships between gambling-related behaviors and sleep problems (Austin et al., 2024; Parhami et al., 2012). This unexpected finding should therefore be interpreted cautiously. It may also reflect the skewed distribution of gambling-related behaviors in the present sample or other unmeasured factors influencing sleep quality, and should be replicated in future studies before firm conclusions can be drawn.

Relationships Among Digital Behavioral Addiction Domains

Significant positive relationships were identified among smartphone addiction, social media addiction, and gaming-related behaviors. These findings suggest that technology-based behaviors may cluster together and potentially share common behavioral or psychological mechanisms. This pattern is also consistent with the I-PACE model, which proposes that different forms of problematic digital behaviors may arise through shared affective, cognitive, and motivational processes while differing in their specific behavioral expressions (Brand et al., 2019). Previous studies similarly indicate that smartphone use, social media use, and gaming-related behaviors frequently co-occur and may involve overlapping digital engagement patterns (Andrade & Viñán-Ludeña, 2025; Moreno et al., 2022).

In contrast, online gambling/betting behavior was not associated with other digital behavioral addiction domains. This distinction may indicate that gambling-related behaviors are driven by somewhat different motivational processes, including reward expectancy and risk-taking tendencies. Unlike other digital behaviors, gambling is characterized by monetary reinforcement and uncertainty of reward, which may contribute to its distinct pattern of associations. Consistent with this interpretation, previous studies suggest that gambling-related behaviors and gaming-related behaviors, despite certain similarities, may involve both overlapping and distinct psychological mechanisms (Fauth-Bühler & Mann, 2015; Mallorquí-Bagué et al., 2017).

An important contribution of the present study is the simultaneous evaluation of multiple behavioral addiction domains within the same occupational sample. While previous studies have typically focused on a single behavioral addiction, the present study examined work addiction, smartphone use, social media use, internet gaming disorder, food addiction, and online gambling/betting together and evaluated their relationships with common psychosocial factors. This multidomain approach provides a more comprehensive understanding of behavioral addiction tendencies among faculty members by demonstrating that different behavioral addiction domains may show distinct patterns of association with demographic, occupational, and psychological characteristics. Such an approach may contribute to the development of more comprehensive prevention, early identification, and intervention strategies tailored to the needs of academic professionals.

Strengths and Limitations

One of the main strengths of this study is its focus on faculty members, a relatively understudied population in behavioral addiction research. Another important strength is the simultaneous evaluation of multiple behavioral addiction domains—including work addiction, smartphone addiction, social media addiction, internet gaming disorder, online gambling/betting behaviors, and food addiction tendencies—within the same sample. Evaluating these domains together with depression, anxiety, stress, and sleep quality also enabled a broader assessment of associated psychosocial factors.

Several limitations should also be considered. First, the cross-sectional design precludes causal interpretation. Second, the use of self-report measures may introduce reporting bias. Third, participants were recruited through voluntary online participation using convenience and snowball sampling, which may have introduced selection bias and limited the generalizability of the findings. Because the survey link was disseminated through multiple e-mail and social media channels without a predefined sampling frame, the total number of faculty members who received the invitation could not be determined; therefore, a response rate could not be calculated. Fourth, because structured clinical interviews were not conducted, behavioral addiction tendencies were assessed using screening instruments rather than clinical diagnoses. Furthermore, given the relatively large number of statistical tests performed, the possibility of Type I error cannot be completely excluded despite the use of Bonferroni correction for post hoc pairwise comparisons. Finally, because most instruments primarily assess risk or tendency rather than clinical diagnosis, findings should be interpreted as behavioral addiction tendencies rather than definitive behavioral addiction conditions.

CONCLUSION

Behavioral addiction tendencies among faculty members were associated with psychological symptoms, sleep quality, and selected occupational characteristics, although these associations differed across behavioral addiction domains. In particular, the relationship between working hours and work addiction, as well as the clustering of digital behavioral addiction domains, emerged as notable findings. This study contributes to the limited literature by simultaneously evaluating multiple behavioral addiction domains and associated psychosocial factors among university faculty members. These

findings may contribute to the development of workplace mental health policies, early identification strategies, and preventive interventions targeting behavioral addiction tendencies in academic settings. Further longitudinal studies are needed to clarify the direction and underlying mechanisms of these relationships.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

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The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of their affiliated institution.

AI Declaration:

Generative AI tools were used for language editing and improvement of manuscript readability. The authors reviewed, revised, and took full responsibility for the final content of the manuscript.

Financial Support

The Authors report no financial support regarding content of this article.

Ethical Declaration

This study was conducted in accordance with the Declaration of Helsinki and approved by the Non-Interventional Scientific Research Ethics Committee of Tokat Gaziosmanpaşa University (Approval No: 25-MOBAEK-455; Date: December 12, 2025).

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

Concept: EAA, FUD, Design: EAA, FUD, Supervising: EAA, Data collection and entry: EAA, FUD, Analysis and interpretation: EAA, Literature search: EAA, FUD, Writing: EAA, Critical review: EAA, FUD.

Corresponding Author

Esma Akpinar Aslan

Department of Psychiatry, School of Medicine, Tokat Gaziosmanpasa University, Tokat, Türkiye.

E-mail: esma.akpinaraslan@gop.edu.tr

ORCID iD: 0000-0003-4714-6894

Journal of Dependence, 2026; 27(3):183-198

JOURNAL OF DEPENDENCE

Research Article

Problematic internet use, problematic smartphone use, social connectedness and social phobia in university students

Cumhur Demiralp, Başaran Gençdoğan

DOI: 10.51982/bagimli.624

Abstract

Objective: This study examined the relationships among problematic smartphone use, problematic internet use, social connectedness, and social phobia among university students. Using a cross-sectional quantitative design, the study was conducted with 279 students enrolled at a public university in eastern Türkiye during the 2020–2021 academic year, selected through convenience sampling.

Method: Data were collected using a Personal Information Form, the Smartphone Addiction Scale, the Problematic Internet Use Scale, the Social Connectedness Scale, and the Liebowitz Social Anxiety Scale. Descriptive statistics, correlation and regression analyses, independent-samples t tests, one-way analysis of variance, the Kruskal–Wallis H test, and Scheffé post hoc tests were used to analyze the data.

Results: The findings showed that problematic smartphone use was positively associated with problematic internet use and the anxiety and avoidance dimensions of social phobia but negatively associated with social connectedness. In addition, social avoidance and social connectedness significantly predicted problematic smartphone use, whereas social anxiety and social connectedness significantly predicted problematic internet use.

Conclusion: Overall, higher levels of problematic technology use were associated with greater social phobia and lower social connectedness among university students.

Keywords: Problematic internet use, Problematic smartphone use, Social connectedness, Social phobia/ Anxiety, Social avoidance.

Cumhur Demiralp
Hakkari University, Vocational School of Health Services, Department of Child Care and Youth Services, Hakkari, Türkiye
Email: cmhrdmrlp@gmail.com
ORCID iD: 0000-0001-7138-2964

Başaran Gençdoğan
Atatürk University Kazım Karabekir Faculty of Education, Department of Educational Sciences, Guidance and Psychological Counseling, Erzurum, Türkiye
Email: basaran35@gmail.com
ORCID iD: 0000-0001-9647-438X

Received: 2026-07-22
Accepted: 2026-09-01

e-ISSN: 3108-7973

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INTRODUCTION

Internet-enabled technologies and smartphones have become integral to university students' academic, social, and recreational lives. Although these technologies provide important opportunities for communication and information access, excessive or poorly regulated use may develop into problematic patterns that interfere with daily and interpersonal functioning (Busch & McCarthy, 2021; Sánchez-Fernández & Borda-Mas, 2023). Problematic internet use generally refers to maladaptive or excessive online engagement associated with negative consequences in everyday life (Caplan, 2018; Davis, 2001), whereas problematic smartphone use involves patterns of smartphone engagement characterized by diminished control and functional impairment (Kwon et al., 2013). Among university students, both forms of problematic technology use have been associated with psychosocial difficulties, including reduced face-to-face interaction, weaker social connectedness, loneliness, and social anxiety (Busch & McCarthy, 2021; Elhai et al., 2020). From a broader digital well-being perspective, recent work emphasizes that technology-related experiences should be evaluated multidimensionally across psychological, social, physical, and academic domains rather than solely in terms of time spent online (Erdemir, 2025; Erdemir & Atik, 2026).

Social connectedness may be particularly relevant to understanding problematic technology use. It refers to individuals' sense of closeness, belonging, and integration within interpersonal relationships and the broader social environment (Lee & Robbins, 1998). University students face new interpersonal environments and developmental demands in which belonging and meaningful social relationships are especially salient. Lower social connectedness has been associated with greater reliance on online communication and problematic smartphone behaviors (Lin et al., 2021). Conversely, individuals who feel more socially connected may have less need to use digital environments as a substitute for unmet interpersonal needs.

Social phobia may represent another important interpersonal factor associated with problematic internet and smartphone use. Individuals experiencing social anxiety or avoidance may perceive online communication as less threatening and more controllable than face-to-face interaction, particularly when they fear negative evaluation. Previous research has linked social anxiety and psychological distress with problematic internet and smartphone use (Busch & McCarthy, 2021; Elhai et al., 2020). Social avoidance may also be relevant because individuals who withdraw from face-to-face interactions may increasingly rely on digitally mediated communication. Recent evidence further suggests that social anxiety can positively predict digital addiction among university students (Atik et al., 2026).

These relationships can be more explicitly understood within Compensatory Internet Use Theory, which proposes that individuals may engage in online activities to cope with unmet psychological or social needs and with difficulties experienced in offline life (Kardefelt-Winther, 2014). Within this framework, social connectedness, social anxiety, and social avoidance may represent different interpersonal conditions associated with compensatory technology use. Individuals with lower social connectedness may turn to online environments to compensate for unmet needs for belonging, closeness, and interpersonal integration. Consistent with this interpretation, lower social connectedness has been associated with greater reliance on online communication and problematic smartphone behaviors (Lin et al., 2021).

Social anxiety and social avoidance may operate through related but somewhat different mechanisms. Individuals with higher social anxiety may find digitally mediated interaction more manageable because it can reduce the immediacy of face-to-face evaluation and provide greater control over interpersonal interaction. Social avoidance, in turn, may reduce participation in direct social situations and increase reliance on online communication as an alternative form of interpersonal engagement.

Previous evidence linking social anxiety with problematic internet and smartphone use supports this interpretation (Atik et al., 2026; Busch & McCarthy, 2021; Elhai et al., 2020). Thus, from a compensatory internet use perspective, lower social connectedness and greater social anxiety or avoidance may be associated with increased reliance on internet- and smartphone-based environments for managing social needs or discomfort. When such compensatory use becomes repeated or poorly regulated, it may be associated with higher levels of problematic internet use and problematic smartphone use.

The present study

Previous research has linked problematic internet and smartphone use with social anxiety and social connectedness; however, these associations have often been examined separately or without distinguishing the anxiety and avoidance dimensions of social phobia. The contribution of the present study lies not in treating these individual associations as entirely new, but in examining social connectedness, social anxiety, and social avoidance simultaneously in relation to two related but distinct forms of problematic technology use: problematic internet use and problematic smartphone use. This approach makes it possible to examine whether the affective component of social phobia (social anxiety) and its behavioral component (social avoidance) show similar or different patterns of association with these two forms of problematic technology use, while also considering social connectedness as an interpersonal resource. In this way, the study is expected to provide a more differentiated account of which aspects of interpersonal functioning are most closely associated with problematic internet use and problematic smartphone use among university students. As a secondary contribution, the study also includes exploratory analyses examining whether these variables differ according to selected demographic characteristics and technology-use behaviors, thereby providing additional descriptive information about the contexts in which problematic technology use may be more pronounced.

Accordingly, the present study investigated the relationships among problematic smartphone use, problematic internet use, social connectedness, social anxiety, and social avoidance. Based on Compensatory Internet Use Theory and the empirical evidence reviewed above, the following hypotheses were proposed:

H1. Problematic smartphone use, problematic internet use, social connectedness, social anxiety, and social avoidance are significantly interrelated.

H2. Social connectedness, social anxiety, and social avoidance significantly predict problematic smartphone use among university students.

H3. Social connectedness, social anxiety, and social avoidance significantly predict problematic internet use among university students.

In addition to these hypothesis-driven analyses, exploratory analyses were conducted to examine whether the study variables differed according to selected demographic characteristics and technology-use behaviors, including age, gender, class level, sleep duration, internet-use duration, social media use, smartphone-use habits, and self-perceived problematic smartphone use. Given the number of comparisons, these analyses were considered secondary and exploratory rather than confirmatory hypothesis tests.

METHODS

Research design

This study employed a descriptive correlational design. Correlational research examines the relationships among two or more variables without manipulating them (Büyüköztürk et al., 2017). This design also enables researchers to assess differences among variables and determine the strength of their relationships (Büyüköztürk et al., 2009).

Participants

The sample comprised 279 volunteer students enrolled at Hakkari University during the 2020–2021 academic year. Participants were recruited

using convenience sampling. Students were invited to participate through both face-to-face contact and online communication channels, depending on the COVID-19 conditions and accessibility at the time of data collection. Online invitations were shared through student WhatsApp groups, e-mail, and course-related communication groups. Participation was voluntary, and students who received the invitation could choose whether to complete the questionnaire.

Because recruitment was based on convenience sampling and existing student communication channels rather than probability sampling, it cannot be assumed that all eligible students had an equal probability of being reached or participating. Incomplete responses were excluded from the analyses. Of the final 279 participants, 184 (65.9%) were female and 95 (34.1%) were male. Most were aged 21–25 years (67.7%), followed by 18–20 (15.8%), 26–30 (11.8%), and 31 or older (4.7%). Regarding class level, 39.1% were first-year, 28.7% second-year, 17.9% third-year, and 14.3% fourth-year students.

Before data collection, an a priori sample-size calculation was conducted using G*Power 3.1 for the multiple regression analyses. Based on three predictors, a medium effect size ($f^2 = 0.15$), $\alpha = .05$, and a power level of .80, the minimum required sample size was calculated as 77 participants. The final sample consisted of 279 students, exceeding this minimum requirement. The sample-size calculation was conducted specifically for the primary regression analyses; the demographic and technology-related group comparisons were treated as secondary exploratory analyses. Because the participants were recruited through convenience sampling from a single university, the generalizability of the findings remains limited.

Data collection tools

In this study, personal information data form, "Liebowitz Social Phobia/Anxiety", "Social Connectedness", "Problematic Internet Use" and "Smartphone Addiction" scales were used in the data collection process.

Personal information data form

The personal information form assessed participants' gender, age, grade level, sleep duration, daily internet and social media use, purposes of internet and smartphone use, and time spent accessing the internet via mobile phones. It also included items on excessive phone use, immediate phone checking in new environments or during free time, and self-perceived problematic smartphone use.

Problematic internet use scale

The Problematic Internet Use Scale assesses healthy and problematic internet use among university students. It contains 33 items across three subdimensions: excessive use, social benefit, and negative consequences (Ceyhan et al., 2007). Scores range from 33 to 165, with higher scores indicating greater problematic use; two items are reverse-coded. The scale has demonstrated high internal consistency in university samples ($\alpha = .94$; Ceyhan et al., 2007). In the present sample, the scale demonstrated excellent internal consistency (*Cronbach's* $\alpha = .97$).

Smartphone addiction scale

The Smartphone Addiction Scale was developed by Kwon et al. (2013) to assess problematic smartphone use. Turkish adaptations were conducted by Noyan et al. (2015) for university students and by Şata and Karip (2017) for adolescents. The unidimensional scale yields scores between 10 and 60, with higher scores indicating higher levels of problematic smartphone use. In the present study, scale scores were treated as a continuous indicator of problematic smartphone use rather than as evidence of a clinical diagnosis of addiction. Reliability coefficients were high across samples, including *Cronbach's* α *values of .867 and .90, test–retest reliability of .926*, and *McDonald's* ω *of .94* (Noyan et al., 2015; Şata & Karip, 2017). In the present sample, the Smartphone Addiction Scale demonstrated excellent internal consistency (*Cronbach's* $\alpha = .94$).

Liebowitz social phobia/anxiety scale

The Liebowitz Social Anxiety Scale was developed by Liebowitz (1987) to assess social anxiety and avoidance. It comprises 24 items across two subdimensions: anxiety and avoidance. Thirteen items address performance situations, and 11 assess social interactions. The scale has demonstrated excellent reliability, including *Cronbach's* α *of .98*, *test–retest reliability of .97*, and *inter-rater reliability of .96* (Heimberg et al., 1999). Turkish adaptation studies also supported its validity and reliability (Dilbaz & Güz, 2001; Soykan et al., 2003). Higher scores indicate greater social anxiety and avoidance. In the present sample, internal consistency was excellent for both the anxiety dimension (*Cronbach's* α = *.92*) and the avoidance dimension (*Cronbach's* α = *.94*).

Social connectedness scale

The Social Connectedness Scale was developed by Lee and Robbins (1995) to assess perceived interpersonal closeness and belonging. It includes eight items rated on a six-point Likert scale, with total scores ranging from 8 to 48; higher scores indicate stronger social connectedness. The scale contains no reverse-coded items. Its Turkish adaptation demonstrated high internal consistency (α = .90; Duru, 2007), supporting its validity and reliability. In the present sample, the Social Connectedness Scale demonstrated excellent internal consistency (*Cronbach's* α = *.95*).

Data collection process

Ethical permission for this study was obtained from the Social and Human Sciences Ethics Committee of Atatürk University, Erzurum, dated 18.02.2021 and numbered 02. Following ethical approval, data were collected from volunteer university students during the COVID-19 pandemic. Because pandemic-related restrictions affected access to students and face-to-face teaching, questionnaires were administered using both face-to-face and online procedures.

When face-to-face access was possible, eligible students were informed about the study and invited to complete the questionnaire voluntarily. When in-person data collection was not feasible, the questionnaire was prepared using Google Forms, and the survey link was distributed to students through WhatsApp groups, e-mail, and course-related communication groups. The invitation provided information about the purpose of the study and the voluntary nature of participation. Students were free to decline participation.

Because the online invitation was circulated through multiple communication channels and the exact number of students who received or viewed the invitation was not recorded, a precise response rate could not be calculated. In addition, because convenience sampling was used, the recruitment procedure did not ensure that every eligible student in the university had an equal probability of participation. Because the mode of questionnaire administration was not recorded as a participant-level variable, the exact numbers of students who completed the questionnaires face-to-face and online could not be determined retrospectively. Consequently, it was not possible to conduct a direct statistical comparison between the two administration modes.

Data analysis

Data were analyzed using IBM SPSS Statistics 22.0. Frequencies and percentages were used to summarize demographic characteristics, while Pearson correlations examined associations among problematic internet use, problematic smartphone use, social connectedness, social anxiety, and social avoidance. Two Enter-method linear regression analyses were conducted, with problematic smartphone use and problematic internet use entered separately as dependent variables and social connectedness, social anxiety, and social avoidance as predictors.

