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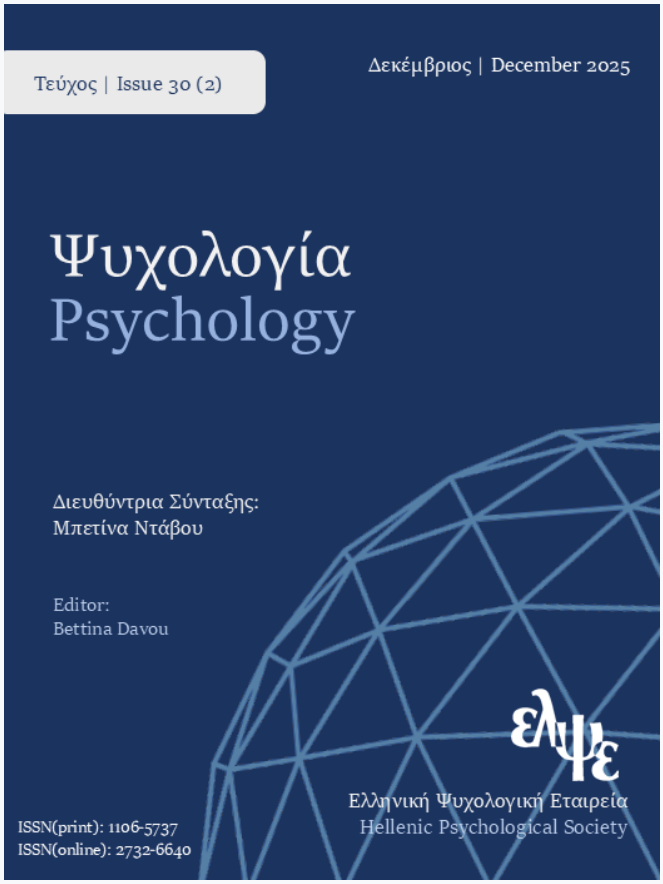

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Internet addiction and psychological distress: Evidence from path analyses in Greek adolescents at different developmental stages

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ABSTRACT

As internet use among adolescents increases, internet addiction has become a crucial public mental health issue, putting adolescents at risk of psychological distress. Research indicates a bidirectional association between internet addiction and adolescents' development of depressive symptoms. Although current evidence shows that anxiety can predict internet addiction, which subsequently predicts depression, the underlying mechanisms of the relationship between internet addiction and mental distress remain unclear, while the role of age differences in internet addiction warrant further research. The present cross-sectional study explores how internet addiction and stress mediate the relationship between anxiety and depression, and how the association between depression and internet addiction varies with the developmental stage of adolescence. A convenient sample of 215 Greek adolescents, aged from 11 to 20 years, were sourced from internet forums, including social media, and completed the Internet Addiction Test (IAT-20) and the Depression, Anxiety and Stress Scale-21 (DASS-21). Middle stage adolescents (ages 15-17), showed increased levels of internet addiction (*Mdn* = 52) compared to early (*Mdn* = 44) and late (*Mdn* = 49.5) stage adolescents. The results from path analyses revealed that internet addiction and stress serially mediate the relationship between anxiety and depression. Furthermore, depression was found to be moderated by the stage of adolescence with the strongest relationship observed in early adolescence (ages 11-14). These findings contribute to a more thorough understanding of how internet addiction is related to psychological distress among adolescents that may assist clinicians with designing age-specific interventions to address both internet addiction and psychological distress.

Over the past three decades, the rapid advancement of new technologies and the widespread use of the internet have significantly transformed various domains, including online communication and social networking among others (Caplan, 2007; Cerniglia et al., 2017). Online social media platforms have become central to communication and self-presentation, especially among adolescents (Shklovski et al., 2006). Statista (2024) reports that over half of the global population, nearly 5 billion people, are active on social media, with about 40% using these platforms for self-promotion and personal branding. The COVID-19 pandemic further accelerated social media usage, with U.S. users spending an average of 65 minutes daily on these platforms, a trend expected to continue. This surge in social media engagement raises important questions about its potential effects on adolescents' mental health, given the critical role these platforms play in their daily lives.

While internet and social media offer numerous opportunities to empower individuals across various life domains (Caplan, 2007), concerns persist regarding the potential disempowering impacts of their extensive use on human functionality, mental health, and well-being. The constant connectivity they offer can lead to feelings

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of being overwhelmed and contribute to stress, anxiety, depression, and social isolation (Ostic et al., 2021). Additionally, data privacy and security breaches pose risks to personal information and digital identities. The widespread internet usage has posed new societal challenges, particularly for younger generations. Its diverse content and unlimited accessibility can lead to addictive behaviors, resulting in excessive and compulsive internet use among young people, and may harm their mental health, social relationships, academic performance, and overall well-being (Mei et al., 2016). It also disrupts sleep patterns, eating habits, and physical activity (Cao & Su, 2007). Given these changes in psychosocial behavior due to the time spent on activities in virtual environments, a distinction between healthy and problematic internet use was deemed necessary (Çikrıkci, 2016).

Internet Addiction/Pathological Internet Use (IA/PIU)

Healthy internet use involves using the internet within set limits and for specific purposes (Cai et al., 2023; Davis, 2001). Conversely, problematic internet use—also known as pathological or compulsive—negatively affects social, psychological, and professional aspects of an individual's life (Caplan, 2005). Terms for addictive internet use include internet addiction (IA), pathological internet use (PIU), internet addiction disorder (IAD), internet overuse, dysfunctional internet behavior, cyberspace addiction, online addiction, net addiction, high internet dependency, problematic internet use, and pathological use of electronic media among others (Byun et al., 2009; Widyanto & Griffiths, 2006). While IA and PIU are commonly used interchangeably (Çikrıkci, 2016), each term may have distinct characteristics (Çikrıkci, 2016).

IA denotes addiction specifically to the internet (Moreno et al., 2013), encompassing various activities such as excessive gaming (Kuss & Griffiths, 2012), social media engagement (Paakkari et al., 2021), compulsive buying, pornography consumption, and other online behaviors. Notably, IA was proposed as a disorder in need of further study in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, American Psychiatric Association, 2013; Holden, 2010). The main reasons for considering IA's formal recognition in the DSM-5 were its prevalence and impact. Research showed that excessive internet use led to significant negative consequences and shared traits with other addictive behaviors, such as compulsive use, withdrawal symptoms, and tolerance. There was also an increasing demand for treatment, with more people seeking help for excessive internet use. However, the potential inclusion of IA in the DSM-5 sparked debate over diagnosing and treating new behavioral addictions, and the broader concept of IA continues to be explored in the mental health field (Pies, 2009).

