The Harmful Dysfunction Analysis applied to the concept of behavioral addiction: A secondary analysis of data from the Health Behaviour in School-aged Children 2018

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Stage 1 protocol and its previous versions are available at https://osf.io/5qyb8/.

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Data availability

This study analyzed data from the Health Behaviour in School-aged Children (HBSC) 2018 study publicly available online and distributed by the HBSC Data Management Centre (https://www.uib.no/en/hbscdata) that coordinates the work with the international datafile and the trend data and is the Data Bank for the HBSC study. The centre distributes data under the HBSC data access policy.

Code availability

The analytical code needed to reproduce the reported analyses is publicly available online at https://osf.io/5qyb8/.

Conflict of Interest Statement

The authors declare that this study is not related to any potential conflict of interest. Simone Amendola is a recommender at PCI Registered Reports.

Author Contributions

Simone Amendola: conceptualization, methodology, formal analysis, writing – original draft, writing – review and editing, visualization. Michael P. Hengartner: conceptualization, methodology, writing – review and editing, visualization, supervision. Jerome C. Wakefield: conceptualization, methodology, writing – original draft, writing – review and editing, visualization, supervision.

Abstract

Objective: The study's principal aim was to explore the usefulness of the Harmful Dysfunction Analysis (HDA) in identifying individuals with pathological social media use (PSMU) and potentially other behavioral addictions as an alternative to using DSM-5-TR-based diagnostic criteria for substance use disorders (SUD) or research criteria for internet gaming disorder (GD).

Method: Using Swiss data (N = 7,510) from the Health Behaviour in School-aged Children Study 2018, we tested weaker (HDA1) and stronger (HDA2) HDA versions. We examined differences between HDA cases and non-cases, convergence between different scoring methods, and between groups differences distinct to each scoring method (i.e., non-overlapping cases) on measures of physical health (physical activity and body mass index) and mental health (psychosomatic health, life satisfaction, school well-being), with models adjusted for age, gender, migration status, and family affluence. Data from Hungary (N = 3,789) was selected to repeat the analysis as a sensitivity investigation.

Results: SUD-based scoring yielded the highest PSMU prevalence of 33.2% while GD-based prevalence was 9%. HDA1 and HDA2 scorings yielded PSMU prevalence of 22.2% and 4.2%, respectively. HDA1-based PSMU cases showed poorer physical and mental health than non-cases with differences of small-to-medium effect size, whereas HDA2 differences were of large effect size. SUD-based cases that overlapped with HDA scoring showed worse physical and mental health than non-overlapping SUD-based cases. Non-overlapping GD and HDA cases showed no significant differences on validators that survived the sensitivity evaluation.

Conclusions: HDA may reduce PSMU prevalence while preserving conceptual and clinical validity. The more demanding HDA2 approach exhibited more convincing validator results than HDA1. From the HDA perspective, substantial SUD-based cases were false positives whereas GD-based scoring produced both false positives and negatives. Our findings suggest that further examination of HDA for advancing the conceptualization of addictive disorders is warranted.

Keywords: harmful dysfunction analysis; theoretical framework; addictive behavior; normal engagement; normal involvement.

Introduction

The present study is an attempt to advance the debate on the validity of the diagnosis of gaming disorder and other specified disorders due to addictive behaviours by improving the differentiation between excessive/high involvement versus pathological behavioral involvement. The Harmful Dysfunction Analysis (HDA) (Wakefield, 1992b, 1992a, 2013, 2015, 2020) is proposed as a useful theoretical framework for constructing improved diagnostic criteria for addictive disorders (Amendola, 2023b; Wakefield & Schmitz, 2014a, 2015). The DSM-5-TR's (American Psychiatric Association, 2022) definition of a mental disorder requires both the presence of symptoms that are manifestations of "a dysfunction in the psychological, biological, or developmental processes underlying mental functioning" and "are usually associated with significant distress or disability in social, occupational, or other important activities", and the Manual asserts that "each disorder…must meet the definition of a mental disorder" (p. 14). Building on the core of the DSM's definition of mental disorder, the HDA postulates that a mental disorder is a *harmful dysfunction* requiring the presence of both a dysfunction, i.e., the failure (even under the appropriate circumstances) of some psychological mechanism to perform a natural function that it was biologically designed to perform, and consequent harm, i.e., the dysfunction causes harm to the individual as evaluated by social values (Wakefield, 2017b, 2017a).