In addition to these hypothesis-driven analyses, exploratory group comparisons were conducted across selected demographic characteristics and

technology-use behaviors. Independent-samples t tests and one-way ANOVA were used where appropriate, followed by Scheffé post hoc tests when significant, while the Kruskal–Wallis H test was applied when parametric assumptions were not met. Scheffé post hoc tests were used only following significant one-way ANOVA results. For significant Kruskal–Wallis tests, the available records from the original dissertation analyses did not document a non-parametric pairwise comparison procedure in sufficient detail to allow its reliable identification or reproduction. Therefore, the revised manuscript reports and interprets only the omnibus Kruskal–Wallis results and does not make unverified pairwise post-hoc claims. No formal adjustment for multiple comparisons across the full set of exploratory analyses was applied. Because these comparisons involved multiple demographic and technology-use variables, they were treated as secondary exploratory analyses rather than confirmatory hypothesis tests and were interpreted cautiously. Normality of the observed study variables was evaluated using skewness and kurtosis values. However, because the present article was prepared from an earlier doctoral dissertation dataset and the original participant-level dataset and regression diagnostic outputs are no longer available in a form that permits reliable retrospective reanalysis, additional diagnostic statistics for multiple linear regression (e.g., tolerance/VIF, Durbin–Watson statistics, and residual plots) could not be reproduced for the present revision. Accordingly, the regression findings should be interpreted with this limitation in mind. **(Table 1).**

Table 1. Normality test results of social phobia scale (anxiety and avoidance dimensions), social connectedness scale, problematic internet use scale and smartphone addiction scale for university students

	Skewness	*Kurtosis*
Smartphone Addiction Scale	.628	-.176
Problematic Internet Use Scale	1.068	.603
Social Connectedness Scale	-.265	.466
Social Phobia (Anxiety Dimension) Scale	.582	.117
Social Phobia (Avoidance Dimension) Scale	.623	-.196

As shown in **Table 1**, the skewness and kurtosis values for social anxiety, social avoidance, social connectedness, problematic internet use, and problematic smartphone use were within ±1.5, indicating an approximately normal distribution (Tabachnick & Fidell, 1996).

RESULTS

Table 2. Correlation analysis of study variables

		1	2	3	4	5
Smartphone Addiction Scale-Short Form	*r*	1				
	p					
Problematic Internet Use Scale	*r*	.604**	1			
	p	**< .001**				
Social Connectedness Scale	*r*	-.254**	-.453**	1		
	p	**< .001**	**< .001**			
Liebowitz Social Anxiety/Phobia Scale Anxiety Dimension	*r*	.199**	.076	-.163**	1	
	p	**< .001**	.203	**.006**		
Liebowitz Social Anxiety/Phobia Scale Avoidance Dimension	*r*	.171**	.243**	-.149*	.289**	1
	p	**.004**	**< .001**	**.013**	**< .001**	

(*) p < .05, (**) p < .001.

As shown in **Table 2**, problematic smartphone use was positively correlated with problematic internet use, social anxiety, and social avoidance, but negatively correlated with social connectedness ($p<.05$). Problematic internet use was negatively associated with social connectedness and positively associated with social avoidance, whereas its relationship with social anxiety was not significant ($p > .05$). Social connectedness was negatively correlated with both social anxiety and social avoidance, while the anxiety and avoidance dimensions were positively correlated with each other ($p < .05$).

Table 3. Linear regression analysis results regarding the prediction of problematic smartphone use by university student social connectedness, social anxiety, and social avoidance

Variable	*B*	*Standard Error*	*Beta*	*t*	*p*
Constant	26.466	4.192		6.314	**< .001**
Social avoidance	.116	.052	.134	2.229	.027
Social anxiety	.091	.055	.100	1.659	.098
Social connectedness	-.257	.069	-.218	-3.731	**< .001**
R = .315	R^2=.099				
$F_{(3,275)} = 10.087$ $p < .001$					
a. Dependent variable: Problematic smartphone use					

As shown in **Table 3**, social avoidance and social connectedness significantly predicted problematic smartphone use ($R = .315$, $R^2 = .099$, $p < .05$), jointly explaining approximately 10% of its variance among university students.

Table 4. Linear regression analysis results regarding the prediction of problematic internet use by university students' social connectedness, social anxiety and social avoidance

Variable	*B*	*Standard Error*	*Beta*	*t*	*p*
Constant	89.178	8.899		10.021	< .001
Social avoidance	-.099	.110	-.050	-.900	.369
Social anxiety	.408	.117	.193	3.493	< .001
Social connectedness	-1.177	.146	-.432	-8.052	< .001
R = .488	R2=.239				
$F(3,275) = 28.717$ $p < .001$					
a. Dependent variable: Problematic internet use					

As shown in **Table 4**, social anxiety and social connectedness significantly predicted problematic internet use ($R = .488$, $R^2 = .239$, $p < .05$), jointly explaining approximately 24% of its variance among university students.

Exploratory analyses showed that male students had higher problematic smartphone use and problematic internet use scores than female students. Problematic smartphone use also differed by class level, with Scheffé comparisons indicating higher scores among third- and fourth-year students than among first-year students. Daily internet-use duration was significantly associated with both problematic smartphone use and problematic internet use in the omnibus Kruskal–Wallis analyses. Other demographic comparisons are presented in **Table 5**.

Several exploratory differences were observed according to internet-use patterns. Entertainment-oriented and social-media use were associated with higher problematic smartphone use and problematic internet use, while internet use for chatting was associated with higher scores on both outcomes and lower social connectedness. Problematic internet use also differed according to gaming, and longer daily social-network use was associated with higher problematic smartphone use and problematic internet use. Additional activity-specific comparisons are reported in **Table 6.**

Table 5. Demographic and internet use characteristics

Variable	Categories	N (%)	SAS $\bar{x} \pm SD$	PIUS $\bar{x} \pm SD$	SCS $\bar{x} \pm SD$	LSAS (Avoidance) $\bar{x} \pm SD$	LSAS (Anxiety) $\bar{x} \pm SD$
Gender	Female	184 (%65.9)	27.28±11.875	64.73±24.786	31.15±10.171	46.99±13.390	50.29±12.996
	Male	95 (%34.1)	30.43±10.961	74.34±29.704	31.99±9.294	45.91±13.844	49.79±12.278
	t		-2.154	-2.864	-.675	.637	.309
	p		**.032**	**.005**	.500	.525	.757
Age	18-20	44 (%15.8)	29.07±10.857	71.42±28.672	29.42±10.271	48.47±14.173	50.37±11.836
	21-25	189 (%67.7)	28.13±11.914	67.37±25.882	31.35±9.783	47.04±13.426	50.92±13.372
	26-30	33 (%11.8)	29.73±11.985	72.12±31.968	33.39±10.671	45.09±14.780	46.82±11.631
	31+	13 (%4.7)	25.23±10.026	55.31±19.889	34.23±7.201	38.46±6.226	46.46±6.887
	KW		1.690	4.532	3.321	7.001	3.879
	p		.639	.209	.345	.072	.275
Class level	Grade 1	109 (%39.1)	26.07±10.851	63.17±22.513	30.88±9.572	46.39±13.195	49.84±12.767
	Grade 2	80 (%28.7)	28.38±11.139	68.73±25.542	31.75±10.096	45.93±13.646	49.95±11.817
	Grade 3	50 (%17.9)	30.16±13.241	71.06±27.828	33.38±10.107	46.30±12.795	50.94±14.018
	Grade 4	40 (%14.3)	32.28±11.618	75.90±36.294	29.88±9.890	49.08±15.252	50.18±13.191
	F		3.390	2.603	1.123	.527	.090
	p		**.019**	.052	.340	.664	.965
How many hours of sleep per day	4-6 hours	40 (%14.3)	27.73±11.345	65.25±23.754	32.13±10.459	47.15±16.351	48.45±12.808
	7-9 hours	212 (%76)	27.95±11.071	66.89±26.032	31.86±9.329	46.45±12.891	50.10±12.649
	10-12+hours	27 (%9.7)	32.73±15.853	81.77±34.925	26.88±12.443	46.38±12.989	52.04±13.168
	KW		1.341	3.829	3.724	.059	.721
	p		.512	.147	.155	.971	.697
How many hours a day university students use the internet	0-2 hours	38 (%13.6)	23.61±8.032	57.74±25.349	31.66±9.674	43.53±13.842	48.63±13.468
	3-5 hours	159 (%57)	26.66±10.882	65.14±24.966	31.59±9.656	46.75±13.247	49.53±12.163
	6-9 hours	57 (%20.4)	34.40±12.382	74.93±26.088	32.11±10.304	46.75±12.088	50.82±12.008
	10-12 hours	12 (%4.3)	30.33±13.276	77.25±29.118	28.00±9.789	48.33±18.042	55.67±14.742
	13+ hours	13 (%4.7)	34.08±13.813	93.83±35.162	29.42±12.206	52.67±17.753	53.83±18.683
	KW		23.069	22.458	2.379	4.055	4.153
	p		**< .001**	**< .001**	.666	.399	.386

(**Note:** SAS: Smartphone Addiction Scale; PIUS: Problematic Internet Use Scale; SCS: Social Connectedness Scale; LSAS (Avoidance): Liebowitz Social Anxiety/ Phobia Scale Avoidance Dimension; LSAS (Anxiety): Liebowitz Social Anxiety/Phobia Scale Anxiety Dimension)

Table 6. Internet use patterns of participants

Variable	Categories	N (%)	SAS x̄ ±SD	PIUS x̄ ±SD	SCS x̄ ±SD	LSAS (Avoidance) x̄ ±SD	LSAS (Anxiety) x̄ ±SD
University students' use of the internet for entertainment purposes	Yes	69 (%24.73)	33.49±12.310	76.04±25.912	30.00±8.451	44.68±13.014	50.78±11.544
	No	210 (%75.27)	26.67±10.936	65.36±26.751	31.90±10.272	47.26±13.667	49.90±13.123
	t		4.358	2.901	-1.393	-1.377	.499
	p		**< .001**	**.004**	.165	.170	.618
University students' use of the internet for social media-Twitter/X-Instagram-Facebook-WhatsApp Purposes	Yes	214 (%76.63)	29.56±12.210	70.37±27.061	31.74±9.723	46.38±13.738	50.88±12.718
	No	65 (%23.37)	24.40±8.512	60.18±24.997	30.43±10.365	47.42±12.899	47.62±12.568
	t		3.831	2.705	.935	-.538	1.817
	p		**< .001**	**.007**	.351	.591	.070
University students' use of the internet for watching films and listening to music purposes	Yes	135 (%48.39)	29.44±11.664	68.56±27.141	31.16±9.098	44.46±12.449	49.91±12.103
	No	144 (%51.61)	27.33±11.581	67.48±26.755	31.69±10.573	48.65±14.218	50.31±13.342
	t		1.516	.333	-.455	-2.614	-.263
	p		.131	.739	.649	**.009**	.793
University students' use of the internet for shopping purposes	Yes	101(%36.20)	28.95±12.339	68.26±27.919	30.93±8.994	43.74±12.673	50.96±12.727
	No	178 (%63.80)	28.02±11.259	67.85±26.382	31.72±10.352	48.26±13.763	49.64±12.753
	t		.643	.120	-.666	-2.709	.831
	p		.521	.904	.506	**.007**	.406
University students' use of the internet for chatting purposes	Yes	106 (%37.92)	30.24±12.186	72.88±28.622	29.20±9.400	45.08±12.861	51.56±12.440
	No	173 (%62.08)	27.20±11.187	65.01±25.411	32.80±9.932	47.57±13.877	49.24±12.871
	t		2.125	2.391	-3.003	-1.499	1.480
	p		**.035**	**.017**	**.003**	.135	.140
University students' use of the internet for gaming purposes	Yes	43 (%15.41)	31.42±11.638	76.51±24.860	30.09±8.375	43.35±13.202	50.86±12.005
	No	236 (%84.59)	27.80±11.588	66.45±27.015	31.68±10.118	47.22±13.533	49.98±12.885
	t		1.884	2.273	-.968	-1.732	.415
	p		.061	**.024**	.334	.084	.679
Duration of daily social networking site use	Less than 1 hour	89 (%31.9)	23.96±10.391	59.21±23.696	32.79±10.041	47.96±14.798	49.49±13.191
	More than 1 hour	190 (%68.1)	30.42±11.658	72.12±27.376	30.80±9.755	46.00±12.889	50.41±12.542
	t		-4.652	-4.029	1.571	1.071	-.559
	p		**< .001**	**< .001**	.117	.286	.576

Table 7. Smartphone use patterns and addiction perception

Variable	Categories	N (%)	SAS x̄ ±SD	PIUS x̄ ±SD	SCS x̄ ±SD	LSAS (Avoidance) x̄ ±SD	LSAS (Anxiety) x̄ ±SD
How many hours a day university students use their phones to access the internet other than talking	0-2 hours	82 (%29.4)	23.68±9.873	57.02±19.972	33.37±10.226	44.90±13.915	48.74±12.105
	3-5 hours	141(%50.5)	28.01±10.605	69.94±27.064	30.38±9.390	46.75±12.558	49.84±12.147
	6-9 hours	41 (%14.7)	36.88±12.406	74.71±27.129	32.34±9.707	47.49±14.782	52.44±14.239
	10-12 hours	7 (%2.5)	29.57±11.928	77.71±27.250	27.86±7.493	52.86±14.358	57.14±15.005
	13+ hours	8 (%2.9)	37.63±15.052	103.50±36.661	28.75±14.791	52.13±18.411	51.13±18.388
	KW		35.648	27.889	7.239	4.334	4.275
	p		**< .001**	**< .001**	.124	.363	.370
University students' complaints about spending too much time on the phone	Yes	116(%41.6)	34.43±10.684	81.70±30.277	29.59±9.976	47.00±13.714	49.59±12.712
	No	163(%58.4)	24.03±10.323	58.25±18.998	32.75±9.614	46.36±13.436	50.49±12.779
	t		8.174	7.372	-2.666	.391	-.578
	p		**< .001**	**< .001**	**.008**	.696	.563
When I enter a new environment, I immediately start playing with my phone	Yes	36(%12.9)	36.14±13.508	97.97±32.409	21.78±8.761	50.86±14.383	56.61±12.807
	No	243(%87.1)	27.20±10.915	63.56±22.932	32.86±9.217	46.00±13.317	49.16±12.467
	t		3.791	6.147	-6.777	2.025	3.337
	p		**< .001**	**< .001**	**< .001**	**.044**	**< .001**
University students' immediately start of dealing with the phone in their free time	Yes	154(%55.2)	32.16±11.330	78.06±28.997	29.38±10.160	48.51±13.906	52.14±13.060
	No	125(%44.8)	23.66±10.278	55.61±17.443	33.97±8.913	44.30±12.730	47.62±11.911
	t		6.559	7.991	-3.964	2.606	2.989
	p		**< .001**	**< .001**	**< .001**	**.010**	**.003**
Purpose of using cell phones the most	Talking	81(%29.0)	24.94±9.825	59.85±22.476	31.67±9.882	44.38±13.946	49.05±12.225
	SMS	19(%6.8)	26.26±10.192	58.53±17.011	37.00±7.386	50.42±13.558	54.21±16.023
	E-mail	10(%3.6)	29.30±16.879	49.10±14.662	35.20±7.671	40.20±11.952	43.60±10.102
	Surfing(internet)	46(%16.5)	31.76±11.503	74.24±26.677	30.57±10.033	46.07±12.950	49.74±11.194
	Social Networking	111(%39.8)	29.15±11.931	72.52±29.362	31.04±9.636	47.37±13.126	50.54±13.113
	Taking Photos	5(%1.8)	37.00±11.937	85.40±24.203	22.40±10.807	59.40±15.010	53.80±15.834
	Gaming	7(%2.5)	31.00±14.810	89.86±28.334	26.71±14.209	54.14±12.694	53.86±13.018
	KW		15.281	28.895	12.544	13.725	5.944
	p		**.018**	**< .001**	.051	**.033**	.430
Perception of Themselves as Having Problematic Smartphone Use	No	136(%48.7)	22.15±9.077	53.04±14.610	33.13±9.395	45.15±12.174	48.88±12.174
	Not sure	117(%41.9)	32.71±9.906	79.08±26.570	31.21±9.640	47.56±14.060	50.85±12.858
	I am definitely	26(%9.3)	41.23±11.738	96.38±31.441	23.58±9.799	50.15±17.017	53.31±14.655
	KW		94.425	91.116	17.268	2.496	3.384
	p		**< .001**	**< .001**	**< .001**	.287	.184

Exploratory analyses indicated that problematic smartphone use and problematic internet use differed according to daily smartphone-based internet-use duration. Students who had received complaints about excessive phone use also reported higher problematic smartphone use and problematic internet use and lower social connectedness. The broadest differences were observed among students who reported immediately using their phones in new environments or during free time, with differences across all five study variables. Problematic technology-use scores also varied according to the primary purpose of smartphone use and participants' self-perceived problematic smartphone use. Full results of these exploratory comparisons are presented in **Table 7**.

DISCUSSION

The present study examined the relationships among problematic smartphone use, problematic internet use, social connectedness, and the anxiety and avoidance dimensions of social phobia in university students. Problematic smartphone use was positively related to problematic internet use and both dimensions of social phobia and negatively related to social connectedness. Problematic internet use was positively related to social avoidance and negatively related to social connectedness, whereas its bivariate association with social anxiety was not significant. In the regression models, social avoidance and social connectedness significantly predicted problematic smartphone use, whereas social anxiety and social connectedness significantly predicted problematic internet use. However, the explanatory power of these models should be interpreted cautiously. The predictors accounted for approximately 10% of the variance in problematic smartphone use and 24% of the variance in problematic internet use. Thus, although the identified interpersonal variables were statistically significant predictors, a substantial proportion of variance in both outcomes remained unexplained. These findings therefore suggest that social connectedness, social anxiety, and social avoidance represent relevant but only partial correlates of problematic technology use, which is likely associated with a broader range of psychological, behavioral, and contextual factors.

The associations involving social connectedness suggest that stronger offline relational resources are associated with lower levels of problematic technology use. Students reporting a stronger sense of belonging and interpersonal closeness also tended to report lower problematic smartphone use and problematic internet use. Conversely, lower social connectedness was associated with higher levels of problematic technology use. These findings are consistent with previous research linking online involvement with face-to-face interaction and social ties and with studies reporting an association between social connectedness and problematic internet use (McIntyre et al., 2015; Shen & Williams, 2011; Yalçınkaya, 2019). However, the cross-sectional design of the present study does not allow conclusions about whether social connectedness influences technology use or whether patterns of technology use influence social connectedness.