IA is characterized by a loss of control over internet use and withdrawal symptoms when offline (Villella et al., 2011). Key features include excessive online time, impaired academic or work performance, strained relationships, and increased stress, anxiety, and depression. Individuals with IA often feel anxious or irritable without internet access and use it to escape real-life problems or emotional pain (Gioia et al., 2021). Research also links feelings of inferiority to increased IA through emotion dysregulation (Çimşir & Akdoğan, 2023). On the other hand, the broader term of PIU encompasses broader concepts beyond addiction, such as internet use that interferes with offline socialization. Moreno et al. (2013) described PIU as "*Internet use that is risky, excessive or impulsive in nature leading to adverse life consequences, specifically physical, emotional, social or functional impairment*" (p. 1885). As internet use becomes increasingly common, new concepts within this broader notion of PIU may emerge. Therefore, in this paper, we adopt a broad, workable definition of IA summarized as the inability of an individual to control internet usage, leading to the occurrence of psychological, social, academic, and/or occupational difficulties (Beard & Wolf, 2001; Caplan, 2010; Davis, 2001; Young, 2004, 2017; Young & Rogers, 1998). This definition aims to encompass the key aspects of IA while distinguishing it from the broader concept of PIU.

Research on IA often parallels other forms of addiction, focusing on its links to mental health issues (Ni et al., 2009). Douglas et al. (2008) found that feelings of isolation, loneliness, low self-confidence and self-esteem

were key antecedents of IA. They also pointed out excessive time spent online, denial of the problem, moodiness and irritation while offline as prominent symptoms of IA. Similarly, a systematic review by Byun et al. (2009) estimated that approximately 9 million Americans suffer from IA, affecting their social, professional, and psychological well-being. Carli et al. (2013) identified depression and symptoms of attention-deficit/hyperactivity disorder (ADHD) as consistently correlated with IA, particularly among males. Global prevalence rates of IA vary, with the highest in the Middle East at 10.9% [95% CI 5.4–16.3] and the lowest in Northern and Western Europe at 2.6% [95% CI 1.0–4.1] (Cheng & Li, 2014), with higher rates reported in regions with more traffic, pollution, and dissatisfaction with life. Notably, a large amount of empirical evidence suggests that a substantial proportion of internet addicts are young individuals, who are particularly vulnerable to its adverse effects (Anderson et al., 2017; Bisen & Deshpande, 2018; Duong et al., 2020).

Internet Addiction in Adolescents

Epidemiological studies worldwide indicate that IA prevalence rates vary significantly among adolescents and young people, ranging from 0.3% to 8.2% in the United States, 1% to 21.3% in Europe, and 6.3% to 37.9% in Asia, with a global pooled prevalence estimated at 6%, highlighting IA as a growing concern globally (Duong et al., 2020). According to Morrison and Gore (2010), young individuals are more prone to IA symptoms, with those perceiving themselves as dependent on the internet exhibiting elevated levels of depressive symptoms. Durkee et al. (2012) identified that adolescents lacking emotional and psychological support face the highest risk of developing problematic internet use. Factors such as high exploratory excitability, low reward dependence, self-esteem issues, poor family functioning, easy internet access, and excessive online gaming have been found to predict IA emergence in adolescents. Conversely, the remission of IA has been associated with low levels of hostility and interpersonal sensitivity (Ko, 2007). Comorbidity with affective disorders (e.g., depression), anxiety disorders (e.g., generalized anxiety disorder, social anxiety disorder), ADHD, and alcohol use are also predictive factors of problematic internet use among adolescents (Bernardi & Pallanti, 2009; Weinstein et al., 2015; Weinstein & Lejoyeux, 2010). Yen et al. (2007, 2008) showed that adolescents with IA had higher ADHD symptoms, depression, social phobia, and hostility, and they highlighted the importance of focusing preventive strategies and therapeutic interventions on hostile and depressed adolescents to address IA effectively.

The impact of IA on adolescents' emotional, psychological, and social well-being has also garnered significant research attention. Pathological internet use has been consistently linked to adolescents' mental health issues (Best et al., 2014; Lam & Peng, 2010), with IA associated with various symptoms of psychological distress, including loneliness, social isolation, insomnia, and irritability (Çikrıkci, 2016) as well as depression, anxiety, and stress (Chi et al., 2019; Lian et al., 2021; Lin et al., 2021; Ma & Gu, 2023; Raudsepp & Kais, 2019; Saikia et al., 2019; Sayed et al., 2022; Shannon et al., 2022; Wang et al., 2018; Xie et al., 2023; Yfanti et al., 2020). Research findings also support that internet-addicted adolescents may rely on maladaptive coping mechanisms, such as avoidance and denial, to deal with psychological distress (Du et al., 2024). These coping strategies can exacerbate the symptoms of distress and perpetuate the cycle of addiction. IA also diminishes overall quality of life, as higher levels of psychological distress correlate with reduced subjective well-being and life satisfaction in young individuals (Noroozi et al., 2021). Additionally, studies exploring neurobiological mechanisms revealed structural brain changes in internet-addicted adolescents, particularly in regions related to impulse control, reward processing, behavioral inhibition, emotional regulation, and decision-making (Weinstein et al., 2017) with parallels drawn between internet gaming disorder (IGD) and drug addiction. Recent research using the actor-partner interdependence model suggested that IGD symptoms are linked to depressive and anxiety symptoms, as well as sleep disturbances, in both adolescents and their siblings (Lin et al., 2021).

Similarly, there is a continuously growing body of literature that concentrates on the various adverse effects associated with excessive internet use. In particular, IA has been found to be associated with interpersonal and

intrapersonal relationship issues, mental and physical health problems, and increased risk of self-injury among adolescents (Kwon et al., 2011; Lam et al., 2009; Liu & Potenza, 2007; Seo et al., 2009). Several studies have also explored potential associations between psychiatric symptoms (e.g., depression), aggressive behaviors, and IA among adolescents (Ha et al., 2007; Jang et al., 2008; Ko et al., 2009b; Morrison & Gore, 2010). In a 2-year follow-up study, Ko et al. (2009a) found that depression and social phobia significantly predicted IA. Lam and Peng (2010) suggested that initially mentally healthy youth who develop IA may subsequently experience depression. They estimated the relative risk of depression among those with IA to be about 2½ times higher than among those without IA after accounting for potential confounders.

Findings from Greek studies align with those of the international literature, linking IA with sleep disorders (Siomos et al., 2010a), and addictive behaviors such as illegal substance use (Fisoun et al., 2012). Adolescents with internet dependence were found to be nearly four times as likely to have comorbid psychiatric conditions and exhibit poor school performance (Tsitsika et al., 2011), prompting parental concern and psychological assistance seeking (Siomos et al., 2010b). Furthermore, locus of control (Touloupis & Teli, 2021), depression, and amount of internet use were found to be predictors of IA among Greek adolescents (Andreou & Svoli, 2013), with dysfunctional internet behavior being correlated with both externalizing (behavioral) and internalizing (emotional) problems (Tsitsika et al., 2014). Moreover, odds of developing IA were increased with visits to internet cafes, the use of Facebook, Twitter, and online games, while using e-mails seemed to be protective against IA (Tsimtsiou et al., 2015). Recent research findings revealed that internet-addicted adolescents presented higher anxiety symptoms compared to their peers (Yfanti et al., 2020), with behavioral and mental health problems (Dermani & Perdikaris, 2022), stressing the need for comprehensive interventions addressing their psychological, social, and emotional needs.