Our ultimate goal is to evaluate whether the HDA framework offers an appropriate approach to increasing the validity of diagnosis of (Internet) Gaming Disorder (GD) and other specified disorders due to addictive behaviors, an area in which the validity of diagnosis remains highly controversial. However, in this preliminary study, we use data on the related condition of Problematic Social Media Use (PSMU), not classified as a behavioral addiction in any major diagnostic manual, as a surrogate to test our hypothesis that the HDA offers a useful approach to validation. Empirical findings on PSMU and GD co-occurrence (Chen et al., 2021; Moreno et al., 2022), symptom similarities (Burén et al., 2021) and correlations (Shmulewitz et al., 2024; Zarate et al., 2022) support their close relationship as impaired forms of engagement with technology-generated stimuli. These findings indicate overlapping diagnostic challenges in distinguishing pathology from normal variation in these two areas. PSMU thus offers an appropriate domain for initial exploration of the potential for HDA diagnosis with an eye to later application to GD. We first review evidence on the addictive potential of some forms of PSMU, the serious challenge of validly discriminating intensive but psychologically

normal-range gaming or other behaviors from pathological versions of those behaviors, and we consider the limitations of current approaches to solving this problem. We then propose a test of the validity of the HDA against other recent approaches to behavioral addiction disorder validation, particularly the "confirmatory approach" that, relying on the components model of addiction (M. Griffiths, 2005), construes potential DSM behavioral addiction categories as strictly analogous logically to DSM's substance use disorder categories (Billieux et al., 2015).

Background

Despite the inclusion of specific diagnostic criteria for "Gaming Disorder" in ICD-11 (World Health Organization, 2019) and "Internet Gaming Disorder" as a "Condition for Further Study" in DSM-5-TR (American Psychiatric Association, 2022), debate continues on the optimal way to define GD as well as other conditions considered behavioral addictions. One issue is how to resolve differences between the DSM-5-TR and ICD-11 definitions of GD (Amendola, 2023b; Borges et al., 2021; Karhulahti et al., 2022). However, a more fundamental challenge is how to validly differentiate high-engagement/excessive but nonpathological gaming from true pathological/disordered gaming and thus limit "false positive" diagnoses (Amendola, 2023b, 2023c; Billieux et al., 2017; Deleuze et al., 2017; Fournier et al., 2023; Lehenbauer-Baum et al., 2015). This question is particularly urgent in a category such as GD that is concerned with an area of behavior in which it is common for individuals to have highly intensive and sometimes excessive involvement from a social or personal perspective that could easily be mistaken for pathological loss of control. In attempting to distinguish such cases, there exist no agreed biomarkers or other etiological markers of GD pathogenesis that could be used as a consensual criterion of validity.

The issue of valid diagnosis is not specific to GD and offers an especially difficult conceptual challenge to the entire field of behavioral addiction. Indeed, in recent years, based on the currently dominant "confirmatory approach" to disorder category formation (considered below), a seemingly endless number of apparently excessive behaviors have been proposed as categories of behavioral addiction. For example, Griffiths (2019) offers a partial list of conditions for which psychometric tests of disorder status have been formulated that includes gaming addiction, work addiction, exercise addiction, social media addiction, Facebook addiction, YouTube addiction, Tinder addiction, shopping addiction, pornography addiction, sex addiction, love addiction, dance addiction, tanning addiction, and television series watching addiction. This proliferation of categories of presumptively undesirable or excessive behavior as possible disorder categories underscores the need for procedures to establish valid diagnostic criteria that avoid over-pathologizing healthy highly-involved users, if

the behavioral addictions field is to gain the credibility and acceptance that it deserves (Billieux et al., 2015, 2019).