The social phobia findings require a more differentiated interpretation. Social avoidance was positively associated with problematic internet use at the bivariate level, whereas the bivariate association between social anxiety and problematic internet use was small and nonsignificant. However, social anxiety emerged as a significant positive predictor of problematic internet use in the multivariable regression model after social avoidance and social connectedness were simultaneously considered. This change may reflect the shared variance among social anxiety, social avoidance, and social connectedness. In particular, social anxiety was positively correlated with social avoidance and negatively correlated with social connectedness, indicating that these interpersonal variables were not statistically independent. Controlling for their overlapping variance may therefore have revealed variance in social anxiety that was more specifically associated with problematic internet use. This pattern is consistent with a possible suppression effect; however, because a formal suppression analysis was not conducted, this interpretation should be considered tentative rather than definitive. More broadly, the finding suggests that the association of social anxiety with problematic internet use may depend on the interpersonal context in which anxiety occurs rather than being evident as a simple bivariate relationship. Digital environments may offer socially anxious students a more controllable setting in which exposure to evaluation can be reduced. Recent structural equation modeling evidence likewise indicates that social anxiety positively predicts digital addiction and may operate as an avoidance-oriented pathway to problematic use (Atik et al., 2026). Nevertheless, the cross-sectional design does not establish directionality, and these findings should be interpreted cautiously.

The demographic findings were limited and should

not be overinterpreted. Male students reported higher problematic internet use and problematic smartphone use, whereas age was unrelated to the study variables. Evidence on gender is mixed: some studies have reported higher problematic use among men, others higher levels among women, and several no difference (Busch & McCarthy, 2021; Kılıç, 2018; Odacı & Çelik, 2011). The present result is consistent with earlier Turkish evidence showing higher internet addiction scores among male university students, although the effect was small and the broader literature remains inconsistent (Erdemir & Kutlu, 2018). Problematic smartphone use was also higher among third- and fourth-year students than first-year students. This difference may reflect cumulative academic demands, established digital routines, or cohort-specific circumstances rather than a simple developmental effect. Because age and grade level are related but not equivalent, the absence of an age effect further suggests that the grade-level finding should be treated cautiously.

Technology-use patterns produced the clearest subgroup differences. Longer daily internet use and longer smartphone-based internet access were consistently associated with higher problematic smartphone use and problematic internet use. This dose-response pattern is compatible with prior findings showing that problematic use increases as time online rises (Kılıç, 2018; Tohumcu, 2018). Duration alone, however, should not be equated with addiction, because students may spend long periods online for academic or occupational reasons. The more informative pattern concerned the combination of extended use, activity type, loss of control, and interference with social functioning.

Purpose of use was also associated with problematic technology use. Entertainment, social media, chatting, gaming, internet browsing, and other highly engaging or continuously available activities were more strongly associated with problematic internet use and problematic smartphone use than primarily functional communication activities. These results are consistent with evidence that problematic internet-use scores vary by purpose and are higher for entertainment, gaming, and communication than for information seeking (Erdemir & Kutlu, 2025). Complementing these findings, research with high school students has shown that aggression levels differ significantly according to internet-use duration, purpose, commonly used sites, game types, and exposure to harmful online content (Erdemir & Özkamalı, 2021). Together, these findings suggest that the behavioral context and content of internet use may be relevant alongside duration of use. Chatting was additionally associated with lower social connectedness, suggesting that frequent online communication does not necessarily correspond to a stronger subjective sense of belonging. Uses such as watching films, listening to music, shopping, or taking photographs showed more selective associations, including differences in social avoidance. Given the number of categories and comparisons, these isolated findings should be interpreted as exploratory rather than as evidence that a particular activity independently causes social phobia.

Situational smartphone behaviors formed a third thematic cluster. Students who immediately engaged with their phones in new environments or during free time reported greater problematic use, higher social phobia, and lower social connectedness. Complaints from other people about excessive phone use showed a similar pattern: students receiving such complaints had higher problematic smartphone use and problematic internet use and lower connectedness. These indicators may capture salience, automaticity, and interpersonal interference more directly than screen time alone. Turning to a phone in an unfamiliar social setting may function as a safety behavior that temporarily reduces discomfort but limits opportunities for corrective interpersonal experience. Likewise, immediate phone use during unstructured time may reflect habitual or poorly regulated engagement rather than intentional use.

Participants' self-perception of problematic smartphone use was also consistent with their standardized scale scores. Students who identified themselves as problematic smartphone use had

higher problematic smartphone use and problematic internet use scores, whereas those who did not identify themselves as addicted reported higher social connectedness. However, this self-identification reflects participants' subjective perception and should not be interpreted as a clinical diagnosis. Such perceptions may reflect experiences of diminished control, unsuccessful attempts to reduce smartphone use, or interference with daily and social functioning (Billieux et al., 2015).

The extensive subgroup analyses warrant particular caution. Numerous tests were conducted across demographic characteristics, durations, purposes, and situational behaviors. Without a formal adjustment for multiple comparisons, the probability of Type I error increases, and some statistically significant differences may be chance findings. The subgroup results should therefore be regarded as exploratory and secondary to the correlation and regression findings. Future research should preregister a smaller set of theoretically justified comparisons or apply procedures such as false discovery rate control, while also reporting effect sizes and confidence intervals to distinguish practically meaningful differences from statistically significant but small effects.

The timing of data collection is an important consideration when interpreting these findings. Data were collected during the 2020–2021 COVID-19 pandemic, when remote education, restrictions on face-to-face interaction, and increased reliance on digital technologies were common among university students. These conditions may have influenced both the amount and patterns of internet and smartphone use observed in the present study. Therefore, findings concerning duration of use, purposes of use, and specific technology-use behaviors should not be assumed to directly represent current post-pandemic university students. The interpersonal associations observed in the study should also be interpreted within this historical context. Replication with contemporary university samples is needed to determine the extent to which these findings remain applicable to current patterns of student technology use.

Limitations of the study

Several limitations should be considered. The participants were recruited through convenience sampling from a single university in Hakkari, which limits generalizability. The cross-sectional and self-report design prevents causal inference and may be affected by common-method and response biases. The large number of subgroup comparisons increased the risk of Type I error, and no formal multiple-testing correction was applied. Because the study was completed in 2022 and the original participant-level dataset and complete analysis files were not available in a form permitting reliable retrospective reanalysis, effect sizes and confidence intervals could not be calculated consistently for the exploratory group comparisons. Consequently, these subgroup findings should be interpreted cautiously as exploratory evidence of group differences rather than as precise estimates of the magnitude or precision of those differences.

Data were collected during the 2020–2021 COVID-19 pandemic using online and face-to-face procedures. Remote education, restrictions on social interaction, and increased reliance on digital devices may have influenced both exposure levels and the relationships observed. Because more than five years have passed and university digital practices have continued to change, replication with current post-pandemic samples is essential. In addition, because administration mode was not recorded at the individual-participant level, the potential effect of data-collection mode on responses could not be examined. Differences between face-to-face and online administration, such as perceived anonymity, social desirability, or response context, may therefore have introduced additional measurement variability. Future studies should record administration mode and, where possible, test whether responses differ across data-collection procedures.

An additional methodological limitation concerns the verification of multiple linear regression assumptions. Although normality of the observed variables was evaluated using skewness and kurtosis

values, the original participant-level dataset and regression diagnostic outputs were not available for retrospective reproduction of additional diagnostics, including linearity, multicollinearity, independence of residuals, and residual-distribution checks. Therefore, these assumptions could not be re-evaluated for the present revision, and the regression findings should be interpreted with appropriate caution.

CONCLUSION

Problematic internet use and problematic smartphone use were associated with university students' social functioning. Lower social connectedness was consistently associated with higher levels of both forms of problematic technology use, while social anxiety and social avoidance showed different patterns of association with these outcomes. Greater duration of internet and smartphone use, highly engaging purposes such as social media, entertainment, chatting, and gaming, and automatic phone use in new environments or free time were also associated with higher problematic technology-use scores. Because the study was cross-sectional, these findings should be interpreted as associations and do not indicate that the identified interpersonal or technology-use characteristics cause, increase, reduce, or protect against problematic technology use.

Future studies should use longitudinal or experimental designs to clarify the temporal relationships among social connectedness, social anxiety and avoidance, problematic internet use, and problematic smartphone use. Multisite studies with probability-based or more diverse sampling would improve generalizability. Researchers should prioritize theoretically specified hypotheses, limit subgroup testing, preregister analyses, apply appropriate multiple-comparison controls, and report effect sizes and confidence intervals. Contemporary post-pandemic data are particularly needed to determine which findings persist under current educational and social conditions.

University prevention efforts should focus on functional impairment and loss of control rather than screen time alone. Brief screening can incorporate duration and purpose of use, automatic phone checking, complaints from others, self-perceived loss of control, and social withdrawal. Psychoeducational or counseling interventions may combine digital self-regulation, time management, social skills, and exposure-based or cognitive-behavioral strategies for social anxiety. Programs that strengthen social connectedness, psychological resilience, and life satisfaction may also reduce reliance on online environments as a compensatory coping strategy (Erdemir, 2026). Multidimensional assessment of digital life balance can help counselors identify psychological, social, physical, and academic risk domains and tailor support accordingly (Erdemir & Atik, 2026).

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Peer-Review

Double blind peer reviewed.

Conflict of Interest

The authors declare that they have no conflict of interest regarding the content of this article.

Financial Support

The authors report no financial support regarding the content of this article.

Is Derived from Thesis?

This study was prepared by rearranging the first author's doctoral thesis entitled "Comparison of the Relationships of Social Phobia and Social Commitment and Problematic Internet Use and Smartphone Addiction in High School and University Students". The thesis was conducted by Cumhur Demiralp under the supervision of Başaran Gençdoğan.

Ethical Declaration

Ethical permission for this study was obtained from the Social and Human Sciences Ethics Committee of Atatürk University, Erzurum, dated 18.02.2021 and numbered 02.

Authorship Contributions

Concept: CD, BG, Design: CD, BG Supervising: BG, Data collection and entry: CD, Analysis and interpretation: CD, Literature search: CD, Writing: CD, Critical review: BG

Corresponding Author

Cumhur Demiralp: Hakkari University, Vocational School of Health Services, Department of Child Care and Youth Services, Hakkari, Türkiye

Email: cmhrdmrlp@gmail.com

ORCID iD: 0000-0001-7138-2964

Journal of Dependence, 2026; 27(3):199-215

JOURNAL OF DEPENDENCE

Research Article

Maraş powder (smokeless tobacco) use and associated factors in adolescents with attention-deficit/hyperactivity disorder: A cross-sectional comparative study

Asiye Arıcı Gürbüz, Hatice Altun, Feyza Hatice Ekici, Hüseyin Sarıkaya, Semiha Cömertoğlu Arslan

DOI: 10.51982/bagimli.626

Abstract

Objective: Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental disorder associated with an increased susceptibility to nicotine and other substance use. This study aimed to compare Maraş powder (smokeless tobacco) use among adolescents with and without ADHD,identify related factors,examine differences by ADHD treatment status,and assess adolescents' knowledge and beliefs about its use.

Method: This cross-sectional comparative study,included 50 adolescents aged 11–17 with ADHD and 50 age- and sex-matched healthy controls. Participants completed a sociodemographic form,a study-specific Maraş powder knowledge,belief and use questionnaire,the DSM-IV Disruptive Behavior Disorders Rating Scale (DBDRS),the Kovacs Children's Depression Inventory and the State-Trait Anxiety Inventory.

Results: Current regular Maraş powder use was reported by 28.0% of the ADHD group and 10.0% of the control group (OR=3.50,95% CI 1.15–10.63;Fisher p=0.040);while ever use was 32.0% versus 10.0% (OR=4.24,95% CI 1.41–12.70;p=0.007).After adjusted for age and sex,ADHD remained associated with regular use (aOR=3.44,95% CI 1.12–11.99,p=0.031).Within the ADHD group,regular use was reported by 4.2% of adolescents with medical treatment versus 50.0% of untreated adolescents (Fisher p<0.001;aOR=0.04,95% CI 0.003–0.31).Regular users had higher DBDRS,depressive,and state-anxiety scores,but not trait-anxiety scores (all Benjamini–Hochberg-corrected p<0.05).Overall,57.0% of participants either agreed with,or were unsure about,the statement that Maraş powder helps smoking cessation,and substantial misconceptions regarding its harms and regulation were observed in both groups.

Conclusion: In this study,ADHD, lower symptom control and the absence of regular ADHD treatment were associated with a higher prevalence of Maraş powder use. Misconceptions about the harms and the regulation of Maraş powder were common among adolescents in both groups.

Keywords: Attention deficit hyperactivity disorder; Smokeless tobacco; Maraş powder; Nicotine; adolescent; Cross-sectional studies

Asiye Arıcı Gürbüz

Department of Child and Adolescent Psychiatry, Dr. Ekrem Tok Mental Health and Diseases Hospital, Adana, Türkiye

Email: asiyearici@hotmail.com

ORCID iD: 0000-0003-2508-7125

Hatice Altun

Department of Child and Adolescent Psychiatry, Faculty of Medicine, Kahramanmaraş Sutcu Imam University, Kahramanmaraş, Türkiye

Email: drhaticealtun@gmail.com

ORCID iD: 0000-0002-6802-8216

Feyza Hatice Ekici

Department of Child and Adolescent Psychiatry, Mersin City Training and Research Hospital, Mersin, Türkiye

Email: feyzasevgen@gmail.com

ORCID iD: 0000-0002-9784-0107

Hüseyin Sarıkaya

Department of Child and Adolescent Psychiatry, Gaziantep Cengiz Gökçek Women and Children's Hospital, Gaziantep, Türkiye

Email: dr42hsyn@gmail.com

ORCID iD: 0009-0004-7137-0997

Semiha Cömertoğlu Arslan

Department of Child and Adolescent Psychiatry, Faculty of Medicine, Kahramanmaraş Sutcu Imam University, Kahramanmaraş, Türkiye

Email: drsemihacrs@gmail.com

ORCID iD: 0000-0002-2296-5853

Received: 2026-07-14
Accepted: 2026-09-08

e-ISSN: 3108-7973

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INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is a childhood-onset common neurodevelopmental disorder characterized by inattention, hyperactivity and impulsivity. While it is stated that approximately 1 in 9 children in the United States is diagnosed with ADHD (Danielson et al., 2024), it has been reported that 1 in every 8 primary school students in our country is affected (Ercan et al., 2022). ADHD is associated with an increased risk of a wide range of adverse outcomes, including impaired quality of life, emotional and social difficulties, academic underachievement, psychiatric comorbidities, accidental injuries, crime and delinquency, substance use disorders, suicide, and premature death (Ercan et al., 2022; Faraone et al., 2021). Beyond these functional impairments, growing evidence indicates that individuals with ADHD have a particular vulnerability to addictive behaviors and substance use disorders, making addiction a major clinical concern in this population (Grassi et al., 2024; Rohner et al., 2023; Schellekens et al., 2020).

Adolescents with ADHD are also more likely to initiate and maintain nicotine use than their peers. Meta-analyses have shown that childhood ADHD predicts nicotine use in mid-adolescence and substance use disorders in young adulthood (Charach et al., 2011; Groenman et al., 2017; Lee et al., 2011), and population-based studies have shown that ADHD symptoms predict earlier smoking onset, faster progression to regular smoking and higher rates of nicotine dependence, even after adjustment for other externalising problems (Kollins et al., 2005; Milberger et al., 1997; Mitchell et al., 2019). This increased vulnerability is thought to result from the interaction of neurobiological and behavioral mechanisms. Behavioural disinhibition and impulsivity, difficulties in emotion regulation and — as proposed by the self-medication hypothesis — the attention-enhancing and affect-regulating effects of nicotine are the mechanisms most often invoked to explain this association (Katzman et al., 2017; Wilens & Morrison, 2011). Nicotine-containing products therefore deserve specific attention in this population, yet almost all available evidence concerns cigarettes rather than smokeless products.

Smokeless tobacco (ST) is used by more than 300 million people worldwide and comprises a heterogeneous group of products — snus and moist snuff in Scandinavia and North America, chewing tobacco and gutkha in South Asia, naswar in Central and South Asia, and toombak in Sudan — that differ substantially in nicotine content, pH and levels of tobacco-specific N-nitrosamines (International Agency for Research on Cancer [IARC], 2007; Siddiqi et al., 2020). Restricting the estimate to smokeless products alone, 348,798 deaths and approximately 8.7 million disability-adjusted life-years were attributable to ST use worldwide in 2017 (Siddiqi et al., 2020); an alternative meta-analytic approach including additional causes of death produced a considerably higher figure of 652,494 deaths (Sinha et al., 2018). Despite this burden, ST is regulated far less strictly than cigarettes in most countries, is frequently perceived as a harmless alternative or as a cessation aid, and its use among adolescents remains substantially less studied than smoking (Cohen et al., 1987; Mehrotra et al., 2019).

Maraş powder is the ST product characteristic of Kahramanmaraş and the neighbouring provinces of southern and south-eastern Türkiye. It is prepared from the powdered leaves of Nicotiana rustica L. mixed with the ash of oak, walnut or grapevine wood in a ratio of about 1:2 to 1:3, moistened, and held in the labial sulcus for periods ranging from a few minutes to several hours, several times a day. The nicotine content of N. rustica is approximately 6–10 times that of N. tabacum, and the alkaline pH created by the wood ash converts nicotine to its un-ionised form and markedly increases buccal absorption (Güven & Tolun, 2012). Consistent with this, urinary cotinine concentrations in Maraş powder users have been reported to be about three times higher than in cigarette smokers (Çok & Öztürk, 2000). Use has been associated with

genotoxic damage in buccal mucosal cells (Özkul et al., 1997), increased oxidative stress (Kılınç et al., 2004) and cardiovascular and nervous-system effects (Güven & Tolun, 2012; Tanrıverdi, 2022). Because it is cheaper than cigarettes and is widely believed to be harmless or even helpful for quitting smoking, it is accessible to adolescents from all income groups (Akbay et al., 2017; Keten et al., 2014).

Although the association between ADHD and cigarette smoking is well documented, no previous study has examined smokeless tobacco use in adolescents with ADHD, and data on Maraş powder in adolescents in general are scarce. Accordingly, the primary aim of this study was to compare the prevalence of ever use and of current regular use of Maraş powder between adolescents with ADHD and age- and sex-matched adolescents without a psychiatric disorder. The secondary aims were: (i) to examine the sociodemographic, familial, peer-related and symptom-related correlates of Maraş powder use in the total sample; (ii) to examine, within the ADHD group, whether Maraş powder use differs according to whether the adolescent is receiving regular pharmacological treatment; and (iii) to describe adolescents' knowledge of and beliefs about Maraş powder. We hypothesised that (H1) both ever use and regular use would be more frequent in the ADHD group, (H2) regular users would show higher disruptive-behaviour symptom scores than non-users, and (H3) misconceptions about the harms of Maraş powder would be common in both groups. The analysis of treatment status was planned as an exploratory, hypothesis-generating analysis.

METHODS

Study design and setting

This was a single-centre, cross-sectional comparative study conducted in the Child and Adolescent Mental Health and Diseases Outpatient Clinic of Kahramanmaraş Sutcu Imam University, Faculty of Medicine Hospital, Kahramanmaraş, Türkiye, comparing adolescents with ADHD and age- and sex-matched healthy controls. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies. Data were collected between January 2018 and January 2020.