Given the prevalence and severity of IA among young users, it is crucial for parents, teachers, healthcare professionals, and policymakers to address this mental health issue proactively. Strategies for prevention, early intervention, and treatment should be implemented to promote healthy internet usage and mitigate the negative consequences associated with excessive internet consumption. Additionally, fostering digital literacy and promoting responsible online behavior can empower young people to navigate the digital world safely and responsibly (for a comprehensive review see Bickham, 2021).

The Present Study

Motivation. Depression is mentioned as comorbid diagnosis (Lukács, 2021; Shin et al., 2021; Veisani et al., 2020; Yen et al., 2007), and constitutes the most critical predisposition factor for IA (Kaess et al., 2014; Young & Rodgers, 1998) with adolescents often engaging in excessive internet use as a means to cope with dysphoric situations, unpleasant emotions, and relational problems (Chen et al., 2021; Trumello et al., 2021). Depressing mood, low self-esteem (Shin et al., 2021), withdrawal and social adjustment inability (Young & Rodgers, 1998) as well as tediousness (Borca et al., 2015) are commonly reported by a significant percentage of adolescent internet users (Cerniglia et al., 2017; Morahan- Martin & Schumacher, 2003; Zhao et al., 2022). Internet dependence often follows depression and exacerbates its symptoms (Trumello et al., 2021). Moreover, excessive internet use is associated with decrease in interpersonal contacts, loss of interest in activities outside of the internet, sleep disorders, weight gain (Li et al., 2013), fatigue (Moretta et al., 2021), poor school performance, involvement in risky situations and infringing behavior (Best et al., 2014; Moretta et al., 2021), which may indicate serious depressive symptoms (Veisani et al., 2020; Zhao et al., 2022). Meanwhile, the anxiety symptoms' prevalence seems higher in addicted users compared to healthy internet users (Ho et al., 2014). Research findings have also revealed common co-occurrence between pathological video-game use and anxiety, depression, and ADHD symptoms (González-Bueso et al., 2018). Lim and Choi (2017) showed that social network services-related stress increased users' emotional exhaustion, intention to switch, and resistance of user.

Although an important body of literature exists linking psychological distress symptoms and IA in adolescence, most of these studies focus on IA as the outcome, with limited information available on the medium to long-term mental health effects among adolescents (Lam & Peng, 2010). As described earlier, depression and anxiety may contribute to the development of IA. However, it is also possible that IA affects the mental health of young people (Lam & Peng, 2010). Irrespective of the specific nature of these relationships, identifying the most prevalent mental health issues comorbid with IA can only shed light on the disorder (Bickham, 2021). Research consistently indicates that depression is a significant predictor of problematic use of video games, internet, and smartphones (Loton et al., 2016; Matar Boumosleh & Jaalouk, 2017; Tan et al., 2016), and the level of depression has been found to be the strongest correlate, even after accounting for demographics, personality traits, and envisioning and pursuing future goals (Przepiorka et al., 2019). Given the close relationship between anxiety and depression, it comes as no surprise that anxiety has also been shown to be stongly associated with IA. The usage of technology by young people as a coping mechanism for depression and anxiety symptoms is likely to explain at least a portion of these observed associations. However, a reciprocal relationship between IA and depression, or anxiety, is likely the most plausible causal chain scenario supported by a broad body of literature (Bickham, 2021; Krossbakken et al., 2018; Loton et al, 2016).

Scope. As aforementioned, research has revealed a bidirectional association between IA and adolescents' development of depressive symptoms; however, the underlying mechanisms remain unclear. These conditions may share a common pathway leading to both problematic internet behaviors and mental health problems. Research findings indicate a potential pathway suggesting that mental health problems may precede internet behaviors. Additionally, relevant research has focused on the link between various psychosomatic disorders and excessive social media use (Paakkari et al., 2021). Interestingly, Vannucci and Ohannessian (2019) reported that "*social media patterns appear to differentially predict psychosocial adjustment during early adolescence, with high social media use being the most problematic"* (p. 1469). Therefore, in this paper, within a broader context of IA (including social network site addiction), the moderating role of the stage of adolescence in the depression-IA pathway is explored. Adolescence is characterized as the phase of transition from being a child to an adult which is roughly considered to be the period between 11 and 19 years of age, and following the broad approximate categorization provided by Salmela-Aro (2011), adolescence is here divided into three stages: early adolescence (11 to 14 years), middle adolescence (15 to 17 years), and late adolescence (18 to 20 years).

Furthermore, few studies have investigated the reverse direction of the pathway, commencing with IA (Lam & Peng, 2010). The study conducted by Zhao et al. (2022) utilized cross-lagged panel analyses to investigate the relationship between adolescents' IA, depressive symptoms, and aggressive behavior over time. The findings suggested that IA triggers both depressive symptoms and aggressive behavior, rather than vice versa. Additionally, the study revealed gender differences, indicating that boys were more prone to aggressive behavior, while girls were more susceptible to depression. Stanković and Nešić (2022) provided evidence of a bidirectional IA-depression association, while anxiety and stress were found to mediate the IA-depression path. Depression and anxiety show pronounced comorbidity, while anxiety disorders tend to precede onset of comorbid depression. Several researchers have suggested a causal role for anxiety in promoting depressive episodes, but few studies have identified specific mechanisms (Starr et al., 2014). Understanding how and why comorbidity emerges is critical to understanding etiology; however, research has rarely attempted to identify specific psychological risk factors that may contribute. The current study examines the little-explored role of IA, by examining a model where anxiety symptoms drive to problematic ınternet use, which in turn elevates risk for depression.

In line with this goal, and drawing from previous study findings, the following research hypotheses are being addressed:

H1: Stage of adolescence moderates the relationship between depression and IA.

H2: IA mediates the relationship between anxiety and depression.

H3: IA and stress serially mediate the relationship between anxiety and depression.

Method

Participants

A convenient sample of 215 Greek adolescents and young adults, aged from 11 to 20 years, were sourced from internet forums, including social media platforms, and completed self-report measures related to internet addiction, depression, anxiety, and stress. The sociodemographic characteristics encompassed gender, stage of adolescence, educational level, place of residence, type of educational institution, ownership of personal connection devices, daily online activity hours, typical internet functions, and preferred social networking applications. From the total sample of the study, 32.1% were boys, and 67.9% were girls. Participants' ages ranged from 11 to 20 years old, with 35.3% being in the early stage of adolescence (ages 11-14), 32.1% in the middle adolescence (ages 15-17), and 32.6% in the late adolescence (ages 18-20). Regarding educational level, 1.4% attended elementary school (5th and 6th grade), 39.5% attended junior high school, 31.2% attended senior high school, and 27.4% studied at university or college. The majority (67.9%) attended public schools, while 32.1% attended private schools. Residence areas varied, with 72.6% of the participants residing in urban areas, 20.5% in semi-urban areas, and 7% in rural areas. The vast majority of participants, corresponding to 94% of the study sample, reported having personal connection devices (e.g., mobile phones, tablets, laptops), while 6% used shared devices. When asked about their dailly time spent on online activities, 0.5% reported spending no time online, 4.2% reported spending 15-30 minutes, 33% reported 1-2 hours, 40.5% reported 3-4 hours, and 21.9% reported spending 5 hours or more online. The online activities most frequently mentioned by the participants included video/music watching (79.1%), chat applications (70.7%), and social media platforms (68.4%). Other activities included seeking information (36.3%), online gaming (34.4%), email usage (28.4%), and engaging in electronic purchases (19.1%). Instagram ranked as the leading social media platform among the participants, with a usage rate of 60%. YouTube closely followed with 58.6%. TikTok held the third position among the social media platforms, with a usage rate of 37.2%, while Facebook trailed at 12.6%. Twitter was the least utilized, with only 4.7% participation.