Social media use and its addictive potential

Social media refers to “websites and applications which enable users to create and share content or to participate in social networking” or “websites and computer programs that allow people to communicate and share information on the internet using a computer or mobile phone” according to the Oxford English Dictionary and the Cambridge Advanced Learner's Dictionary & Thesaurus, respectively. The present study focuses on social media use for social networking rather than on the broader concepts of smartphone use and screen time. Indeed, social media and networking are only some of the possible activities to which screen time and smartphone use refer.

Besides disorders due to addictive behaviors related to gaming and gambling, the ICD-11 considers the possibility of other problematic behaviors as “other specified disorders due to addictive behaviours” (code: 6C5Y). According to the results of a recent review and experts’ opinions study (Brand et al., 2020), problematic forms of pornography use, buying and shopping, and use of social networks may represent conditions of clinical importance and fit the category of “other specified disorders due to addictive behaviours”. Additionally, the American Psychological Association (2023) issued its “Health Advisory on Social Media Use in Adolescence” recommending screening adolescents for signs of PSMU, which refer to typical symptoms of addictive behaviors, and training adolescents to recognize them. In an updated document, PSMU is linked with hypersensitivity to social feedback/stimuli and rejection from others (e.g., likes and followers counts) and underdeveloped impulse control (e.g., infinite scroll) contributing to difficulty disengaging from social media and symptoms of dependency (American Psychological Association, 2024). The importance of poor social competencies (Boer, Stevens, Finkenauer, & Eijnden, 2022; Chegeni et al., 2021) and fear of missing out (Kuss & Griffiths, 2017) as part of PSMU were also emphasized. All of this aligns well with a previous contribution discussing the complexity of social media (Bayer et al., 2020). Despite the conceptualization and validity of PSMU as a behavioral addiction being debated (Casale, 2020; Varona et al., 2022; Zendle & Bowden-Jones, 2019), findings from qualitative studies examining subjects’ perspectives about the use of social media supported the view that some forms of social media use may be addictive (Ciudad-Fernández et al., 2024; O’Reilly et al., 2018; Throuvala et al., 2019, 2021). The PSMU may thus refer to a spectrum of PSMU patterns with the possibility that one extreme of the spectrum (or some difficult-to-define part of the spectrum) is a problematic/harmful disorder, whereas other parts are problematic/harmful non-disorders.

The present study attempts to provide insights that will be helpful to the correct identification of addictive behaviors in general. It uses PSMU as a condition with addictive potential, in a test of validity. In line with the above discussion, PSMU is a particularly good domain in which to explore whether an HDA approach can discriminate disordered from non-disordered variants. According to a recent meta-analytic study, the estimated prevalence of PSMU ranges from 5% to 25% depending on the classification scheme used (Cheng et al., 2021). This very substantial range suggests differences in how various diagnostic instruments draw the line between pathology versus high-frequency normality. The literature reveals that PMSU correlates with a variety of negative conditions, including poorer social support, cyberbullying, and lower well-being across multiple domains of functioning including psychological, school, and sleep problems (Boer et al., 2020; Boer, Stevens, Finkenauer, Koning, et al., 2022; Boer, van den Eijnden, et al., 2022; Boniel-Nissim et al., 2022; Borraccino et al., 2022; Marengo et al., 2021; Šablatúrová et al., 2022), as well as with lower life satisfaction and school performance (Van Den Eijnden et al., 2018). Yet, findings of initial longitudinal studies show no significant causal relationship between PSMU and distress (Di Blasi et al., 2022). Other longitudinal studies present a confusing picture in which PSMU correlates with such conditions as anxiety, insomnia, and depression, but at an individual level it is at most weakly and inconsistently causally related to such conditions (Chang et al., 2022; Lin et al., 2021). Despite the findings suggesting a negative impact on functioning, the definition of the category of PMSU, resulting from the use of a confirmatory approach (see below), appears to potentially encompass high and pathological involvement, which might explain the confusing findings.