Participants and sampling

Adolescents aged 11–17 years who consecutively presented to the outpatient clinic during the study period and who received a diagnosis of combined presentation ADHD according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) were invited to participate (n = 50). The diagnosis was established by a child and adolescent psychiatrist on the basis of a clinical interview conducted with the adolescent and at least one parent, supplemented by information on functioning at school.

Exclusion criteria for the ADHD group were: a lifetime diagnosis of a psychotic disorder or bipolar disorder; autism spectrum disorder; intellectual disability or any cognitive impairment that would prevent completion of the self-report instruments; a neurological disorder affecting cognition; known genetic, neurological, metabolic or endocrine disorders; severe head trauma or organic brain damage; and refusal to participate after detailed information about the study. Frequently co-occurring disorders were not used as exclusion criteria: adolescents with oppositional defiant disorder, conduct disorder, anxiety disorders, depressive disorders, tic disorders and specific learning disorder were included, and their comorbidities are reported in Table 2. This decision was made in order to preserve the clinical representativeness of the sample, and it is taken into account in the interpretation of the findings.

The comparison group comprised 50 healthy adolescents matched to the ADHD group by age and sex. Participants were recruited from adolescents attending the Child and Adolescent Psychiatry outpatient clinic for routine consultation and were randomly selected after applying the predefined

exclusion criteria. The absence of any psychiatric disorder was confirmed through a comprehensive psychiatric evaluation conducted by a child and adolescent psychiatrist, together with verification that neither the adolescent nor the accompanying parent reported any current or lifetime psychiatric diagnosis or psychotropic medication use. Adolescents who met the diagnostic criteria for any psychiatric disorder were excluded from the study. Additional exclusion criteria for the comparison group included a history of genetic, neurological, metabolic, endocrine disorders or severe head trauma or organic brain damage as well as any previous psychiatric treatment.

During the study period, 463 children and adolescents with DSM-5 ADHD were screened for eligibility. Of these, 178 declined to participate, 126 were excluded because of incomplete study forms, and 109 were excluded for meeting one or more of the predefined exclusion criteria. The final analytic sample comprised 100 adolescents (50 per group) with complete data on all study variables; there were no missing values for the primary outcome or for any of the scales used.

Ethical considerations

Ethical approval for the study was obtained from the Clinical Research Ethics Committee of Kahramanmaraş Sutcu Imam University, Faculty of Medicine (Decision No. 2; Session No. 2017/18; Approval Date: November 8, 2017). All procedures were performed in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants and their parents. Participants were informed that their answers about tobacco and substance use would not be shared with their parents or their school, and the questionnaires were completed in a separate room in order to reduce social desirability bias.

Diagnostic and symptom assessment

All participants, including both the ADHD and control groups, underwent a comprehensive psychiatric evaluation by a certified child and adolescent psychiatrist using the Kiddie Schedule for Affective Disorders and Schizophrenia, Present and Lifetime Version for DSM-5 (K-SADS-PL-DSM-5) (Kaufman et al., 1997; Ünal et al., 2019). The semi-structured diagnostic interview was administered according to standardized guidelines and included separate interviews with both the child and parent. ADHD diagnoses were established based on the DSM-5 criteria. Intellectual disability was excluded according to the Wechsler Intelligence Scale for Children—Revised (WISC-R).

Parents of the children completed the sociodemographic data form and the DSM-IV Disruptive Behavior Disorders Rating Scale (DBDRS). Both the study group and the control group completed the 'Maraş powder knowledge, belief and use questionnaire' prepared by the researchers, the Kovacs Children's Depression Inventory (CDI), which was employed to assess the children's depression levels, and the State-Trait Anxiety Inventory (STAI-1 and STAI-2), which was used to assess the children's anxiety levels.

Measures

Sociodemographic and clinical form. A form developed by the researchers recorded the adolescent's age, sex, school grade, chronic physical illness, parental age and education, family income, family structure, place of residence, and — for the ADHD group — treatment status, medication type, treatment duration and psychiatric comorbidity. Because tobacco use is strongly socially patterned, the form also recorded cigarette, alcohol and other substance use by the adolescent, Maraş powder use within the family, and Maraş powder use by close friends.

Maraş powder knowledge, belief and use questionnaire. Because no validated instrument assessing Maraş powder use and beliefs in adolescents was available, the questionnaire was developed by the research team based on the existing literature on Maraş powder and smokeless tobacco (Akbay et al., 2017; Keten et al., 2014) and the WHO Framework

Convention on Tobacco Control themes of harm perception, dependence and regulation. Belief items were rated as "agree", "no idea" or "disagree". The questionnaire was designed for descriptive purposes only and no formal psychometric validation (including content validity, factor analysis, internal consistency or test–retest reliability) was performed; the instrument is therefore used descriptively rather than as a scale.

Operational definitions. Maraş powder use was assessed with a single item with four mutually exclusive response options, and the following operational definitions were applied consistently throughout the manuscript:

• Never use: the adolescent has never tried Maraş powder, not even once.

• Experimentation: the adolescent has tried Maraş powder once or a few times but does not use it continuously, and did not report ongoing use at the time of assessment.

• Current regular use: the adolescent reports using Maraş powder continuously ("yes, continuously") at the time of assessment. All adolescents in this category reported ongoing use for at least the previous month, with a defined daily frequency and a defined duration of use (Table 6).

• Ever use: experimentation or current regular use, i.e. any lifetime use.

The Kiddie Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version DSM-5 (K-SADS-PL-DSM-5). The K-SADS-PL is a semi-structured interview to determine psychopathology in children and adolescents aged 6–18, according to the DSM-5 criteria (Kaufman et al., 1997). It is designed to assess the past and present psychopathology of children and adolescents. Validity and reliability studies have been conducted on the Turkish sample of the scale, which is based on DSM-5 diagnostic criteria (Ünal et al., 2019).

DSM-IV Disruptive Behavior Disorders Rating Scale — parent form. The DSM-IV Disruptive Behavior Disorders Rating Scale (Turgay's ADHD Scale — ADHD-RS-IV; DBDRS) is an evaluation tool developed by Atilla Turgay using the DSM-IV symptoms without changing the meanings. The scale consists of 41 items and comprises inattention, hyperactivity/impulsivity, conduct disorder and oppositional defiant disorder subscales. Items are rated on a 4-point Likert-type scale from 0 (none) to 3 (very much); higher scores indicate greater symptom severity. In the present study the scale was completed by the parent accompanying the adolescent, under the supervision of the clinician. The study on the reliability and validity of the Turkish version of the scale was performed by Ercan et al. (2001).

Kovacs Children's Depression Inventory (CDI). A self-report scale developed for children and adolescents aged 6–17 years (Kovacs, 1981), consisting of 27 items scored 0, 1 or 2, with a maximum score of 54; higher scores indicate more severe depressive symptoms. The Turkish validity and reliability study was conducted by Öy (1991).

State-Trait Anxiety Inventory (STAI-1 and STAI-2). Consists of 20-item state and 20-item trait anxiety subscales (Spielberger et al., 1971). Reversed items are included in both scales. Items in the scale are scored between 1 and 4. Scores on both scales range from 20 to 80, with higher scores indicating elevated levels of anxiety. The Turkish validity and reliability study was conducted by Öner and Le Compte (1985).

Sample size and statistical power

No a priori sample size calculation was performed; the sample size of 50 participants per group was determined pragmatically by the number of eligible adolescents who could be recruited consecutively during the study period, which is a limitation of the study. A post hoc evaluation indicates that, for a two-sided α of 0.05, the achieved sample provides 63% power to detect the observed difference in

regular use (28.0% vs. 10.0%; Cohen's h = 0.47), 78% power for the observed difference in ever use (32.0% vs. 10.0%), and 98% power for the observed within-group difference by treatment status (50.0% vs. 4.2%). For continuous outcomes, the design provides 80% power to detect a standardised mean difference of d ≥ 0.56 between two groups of 50. The study is therefore adequately powered for medium-to-large effects but underpowered for small effects, and all subgroup analyses involving the 19 regular users should be regarded as exploratory.

Statistical analysis

All statistical analyses were performed using jamovi version 2.6.44.0 and Python 3.13 (SciPy 1.17, statsmodels) for the exact tests, effect-size confidence intervals and penalised regression models. Normal distribution assumptions were evaluated by examining the Kolmogorov–Smirnov and Shapiro–Wilk tests, skewness/kurtosis values and histograms. Between-group comparisons of continuous variables used the Welch t-test or the Mann–Whitney U test according to distributional assumptions. For categorical variables, Pearson's χ^2 test was used when all expected cell frequencies were ≥ 5; when any expected frequency was < 5, Fisher's exact test was used, and for the two primary comparisons both tests are reported so that the robustness of the result is transparent.

Effect sizes with 95% CI are reported for every comparison: odds ratios (OR) for binary outcomes (with the Haldane–Anscombe 0.5 correction when a zero cell was present), Cramér's V for larger contingency tables, and Cohen's d / Hedges' g for continuous variables, with the rank-biserial correlation reported when the Mann–Whitney U test was used. Because the comparisons of the seven symptom, depression and anxiety measures constitute two families of multiple tests (Table 3 and Table 7), p values within each family were adjusted with the Benjamini–Hochberg false discovery rate procedure and both unadjusted and adjusted values are presented. All other analyses, including all subgroup analyses within the ADHD group, are explicitly exploratory and their p values are not corrected; they are interpreted as hypothesis-generating.

Because the number of events was small (19 regular users in the total sample and 14 within the ADHD group) and because one cell of the treatment analysis contained a single event, adjusted analyses used Firth penalised (bias-reduced) logistic regression with profile penalised-likelihood 95% CI and penalised likelihood-ratio tests, which is the recommended approach in the presence of sparse data and quasi-complete separation. Four pre-specified models were fitted: in the total sample, Model 1 adjusted for age and sex and Model 2 additionally for peer Maraş powder use; within the ADHD group, Model 3 adjusted for age and sex and Model 4 additionally for peer use and psychiatric comorbidity. The number of covariates was deliberately restricted to approximately one variable per 5 events; models with a larger covariate set (including family use and cigarette smoking) were fitted as sensitivity analyses and are described in the text. Continuous variables are presented as mean (M) and standard deviation (SD) and categorical variables as number (n) and percentage (%), with the denominator stated for every percentage. A two-sided p value below 0.05 was considered statistically significant.

RESULTS

Sample characteristics

The two groups did not differ significantly in age, sex, education, parental age and education, family income, family structure, place of residence, or Maraş powder use within the family **(Table 1)**. Two variables differed between the groups: a close friend who used Maraş powder was reported more frequently by adolescents with ADHD (50.0% vs. 30.0%; χ^2 p = 0.041, Fisher p = 0.066; OR = 2.33, 95% CI 1.03–5.30), as was any current substance use (46.0% vs. 22.0%; p = 0.011; OR = 3.02, 95% CI 1.27–7.21). Lifetime cigarette smoking was more frequent in the ADHD group but the difference was not statistically significant (60.0% vs. 46.0%; p =

Table 1: Sociodemographic, Familial and Substance-Related Characteristics of the Participants

Characteristic	ADHD group (n = 50)	Control group (n = 50)	p	Effect size (95% CI)
Age, years, M (SD)	15.08 (1.65)	14.82 (1.85)	0.460	d = 0.15 (−0.24 to 0.54)
Education, years, M (SD)	9.56 (1.53)	9.50 (1.75)	0.856	d = 0.04 (−0.36 to 0.43)
Mother's age, years, M (SD)	39.76 (5.75)	39.90 (5.84)	0.904	d = −0.02 (−0.42 to 0.37)
Father's age, years, M (SD)	45.42 (5.74)	44.36 (5.34)	0.341	d = 0.19 (−0.20 to 0.58)
Number of siblings, M (SD)	2.08 (1.14)	2.08 (1.05)	1.000	d = 0.00 (−0.39 to 0.39)
Male sex, n (%)	35 (70.0)	33 (66.0)	0.668	OR = 1.20 (0.52–2.79)
Chronic physical illness, n (%)	6 (12.0)	8 (16.0)	0.564	OR = 0.72 (0.23–2.24)
Mother high school or above, n (%)	21 (42.0)	22 (44.0)	0.840	OR = 0.92 (0.42–2.03)
Father high school or above, n (%)	28 (56.0)	30 (60.0)	0.685	OR = 0.85 (0.38–1.88)
Monthly household income above the minimum wage, n (%)	15 (30.0)	13 (26.0)	0.656	OR = 1.22 (0.51–2.93)
Non-nuclear family, n (%)	6 (12.0)	4 (8.0)	0.505	OR = 1.57 (0.41–5.94)
District/village residence, n (%)	10 (20.0)	10 (20.0)	1.000	OR = 1.00 (0.38–2.66)
Maraş powder use in the family, n (%)	19 (38.0)	18 (36.0)	0.836	OR = 1.09 (0.48–2.45)
Maraş powder use by a close friend, n (%)	25 (50.0)	15 (30.0)	0.041	OR = 2.33 (1.03–5.30)
Ever smoked cigarettes, n (%)	30 (60.0)	23 (46.0)	0.161	OR = 1.76 (0.80–3.89)
Ever used alcohol, n (%)	14 (28.0)	8 (16.0)	0.148	OR = 2.04 (0.77–5.42)
Ever used illicit drugs, n (%)	4 (8.0)	2 (4.0)	0.678*	OR = 2.09 (0.36–11.95)
Any current substance use, n (%)	23 (46.0)	11 (22.0)	0.011	OR = 3.02 (1.27–7.21)

Note. M = mean; SD = standard deviation; OR = odds ratio; CI = confidence interval; d = Cohen's d. p values are from Welch's t-test for continuous variables and Pearson's χ^2 test for categorical variables. Percentages are calculated within each group (denominator = 50). * Fisher's exact test was used because an expected cell frequency was below 5.

0.161). These variables were considered as potential confounders in the adjusted analyses.

Within the ADHD group, 24 adolescents (48.0%) were receiving regular pharmacological treatment, most frequently long-acting methylphenidate (20/24; 83.3%), and 32 (64.0%) had at least one psychiatric comorbidity, most frequently conduct disorder (11/50; 22.0%) and oppositional defiant disorder (8/50; 16.0%) **(Table 2)**. Treatment duration was 12–24 months in 12 adolescents and 24–36 months in 9. In the previous version of the manuscript, treatment duration was inadvertently reported as a mean of 3.71 (0.91) "years"; this value was the mean of the ordinal category codes rather than a duration in years, and it has been replaced by the categorical distribution shown in Table 2.

Knowledge and beliefs about Maraş powder

Knowledge and beliefs were assessed in all 100 participants **(Figure 1)**. Most adolescents agreed that Maraş powder is harmful to health (90/100; 90.0%) and that it is addictive (83/100; 83.0%). However, uncertainty was widespread: 57.0% either agreed with (17.0%) or reported no idea about (40.0%) the statement that Maraş powder helps smoking cessation, 74.0% had no idea whether its nicotine content exceeds that of cigarettes, and only 38.0% correctly rejected the statement that indoor use is not prohibited. Only 9.0% reported knowing where treatment for Maraş powder dependence is available. Beliefs did not differ significantly between the ADHD and control groups for any item (all $p > 0.05$, uncorrected).

Table 2: Clinical Characteristics of the ADHD Group (n = 50)

Clinical characteristic	n (%)
Receiving regular pharmacological treatment	24 (48.0)
Not receiving treatment	26 (52.0)
Medication among treated adolescents (n = 24)	
Short-acting methylphenidate	1 (4.2)
Long-acting methylphenidate	20 (83.3)
Atomoxetine	1 (4.2)
Long-acting methylphenidate + atypical antipsychotic	1 (4.2)
Short- + long-acting methylphenidate	1 (4.2)
Duration of current treatment (n = 24)	
12–24 months	12 (50.0)
24–36 months	9 (37.5)
36–48 months	1 (4.2)
> 48 months	2 (8.3)
At least one psychiatric comorbidity	32 (64.0)
Conduct disorder	11 (22.0)
Oppositional defiant disorder	8 (16.0)
Anxiety disorder	6 (12.0)
Depressive disorder	2 (4.0)
Tic disorder	1 (2.0)
Adjustment disorder	1 (2.0)
Trichotillomania	1 (2.0)
Oppositional defiant disorder + depressive disorder	1 (2.0)
Conduct disorder + alcohol/substance use disorder	1 (2.0)
Other (specific learning disorder, enuresis, conversion, etc.)	0 (0.0)

Note. Percentages for medication type and treatment duration are calculated within the treated subgroup (denominator = 24); all other percentages use the whole ADHD group (denominator = 50). Comorbid diagnoses were established clinically according to DSM-5 criteria. Comorbid disorders were not exclusion criteria.

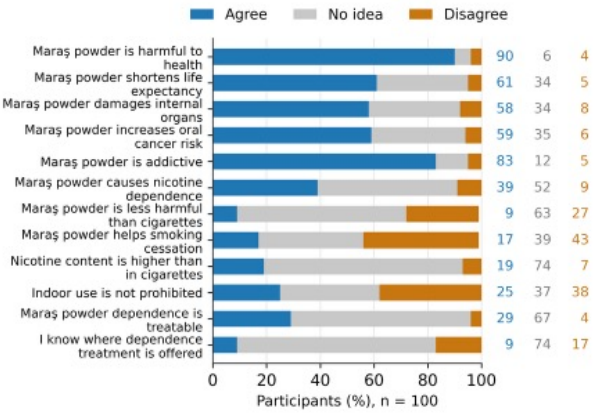

Figure 1: Knowledge of and Beliefs About Maraş Powder Among All Participants (N = 100)

Note. Stacked bars show the percentage of participants who agreed with, had no idea about, or disagreed with each statement. Because n = 100, the values printed to the right of each bar correspond to both counts and percentages; each value is coloured to match its bar segment (blue = agree, grey = no idea, amber = disagree). The item "Indoor use is not prohibited" is negatively worded, so that "disagree" (38.0%) represents the correct answer.

Symptom, depression and anxiety scores in the two groups

The ADHD group had significantly higher scores on all DBDRS subscales than the control group (all Benjamini–Hochberg-corrected $p \leq 0.001$; Hedges' g between 0.77 and 1.37). There was no statistically significant difference between the groups in CDI ($p = 0.826$), state anxiety ($p = 0.652$) or trait anxiety ($p = 0.065$) scores **(Table 3)**.