Measures

Internet Addiction. The 20-item Internet Addiction Test (IAT-20) developed by Young (1998) was administered to measure characteristics and behaviors associated with the compulsive use of the internet including compulsivity, escapism, and dependency. Additionally, the test assesses problems related to personal, occupational, and social functioning that may arise from internet use. Participants were required to respond in a 5-point Likert-scale, indicating the extent to which they endorse each particular behavior or statement. The IAT-20 is one of the most commonly used tools for assessing internet addiction. It is designed to gauge the severity of compulsive internet use among individuals who are frequent and experienced internet users. The test is applicable to both adults and adolescents. The IAT total score is the sum of the ratings given by the examinee for the 20 item responses. The maximum score is 100 points. The higher the score, the greater the severity of IA. Total scores that range from 0 to 30 points are considered to reflect a normal level of internet usage; scores of 31 to 49 indicate the presence of a mild level of IA; 50 to 79 reflect the presence of a moderate level; and scores of 80 to 100 indicate a severe dependence upon the internet. The IAT-20 scale is a worldwide accepted and validated testing instrument, adapted to the Greek cultural context by Tsimtsiou et al. (2014) with good psychometric properties, comparable with the original IAT and the previously published translated versions. The Cronbach's α in this survey was adequate (α=.895).

Depressive, Anxiety, and Stress Symptoms. The Depression, Anxiety and Stress Scales-21 (DASS-21; Lovibond & Lovibond, 1995) was employed to measure anxiety, depression and stress symptoms. This self-report instrument constitutes the shortened form of Lovibond and Lovibond's (1995) DASS-42. The scale consists of three subscales that include seven items rated on a 4-point Likert scale to measure the aforementioned negative psychological states. The depression scale assesses symptoms such as dysphoria, hopelessness, self-worthlessness, and lack of interest. The anxiety scale comprises items evaluating somatic symptoms, situational anxiety, and the subjective experience of anxious affect, while the stress scale appraises a condition of persistent arousal and tension, which consists of symptoms such as difficulty in relaxing, agitation, irritability, and impatience. Preliminary evidence suggested that the DASS-21 possesses adequate convergent and discriminant validity in clinical and nonclinical groups across different cultures (Lovibond & Lovibond, 1995). Regarding the use of the DASS as a screening tool in children and adolescents, Lovibond and Lovibond (1995) suggested that, provided there is sufficient language proficiency, there is no significant objection to employing these scales for comparative purposes with children as young as 12 years old. Other studies have applied the DASS-21 scale to children and adolescents aged between 7 and 15 years old (Duffy et al. 2005; Szabó, 2009; Szabó & Lovibond, 2006), while the factor structure exporation demonstrated that the core symptoms of depression and anxiety seem similar in adults and adolescents. The DASS-21 scale demonstrated adequate psychometric properties in the Greek population (Kyriazos et al., 2018; Pezirkianidis et al., 2018). In the present study, Cronbach's α reliability for all three subscales was high (α=.947).

Procedure

The data was collected between January and May 2022 using the snowball sampling method, as participants were encouraged to share the form with other peer adolescents of the same age. The data collection process was facilitated through the Google Forms platform, given its immediacy, user-friendly interface, and possibility of quick distribution of the questionnaire. At the beginning of the online survey, participants were presented with an electronic informed consent form, which included a detailed description of the study's purpose, procedures, risks, benefits, and confidentiality measures, ensuring they understood what their participation involved. After reviewing the informed consent form, participants were required to provide their consent by selecting a checkbox indicating their agreement. This electronic action served as their formal consent to participate in the study. Each participant's consent was recorded electronically, with the system logging the date and time of their consent, securely stored for verification and compliance purposes. Participants were assured of the voluntary nature of their involvement, with no repercussions for choosing non-participation. Anonymity and confidentiality were guaranteed, with data analyzed in aggregate form to protect individual identities. Participants were informed of their right to withdraw at any time without any consequence. Additionally, they had the opportunity to ask questions and seek clarification before consenting, upholding principles of informed consent and ethical research conduct. Individuals outside the age range of 11 to 20 years and those who were not Greek residents at the time of the study were excluded. Additionally, participants who did not complete the entire survey, provide valid responses, or give electronic informed consent were excluded. The study was conducted in accordance with the institution's research ethics policy, which did not require prior approval from the University's Ethics and Compliance Committee for this type of research.

Data Analysis

We first curated the dataset comprised of 215 participants and confirmed randomness (there were no participants that answered the highest, lowest, or the same value in all items of the questionnaires provided). We used descriptive statistics to describe the basic features of the participants. To test the primary research hypotheses outlined in this paper, we employed path analyses. As a preliminary descriptive analysis, we specifically focused on differences related to gender and stages of adolescence, in accordance with existing literature, since these

demographics are most commonly studied in relation to IA and mental distress in adolescents (Carli et al., 2013; Chang & Kuhlman, 2022; Karacic & Oreskovic, 2017; Kawabe et al., 2016; Ko et al., 2012; Sayed et al., 2022). Subsequently, we tested whether the data for each variable of interest across groups (with respect to gender and stages of adolescence) significantly deviated from a normal distribution using the Kolmogorov-Smirnov (K-S) test (correcting for small values at the tails of probability distributions by adopting the Lilliefors test). In cases of non-normality, non-parametric tests were employed to explore differences between independent samples, comparing distributions across groups using either the Mann-Whitney *U* test for two samples or the Kruskal-Wallis one-way ANOVA for more than two samples. We then examined the psychometric properties of the IAT-20 and DASS-21 scales. In the path analyses conducted here, bootstrapping with 5,000 samples was used to generate an empirically derived representation of the sampling distribution of the conditional effect (i.e., the moderation effect) and indirect effect (i.e., mediation effect), and this empirical representation was used for the construction of 95% confidence intervals (denoted here as 95%BootCI). Thus here, unlike the normal theory approach, no assumption is made about the shape of the sampling distribution of the conditional and indirect effects. Bootstrapping method is superior to Sobel's test because it is a non-parametric test which does not require normality assumption, is applicable to small sample sizes, and increases the power of the test (Preacher & Hayes, 2008).