High involvement versus pathological involvement

Billieux et al. (2019) reviewed the characteristics of high involvement and pathological involvement in video games as well as the boundaries between the two conditions. The authors referred to previous studies showing that high involvement in terms of time spent playing video games is not necessarily problematic or associated with impairment/distress. At the same time, there is a close association between time spent gaming and risk of GD diagnosis using standard criteria (Jeong et al., 2018; Király et al., 2019; Liao et al., 2023; Pontes et al., 2022). This suggests that, while time spent playing video games is associated with GD diagnosis under current approaches, it may not be an effective indicator for validly differentiating high versus pathological involvement.

The Dualistic Model of Passion (Vallerand et al., 2003) was suggested as a useful theoretical framework for identifying pathological gamers characterized by the inability to control gaming or by a compulsive pattern of gaming that interferes with daily functioning (Billieux et al., 2019). This conceptualization is in line with the definition of GD in the ICD-11 from the World Health

Organization (World Health Organization, 2019) which focuses specifically on impaired control over behavior and its negative consequences in daily life. The ICD's approach is congruent in many respects with the HDA approach, as we shall see. By contrast, in the DSM-5-TR, GD is conceptualized under a broader addiction framework in which loss of control or impaired control over gaming is only one of the dependence symptoms (Amendola, 2023b; American Psychiatric Association, 2013). Consequently, the importance of impaired control over behavior, although acknowledged as one essential aspect of addiction, remains understudied as a primary factor indicating pathological involvement (Fillmore, 2003; Kahler et al., 1995; Leeman et al., 2012, 2014; Sripada, 2022). Regarding PSMU specifically, it has been recently documented that help-seekers may apply different self-limiting strategies to control social media use and that success in achieving it depends on both individual and environmental factors but also that lack of knowledge about PSMU complicates seeking and receiving support (Vainio et al., 2023).

The confirmatory approach to behavioral addiction and its challenges

Increasing recent criticism has been aimed at what has come to be called the "confirmatory approach" to behavioral addictions. This criticism is also aimed at distinctive features of the DSM-5-TR approach that differentiate it from the ICD-11. The basic idea of the DSM criteria is to adapt behavioral addiction criteria from the DSM substance use disorder (SUD) criteria (Brown, 1993; M. Griffiths, 1996, 2005; Marlatt et al., 1988). This yields a logically appealing approach that consists of simply confirming that analogs of SUD criteria are satisfied by the target behavior (Billieux et al., 2015; Flayelle et al., 2022).

Thus, according to the confirmatory approach, new apparently excessive behavior can be conceptualized as a behavioral addiction if one can, first, demonstrate the presence of symptoms similar to those of SUD; second, create new psychometric measures of the behavior using SUD criteria; and third, establish associations with variables traditionally correlated with SUD. By following these steps, a considerable number of daily life activity that are normally prone to intensive involvement can be theorized as a behavioral addiction when performed in an intensive high-engagement way, resulting in the proliferation of behavioral addictions (Billieux et al., 2015). Accordingly, several studies have questioned the validity of the confirmatory approach (Deleuze et al., 2017; Fournier et al., 2023; Lehenbauer-Baum et al., 2015). Despite stimulating critical thinking and new research, these studies have often had methodological limitations (e.g., interpretation of results based on small sample sizes and possibly resulting from researchers arbitrary choices, use of extreme groups) that may have influenced their results (Amendola, 2023c, 2023a; Fisher et al., 2020; Nylund-Gibson & Choi, 2018). At the same time, Griffiths (2019) emphasized the need for some

degree of a confirmatory approach to unify the study of addictions, suggesting that "addictions should be conceptualized based on similarities rather than differences […] otherwise there is little point in calling such behaviours 'addictions.'" (p.181). However, Griffiths' concern does not require a mechanical analogy to SUD criteria, and could be addressed by retaining some core features of SUD. As we discuss below, this is how Griffiths has pursued his "components model" that, based on DSM SUD criteria, requires several necessary components of behavioral addiction. Alternative perspectives to the confirmatory approach have been proposed. For example, the (addictive) behaviors have been considered as reflecting impulse control or compulsive problems, or a coping strategy to deal with problems in daily life, rather than true addiction (Kardefelt-Winther et al., 2017).