Maraş powder use in the two groups

Current regular use of Maraş powder was reported by 14 of the 50 adolescents with ADHD (28.0%) and by 5 of the 50 control adolescents (10.0%), while 2 adolescents (4.0%) in the ADHD group and none in the control group reported experimentation without regular use; 34 (68.0%) and 45 (90.0%) respectively had never used the product **(Table 4, Figure 2).**

Table 3: Comparison of Symptom, Depression and Anxiety Scores Between the ADHD Group and the Control Group

Measure	ADHD group (n = 50) M (SD)	Control group (n = 50) M (SD)	p	pBH	Hedges' g (95% CI)
DBDRS Inattention	14.92 (5.50)	7.76 (4.90)	<0.001	<0.001	1.37 (0.94 to 1.81)
DBDRS Hyperactivity/ impulsivity	9.82 (5.32)	4.12 (4.13)	<0.001	<0.001	1.19 (0.77 to 1.62)
DBDRS Oppositional defiant	11.66 (6.04)	7.64 (4.18)	<0.001	<0.001	0.77 (0.37 to 1.18)
DBDRS Conduct	4.70 (5.65)	1.32 (2.37)	<0.001	<0.001	0.77 (0.37 to 1.19)
Kovacs Children's Depression Inventory	17.16 (8.98)	16.76 (9.15)	0.826	0.826	0.04 (−0.35 to 0.44)
State Anxiety Inventory	42.64 (11.99)	43.74 (12.30)	0.652	0.760	−0.09 (−0.48 to 0.30)
Trait Anxiety Inventory	45.60 (10.38)	49.94 (12.75)	0.065	0.091	−0.37 (−0.77 to 0.02)

Note. DBDRS = DSM-IV Disruptive Behavior Disorders Rating Scale; CI = confidence interval; pBH = p value after Benjamini–Hochberg false discovery rate correction within this family of seven tests. Welch's t-test was used for all measures except the conduct subscale, for which the Mann–Whitney U test was used (rank-biserial r = 0.36).

Table 4: Maraş Powder Use by Group

Maraş powder use	ADHD group (n = 50) n (%)	Control group (n = 50) n (%)	p	OR (95% CI)
Current regular use	14 (28.0)	5 (10.0)	0.022 (Fisher 0.040)	3.50 (1.15–10.63)
Experimentation without regular use	2 (4.0)	0 (0.0)	—	—
Never used	34 (68.0)	45 (90.0)	—	—
Ever use (regular + experimentation)	16 (32.0)	5 (10.0)	0.007 (Fisher 0.013)	4.24 (1.41–12.70)

Note. OR = odds ratio for the ADHD group relative to the control group; CI = confidence interval. p values are from Pearson's χ^2 test with Fisher's exact p given in parentheses. Percentages use a denominator of 50 in each group. Categories are mutually exclusive; "ever use" combines regular use and experimentation.

The difference was statistically significant both for regular use ($\chi^2 = 5.26$, $p = 0.022$; Fisher $p = 0.040$; OR = 3.50, 95% CI 1.15–10.63; Cramér's V = 0.23) and for ever use ($\chi^2 = 7.29$, $p = 0.007$; Fisher $p = 0.013$; OR = 4.24, 95% CI 1.41–12.70; V = 0.27).

The frequencies reported in the previous version of the manuscript contained a numerical error: the number of regular users in the ADHD group was given as 11 although the percentage (28.0%) corresponded to 14 adolescents, so that the frequencies summed to 47 rather than 50 and conflicted with the 14 regular users implied by the treatment analysis and with the 19 regular users used in the scale comparisons. The complete dataset has been re-checked; the correct figure is 14 (28.0%), the total number of regular users in the whole sample is 19, and all tables, figures, the abstract and the main text are now mutually consistent.

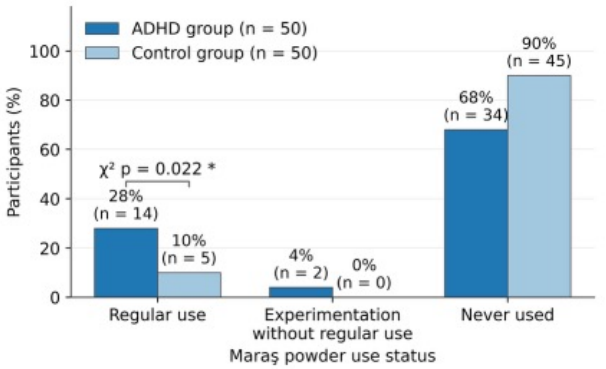

Figure 2: Distribution of Maraş Powder Use Status in the ADHD Group and the Control Group

Note. Bars show the percentage of adolescents in each group; the corresponding counts are given in parentheses above each bar (denominator = 50 per group). Regular use and ever use differed significantly between groups (χ^2 p = 0.022 and p = 0.007, respectively).

Maraş powder use and ADHD treatment status

Within the ADHD group, current regular use was reported by 1 of the 24 adolescents receiving regular pharmacological treatment (4.2%) and by 13 of the 26 untreated adolescents (50.0%) (χ^2 = 13.00, p < 0.001; Fisher p < 0.001; OR = 0.04, 95% CI 0.01–0.37) **(Table 5, Figure 3)**. Treated and untreated adolescents did not differ significantly in age, sex, parental education, income, place of residence, family or peer Maraş powder use, or psychiatric comorbidity, but the small subgroup sizes mean that clinically relevant imbalances cannot be excluded. This analysis was pre-specified as exploratory and treatment was not randomly allocated; the finding is therefore reported as an association only.

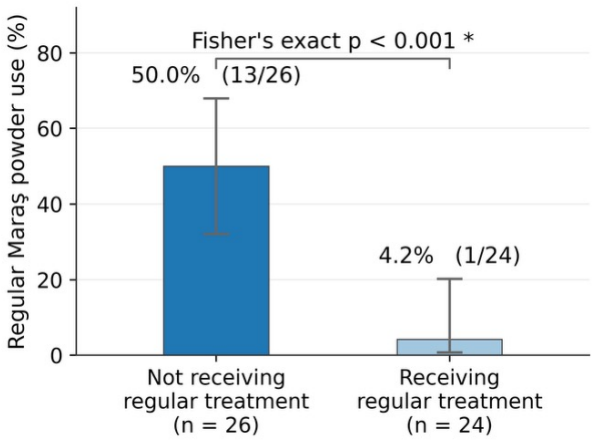

Figure 3: Prevalence of Current Regular Maraş Powder Use in the ADHD Group According to Treatment Status

Note. Bars show percentages with 95% Wilson confidence intervals; counts and denominators are printed above each bar. The difference was statistically significant (Fisher p < 0.001), but treatment was not randomly allocated and the estimate is based on a single event in the treated subgroup.

Characteristics of regular users

The 19 adolescents who reported current regular use had started using Maraş powder at a mean age of 14.89 (SD 0.81) years (range 13–16). Duration of use was 6–12 months in 8 adolescents (42.1%) and longer than 12 months in 8 (42.1%); 9 (47.4%) reported using the product fewer than 5 times per day and 10 (52.6%) 5–10 times per day. The most frequent reason for use was to feel better or to reduce stress (16/19; 84.2%), followed by curiosity (9/19; 47.4%). Twelve adolescents (63.2%) obtained the product from a grocery store. All 19 regular users had also smoked cigarettes, and 8 (42.1%) reported

Table 5: Maraş Powder Use in the ADHD Group by Treatment Status

Maraş powder use	Receiving treatment (n = 24) n (%)	Not receiving treatment (n = 26) n (%)	p	OR (95% CI)
Current regular use	1 (4.2)	13 (50.0)	<0.001 (Fisher <0.001)	0.04 (0.01–0.37)
Ever use	1 (4.2)	15 (57.7)	<0.001 (Fisher <0.001)	0.03 (0.00–0.27)

Note. OR = odds ratio for adolescents receiving regular treatment relative to untreated adolescents; CI = confidence interval. Percentages use denominators of 24 (treated) and 26 (untreated). Treatment was not randomly allocated; see Limitations.

concurrent alcohol or cannabis use; 9 (47.4%) were considering quitting and 9 (47.4%) had previously attempted to quit **(Table 6)**. The 2 adolescents who reported experimentation only had first tried Maraş powder at ages 12 and 13.

Table 6: Characteristics of Current Regular Maraş Powder Users (n = 19)

Characteristic	n (%) or M (SD)
Age at onset of use, years, M (SD) [range]	14.89 (0.81) [13–16]
Duration of use	
0–6 months	3 (15.8)
6–12 months	8 (42.1)
12–18 months	5 (26.3)
18–24 months	2 (10.5)
> 24 months	1 (5.3)
Daily frequency of use	
< 5 times	9 (47.4)
5–10 times	10 (52.6)
Source of supply	
Grocery store	12 (63.2)
Supermarket	1 (5.3)
Friends	2 (10.5)
Grocery store and friends	4 (21.1)
Concurrent tobacco/substance use	
Cigarettes only	9 (47.4)
Cigarettes and alcohol	5 (26.3)
Cigarettes, alcohol and cannabis	3 (15.8)
Not reported	2 (10.5)
Main self-reported reasons for use (multiple answers allowed)	
Feeling better / reducing stress	16 (84.2)
Curiosity	9 (47.4)
Not being excluded by peers	3 (15.8)
Weight control	3 (15.8)
Low cost	2 (10.5)
Feeling grown-up	1 (5.3)
To quit smoking	1 (5.3)
Considering quitting Maraş powder	9 (47.4)
Previous quit attempt	9 (47.4)

Note. Percentages use a denominator of 19 unless otherwise stated. Reasons for use allowed multiple answers, so percentages sum to more than 100. Concurrent substance use was not reported by 2 adolescents. These descriptive data support the operational definition of regular use given in the Methods.

Symptom, depression and anxiety scores by Maraş powder use

Adolescents with current regular use scored significantly higher than non-regular users on all four DBDRS subscales, on the CDI and on state anxiety, with all differences remaining significant after Benjamini–Hochberg correction; effect sizes were moderate to very large (Hedges' g = 0.52–1.97, largest for conduct symptoms). Trait anxiety did not differ between the groups (p = 0.944, g = 0.02) **(Table 7, Figure 4)**. These comparisons combine the ADHD and control groups; the same pattern was observed when the analysis was restricted to the ADHD group, but with wider confidence intervals owing to the smaller sample.

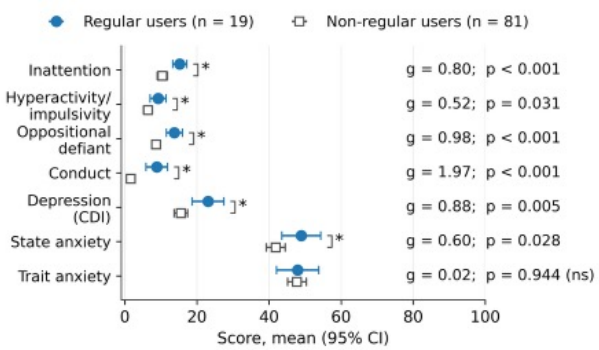

Figure 4: Symptom, Depression and Anxiety Scores of Current Regular Maraş Powder Users (n = 19) and Non-Regular Users (n = 81)

Note. Symbols show group means and horizontal lines the 95% confidence intervals. Hedges' g and the Benjamini–Hochberg-corrected p value are printed to the right of each pair; * indicates a difference that remained significant after Benjamini–Hochberg correction, ns indicates a non-significant difference.

Adjusted analyses

In the total sample, ADHD remained associated with current regular use after adjustment for age and sex (aOR = 3.44, 95% CI 1.12–11.99, p = 0.031; Model 1). When peer Maraş powder use was added, the association was attenuated and no longer statistically significant (aOR = 2.87, 95% CI 0.81–11.59, p = 0.102), whereas having a close

Table 7: Comparison of Symptom, Depression and Anxiety Scores Between Current Regular Maraş Powder Users and Non-Regular Users

Measure	Regular users (n = 19) M (SD)	Non-regular users (n = 81) M (SD)	p	pBH	Hedges' g (95% CI)
DBDRS Inattention	15.26 (4.05)	10.42 (6.40)	<0.001	<0.001	0.80 (0.29 to 1.31)
DBDRS Hyperactivity/ impulsivity	9.26 (4.57)	6.43 (5.63)	0.027	0.031	0.52 (0.01 to 1.02)
DBDRS Oppositional defiant	13.79 (4.63)	8.68 (5.31)	<0.001	<0.001	0.98 (0.47 to 1.50)
DBDRS Conduct	8.89 (6.24)	1.63 (2.77)	<0.001	<0.001	1.97 (1.41 to 2.55)
Kovacs Children's Depression Inventory	23.11 (9.16)	15.52 (8.41)	0.003	0.005	0.88 (0.37 to 1.40)
State Anxiety Inventory	48.95 (11.17)	41.84 (11.97)	0.020	0.028	0.60 (0.09 to 1.11)
Trait Anxiety Inventory	47.95 (12.17)	47.73 (11.75)	0.944	0.944	0.02 (−0.48 to 0.52)

Note. DBDRS = DSM-IV Disruptive Behavior Disorders Rating Scale; CI = confidence interval; pBH = Benjamini–Hochberg-corrected p value within this family of seven tests. Welch's t-test was used for all measures except the conduct subscale (Mann–Whitney U test; rank-biserial r = 0.67). Non-regular users include never users and adolescents who reported experimentation only.

friend who used Maraş powder was strongly associated with regular use (aOR = 9.08, 95% CI 2.45–49.45, p < 0.001) and each additional year of age approximately doubled the odds (aOR = 2.04, 95% CI 1.20–4.03, p = 0.007; Model 2). In a sensitivity model additionally including family use and lifetime cigarette smoking, the ADHD estimate was essentially unchanged (aOR = 3.50, 95% CI 0.84–18.10, p = 0.086); it should be noted that all 19 regular users had smoked cigarettes, which produces quasi-complete separation and makes the smoking estimate unstable even under penalisation **(Table 8, Figure 5)**.

Table 8: Firth Penalised Logistic Regression Models for Current Regular Maraş Powder Use

Model / predictor	aOR	95% CI	p
Model 1 — total sample, outcome: current regular use (n = 100, events = 19)			
ADHD (vs. control)	3.44	1.12–11.99	0.031
Age (per year)	2.23	1.44–3.93	<0.001
Male sex (vs. female)	1.25	0.40–4.12	0.706
Model 2 — total sample, further adjusted for peer use (n = 100, events = 19)			
ADHD (vs. control)	2.87	0.81–11.59	0.102
Age (per year)	2.04	1.20–4.03	0.007
Male sex (vs. female)	1.04	0.28–3.86	0.954
Close friend using Maraş powder	9.08	2.45–49.45	<0.001
Model 3 — ADHD group only, outcome: current regular use (n = 50, events = 14)			
Regular ADHD treatment (vs. none)	0.04	0.003–0.31	<0.001
Age (per year)	3.07	1.42–10.50	0.001
Male sex (vs. female)	2.01	0.33–14.39	0.443
Model 4 — ADHD group only, extended adjustment (n = 50, events = 14)			
Regular ADHD treatment (vs. none)	0.10	0.006–0.89	0.038
Age (per year)	3.09	1.26–11.49	0.010
Close friend using Maraş powder	3.28	0.45–35.31	0.240
Psychiatric comorbidity (vs. none)	2.77	0.26–36.35	0.385

Note. aOR = adjusted odds ratio from Firth penalised (bias-reduced) logistic regression; CI = confidence interval (profile penalised-likelihood); p values are from penalised likelihood-ratio tests. Models 1 and 2 use the total sample (100 participants, 19 events); Models 3 and 4 use the ADHD group only (50 participants, 14 events). Given the small number of events, all adjusted estimates are exploratory.

Within the ADHD group, the absence of regular pharmacological treatment remained associated with regular use after adjustment for age and sex (aOR for treatment = 0.04, 95% CI 0.003–0.31, p < 0.001; Model 3) and after further adjustment for peer use and psychiatric comorbidity (aOR = 0.10, 95% CI 0.006–0.89, p = 0.038; Model 4). Given 14 events, wide confidence intervals and the observational design, these estimates should be regarded as exploratory.

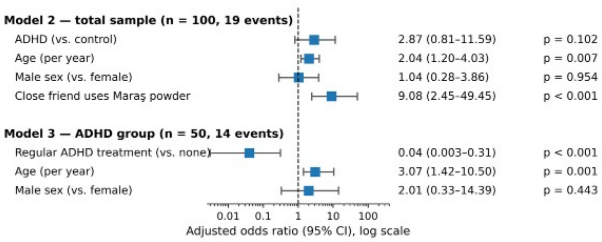

Figure 5: Adjusted Odds Ratios for Current Regular Maraş Powder Use From Firth Penalised Logistic Regression

Note. Squares show adjusted odds ratios and horizontal lines the 95% profile penalised-likelihood confidence intervals on a logarithmic scale; the dashed vertical line marks the null value of 1. The upper block shows Model 2, fitted in the total sample (n = 100, 19 events), and the lower block Model 3, fitted within the ADHD group (n = 50, 14 events); model numbering corresponds to Table 8. Numerical values are given to the right of the plot.

DISCUSSION

This cross-sectional study compared adolescents with ADHD and age- and sex-matched adolescents without a psychiatric disorder with respect to the use of Maraş powder, a high-nicotine smokeless tobacco product. Three findings emerged, corresponding to the three aims of the study.

Primary aim: prevalence of use. Both ever use (32.0% vs. 10.0%) and current regular use (28.0% vs. 10.0%) were about three times more frequent among adolescents with ADHD, and the association with regular use persisted after adjustment for age and sex. To our knowledge, this is the first study to examine a smokeless tobacco product in adolescents with ADHD. The direction and magnitude of the association are consistent with the literature on cigarette smoking: meta-analyses have shown that childhood ADHD is associated with nicotine use in mid-adolescence and with subsequent substance use disorders (Charach et al., 2011; Groenman et al., 2017; Lee et al., 2011), and population-based studies have shown earlier smoking onset and faster progression to regular use in adolescents with ADHD symptoms (Kollins et al., 2005; Milberger et al., 1997; Mitchell et al., 2019). Our data extend this pattern to a smokeless product whose nicotine delivery is at least as high as that of cigarettes (Çok & Öztürk, 2000; Güven & Tolun, 2012). Importantly, the association was attenuated when peer Maraş powder use was taken into account, and all regular users were also cigarette smokers; this suggests that the elevated prevalence in ADHD reflects a broader pattern of poly-tobacco use embedded in a peer context rather than a product-specific vulnerability. Because the design is cross-sectional, it cannot be determined whether ADHD-related characteristics lead to Maraş powder use, whether both share common causes such as externalising problems and peer affiliation, or whether nicotine exposure aggravates symptoms.

Secondary aim: treatment status. Within the ADHD group, regular Maraş powder use was less frequent among adolescents receiving regular pharmacological treatment (4.2%) than among untreated adolescents (50.0%), and this difference persisted in adjusted exploratory models. Superficially, this is consistent with a meta-analytic review reporting that stimulant treatment was associated with a reduced risk of later alcohol and substance use disorders (Wilens et al., 2003) and with the reduction in substance-related emergency visits during medicated periods (Asherson, 2017). However, other meta-analyses have found that stimulant treatment neither increases nor decreases the subsequent risk of alcohol, cigarette, cannabis or other substance use (Humphreys et al., 2013; Molina et al., 2023), and the management of ADHD co-occurring with

substance use is itself recognised as a complex clinical problem (Barbuti et al., 2023). More importantly, in the present study treatment was not randomly allocated. Adolescents who remain in regular treatment may differ from untreated adolescents in adherence, family monitoring, help-seeking, access to health care, symptom severity and unmeasured socioeconomic characteristics, and reverse causality is equally plausible: adolescents who use tobacco regularly may be less likely to attend appointments and to continue medication. Only 1 event occurred in the treated subgroup, so the estimate is imprecise. We therefore describe this finding strictly as an association between regular ADHD treatment and a lower prevalence of Maraş powder use; the present data do not show that ADHD treatment prevents smokeless tobacco dependence, and the term "protective factor" used in the previous version of the manuscript has been removed throughout.