For the purposes of path analyses, Hayes PROCESS macro (Hayes, 2013) was utilized to fit all models under consideration, and automatically construct the bootstrap confidence intervals (along with a *p*-value, or a standard error computed) for any conditional or indirect effect in each model under estimation. All data analyses were conducted using the IBM Statistics SPSS 28 (Hinton et al., 2014). For the fisrt research hypothesis (H1), model 1 of the Hayes Process Macro for moderation analysis was fitted, using a categorical moderator (adolescence's stage), and continuous independent (depression) and dependent (IA) variables. For the second research hypothesis (H2), model 4 of the Hayes Process Macro for simple mediation analysis was fitted, in order to examine how the influence between the constructs of anxiety and depression may take an indirect path through a mediator variable (IA). For the third research hypothesis (H3), model 6 of the Hayes Process Macro for serial mediation was fitted, hypothesizing a causal chain linking of two mediators. Here, IA and stress were hypothesized to operate in serial in the relationship between anxiety and depression. The conceptual and statistical diagrams of moderation and mediation models describing the first to third research hypotheses (H1-H3) under consideration are displayed in Figure 1a-1c, respectively.

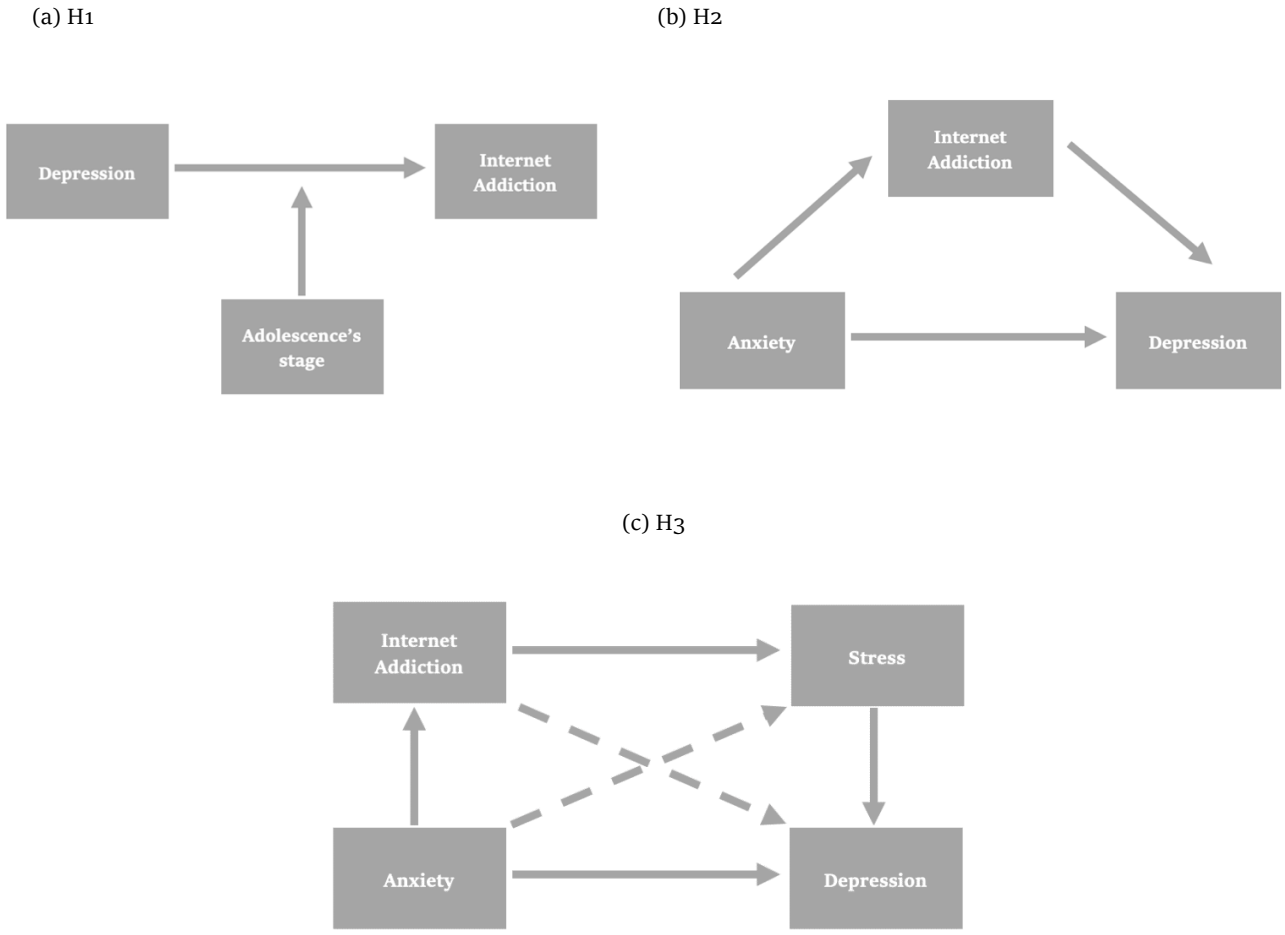
Results

Descriptive Statistics and Preliminary Analysis

Merely 7% of participants demonstrated normal internet use, with 46% exhibiting mild addictive behavior. Furthermore, 45.1% displayed moderate addictive behavior, while a small proportion, 1.9%, met the criteria for severe dependence upon the internet. On average, the mean internet usage score was calculated at 49.14 (*SD* = 12.89). According to the criteria of the IAT-20, the score obtained by adolescents participating in this study positions them at the borderline between mild and moderate addictive behavior. Additionally, findings indicated that nearly half of the participants (47.9%) demonstrated normal levels in the depression subscale of DASS-21, with 9.8% and 23.6% exhibiting mild and moderate depressive behavior, respectively. Furthermore, 6% displayed symptoms of severe depression, while a proportion of 12.7% met the criteria for extremely severe symptoms of depression. Concerning adolescents' anxiety levels, more than half of the participants (53.1%) demonstrated normal anxiety levels, with 10.7% and 10.2% exhibiting mild and moderate levels of anxiety, respectively. Furthermore, 7.9% and 18.1% displayed severe and extremely severe symptoms of anxiety. Shifting focus to the stress subscale, a majority (56.8%) reported normal stress levels. However, 13.5% and 14.9% contended with mild to moderate stress, respectively. Furthermore, 9.3% of the participants met the criteria for

severe stress, while 5.3% experience extremely severe stress levels. On average, the recorded depression levels fell within the mild to moderate range (M = 6.18, SD = 5.34), while anxiety levels were mild (M = 4.9, SD = 5.15). Conversely, adolescent stress levels, on average, appeared within the normal range (M = 6.9, SD = 5.29).