A major problem with Griffiths' argument is that SUD diagnostic criteria themselves vary in their face validity as indicators of pathology. Thus, the validity of the analogous criteria Griffiths has used have been questioned as being peripheral or irrelevant to diagnosis of behavioral addiction. For example, Charlton (2002) and Charlton and Danforth (2007) examined the components model of addiction as applied to computer and video game use, with two factors labelled "Addiction" and "Low engagement" consistently found across the two studies, and these results provided evidence that some criteria (i.e., tolerance, euphoria, cognitive salience) of the components model may be peripherical as criteria for addiction or represent phenomena that occur early in the process of disorder development and are best considered risk factors. The primary grounds for criterion selection in the present study are conceptual, in terms of face validity in satisfying the dysfunction and harm criteria of the HDA. However, previous reviews offer useful input to these judgments. A systematic review of the psychometric validity and usefulness of the tolerance criterion for Gaming Disorder (Razum et al., 2023) found that tolerance lacks relevance in measuring Gaming Disorder. Withdrawal is perhaps one of the more controversial but least studied criteria. A review by Kaptsis et al. (2016) found that that many of the reviewed studies reported no withdrawal symptoms in their samples, but overall "the available evidence on Internet gaming withdrawal is very underdeveloped" (p. 58). Starzec et al. (2024) observed that most of the studies on GD withdrawal that they reviewed had no control for abstinence in evaluating withdrawal, raising questions about the validity of responses. In Castro-Calvo et al.'s (2021) Delphi study of expert appraisals of criteria for GD, withdrawal was among the intermediate group with 31% endorsement for diagnostic validity, meeting the study's criteria neither for inclusion (>80% endorsement) nor exclusion (<20% endorsement). It is difficult to draw any conclusions from this weak result for two reasons. First, other criteria that are widely seen as indicative of addictive dysfunction—for example, craving—also fell into this intermediate category, perhaps because they are less prevalent and thus seen as less "important" (which is how the study's question was worded). Second, as noted, recent reviews indicate that withdrawal in GD has not been

extensively studied in methodologically adequate ways and so it is not yet a salient, well-defined, and well-supported marker for many in the field.

Moreover, the DSM symptom threshold for SUD diagnosis—any two or more out of nine possible symptoms—has been criticized as too low, potentially yielding false positive problems for the substance use disorder category itself (Wakefield & Schmitz, 2014a, 2015). Those taking a confirmatory approach, including Griffiths in his components model, implicitly attempt to address this problem by following DSM's approach in GD criteria of requiring more symptoms than are required for SUD, and picking and choosing what they consider central among the SUD criteria. Yet, given the essential rationale of the confirmatory approach in which the symptomatic equivalence of a form of behavior to SUD is postulated as the rationale for diagnosis of behavioral addiction, these alterations and the raised threshold levels appear conceptually arbitrary until tested for validity. These various issues regarding SUD criteria and their uses make the current overarching confirmatory approach to behavioral addiction, and the components model on which it is based, a questionable conceptual baseline for diagnosing behavioral addiction pending further validation of criteria and thresholds.

The Harmful Dysfunction Analysis of the concept of behavioral addiction

In accordance with the viewpoints expressed by previous commentators (Billieux et al., 2015; Kardefelt-Winther et al., 2017), it is possible that the risk of over-pathologizing common behaviors results from two challenges to validity: (1) the use of atheoretical and confirmatory approaches with a focus on symptoms analogous to the DSM's SUD symptoms rather than a focus on key dimensions that have conceptual validity, such as dysfunction and impairment/distress; and (2) inherent ambiguities in vague SUD-type symptom descriptions that have long been criticized as encompassing both pathological and normal-range phenomena. Regarding the first problem, although the DSM-5-TR definition of GD includes some criteria indicating the presence of impairment/distress (e.g., criteria 6 and 9), the presence of impairment/distress is not a requirement for the GD diagnosis because diagnosis depends only on any five (or more) of the nine criteria being met, regardless of their content. Moreover, the aspect of dysfunction in psychological domains has not been explicitly addressed or required by the criteria, either. Therefore, the risk of false-positive cases, even when judged by the DSM's own definition of mental disorder, needs to be considered. It is true that the high DSM diagnostic threshold of 5 or more symptoms—as compared to the SUD threshold of 2 or more symptoms—does make it highly likely that most diagnosed cases will have symptoms of dysfunction and impairment/distress. However, in addition to a risk of false positives, the DSM-5 diagnostic threshold risks making false negative diagnoses in which true disorder is present at a lower