Symptom severity in regular users. Regular users had higher inattention, hyperactivity/impulsivity, oppositional defiant and — most markedly — conduct symptom scores, as well as higher depression and state anxiety scores, than non-users. The largest effect was observed for conduct symptoms ($g = 1.97$), whereas the difference in hyperactivity/impulsivity was moderate ($g = 0.52$) and trait anxiety did not differ at all. This profile suggests that the association is driven more by externalising psychopathology than by ADHD core symptoms alone, and the dissociation between state and trait anxiety is compatible with a state-dependent phenomenon (for example, withdrawal-related distress or situational stress) rather than a stable anxious disposition. Because the study is cross-sectional and did not assess dopamine function, reward processing or emotion regulation directly, no inference can be drawn about the neurobiological mechanisms sometimes invoked in this context; the elevated scores may reflect psychopathology leading to tobacco use, the effects of nicotine on symptoms, or shared underlying externalising liability and unmeasured variables. Our finding that regular users exhibited particularly elevated conduct and other externalising symptoms is consistent with previous studies indicating that externalising psychopathology, rather than ADHD core symptoms alone, is a major correlate of tobacco use in adolescents (Charach et al., 2011; Lee et al., 2011; Molina & Pelham, 2003).

Knowledge and beliefs. Although 90.0% of adolescents recognised that Maraş powder is harmful — consistent with a study of male high-school students in Kahramanmaraş (Keten et al., 2014) — specific knowledge was poor: 57.0% agreed with or were unsure about the claim that it helps smoking cessation, 74.0% did not know that its nicotine content exceeds that of cigarettes, and only 38.0% knew that indoor use is prohibited. Comparable misperceptions of smokeless tobacco have been reported among adolescents in the United States (Cohen et al., 1987) and are a recognised feature of the global smokeless tobacco literature, in which weaker regulation and lower risk perception coexist (Mehrotra et al., 2019; Siddiqi et al., 2020). Given that most regular users in our sample obtained the product from a neighbourhood grocery store and cited stress relief as their main reason for use, prevention efforts targeting adolescents — particularly those in psychiatric care — should address both product-specific misconceptions and access.

Limitations

The following limitations should be considered when interpreting these findings. (1) The design is cross-sectional, so no causal or temporal inference is possible for any of the reported associations. (2) The study was conducted in a single centre with a relatively small sample (50 per group), and no a priori sample size calculation was performed; the study is underpowered for small effects. (3) Subgroup sample sizes are small — 19 regular users in total and only 1 event in the treated subgroup — so several estimates have wide confidence intervals and are unstable. (4) All tobacco and substance use data are self-reported and were not biochemically verified (for example by salivary or urinary cotinine), so recall bias and social desirability bias may have led to underreporting despite the confidentiality procedures used. (5) The

Maraş powder questionnaire was developed by the researchers and has not undergone psychometric validation. (6) Several potentially important confounders were not measured: electronic cigarette use, waterpipe use, parental tobacco use, household tobacco exposure, parental monitoring, and detailed socioeconomic indicators; residual confounding is therefore likely even in the adjusted models. (7) Multiple comparisons were performed; although the two families of scale comparisons were corrected with the Benjamini–Hochberg procedure, the remaining analyses were exploratory and uncorrected, and borderline p values should be interpreted cautiously. (8) The comparison group was recruited from a hospital paediatric clinic rather than from the community, which may limit generalisability. (9) Another limitation is that only adolescents with combined-type ADHD were included; therefore, the findings may not be generalisable to individuals with predominantly inattentive or predominantly hyperactive-impulsive ADHD presentations. (10) Treatment was not randomly allocated and treatment adherence was not verified.

CONCLUSION

In this single-centre cross-sectional study, adolescents with ADHD reported both ever use and current regular use of Maraş powder about three times more frequently than matched adolescents without a psychiatric disorder, and regular use was associated with greater disruptive-behaviour symptom severity, more depressive symptoms and higher state anxiety. Within the ADHD group, regular pharmacological treatment was associated with a markedly lower prevalence of regular use. These results are preliminary and hypothesis-generating: they identify adolescents with ADHD — particularly those with prominent externalising symptoms, those who are not in regular treatment and those whose friends use the product — as a group in which smokeless tobacco should be screened for and addressed, but they do not demonstrate that ADHD treatment prevents smokeless tobacco use. Prospective, multicentre studies with biochemical verification of nicotine exposure and adequate control of family, peer and socioeconomic factors are needed to test the associations reported here.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declare that they have no conflict of interests regarding content of this article.

Financial Support

The Authors report no financial support regarding content of this article.

Ethics Approval

The study protocol was approved by the Clinical Research Ethics Committee of Kahramanmaraş Sutcu Imam University, Faculty of Medicine, Kahramanmaraş, Türkiye (decision no. 02, date: 08.11.2017). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participating adolescents and from their parents or legal guardians.

Author Contributions

Concept: AAG, HA, FHE. Design: AAG, HA, FHE. Supervising: AAG, HA, ASC. Financing and equipment: AAG, HA, FHE, HS, SCA. Data collection and entry: AAG, HA, HS. Analysis and interpretation: AAG, HA, SCA. Literature search: AAG, HA, HS. Writing: AAG, HA, HS. Critical review: AAG, HA, HS. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Corresponding Author

Asiye Arıcı Gürbüz

Department of Child and Adolescent Psychiatry, Dr. Ekrem Tok Mental Health and Diseases Hospital, Adana, Türkiye

Email: asiyearici@hotmail.com

ORCID iD: 0000-0003-2508-7125

Journal of Dependence, 2026; 27(3):216-233

JOURNAL OF DEPENDENCE

Review

Problematic smartphone use and partner phubbing in romantic relationships: A critical narrative review and recursive systemic model

M. Selenga Gürmen

DOI: 10.51982/bagimli.625

Abstract

Smartphone use is embedded in contemporary couple relationships and is not inherently disruptive. Relational difficulties may emerge, however, when smartphone use becomes difficult to regulate or repeatedly displaces attention during interactions in which a partner expects availability. This critical narrative review examines the relationship between problematic smartphone use (PSU) and partner phubbing and proposes a recursive systemic model. Literature identified through searches of PubMed/MEDLINE, Academic Search Ultimate through EBSCOhost, and Google Scholar, supplemented by citation tracing, was critically synthesized across cross-sectional, experimental, daily-diary, dyadic, longitudinal, qualitative, and intervention studies. The evidence indicates that PSU may increase vulnerability to phone-directed attentional disengagement, but does not by itself determine relational harm. Consequences depend on the context and function of use, couple norms, perceived responsiveness, attachment-related appraisals, and subsequent partner responses. Perceived partner phubbing is more consistently associated with relationship outcomes than self-reported enacted behavior, while shared or integrated phone use may reduce adverse effects. Partner phubbing is linked most consistently with lower relationship satisfaction and with disruptions in communication, intimacy, affection, and responsiveness; it may also contribute to jealousy, surveillance, conflict, withdrawal, and retaliatory phone use. Nevertheless, causal and longitudinal evidence remains limited, and findings support components of a reciprocal process more strongly than a complete causal pathway. A recursive systemic model is proposed in which individual vulnerabilities, interactional meanings, and couple responses mutually influence phone use and relational distress. Research and clinical practice should therefore move beyond screen time toward the regulation, meaning, and organization of smartphone use within the couple relationship.

Keywords: Problematic smartphone use; Partner phubbing; Technoference; Romantic relationships; Relationship satisfaction; Systemic perspective

M. Selenga Gürmen
Özyeğin University, Department of Psychology, Istanbul, Türkiye
Email: selenga.gurmen@ozyegin.edu.tr
ORCID iD: 0000-0003-0109-6051

Received: 2026-07-24
Accepted: 2026-09-08

e-ISSN: 3108-7973

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INTRODUCTION

Smartphones are embedded in contemporary couple life: they sustain contact, coordinate responsibilities, and can become shared resources for enjoyment and connection (Duran et al., 2011; Kelly & Miller-Ott, 2022; Pickens & Whiting, 2020). Their presence is therefore not inherently disruptive. Relational difficulty is more likely when use is difficult to regulate, repeatedly interrupts shared activity, or displaces attention during moments in which a partner expects availability (McDaniel & Coyne, 2016; Miller-Ott & Kelly, 2015). This distinction is important because the literature often moves too quickly from frequent smartphone use to addiction, and from co-present use to relational harm.

The broader term problematic smartphone use (PSU) is used here for patterns marked by impaired regulation, persistence despite negative consequences, or interference with functioning. This language avoids treating all heavy use as a unitary disorder while retaining dependence-related features such as salience, conflict, withdrawal, and loss of control (Griffiths, 2005). Within romantic relationships, salience and impaired control may become visible when phone-related activity repeatedly captures attention despite competing relational demands, whereas conflict and persistence despite negative consequences may be reflected in continued use after a partner has communicated distress. These dependence-related features may increase the likelihood of partner phubbing, but partner phubbing itself should not be treated as evidence of addiction. PSU may arise through different pathways, including impulsivity, reassurance seeking, avoidance, fear of missing out (FoMO), boredom, and emotion regulation (Billieux et al., 2015; Elhai et al., 2019; Holte, 2025; Stirnberg et al., 2024). The smartphone may also provide access to problematic social media use, gaming, or messaging rather than constitute a single object of addiction (Billieux et al., 2015). Partner phubbing, by contrast, concerns how phone-directed attention enters a specific romantic interaction. It is related to PSU but neither equivalent to it nor an inevitable consequence of it.

Phubbing refers to attending to a phone rather than a physically present person (Chotpitayasunondh & Douglas, 2016; Karadağ et al., 2015). Partner phubbing usually denotes smartphone-related inattention toward a romantic partner and is commonly measured from the recipient's perspective (Roberts & David, 2016). Across studies, perceived partner phubbing is associated with lower satisfaction and relationship quality, reduced intimacy and responsiveness, and greater conflict, jealousy, emotional loneliness, surveillance, and communication difficulty (Arshad & Imran, 2022; Beukeboom & Pollmann, 2021; Denes et al., 2025; Ni et al., 2025; Schokkenbroek et al., 2022; Wang & Zhao, 2023). Findings from Türkiye broadly converge, linking partner phubbing with satisfaction, communication, commitment, mindfulness, and self-disclosure (Aslanturk & Arslan, 2025; Kılıçarslan & Parmaksız, 2023; Öncü & Kuşcu, 2024; Tiryaki Göksu et al., 2025; Türk Kurtça, 2026).

The majority of the literature is cross-sectional, individual, and perception-based. Partners may disagree about whether an interruption occurred, whether it was justified, and what it communicated. Perceived phubbing and negative evaluations of phone use appear more consistently associated with daily relationship quality than the partner's self-reported enacted behavior, while shared or integrated use can weaken adverse associations (Beukeboom & Pollmann, 2021; Carnelley et al., 2023; Frackowiak et al., 2022; Kelly & Miller-Ott, 2022). Daily and dyadic studies further suggest anger, retaliation, actor–partner differences, demand–withdraw patterns, and reciprocal phone use rather than a one-directional effect (Bröning & Wartberg, 2022; Carnelley et al., 2026; Mosley et al., 2025; Thomas et al., 2022; Togar et al., 2023). Longitudinal findings are similarly qualified: reciprocal links have been reported among phubbing, need fulfilment, and satisfaction, but complete indirect pathways through responsiveness have not consistently persisted over time (Booth et al., 2021; Li et al., 2026).

Existing reviews provide important foundations for this synthesis. Ni et al. (2025) pooled findings from 52 studies to examine associations between partner phubbing and individual antecedents, relational outcomes, and potential moderators. Putri and Hasanati (2026) organized recent empirical findings into psychological and relational antecedents and consequences. Both reviews discuss relational mechanisms, and their coverage includes studies of perception and reciprocal responses. The present review therefore does not claim that these topics were previously absent. Its contribution is to examine how differences in informant, measurement, and research design affect the interpretation of those mechanisms, and to integrate shared phone use and feedback processes into a model whose evidential limits are explicit. In particular, associations based on a recipient's report are distinguished from enacted behavior, concurrent mediation from temporal processes, and proposed feedback from directly tested relationships. Drawing on systemic accounts of interdependence and circular influence (Hertlein & Twist, 2019; Watzlawick et al., 1967), this review aims to clarify the relationship between PSU and partner phubbing, critically evaluate evidence for the processes connecting phone use with relationship functioning, and develop a recursive systemic model to guide further research.

METHODS

A critical narrative design was selected because the evidence spans cross-sectional surveys, qualitative studies, experiments, daily diaries, dyadic analyses, longitudinal research, and limited intervention evidence. The aim was to compare assumptions, methods, convergent findings, and contradictions rather than estimate a single pooled effect (Ferrari, 2015; Grant & Booth, 2009; Green et al., 2006). The review was developed with reference to SANRA to support a clear rationale, transparent search, appropriate referencing, critical appraisal of the evidence, and conclusions proportionate to the data (Baethge et al., 2019). SANRA was used as a narrative-review quality framework, not as a systematic-review reporting guideline or study-level risk-of-bias tool. Ethics committee approval and informed consent were not required because this article is a critical narrative review of previously published literature.

PubMed/MEDLINE, Academic Search Ultimate through EBSCOhost, and Google Scholar were searched between June and July 2026, with the original final searches conducted on 21 July 2026. During revision, verification searches were conducted in PubMed/MEDLINE and Academic Search Ultimate through EBSCOhost on 3 September 2026, and Google Scholar on 4 September 2026. These searches were used to cross-check the existing references and identify potentially relevant omissions; they were not an exact rerun of the original searches. Publication eligibility retained a cutoff of 21 July 2026, based on the first peer-reviewed publication date, including online-first publication. No lower publication-year limit or publication-date filter was applied at retrieval; later issue dates were distinguished from first publication dates during eligibility checks. Searches were conducted in English and Turkish.

The core PubMed query combined title/abstract terms with MeSH terms for spouses and marriage and was submitted as follows: ((phubb*[Title/Abstract] OR pphubb*[Title/Abstract] OR "phone snubbing"[Title/Abstract] OR technoferen*[Title/Abstract]) OR "technology interference"[Title/Abstract] OR "technological interference"[Title/Abstract] OR "phone interference"[Title/Abstract] OR "smartphone interference"[Title/Abstract] OR ((smartphone*[Title/Abstract] OR "mobile phone"[Title/Abstract] OR "mobile phones"[Title/Abstract] OR "cell phone"[Title/Abstract] OR "cell phones"[Title/Abstract]) AND (interrupt*[Title/Abstract] OR interferen*[Title/Abstract]))) AND (romantic*[Title/Abstract] OR partner*[Title/Abstract] OR couple[Title/Abstract] OR couples[Title/Abstract] OR spous*[Title/Abstract] OR marital[Title/Abstract] OR marri*[Title/Abstract] OR cohabit*[Title/Abstract] OR

dating[Title/Abstract] OR "Spouses"[MeSH Terms] OR "Marriage"[MeSH Terms]). This query returned 67 records.

The first supplementary PubMed query examined the association between problematic smartphone use and phubbing: ("problematic smartphone use"[Title/Abstract] OR "problematic mobile phone use"[Title/Abstract] OR "smartphone addiction"[Title/Abstract] OR "mobile phone addiction"[Title/Abstract] OR "cell phone addiction"[Title/Abstract] OR "smartphone dependence"[Title/Abstract] OR "mobile phone dependence"[Title/Abstract]) AND (phubb*[Title/Abstract] OR pphubb*[Title/Abstract] OR "phone snubbing"[Title/Abstract] OR technoferen*[Title/Abstract]). This query returned 53 records.

A second supplementary PubMed query addressed potential psychological mechanisms: ("problematic smartphone use"[Title/Abstract] OR "problematic mobile phone use"[Title/Abstract] OR "smartphone addiction"[Title/Abstract] OR "mobile phone addiction"[Title/Abstract] OR "cell phone addiction"[Title/Abstract] OR "smartphone dependence"[Title/Abstract] OR "mobile phone dependence"[Title/Abstract]) AND (attachment[Title/Abstract] OR "fear of missing out"[Title/Abstract] OR FOMO[Title/Abstract] OR "emotion regulation"[Title/Abstract] OR "emotional regulation"[Title/Abstract] OR "self regulation"[Title/Abstract] OR "self-regulation"[Title/Abstract] OR "self control"[Title/Abstract] OR "self-control"[Title/Abstract] OR "compensatory internet use"[Title/Abstract]). This query returned 380 records. The supplementary searches were not restricted to romantic-couple samples and served to identify contextual evidence rather than exclusively partner-phubbing research.

Together, the three PubMed searches returned 500 record occurrences, yielding 484 unique PubMed records after resolving 16 repeated occurrences by PMID. No publication-date, age, human, article-type, or full-text filters were applied. PubMed's query translations and warnings were retained in the search log, including a phrase-not-found warning for "smartphone interference" in the core query.

The Academic Search Ultimate (EBSCOhost) query used title (TI) and abstract (AB) fields: (TI (phubb* OR pphubb* OR "phone snubbing" OR technoferen*) OR AB (phubb* OR pphubb* OR "phone snubbing" OR technoferen*) OR ((TI (smartphone* OR "mobile phone" OR "cell phone" OR technolog*) OR AB (smartphone* OR "mobile phone" OR "cell phone" OR technolog*)) AND (TI (interferen* OR interrupt*) OR AB (interferen* OR interrupt*)))) AND (TI (romantic* OR partner* OR couple OR couples OR spous* OR marital OR marri* OR cohabit* OR dating) OR AB (romantic* OR partner* OR couple OR couples OR spous* OR marital OR marri* OR cohabit* OR dating)). The search returned 337 records, all of which were exported as bibliographic metadata, with abstracts where available. Results were displayed by relevance with "All dates" selected and no active filters shown. The initial 709-result search attempt was not included in these retrieval counts.

Google Scholar was searched using four queries: "partner phubbing", technoference couples, "problematic smartphone use" phubbing, and "partner sosyotelizmi". The first 100 relevance-ranked results were captured for the first query and the first 50 for each of the remaining queries, producing 250 captured result positions. Searches used the "Any time" setting, with patents excluded and citation-only records included. These counts represent the results actually captured, not Google Scholar's estimated totals or a deduplicated publication count. The reduction of the initial Google Scholar search plan after collection of the first query's results was recorded in the search log.