Figure 1.*Diagrams of Moderation and Mediation Models Representing the Research Hypotheses Under Consideration*



Gender Differences. Regarding IA, there were no significant differences between boys and girls (t(213) = -0.79, p = .431), despite girls reported higher scores than boys (M = 48.13, SD = 13.88), both exhibiting, on average, mildly addictive behavior. Depression levels appear higher in girls (Mdn = 6) than in boys (Mdn = 4). A Mann-Whitney test indicated that this difference is statistically significant (U(N_{girls} = 146, N_{boys} = 69) = 4185.50, z = -2.01, p = .045). Anxiety levels were also statistically significantly higher in girls (Mdn = 4) than in boys (Mdn = 2) (U(N_{girls} = 146, N_{boys} = 69) = 3852, z = -2.80, p = .005). The same holds for the stress subscale for girls (Mdn = 7) compared to boys (Mdn = 5) (U(N_{girls} = 146, N_{boys} = 69) = 4107, z = -2.19, p = .029).

Stage of Adolescence Differences. Middle stage adolescents, that is ages 15-17, (Mdn = 52) showed increased levels of IA compared to early (ages 11-14) (Mdn = 44) and late (ages 18-20) (Mdn = 49.5) stage adolescents. A Kruskal-Wallis test was performed on the scores of the three groups (early, middle and late adolescence). The differences between the rank totals were significant (H(2) = 8.62, p = .013). Post hoc comparisons were conducted using Mann-Whitney tests with a Bonferroni adjusted alpha level of .017. The difference in IA between early and middle stage adolescents was statistically significant (U(N_{early} = 76, N_{middle} = 69) = -30.35, z = -2.94, p = .010). None of the other comparisons were significant after the Bonferroni adjustment (ps > .017). Additionally, there was evidence of statistically significant differences in depression (H(2) = 7.51, p = .023), anxiety (H(2) = 8.13, p = .017) and stress levels (H(2) = 7.18, p = .028) experienced between adolescents at different stages. Post-

hoc Bonferroni-adjusted Mann-Whitney tests showed that depression levels were significanty higher for middle stage adolescents (*Mdn* = 7) compared to those in the early stage (*Mdn* = 4) ($U(N_{early} = 76, N_{middle} = 69) = -29.96$ $z = -2.62$, $p = .027$); anxiety levels were also significantly higher in the middle stage of adolescence compared to the early stage (*Mdn* = 2) ($U(N_{early} = 76, N_{middle} = 69) = -29.22$, $z = -2.85$, $p = .013$); the same holds for stress levels, found significantly increased for adolescents in the middle stage (*Mdn* = 8) compared to those in the early stage (*Mdn* = 5) ($U(N_{early} = 76, N_{middle} = 69) = -27.03$, $z = -2.62$, $p = .026$). None of the other comparisons were significant after the Bonferroni adjustment (*p*s > .017).

Hypothesis Testing

Concering the first research hypothesis, the study assessed the moderating role of adolescence's stage on the relationship between depression and IA. Here, the early stage of adolescence represents the reference category. The results revealed that although adolescents in the middle stage have a higher IA in comparison to those in the early stage, differences in IA between early and middle adolescents were insignificant ($p > .05$). Furthermore, participants in the late adolescence report lower IA levels in comparison to those in early stage. However, the differences in IA between ealrly and late adolescence were insignificant ($p > .05$). Two interaction effects were found to be significant. The impact of depression on IA in middle adolescence is statistically signficantly different (lower) from that in early adolescence ($b = -.992$, t=-2.47, $p = .014$). Further, the impact of depresion on IA in late adolescence was also statistically significantly different (lower) from that in early adolescence ($b = -1.185$, $t = -3.32$, p=.001). Test of unconditional interaction was also found to be significant ($p = .004$). The conditional effects showed that for participants in the early ($p < .001$), middle ($p = .008$) and late stage of adolescence ($p = .008$), the effects of depression on IA were significant. The results revealed a negative and significant moderating impact of adolescence's stage on the relationship between depression and IA, supporting H1.

As regards the second research hypothesis, the study assessed the mediating role of IA on the relationship between anxiety and depression. A heteroscedasticity-consistent standard error and covariance matrix estimator was used. The results revealed a significant indirect effect of impact of anxiety on depression ($b = .058$; $t = 2.92$, 95%BootCI = [0.02, 0.10]), supporting H2. Furthermore, the direct effect of anxiety on depression in presence of the IA was also found significant ($b = .749$, $t = 16.13$, $p < .001$). Hence, IA was found to partially mediate the relationship between anxiety and depression. Further, we can infer a complementary partial mediation, following Zhao et al.'s (2010) discussion for partial mediation concept, since the indirect effect and the direct effect had the same sign. Noteworthy, anxiety was found to have a significant impact on IA ($b = .892$, $t = 5.69$, $p < .001$), and IA a significant impact on depression ($b = .065$, $t = 3.63$, $p < .001$).

In the third research hypothesis, we examined whether IA and stress serially mediate the relationship between anxiety and depression. In contrast to parallel mediation, serial mediation means that the mediators themselves are in a hierarchical causal relationship. Serial mediation is especially useful for investigating fine-grained causal chains of mediation (Hayes, 2013). A heteroscedasticity-consistent standard error and covariance matrix estimator was also used here. The results revealed a significant indirect effect of anxiety on depression through IA and stress ($b = .05$, $t = 3.41$, 95%BootCI = [0.03, 0.08]), supporting H3. On the basis that the indirect effect in a serial mediation model is split up into specific indirect effects, three indirect effects can be distinguished in our two-mediator case. First, there is the long-way mediation, which involves both mediators. Second, there are two shortcut mediations, which each involve only one mediatior. The long-way mediation represents a causal chain of mediators and is therefore the foundation of the serial mediation hypothesis. In our study, serial mediation can be claimed since the long-way mediation was found to be statistically significant. Furthermore, the direct effect of anxiety on depression in presence of the two mediators was also found significant ($b = .321$, $t = 5.00$, $p < .001$). Hence, there is a partial complementary serial mediation of IA and stress on the relationship between anxiety and depression. For the sake of completeness, we also note that anxiety was

found to have a significant impact on IA (b = .892, t = 5.69, p < .001), anxiety on stress (b = .728, t = 16.71, p <. 001), and IA on stress (b = .095, t = 5.61, p < .001). Further, stress was found to have a significant impact on depression (b = .589, t = 8.40, p < .001), while IA did not significantly affect depression (b = .009, t = 0.59, p = .557). The total effect (sum of the direct and all indirect effects) was also found to be statistically significant (b = .807, t = 18.86, p < .001).

Discussion

In this study, we aimed to explore the relationship between IA and the manifestation of psychological distress symptoms such as anxiety, stress, and depression among Greek adolescents at different developmental stages. Initially, we posited that the stage of adolescence might influence the relationship between depression and IA. Additionally, building upon the established relationship between anxiety and depression in the existing literature, we proposed that during adolescence, IA and stress could play intervening roles in this relationship. Our primary focus was on understanding this complex process. Initially, we employed a basic mediation model to investigate the underlying mechanism linking anxiety with depression, with IA as the mediator variable, suggesting that IA intervenes in their causal relationship. Subsequently, we developed a multiple mediation model suggesting a hierarchical causal relationship between two mediators, IA and stress, within our model, influencing each other. Consequently, we conducted a serial mediation analysis to gain insights into the dynamics of the causal relationship between anxiety and depression.