number of symptoms. More importantly, it has no conceptual rationale as a threshold given its dramatic deviation from the two-symptom SUD threshold and the theory of the confirmatory approach, and so requires validation.

In some ways, the ICD-11 comes closer to the HDA approach than does the dominant DSM approach. A focus on significant harm/distress and persistence over time, and not just a repetitive behavior in itself, has been recommended by previous writers (Kardefelt-Winther et al., 2017) and the optimal nature of exclusion criteria has been debated (M. Griffiths, 2019; Kardefelt-Winther et al., 2017). The ICD-11 definition of GD benefited from these suggestions and incorporated a criterion that requires not just excessive involvement but impaired control over gaming, reflecting a dysfunction, in addition to the other three criteria of increasing priority of gaming over other activities, continuation of gaming despite negative consequences, and significant distress or impairment resulting from gaming. The perceived validity of the ICD-11 criteria by experts is high, with all four reaching a consensus for "inclusion" as diagnostically valid in Castro-Calvo et al.'s (2021) Delphi study, whereas only four out of nine DSM-5-TR criteria reached an inclusion consensus. Moreover, ICD-11 adds useful indicators of the "boundary with normality (threshold)," emphasizing that sheer excessive use without other indicators of disorder does not qualify for diagnosis. However, questions remain about the source of the perceived validity of the ICD-11 criteria and how the precision and conceptual validity of the criteria might best be increased in the future. The present study is a first step toward clarifying whether an explicit HDA approach can provide a path to increased clarity, specificity, and validity.

In the case of addictive disorders, dysfunctions may be caused by evolutionarily novel stimuli (e.g., technological creations) for which the brain and other biological systems were not designed and that lead to failures of designed regulatory systems (Wakefield, 2017b, 2017a). The dysfunction that results from the novel input has been referred to as a dysfunction in self-regulation, a dysfunction of the desire/deliberation/choice system, a pathological degree of diminution of control (Wakefield, 2009, 2013, 2017a, 2017b) or a motivational dysfunction (Wakefield, 2018, 2020). The compulsive behavior may be a symptom that the biological design of motivational and choice systems has failed. This fits well with the discussion about mechanistic and functional explanations of addiction and may represent a phenomenon that unifies all the manifestations of interest (Murphy & Smart, 2018). Wakefield and Conrad (2019) clarified that “social values or standards are not synonymous with the attitudes or opinions that predominate at any given moment” and that “whether a condition is a disorder is not determined by how the diagnosed individual subjectively happens to feel about the condition’s effects, but by more ‘objective’ standards determined by the culture’s value system” (p.1). In this sense, there is some degree of social relativity present in disorder status because harm is related to what a specific culture values as important and as indicating impairment/distress.

The HDA offers a potentially useful perspective on how to distinguish high involvement and pathological (i.e., dysfunctional and harmful) involvement. According to this view, both dysfunction and harm are required for a disorder. Dysfunction not causing harm does not qualify as a disorder but rather as a harmless abnormality. For example, some passionate or excessive gamers/social media users (e.g., professional gamers, influencers) may experience difficulties in controlling the time spent gaming/using social media or resisting the urge to play/use social media but their functioning in daily life is not directly affected (e.g., they display good sleep quality, are physically active, attend school/work, and maintain intimate/social relationships). The behavior and experience of such gamers/social media users do not qualify as an addictive disorder or psychopathology. Similarly, the absence of harm may distinguish addiction from addictive disorder (Wakefield, 2020).