Because source selection was iterative and purposive rather than based on a fixed systematic screening workflow, definitive numbers of records screened and studies retained were not generated and could not be reconstructed reliably. The source-specific

figures reported above therefore represent records retrieved or result positions captured, rather than a PRISMA-style screening denominator or final inclusion count.

Peer-reviewed studies of adults in romantic relationships were included when they directly examined partner phubbing, technoference, or smartphone-related interference in couple processes. General-phubbing studies were retained when they clarified individual vulnerabilities or the proposed pathway from PSU to partner phubbing. Study identification, selection, and synthesis were conducted by the author. Selection was iterative and purposive: sources were retained on the basis of their relevance to the review questions, contribution to conceptual clarification, methodological strength, or capacity to explain convergent, contradictory, or reciprocal findings. Conceptual contribution was assessed according to whether a source clarified construct boundaries, informed a proposed pathway, or challenged the emerging interpretation. Methodological appraisal considered sampling, measurement overlap and reliability, temporal ordering, partner interdependence, and alternative explanations; no numerical quality scores were assigned. The final evidence set included empirical studies using cross-sectional, qualitative, experimental, daily-diary, dyadic, longitudinal, and intervention designs, together with relevant meta-analytic, review, and theoretical sources.

Findings were organized around construct definition, individual vulnerabilities, relational appraisals, proximal mechanisms, outcomes, and reciprocal processes. Evidence was interpreted in relation to study design and the claims each design could support. Meta-analytic findings were used to assess convergence across studies, whereas experimental, daily-diary, dyadic, longitudinal, and intervention research received particular attention when evaluating temporal, interpersonal, or causal interpretations. Cross-sectional mediation was treated as covariation compatible with a proposed mechanism rather than evidence of temporal ordering. No formal study-level risk-of-bias assessment or quantitative certainty grading was conducted. Consistent with the critical narrative design, the review does not claim exhaustive systematic coverage.

Critical synthesis of the evidence

Conceptual Boundaries and PSU as a Vulnerability

Partner phubbing requires a distinction between phone-directed behavior, a recipient's report of that behavior, and the meaning assigned to it. Enacted partner phubbing refers to the user's own reported or observed phone-directed disengagement during couple interaction. Perceived partner phubbing refers to a recipient's report of the partner's phone-related inattention; this report is not equivalent to direct observation or necessarily to a separate feeling of exclusion (Carnelley et al., 2023; Roberts & David, 2016). Measures differ in how much they combine descriptions of behavior with judgments of neglect or disruption (Campbell & Murray, 2015; Çizmeci, 2017; Lapierre & Zhao, 2024). A high score may reflect recurrent disengagement, sensitivity to inattention, prior rejection, existing dissatisfaction, or their interaction. General phubbing is not partner-specific, whereas technoference encompasses interruptions from phones and other technologies (McDaniel & Coyne, 2016). Integrated or shared phone use includes the partner in the activity, for example through joint viewing or planning, and should not automatically be classified as phubbing (Beukeboom & Pollmann, 2021; Kelly & Miller-Ott, 2022). **Table 1** summarizes these distinctions and gives examples of measurement instruments.

Context further limits behavior-only definitions. Expectations of attention are stronger during disclosure, support seeking, conflict, dates, or bids for affection than during loosely structured shared time. Expectancy Violations Theory accordingly locates the effect in whether behavior is expected and how the violation is evaluated, rather than in phone use alone (Burgoon, 1993; Miller-Ott & Kelly,

Table 1: Conceptual distinctions among smartphone-related constructs in romantic relationships

Construct	Primary level	Core feature	Measurement examples / operationalization	Relevance to romantic relationships	Representative sources
Problematic smartphone use	Individual	Difficulty regulating smartphone use and continued use despite impairment or conflict	Impairment and regulation questionnaires, for example the Smartphone Addiction Scale–Short Version (SAS-SV); interpretation requires validation for the target population.	May increase the likelihood that phone-directed attention displaces couple interaction	Billieux et al. (2015); Kwon et al. (2013)
Smartphone addiction	Individual	Addiction-model symptoms such as salience, withdrawal, tolerance, conflict, and relapse	Addiction-labelled symptom measures, for example SAS-SV; a questionnaire score is not by itself a diagnosis.	Common in the literature but diagnostically and conceptually contested	Billieux et al. (2015); Griffiths (2005); Kwon et al. (2013)
General phubbing	Interpersonal	Attending to a phone rather than a physically present person	Phubbing Scale (Karadağ et al., 2015), assessing communication disturbance and phone obsession.	Provides antecedent evidence but is not specific to romantic relationships	Chotpitayasunondh & Douglas (2016); Karadağ et al. (2015)
Partner phubbing	Couple interaction	Phone-related disengagement during interaction with a romantic partner	Partner Phubbing Scale (Roberts & David, 2016); its original nine-item form is recipient-rated.	Directly concerns attention, availability, and relational priority	Roberts & David (2016)
Perceived partner phubbing	Recipient perception	Recipient-reported phone-related inattention during couple interaction	Recipient-rated Partner Phubbing Scale or diary adaptations; records reported phone-related inattention, not direct observation.	Most consistently associated with daily relationship quality and satisfaction	Carnelley et al. (2023); Frackowiak et al. (2022)
Enacted partner phubbing	Actor behavior	Phone use reported or displayed by the person using the device	Actor-worded daily reports of own phone-directed behavior; observational coding when available. Self-report remains distinct from observed behavior.	May not correspond closely with the partner's perception	Carnelley et al. (2023)
Technoference	Interactional or family-system level	Interruption of interaction by phones or other technologies	Technology Device Interference Scale (TDIS) and Technology Interference in Life Examples Scale (TILES); conflict should be measured separately.	Assesses broader technology interruptions; not equivalent to PSU or phone-specific phubbing	Lapierre & Zhao (2024); McDaniel & Coyne (2016)
Integrated or shared phone use	Dyadic interaction	Phone use that includes both partners in the activity	Study-specific reports of including the partner in phone use, such as shared viewing or content exchange; no single standard measure is assumed.	May facilitate connection and should not automatically be classified as phubbing	Beukeboom & Pollmann (2021); Kelly & Miller-Ott (2022)

Note: The categories overlap but are not interchangeable. The same instrument may be used under different construct labels, so item wording and informant must be checked. SAS-SV was originally validated in adolescents; its inclusion is an instrument example, not an endorsement of its original thresholds for adults or a claim that all reviewed studies used it. Most partner-phubbing research assesses recipient reports rather than observed behavior.

2015; Roberts & David, 2024). Couples develop explicit or implicit rules about meals, bedtime, privacy, work availability, outside contacts, and response times; dissatisfaction may arise when these rules differ or become visible only after a perceived violation (Duran et al., 2011; Miller-Ott et al., 2012; Pickens & Whiting, 2020). Conversely, phones can be incorporated into joint activity, and shared use can buffer some negative associations (Beukeboom & Pollmann, 2021; Kelly & Miller-Ott, 2022). Accordingly, the relational consequences of phone use depend partly on whether the use includes the partner, fits the context, and is adequately explained.

Evidence nevertheless supports PSU as an important antecedent. General phubbing is associated with mobile phone, internet, messaging, gaming, and social-media difficulties, lower self-control, FoMO, and social comparison (Bajwa et al., 2023; Chotpitayasunondh & Douglas, 2016; Karadağ et al., 2015). In Ni et al.'s (2025) meta-analysis, media addiction was the strongest antecedent of partner phubbing among the variables examined. Yet much of this evidence comes from student samples, general-phubbing measures, and cross-sectional self-report. It supports a vulnerability pathway, not a universal causal chain. PSU may increase attentional capture and difficulty disengaging, whereas relational consequences emerge more proximally when that use interrupts the couple's interaction (Lapierre & Zhao, 2024). An individual planning intervention reduced self-reported phubbing but did not improve intimacy, depressive symptoms, or life satisfaction, suggesting that reducing phubbing alone may be insufficient to change broader relational or individual outcomes (Radtke et al., 2024).

The function of use also matters. Similar outward behavior may reflect habitual checking, social reassurance, anxiety reduction, boredom, reward seeking, or withdrawal from an uncomfortable exchange (Billieux et al., 2015; Elhai et al., 2019; Holte, 2025; Stirnberg et al., 2024). Screen time alone therefore cannot establish either PSU or relational harm. More relevant indicators include impaired control, salience, cue-driven attention, persistence despite conflict, and displacement of valued interaction. Equally, relational distress may increase the appeal of the phone, making problematic engagement both a possible antecedent and a response. Cross-sectional pathways from problematic media use through responsiveness to relationship outcomes received limited longitudinal support, illustrating why statistical mediation should not be mistaken for a confirmed sequence (Booth et al., 2021).

For this review, partner phubbing is defined as smartphone-related attentional disengagement during couple interaction that is enacted or perceived as reducing availability to the partner. This formulation preserves a behavioral component while recognizing that consequences depend on regulation, context, expectations, appraisal, and response. PSU may function as one antecedent of partner phubbing; however, the constructs remain conceptually distinct, and partner phubbing may also occur in the absence of PSU.

Individual Vulnerabilities, Appraisals, and Couple Norms

Attachment insecurity, FoMO, self-regulation, and emotion-related coping may explain both why attention moves toward the phone and why the movement becomes threatening. In general-phubbing studies, anxious and avoidant attachment have been associated with phubbing partly through PSU; avoidant attachment has also been linked through smartphone attachment and lower self-regulation (Sun & Miller, 2023a, 2023b). Holte (2025) reframed the device as a potential refuge that offers reassurance or emotional security, while longitudinal evidence suggests that seeking positive emotion and escaping negative emotion partly connect FoMO or depressive symptoms with later PSU (Stirnberg et al., 2024). These findings are more informative when treated functionally: attachment does not mechanically produce phubbing, but may shape what the phone provides when closeness, autonomy, or emotional regulation becomes difficult.

Self-control accounts are therefore necessary but insufficient. Lower self-control and self-regulation are associated with smartphone addiction and phubbing (Chotpitayasunondh & Douglas, 2016; Sun & Miller, 2023b), yet regulation is context dependent. Turning to a phone during conflict may reflect cue-driven habit and an attempt to reduce activation or avoid escalation. Likewise, FoMO and social comparison may keep attention oriented toward online activity even during valued face-to-face contact (Bajwa et al., 2023), but the available studies do not establish that these motives operate during particular couple episodes.

Attachment also organizes the recipient's appraisal. Experimental and survey findings indicate that partner phubbing can evoke jealousy and poorer evaluations, with stronger jealousy among more anxiously attached individuals (David & Roberts, 2021). On days of higher perceived partner phubbing, participants reported greater resentment, curiosity, conflict, and retaliation. Higher depressed mood and lower self-esteem were particularly evident among individuals higher in attachment anxiety (Carnelley et al., 2026). Dyadic evidence is mixed: attachment anxiety shows actor associations with perceived phubbing, avoidant partners may be perceived as more disengaged, and effects can differ by gender and relationship duration (Bröning & Wartberg, 2022; Mosley & Parker, 2023). Thus, attachment may shape the user's motive, the recipient's interpretation, and the subsequent response, but no single attachment pathway is consistently supported across designs.

Relational norms translate these vulnerabilities into interactional meaning. An unexplained check during a vulnerable disclosure leaves the recipient to infer whether the behavior signifies urgency, boredom, avoidance, secrecy, or low priority. A generally responsive partner may receive a more benign interpretation, whereas repeated interruptions can become evidence of an established pattern (Roberts & David, 2022, 2024). Once negative expectations form, ambiguous use may be noticed more readily and interpreted more harshly; the appraisal of one episode therefore changes the context of the next. This is not evidence that perception is inaccurate. It indicates that perceived partner phubbing is jointly organized by current behavior and relational history.

A systemic account also requires attention to disagreement and power. One partner may regard an unspoken rule as obvious while the other sees no violation; requests for attention may then be framed as care or control, and continued use as autonomy or neglect. Such circularity does not imply equal responsibility. Persistent use despite clearly communicated consequences remains the user's responsibility, and uncertainty does not justify coercive surveillance or demands for device access. Dyadic evidence suggests that power imbalance and income disparity may shape some associations among partner phubbing, mobile-phone conflict, and relationship satisfaction (Togar et al., 2023). More broadly, power may also affect whose expectations and definitions of acceptable phone use prevail within the relationship, although these processes have received limited direct investigation.

Relational Mechanisms, Outcomes, and Recursive Couple Processes

Across studies, the most plausible proximal mechanism is not the device itself but disruption of the processes through which partners communicate availability. Perceived exclusion, lower responsiveness, communication dissatisfaction, reduced positive interaction, diminished intimacy, and affection deprivation are repeatedly associated with partner phubbing and relationship evaluations (Beukeboom & Pollmann, 2021; Booth et al., 2021; Denes et al., 2025; Kılıçarslan & Parmaksız, 2023; Mushquash et al., 2022; Wang et al., 2025). These constructs overlap, and many are reported by the same individual at the same time; a series of significant indirect effects does not establish a fixed causal sequence. Taken together, these findings suggest that phone-directed disengagement becomes harmful when it interrupts contingent attention,

validation, disclosure, affectionate exchange, or repair.

Evidence across designs sharpens this conclusion. Shared phone use weakens some associations because the device no longer clearly excludes the partner (Beukeboom & Pollmann, 2021). Daily increases in technoference co-occur with poorer face-to-face interaction, more technology conflict, negative mood, and lower relationship quality (McDaniel & Drouin, 2019). Daily studies indicate that perceived partner phubbing is more consistently associated with relationship quality than enacted phubbing (Carnelley et al., 2023; Frackowiak et al., 2022). In Carnelley et al. (2023), however, these daily associations did not persist over time. Cross-sectional dyadic pathways through responsiveness are stronger than longitudinal ones, suggesting that responsiveness may be an immediate, interaction-level process rather than a stable year-to-year mediator (Booth et al., 2021). These differences in timescale are theoretically informative, not merely inconsistent.

Communication and affection findings likewise converge at the process level. Effective communication statistically accounts for associations between phubbing and marital satisfaction, while appraisal and communication dissatisfaction connect technoference with intimacy (Kılıçarslan & Parmaksız, 2023; Mushquash et al., 2022). Lower positive marital interaction and greater conflict form related pathways (Wang & Zhao, 2023), and perceived relationship quality is associated with reduced self-disclosure in Turkish participants (Tiryaki Göksu et al., 2025). Dyadic findings link phubbing with affection deprivation and satisfaction, yet similarity between partners' phubbing does not protect the relationship (Denes et al., 2025). Mutual disengagement may normalize the behavior without meeting either partner's needs.

When reduced availability is interpreted as threatening or rejecting, disconnection may escalate into jealousy, surveillance, or conflict. Experimental findings support an immediate jealousy response, particularly under attachment anxiety, while cross-sectional evidence links phubbing with jealousy in married adults (Arshad & Imran, 2022; David & Roberts, 2021). Perceived partner phubbing is also associated with electronic surveillance through uncertainty and lower responsiveness (Schokkenbroek et al., 2022). These pathways remain temporally uncertain: mistrust may heighten surveillance and phubbing perceptions, and surveillance can provoke greater secrecy or defensiveness. The literature also insufficiently distinguishes reassurance seeking from coercive monitoring. Relational context can explain how surveillance enters a cycle without excusing intrusive or controlling behavior.

Conflict and demand–withdraw findings make circularity more explicit. Phone-related conflict rises on days of greater technoference, and reduced positive interaction may accompany greater marital conflict (McDaniel & Drouin, 2019; Roberts & David, 2016; Wang & Zhao, 2023). In dyadic couples, demand–withdraw patterns statistically connect perceived partner phubbing with both partners' satisfaction (Mosley et al., 2025). The smartphone may be both the target of pursuit and a means of withdrawal: one partner demands attention, the other turns further toward the device, and increased withdrawal intensifies pursuit. Roles can also shift as the recipient retaliates through their own phone use for revenge, distraction, support, or autonomy (Carnelley et al., 2026; Thomas et al., 2022). The evidence supports interconnected segments of this cycle, although the complete sequence has rarely been tested prospectively.

Relationship satisfaction is the most consistent outcome, with convergent associations across dating, cohabiting, married, and culturally diverse samples (Arshad & Imran, 2022; Beukeboom & Pollmann, 2021; Denes et al., 2025; Ni et al., 2025; Roberts & David, 2016; Wang & Zhao, 2023). Yet satisfaction is broad, overlaps with communication and intimacy, and may color reports of partner behavior.

Daily within-person evidence supports short-term covariation rather than inevitable deterioration (Carnelley et al., 2023; McDaniel & Drouin, 2019). Dyadic studies show robust actor effects but mixed partner effects and moderation, indicating that one partner's experience is not uniformly transmitted to the other (Bröning & Wartberg, 2022; Mosley & Parker, 2023; Türk Kurtça, 2026).

The evidence for intimacy, commitment, and well-being is promising but thinner. Meta-analytic and mechanism studies link partner phubbing with lower intimacy and closeness (Beukeboom & Pollmann, 2021; Ni et al., 2025), while affection deprivation appears relevant to both partners' satisfaction (Denes et al., 2025). Emotional loneliness and satisfaction statistically connect phubbing with lower commitment in Türkiye, but cross-sectional data cannot establish whether disengagement reduces commitment or lower commitment encourages independent phone use (Aslanturk & Arslan, 2025). Partner phubbing has also been linked to lower life satisfaction and greater depressive symptoms through relationship conflict and satisfaction (Roberts & David, 2016). Daily studies further indicate greater anger and, particularly among individuals higher in attachment anxiety, poorer mood and self-esteem on days of increased perceived phubbing (Carnelley et al., 2026; Thomas et al., 2022).

Longitudinal evidence provides the clearest test of the proposed direction and remains mixed. Among Chinese newlyweds, longitudinal associations between perceived partner phubbing, need fulfilment, and marital satisfaction varied by gender. Bidirectional associations were more evident among husbands, whereas findings for wives were primarily unidirectional (Li et al., 2026). In contrast, annual dyadic data offered little support for complete longitudinal mediation from problematic media use through responsiveness to relationship outcomes (Booth et al., 2021). The difference may reflect constructs, developmental stage, and measurement interval: responsiveness can change within seconds, retaliation within an interaction, daily quality across hours, and commitment across months or years. A process can be consequential at one timescale without producing a stable cross-lagged effect at another.

Taken together, the evidence supports a recursive, multilevel formulation. PSU, attentional capture, and emotion-related motives may increase enacted disengagement. Context and couple norms shape whether it is perceived as a relational violation. Perceived exclusion or low responsiveness can evoke withdrawal, criticism, jealousy, surveillance, or reciprocal phone use. These reactions may increase conflict and reduce intimacy, satisfaction, or commitment; relational distress can then increase vigilance toward phone use or make the device more attractive as refuge and avoidance. Repetition may create a "social allergen" effect in which later interruptions are evaluated more negatively as irritation and adverse expectations accumulate (Roberts & David, 2022). Table 2 compares selected studies central to these claims by sample, design, measurement, findings, and limitations; it is not a complete inventory of every source cited in the review.