The derived results revealed that only 7% of participants exhibited healthy internet usage. These findings are similar to those previously published for young adults (Kawabe et al., 2016; Ko et al., 2012; Sayed et al., 2022). In accordance with the correlations of risky forms of internet behavior and the developmental stages of adolescence, previous research findings showed that adolescents aged 15-16 years were the most prone to the development of IA, whereas adolescents aged 11-12 years showed the lowest level of IA (Karacic & Oreskovic, 2017). In this study, those aged 15 to 17 years (middle adolescence) demonstrated the highest degree of addiction. Thus, we also found that middle stage adolescents exhibited higher IA levels compared to those in the early stage. Meanwhile, IA levels decreased in late adolescence compared to the early stage. These findings could be attributed to increased independence at this age, resulting in less parental control over free time and social activities. Further, impact of depression on IA in early adolescence was higher compared to the middle and late stage of adolescence. Given that the prevalence of depression more than doubles during the transition from childhood to adolescence, and since adolescent-onset depression has been found to be associated with altered social functioning into middle adulthood (with prevalence rates of depression onset being 9% in early adolescence, 13.8% in middle adolescence, and 11.9% in late adolescence) (Chang & Kuhlman, 2022), it is not surprising that a significant moderating impact of adolescence's stage on the relationship between depression and IA was supported in our study. In fact, the derived results indicate that the relationship between depression and IA emerges in early adolescence with the strength of the depression-IA relationship being strongest in early adolescence. As adolescents proceed from early to middle and late adolescence, the strength of this relationship diminishes with the strength of this relationship going from a fairly strong positive to a weaker one. These findings increase our understanding of the dynamics between depression-IA path and different developmental stages of adolescence. Hence, early intervention and targeted support are necessary to be implemented at this stage to proactively mitigate the impact of depression on IA during early adolescence.

Moreover, the results uncovered significant relationships between IA, anxiety, and depression. Anxiety had a significant impact on IA suggesting that adolescents experiencing higher levels of anxiety may be more prone to developing IA probably as a coping mechanism, or as a means of distraction, from overwhelming and painful emotions. Further, IA was found to have a significant impact on depression, suggesting that adolescents who struggle with controlling their internet use or who engage in excessive online activities may be at a higher risk

of experiencing symptoms of depression. These findings align with prior research that has explored the complex interconnections between mental health issues and problematic internet use among adolescents. In particular, several studies have suggested a positive link between IA and depression (Ma & Gu, 2023; Wang et al., 2018), with adolescent development acting as a mediating factor in the IA-depression pathway (Chi et al., 2019). Furthermore, research findings have revealed that IA predicts the emergence of moderate levels of depressive symptoms (Lau et al., 2018), particularly highlighting that problematic social media use at baseline was linked to depressive symptoms at baseline, and changes in problematic social media use corresponded to changes in depressive symptoms (Raudsepp & Kais, 2019). Additionally, several studies have confirmed a significant, robust positive correlation not only between IA and depression but also with stress (Sayed et al., 2022; Shannon et al., 2022) and anxiety (Lian et al., 2021; Saikia et al., 2019; Yfanti et al., 2020). Evidence also exists for moderate but statistically significant correlations between problematic social media use and depression, anxiety, and stress, with no evidence of heterogeneity of these summary correlations by age and gender among adolescents and young adults (Shannon et al., 2022).

Hence, current evidence shows that anxiety can predict IA, which in turn predicts depression; meanwhile the more engaged to internet individuals are, the higher their stress level is, and the more likely they are to present depressive symptoms. Nevertheless, although previous studies have investigated IA, the main focus has been the bivariate study of IA and other factors rather than the relationship between depression, anxiety, stress, and IA (Xie et al., 2023). In our study, IA was found to mediate the relationship between anxiety and depression, in line with the findings in the study of Xie et al. (2023), which demonstrated that depression, anxiety, and IA were positively correlated, while anxiety can predict IA, and IA can predict depression. In other words, our study lay bare that anxiety appears to be a common etiological factor of IA as it is the case with other addictive behaviors as well (Rieselbach et al., 2023).

Further, in our study we confirmed a complementary partial mediation. This means that there could be another potential mediator with the same sign as the existing mediator “hidden” in the direct effect (Demming et al., 2017). Therefore, we then investigated a causal chain of mediation hypothesizing that IA and stress serially mediate the relationship between anxiety and depression. The results revealed a significant indirect effect of anxiety on depression through IA and stress, suggesting that adolescents experiencing higher levels of anxiety may be more prone to developing IA, with those spending more time online or being more deeply engaged with internet experiencing higher levels of stress, thus amplifying their susceptibility to developing depressive symptoms thereafter. Excessive internet use can lead to stress through various mechanisms, such as social comparison, cyberbullying, information overload, or disruptions in sleep patterns (Garett et al., 2018; Lim & Choi, 2017; Marciano et al., 2022; Tandon et al., 2021; Woods & Scott, 2016; Xanidis & Brignell, 2016; Zubair et al., 2023). The online environment may also contribute to feelings of isolation, loneliness, and inadequacy (Tok & Arslan Aldemir, 2023), which are risk factors for depression. Hence, the present study contributes to the existing knowledge regarding the negative impact of IA on adolescents’ well-being by shedding light on the interrelationships between psychological distress and addictive behaviors marked by a vicious circle of pathology during a critical period of human development. Along these lines, anxiety appears to play a pivotal role in understanding the development of pathological internet use in adolescence, which in turn may exacerbate adolescents’ mental health needs.

As it can be seen, by understanding the complex interplay between internet engagement, depression, anxiety, and stress, interventions can be tailored to effectively support mental well-being in the digital era, aimed at addressing both problematic internet use and psychological distress among adolescents. Such interventions may include cognitive-behavioral techniques to address maladaptive coping strategies, improving digital literacy skills, promoting healthy coping mechanisms, and providing support for underlying mental health issues (Chadha et al., 2024). Moreover, interventions may include strategies to promote healthy internet use habits, stress

management techniques, and mental health support services tailored to the needs of individuals who are heavily engaged with online activities. Educating adolescents and their caregivers about the potential negative consequences of excessive internet use and the importance of maintaining a healthy balance between online and offline activities can help mitigate the risks associated with high levels of internet engagement and prevent the onset or worsening of mental health disorders (Hussain & Griffiths, 2018). It is also essential for educators (e.g., teachers, coaches) and school personnel to receive training in order to recognize signs of excessive internet use and make referrals as well as participate in intervention programs, such as those approved by the Institute of Educational Policy (e.g., SaferInternet4kids). Additionally, the role of school psychologists is of paramount importance in addressing these issues effectively, by providing specialized support and intervention strategies, thereby ensuring a holistic approach to managing internet use and promoting overall mental well-being among students.