Conversely, harmful consequences in the absence of a dysfunction do not qualify as a disorder. For example, obesity or postural problems may be consequences of inactivity or sedentary behaviors due to high amount of time spent gaming/using social media in absence of a dysfunction. Information about the specific contexts in which symptoms occur can often help to clarify whether a syndrome is due to a dysfunction or to normal mental functioning under stressful or problematic circumstances (Wakefield & First, 2012). For example, some gamers/social media users may use technological devices to cope with adverse events and/or negative and painful emotions that may decrease self-regulation and motivation. Under these circumstances, the gaming/social media use behavior may increase distress even if a dysfunction causing the behavior itself is absent. According to the HDA, if there is only harm and no dysfunction, the behavior does not qualify as a disorder. However, the possibility also exists that problematic contexts can cause internal dysfunctions in vulnerable individuals, with symptoms then no longer dependent on the context, and this can complicate diagnostic inferences (Wakefield & First, 2012). The importance of environmental influences, such as familial and social/cultural norms and values, has been previously discussed in-depth (Bax, 2014; Snodgrass et al., 2021).

Study objectives

The principal aim of the study was to explore the usefulness of the HDA applied to the concept of PSMU in differentiating individuals showing a pathological involvement with social media from those with a high non-pathological involvement. HDA as an alternative approach to the study of behavioral addictions was further analyzed investigating similarities and differences with DSM-5-TR-based scoring. This aim was pursued by 1) exploring differences between HDA cases and non-cases (i.e., the rest of the sample), 2) examining convergence between different scoring methods and 3) comparing groups based on distinct scoring methods (i.e., non-overlapping cases) on measures of

physical health (physical activity and body mass index) and mental health (i.e., psychosomatic health, life satisfaction, school well-being). In the latter analysis, different groups of non-overlapping cases as defined by different scoring methods were directly compared. Adjusted models for age, gender, migration status, and family affluence were also tested.

Methods

We report how sample size was determined, all data exclusions (if any), all manipulations, and selected measures from the original study.

Data

The present study used data from the Health Behaviour in School-aged Children (HBSC) study, a World Health Organization collaborative cross-national study of adolescent health and well-being. The survey is undertaken every four years using a self-report questionnaire exploring health behaviors and complaints, school context, family and peer relationships, with randomly selected representative samples of adolescents aged 11-15 years. Data collection is conducted under a multidisciplinary protocol developed (and updated over the years) by the international surveillance group made up of researchers from all the participating countries (Inchley et al., 2018). The HBSC International Protocol specifies a nationally representative sample of approximately 1,500 pupils from each age group in each participating country, giving a total national sample size of approximately 4,500 children. According to the study protocol, ethical approval for the study protocol was sought from the involved institutions and where ethics committees were not in place, countries adhered to national ethical guidelines concerning research with children and submitted the protocol to any relevant board at country level. Data from the HBSC 2018 was obtained from the HBSC Data Management Centre (https://www.uib.no/en/hbscdata), that coordinates the work with the international datafile and the trend data and is the Data Bank for the HBSC study. The present study was not required to undergo independent approval by an ethical committee because freely online available data, with no identifiable information, was re-analyzed. Data from Switzerland (N= 7,510) and Hungary (N= 3,789) (randomly selected for conducting sensitivity analyses; see statistical analysis paragraph below) was used.

Measures

Independent variable

The nine-item Social Media Disorder Scale (SMDS) measures symptoms of PSMU during the last year (van den Eijnden et al., 2016). It consists of nine items with a dichotomous response (“yes”, “no”) corresponding to the nine diagnostic criteria for GD according to the DSM-5. The questions

were introduced as follows: "We are interested in your experiences with social media. The term social media refers to social network sites (e.g. Facebook, [add other local examples]) and instant messengers (e.g. [insert local examples], WhatsApp, Snapchat, Facebook messenger). During the past year, have you…", followed by items description. The scale showed adequate psychometric properties in recent studies (Boer et al., 2020; Boer, Stevens, Finkenauer, Koning, et al., 2022; Boer, van den Eijnden, et al., 2022).