Table 2: Selected empirical studies informing the critical synthesis and proposed model
Studies are groupedTab by design. Dyadic describes the use of data from both partners and can apply to cross-sectional, diary, or longitudinal research. The table is illustrative, not a complete list of included sources. Sample descriptions and measure labels are kept at the level established in the source; unspecified instrument versions are not inferred.

Study / design	Sample	Phubbing or related measure	Other variables	Principal findings	Main limitations
Beukeboom & Pollmann (2021) Cross-sectional surveys	Two samples of adults in romantic relationships; N = 507 and 386.	Recipient-rated partner-phubbing questionnaire; shared-use reports.	Exclusion, responsiveness, intimacy, jealousy, phone conflict, satisfaction.	Phubbing was associated with poorer satisfaction; exclusion and related appraisals were candidate explanatory variables. Shared use attenuated some negative associations.	Concurrent, single-informant measures; item overlap and indirect effects cannot establish temporal mediation.
Kılıçarslan & Parmaksız (2023) Cross-sectional survey	712 married adults in Central Anatolia, Türkiye; 347 women, 365 men.	General Phubbing Scale; not equivalent to recipient-rated partner phubbing.	Effective communication and marital satisfaction.	Higher phubbing tendencies were associated with poorer communication and marital satisfaction; a statistical indirect association was reported.	Individual reports, not paired couple data; general phubbing does not isolate a particular partner interaction.
Aslanturk & Arslan (2025) Cross-sectional survey	320 adults in Türkiye; 75.6% women, 76.2% unmarried; ages 18–55.	Nine-item Partner Phubbing Scale, Turkish adaptation.	Emotional loneliness, relationship satisfaction, commitment.	Perceived phubbing was linked to commitment through concurrent associations involving loneliness and satisfaction.	Predominantly young, female sample; one partner reports all variables; temporal order remains unresolved.
David & Roberts (2021) Experiment and survey	Adults reporting on romantic relationships in an experimental study and a separate survey.	Manipulated partner-phubbing scenario in Study 1; reported partner phubbing in the survey.	Jealousy, attachment anxiety, relationship satisfaction.	Experimental phubbing affected immediate jealousy and relationship evaluations; attachment anxiety qualified jealousy responses.	Experimental evidence concerns the manipulated episode and immediate responses, not long-term change or the entire recursive model.
McDaniel & Drouin (2019) Dyadic daily diary	Both partners in 173 romantic relationships; 14 days.	Daily reports of technology interruptions during couple interaction.	Relationship quality, technology conflict, interaction quality, mood.	More technoference than usual co-occurred with poorer relationship evaluations, more technology conflict, and worse mood.	Within-person covariation remains observational; interruptions involve technologies beyond smartphones.
Frackowiak et al. (2022) Daily diary	133 adults in intimate relationships; seven days.	Daily occurrence and intensity reports, with separate appraisal questions.	Perceived responsiveness, moral judgments, relationship quality.	Phubbing occurrence alone did not distinguish satisfaction across days; greater intensity was associated with more negative appraisals and lower responsiveness.	One-person diary reports; same-day association does not establish causal direction or objective behavior.
Carnelley et al. (2023) Dyadic daily diary and follow-up	Romantic couples completing daily reports, with relationship outcomes assessed again two months later.	Separate daily recipient-rated phubbing and actor reports of own enacted phubbing.	Relationship quality; attachment anxiety and avoidance.	Perceived phubbing was associated with lower daily quality; enacted reports were not. Perceived-phubbing associations did not persist at follow-up.	Self-reported enacted behavior is not observation; diary and follow-up results depend on timescale and model.
Bröning & Wartberg (2022) Cross-sectional dyadic	163 German heterosexual couples in long-term relationships.	Recipient reports of partner phubbing from both members.	Attachment and relationship satisfaction.	Actor and partner associations differed; attachment-related patterns were not uniform across partners.	Dyadic modelling handles interdependence but cannot establish temporal or causal paths; restricted couple composition.
Mosley et al. (2025) Cross-sectional dyadic mediation	103 heterosexual couples.	Perceived partner phubbing reported by each partner.	Demand–withdraw patterns and couple satisfaction.	Demand–withdraw patterns statistically linked phubbing with couple satisfaction, providing evidence for an interpersonal association.	Concurrent mediation does not demonstrate that demands cause subsequent phone withdrawal or vice versa.

Table 2 (Continued)

Türk Kurtça (2026) Cross-sectional dyadic mediation	704 unmarried heterosexual couples in Türkiye; N = 1,408, ages 18–35.	Perceived partner-phubbing measure completed by both partners.	Relationship mindfulness and perceived relationship quality.	Actor-level indirect associations through mindfulness were supported; partner-level indirect findings were partial.	No temporal ordering; restricted age and relationship groups; partner mindfulness did not directly predict the other partner's quality.
Booth et al. (2021) Longitudinal dyadic	Married couples; both spouses surveyed at three time points one year apart.	Problematic media-use measures; broader than a phone-specific partner-phubbing scale.	Partner responsiveness and relationship outcomes.	Concurrent indirect associations were clearer than complete prospective mediation through responsiveness.	Annual spacing may miss brief interaction processes; problematic media use and partner phubbing are not interchangeable constructs.
Li et al. (2026) Longitudinal dyadic	310 Chinese heterosexual newlywed couples; three waves six months apart.	Repeated recipient reports of partner phubbing.	Need fulfilment and marital satisfaction.	Bidirectional links involving need fulfilment were found for husbands. Wives' findings included paths from satisfaction to later phubbing.	Gender-specific paths and newlywed sample constrain generalization; observational cross-lagged findings do not prove causation.
Radtke et al. (2024) Randomized intervention	208 cohabiting individuals, ages 18–65; one partner per relationship; three measurements.	Self-reported own phubbing; individual action/coping planning versus information control.	Intimacy, interaction quality, depressive symptoms, life satisfaction.	Planning reduced self-reported phubbing; improvements in intimacy or individual well-being were not established.	One partner participated; no evidence that a dyadic treatment, negotiated rules, or systemic intervention is effective.

Note: Sample sizes refer to individuals unless explicitly identified as couples. Findings are paraphrased for comparison rather than pooled. "Indirect association" does not imply a demonstrated mechanism. Studies that assessed general phubbing or problematic media use are explicitly identified because they provide indirect support for partner-specific claims.

Figure 1 presents a conceptual synthesis of the reviewed literature, organizing partner phubbing as a recursive systemic process rather than a strictly linear pathway. The figure separates pathways supported by converging evidence from reciprocal pathways that remain primarily theoretical.

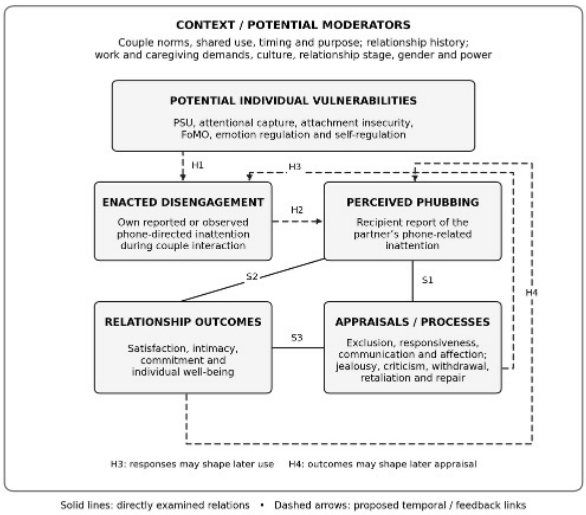

Figure 1. Proposed recursive systemic model of smartphone use and partner phubbing

Note. Solid lines (S1–S3) indicate directly examined associations, predominantly observational; they do not establish causation or temporal order. Support concerns the relations specified in the evidence key, not every construct in the connected boxes. Dashed arrows (H1–H4) indicate proposed temporal or feedback pathways with indirect, mixed, or incomplete evidence. Contextual factors are not assumed to moderate every connection. Enacted behavior and recipient reports are distinct sources; appraisals and relational processes require item-level separation from phubbing measures. PSU = problematic smartphone use; FoMO = fear of missing out. The complete sequence is untested; reciprocity does not imply equal responsibility. Evidence key. S1: Perceived phubbing is associated with exclusion, responsiveness, and related processes (Beukeboom & Pollmann, 2021); experimental evidence addresses selected immediate responses such as jealousy (David & Roberts, 2021). S2: Perceived phubbing is associated with relationship outcomes across surveys and daily studies (Carnelley et al., 2023; Ni et al., 2025). S3: Relational processes and outcomes are

associated in cross-sectional dyadic models (Mosley et al., 2025); prospective mediation is less consistent (Booth et al., 2021). H1: General-phubbing and media-use findings support potential vulnerabilities, but do not establish the proposed transition within a couple (Chotpitayasunondh & Douglas, 2016; Ni et al., 2025). H2: The interpretation of enacted behavior is a proposed contextual process; enacted and perceived reports do not show equivalent outcome associations (Carnelley et al., 2023). H3: Daily retaliation supports concurrent links with reciprocal phone use, but not the full episode-level feedback sequence (Thomas et al., 2022). H4: Feedback from relationship functioning to phone use or appraisal is only partly addressed by mixed longitudinal findings (Booth et al., 2021; Li et al., 2026).

Cultural Context and Evidence from Türkiye

Research from Türkiye broadens the evidence beyond relationship satisfaction by linking partner phubbing with effective communication, self-disclosure, emotional loneliness, commitment, mindfulness, and dyadic relationship quality (Aslanturk & Arslan, 2025; Karaman & Arslan, 2024; Kılıçarslan & Parmaksız, 2023; Öncü & Kuşcu, 2024; Tiryaki Göksu et al., 2025; Türk Kurtça, 2026). However, their samples and measures are not interchangeable. Kılıçarslan and Parmaksız (2023) studied 712 married adults using a general Phubbing Scale, alongside communication and marital-satisfaction measures; this assesses a different construct from a recipient-rated Partner Phubbing Scale. Aslanturk and Arslan (2025) used the Turkish adaptation of the latter in 320 adults in romantic relationships, predominantly women and unmarried participants, to examine emotional loneliness, satisfaction, and commitment. These cross-sectional, individual-report findings do not establish partner effects or temporal mediation. Çakır and Köseliören (2022) assessed broader technoference, satisfaction, and conflict in 264 married people in Istanbul; the sample should not be read as 264 matched couples. General-phubbing research from Türkiye also informs the study of individual vulnerabilities, but cannot by itself establish partner-specific mechanisms (Karadağ et al., 2015).

Dyadic evidence offers a useful extension. Türk Kurtça (2026) examined 704 unmarried heterosexual couples aged 18–35 and found actor-level indirect associations through relationship mindfulness, with only partial support for partner-level indirect pathways. This permits analysis of interdependence, but the cross-sectional design still cannot establish a causal sequence. The combination of clearer actor findings and more qualified partner findings resembles patterns in international dyadic research (Bröning & Wartberg, 2022; Mosley & Parker, 2023). Other cross-sectional work examines social media addiction, phubbing, relational needs, and satisfaction (Karaman & Arslan, 2024). Other studies address self-disclosure and perceived relationship quality (Tiryaki Göksu et al., 2025), relationship satisfaction (Öncü & Kuşcu, 2024), and subgroup differences in recipient-rated phubbing (Soyer & Ömür Sünbül, 2026). Their extension to additional constructs should not be mistaken for stronger causal evidence. Collectively, the studies support the relevance of these associations in Türkiye while retaining limitations related to self-report, sample composition, and measurement heterogeneity.

The findings should not be explained through untested cultural generalizations. Claims that collectivism or family cohesion makes phubbing uniquely harmful require direct comparative evidence. Within Türkiye, expectations about attention, privacy, work accessibility, family contact, gender, and autonomy likely vary by age, socioeconomic position, relationship stage, and context; subgroup differences caution against treating Turkish couples as homogeneous (Soyer & Ömür Sünbül, 2026). More informative cross-cultural research would test measurement invariance and compare the norms and meanings that organize phone use, rather than merely asking whether a negative correlation replicates.

DISCUSSION

An Integrative Systemic Account

The central conclusion is that partner phubbing is neither a synonym for PSU nor simply poor communication. PSU helps explain why attention may be captured and difficult to redirect; relationship science explains why that shift becomes consequential. Partner phubbing is the relational interface between these levels: a phone-directed behavior becomes meaningful through the interaction in which it occurs. This formulation avoids reducing partner phubbing either to an addiction symptom or to a communication problem. An exclusively addiction-based account overlooks context, appraisal, shared use, and reciprocity, whereas an exclusively relational account overlooks impaired control, cue-driven attention, FoMO, and emotion-regulation motives (Billieux et al., 2015; Elhai et al., 2019; Holte, 2025; Stirnberg et al., 2024).

Consistent with systemic accounts of interdependence and circular influence (Hertlein & Twist, 2019; Watzlawick et al., 1967), the model begins with individual vulnerabilities but locates the maintenance of partner phubbing within recursive couple interaction. A partner may turn toward the phone automatically, for reassurance, or to withdraw from discomfort. The recipient may experience exclusion and respond with a direct request, criticism, jealousy, surveillance, withdrawal, or retaliation. The user's response—repair, explanation, defensiveness, or further disengagement—changes the meaning of the original interruption. Over time, repeated episodes influence rules, expectations, and sensitivity to later events. Lower satisfaction and intimacy are therefore not only endpoints; they become contexts that shape subsequent phone use and appraisal.

Evidence across research designs supports different segments of the proposed model, including associations between PSU and phubbing, immediate appraisals, daily retaliation, actor–partner variation, and reciprocal longitudinal associations (Booth et al., 2021; Carnelley et al., 2023, 2026; David & Roberts, 2021; Li et al., 2026; Ni et al., 2025). To the best of the author's knowledge, no study identified in this review has tested the complete recursive sequence.

The perceived–enacted distinction is central. Stronger effects for perceived phubbing do not mean that behavior is irrelevant or that recipients are "too sensitive." They show that relational consequences operate through meaning, while also raising shared-method concerns. Agreement and disagreement between partners are themselves systemic data: they may reveal low awareness, different rules, defensive attribution, or unequal authority to define what counts as an interruption. The findings on shared phone use further demonstrate that technological presence is not inherently disruptive; its consequences depend partly on how attention is organized between partners (Beukeboom & Pollmann, 2021; Kelly & Miller-Ott, 2022).

Clinical and Research Implications

The clinical implications are proposals derived from the synthesis and systemic model, rather than established treatments for partner phubbing. Radtke et al. (2024) found that an individual planning intervention reduced self-reported phubbing, without establishing improvements in intimacy, depressive symptoms, or life satisfaction. The findings therefore do not demonstrate that reducing phubbing alone improves broader relational or individual functioning. Within clinical assessment, it may be useful to distinguish high but functional use from impaired regulation, clarify the activities accessed through the phone, and explore whether use serves reassurance, stimulation, avoidance, or emotion regulation. Inviting both partners to describe specific episodes could help identify differences in perceived interruption, intention, impact, and response. These assessment considerations require evaluation in couple-based research.

Possible topics for collaborative discussion include expectations about attention, explanations for

work or caregiving interruptions, shared phone use, and responses to perceived neglect. Negotiated agreements, specific requests for attention, acknowledgment of impact, and efforts to restore responsiveness may be considered in case formulation, but their effectiveness for partner phubbing has not been established by the evidence reviewed here. Trials are needed to determine whether these approaches improve outcomes beyond reducing phone use. Assessment of surveillance, power, and coercive control remains important; a recursive formulation neither assigns equal responsibility to both partners nor justifies intrusive monitoring.

Future research should prioritize designs that match the timescale of the proposed process. Dyadic experience sampling can assess both partners' enacted and perceived phubbing, appraisals, bids, criticism, withdrawal, retaliation, and repair within episodes. Observational studies can test whether interruptions alter responsiveness and whether explanations or negotiated rules change the response. Longer follow-up can examine accumulation, commitment, and stability. Objective smartphone logs can improve measurement of frequency and checking but cannot determine whether use was urgent, shared, or rejecting; they should supplement rather than replace contextual and dyadic reports.

Measurement requires clearer separation of PSU, enacted phubbing, perceived partner phubbing, technoference, phone conflict, and appraisal. Disagreement should be analyzed rather than averaged away. Research should also test thresholds and couple profiles: high PSU with accepted use, low-frequency but highly conflictual interruption, reciprocal disengagement, occupationally driven use, or attachment-related surveillance may represent different processes. More diverse samples are needed across age, relationship duration, sexual orientation, gender identity, socioeconomic position, parenting status, and treatment-seeking contexts.

Null and contradictory findings are theoretically essential. Nonsignificant partner effects, weak longitudinal mediation, the buffering role of shared use, and the absence of well-being change after reduced phubbing all challenge a simple dose–response model (Booth et al., 2021; Carnelley et al., 2023; Radtke et al., 2024). Intervention trials should include both partners and compare individual regulation strategies with dyadic approaches targeting expectations, responsiveness, and interactional cycles. Trials should test whether improvement is driven by reduced phone use, changes in couple norms and appraisals, better repair, or changes in the regulatory function served by the device.

Limitations of the Review

This review was purposive rather than exhaustive. Searches were conducted in English and Turkish, which may have limited the identification of relevant evidence published in other languages. Because study selection and synthesis were conducted by one author, interpretive and selection bias cannot be excluded. No formal study-level risk-of-bias or certainty grading was applied. Conceptual overlap and heterogeneous measures also limit direct comparison. Accordingly, the proposed systemic model should be regarded as an interpretive integration of converging evidence segments, not as a causal framework validated in its entirety.

CONCLUSION

PSU and partner phubbing are related but distinct constructs. Problematic use may increase vulnerability to phone-directed disengagement, yet phubbing can also occur without impaired regulation, and addiction cannot be inferred from phubbing alone. Associations with relationship functioning depend on what is measured, whose perspective is obtained, and the context of use. The proposed recursive systemic model integrates these distinctions with appraisals and couple responses while separating directly examined relations from unconfirmed temporal and feedback pathways. Its value lies in generating testable questions about how smartphone use and relationship processes become connected; the complete model and its proposed clinical applications require further empirical evaluation.

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Peer-Review

Double blind peer reviewed

Conflict of Interest

The authors declares no conflict of interests regarding the content of this article.

Financial Support

The Authors report that no financial support was received for this article.

Ethical Declaration

As this article is a review of previously published literature and did not involve human participants, ethics committee approval and informed consent were not required.

Author Contributions

Concept: MSG, Design: MSG, Literature search: MSG, Writing: MSG, Critical review: MSG

Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this manuscript, the author used OpenAI's ChatGPT to assist with language editing and the preliminary organization, comparison, and cross-checking of bibliographic search records. All decisions concerning source selection, interpretation, and conclusions were made by the author, who reviewed the relevant outputs and takes full responsibility for the content of the manuscript.

Corresponding Author

M. Selenga Gürmen

Özyeğin University, Department of Psychology, Istanbul, Türkiye

Email: selenga.gurmen@ozyegin.edu.tr

ORCID iD: 0000-0003-0109-6051