Furthermore, since our study suggests that IA and stress act as mediators between anxiety and depression, interventions can aim to reduce the likelihood of internet overuse as a self-soothing means to deal with anxiety, consequently lowering the risk of depression. This can be achieved by helping adolescents develop psychological traits that mitigate anxiety, fostering positive coping strategies, and enhancing emotional regulation skills. To this end, integrative well-being enhancement interventions embedded into current educational practices could ensure the development of resilience and prepare young people to bounce back from overwhelming emotions or acute stress by tapping into psychological and social resources (Yotsidi et al., 2023). Given that adolescence is deemed to be a transitional period of identity crisis (Erikson, 1968), thus an anxiety-provoking period *per se*, the planning and implementation of holistic approaches aiming at promoting adolescents' psychological resilience against anxiety, especially at younger ages, should become a mental health priority. By addressing these underlying factors, targeted age-specific interventions can effectively promote mental well-being and mitigate the negative impacts of excessive internet use on adolescents' mental health.

It is also worth noting here that the research design chosen and the data-gathering procedures followed raise four important issues that must be considered when interpreting our findings. First, the imbalance in gender representation may influence the study's findings. Although both boys and girls exhibited mildly addictive IA behavior on average, girls reported higher IA scores as well as higher levels of depression, anxiety, and stress. This finding is either consistent with or in contrast to some existing literature. For instance, a meta-analysis by Carli et al. (2013) found that depression was more commonly linked to IA in males. However, cross-lagged panel analyses by Zhao et al. (2022) suggested that internet-addicted boys were more prone to aggressive behavior, while girls were more susceptible to depression. Conversely, Shannon et al. (2022) found no evidence of heterogeneity in the relationship between problematic social media use and depression, anxiety, and stress by age and gender among adolescents. This discrepancy may be attributed to the gender imbalance in our study or may reflect recent trends in IA, underscoring the need for a more balanced sample to better understand IA and psychological distress across genders. Second, the use of a convenience sample in this study, where participants are selected based on their availability or accessibility, may not adequately represent the broader adolescent population, limiting the generalizability of the results. Future research could benefit from employing more diverse and representative sampling techniques to mitigate these limitations. Nevertheless, it's noteworthy that the study sample still encompasses a diverse adolescent demographic, with nearly equal proportions across the early, middle, and late stages of adolescence. Third, this is a cross-sectional study that was carried out through self-reporting in questionnaires, potentially introducing biases due to self-reporting. Consequently, the capacity to establish causality between psychological distress and adolescent IA might be compromised. Future research investigations should adopt longitudinal designs to enhance the robustness of conclusions regarding the intricate relationship between depression, anxiety, stress, and adolescent IA. Another limitation is the lack of control for potential confounding variables such as socio-economic status, family dynamics, or pre-existing mental health

conditions. Without controlling for these factors, it is difficult to isolate the specific relationship between psychological distress and adolescent IA. Future research should address these potential confounders to enhance the validity of the findings.

Notwithstanding the aforementioned limitations, this study underscores the complexity of the relationship between IA and psychological distress among adolescents, emphasizing the significance of considering both individual and developmental factors in prevention and early intervention strategies. The increasing prevalence of internet usage among adolescents has raised concerns about IA, which subsequently heightens the likelihood of experiencing psychological distress. Research findings suggest a bidirectional association between IA and the emergence of depressive symptoms in adolescents. However, the exact mechanisms underpinning this relationship remain unclear. In this study, the IA and stress were identified as mediators in the relationship between anxiety and depression. This implies that the presence of anxiety may lead to IA and stress, which in turn increases the likelihood of experiencing depressive symptoms. Further, the association between depression and IA was found to be moderated by the stage of adolescence. This suggests that the impact of depression on IA varies across different developmental stages of adolescence, with the strongest relationship observed in early adolescence. Understanding these relationships can assist clinicians in designing tailored prevention and treatment interventions for IA, considering the age-specific needs of adolescents. This may involve targeted interventions to address both IA and psychological distress, aiming to break the circle of reinforcement between these conditions.

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ΕΜΠΕΙΡΙΚΗ ΕΡΓΑΣΙΑ | RESEARCH PAPER

Εθισμός στο διαδίκτυο και ψυχολογική δυσφορία: Εμπειρικά στοιχεία από αναλύσεις μονοπατιού σε Έλληνες εφήβους σε διαφορετικά αναπτυξιακά στάδια

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ABSTRACT IN GREEK

Ο εθισμός στο διαδίκτυο έχει εξελιχθεί σε ένα καίριο ζήτημα δημόσιας ψυχικής υγείας, θέτοντας τους εφήβους σε κίνδυνο ψυχολογικής δυσφορίας. Η έρευνα υποδεικνύει μια αμφίδρομη και κυκλική σχέση μεταξύ του εθισμού στο διαδίκτυο και της ανάπτυξης συμπτωμάτων κατάθλιψης από τους εφήβους· ωστόσο, οι υποκείμενοι μηχανισμοί παραμένουν ασαφείς. Στοιχεία δείχνουν ότι το άγχος μπορεί να προβλέψει τον εθισμό στο διαδίκτυο, ο οποίος εν συνεχεία προβλέπει την κατάθλιψη. Επιπλέον, αρκετές μελέτες δείχνουν ότι οι εφήβοι ηλικίας 12-18 ετών που είναι εθισμένοι στο διαδίκτυο αντιμετωπίζουν αυξημένο κίνδυνο κατάθλιψης. Στην παρούσα μελέτη, διερευνάται πώς ο εθισμός στο διαδίκτυο και το στρες διαμεσολαβούν στη σχέση μεταξύ άγχους και κατάθλιψης, και πώς η σχέση μεταξύ κατάθλιψης και εθισμού στο διαδίκτυο μπορεί να διαφέρει ανάλογα με το συγκεκριμένο αναπτυξιακό στάδιο της εφηβείας. Για τον σκοπό αυτό, ένα δείγμα ευκολίας 215 Ελλήνων εφήβων, ηλικίας 11 έως 20 ετών, αντλούμενο από φόρουμ του διαδικτύου, συμπεριλαμβανομένων των μέσων κοινωνικής δικτύωσης, συμπλήρωσε κλίμακες αυτοαναφοράς σχετικά με τον εθισμό στο διαδίκτυο, την κατάθλιψη, το άγχος και το στρες. Τα αποτελέσματα έδειξαν ότι ο εθισμός στο διαδίκτυο και το στρες διαμεσολαβούν σειριακά στη σχέση άγχους-κατάθλιψης. Επιπλέον, το επιμέρους στάδιο της εφηβείας βρέθηκε να παίζει ρυθμιστικό ρόλο στη σχέση κατάθλιψης-εθισμού στο διαδίκτυο. Τα ευρήματα αυτά συμβάλλουν στην πληρέστερη κατανόηση του τρόπου με τον οποίο ο εθισμός στο διαδίκτυο σχετίζεται με την ψυχολογική δυσφορία μεταξύ των εφήβων και στην κλινική πρακτική για τον σχεδιασμό ηλικιακά στοχευμένων παρεμβάσεων πρόληψης και θεραπείας για την από κοινού αντιμετώπιση του εθισμού στο διαδίκτυο και της ψυχολογικής δυσφορίας στους εφήβους.

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