Considering that our interest was on diagnosis and conceptualization of addictive disorder, we focused in this study on the definition and criteria for GD and SUD from the DSM-5-TR. Although testing for ICD-11 criteria would have also been useful, the Social Media Disorder Scale items used here were constructed to be compatible with the DSM-5-TR criteria, so an attempt to use them as measures for ICD-11 criteria would have involved questionable assumptions about how they were interpreted by respondents. Thus, we left the evaluation of ICD-11 criteria for another time. It should be noted that we would expect a substantial convergence between HDA and ICD-11 diagnoses because HDA and ICD-11 GD criteria applied to PSMU both require what amounts to the presence of both harm and dysfunction for diagnosis.

DSM-5-TR-based scoring methods derived from the diagnostic threshold for the diagnosis of GD (i.e., endorsing at least five of the nine diagnostic criteria) and SUD (i.e., endorsing at least two of the seven diagnostic criteria explored by the instrument), were used (Table 1). Consequently, DSM-5-TR GD-based PSMU was considered present if five or more symptoms were met ("yes"). Conversely, DSM-5-TR SUD-based PSMU was considered present if two or more symptoms were met.

Harmful dysfunction analysis (HDA) of Problematic Social Media Use (PSMU)

According to the HDA, dysfunction and harm are both required for the diagnosis of a disorder. The nine items of the scale exploring symptoms of PSMU were categorized depending on whether each item indicated dysfunction or harm or neither one (Table 1). The latter category was necessary because some items do not directly indicate harm and do not most plausibly reflect an underlying dysfunction according to the HDA.

Note that both the concepts of "dysfunction" and "harm" are fuzzy and open to a degree of interpretation, and the DSM criteria were not originally formulated with these concepts in mind. Consequently, there is a degree of judgment involved in our categorization, and alternative judgments are possible. In this study, where possible we followed or tried to remain consistent with consensus judgments of harm and dysfunction made in earlier studies of alcohol use disorder (Wakefield & Schmitz, 2014a, 2015). Nonetheless, the formulations of several of the DSM criteria retain a degree

of ambiguity as to whether a criterion suggests a dysfunction or a normal-range behavior, and similarly whether a criterion rises to the level and kind of harm that would justify a diagnosis. Thus, to evaluate whether a more demanding approach would yield different and potentially more valid results, we tested two versions of the HDA. The first version, HDA1, as in earlier studies of alcoholism, required just one dysfunction and one harm symptom, whereas the second version, HDA2, required two dysfunction and two harm symptoms, to reach diagnostic threshold.

Thus, we categorized items indicative of reduced inhibitory control (persistence despite desiring to stop), lessened interest in alternative rewards (preoccupation with this one type of reward), and withdrawal symptoms as suggesting that internal mechanisms are not functioning as designed (Wakefield, 2018; Wakefield & Schmitz, 2014a, 2015). The withdrawal item content was judged as indicating dysfunction because it has been judged a consensus HDA dysfunction indicator in previous studies in adjacent areas of research (see, e.g., Wakefield & Schmitz, 2014, 2015), and because symptoms following pausing of gaming suggest impaired control or self-regulation under the HDA framework. This was also in line with the recent classification of withdrawal symptoms as aspects of obsessive passion (Infanti et al., 2023). We categorized neglect of other activities and roles, serious conflict with family members, and regular arguments with others as harm caused by excessive use. Items exploring tolerance, escape/mood regulation (which can be adaptive), and deception of others in regard to one's behavior were not judged to be direct indicators of dysfunction or harm. The categorization of these latter symptoms was consistent with recent research on GD that suggests that those criteria are weak or questionable indicators of addictive disorder (Castro-Calvo et al., 2021; Ko et al., 2020; Yen et al., 2022). PSMU diagnosis based on the HDA (HDA1) required that an individual meet at least one dysfunction criterion and at least one harm criterion, as previously reported (Amendola, 2023b; Wakefield & Schmitz, 2014a), or, for our stronger criterion, HDA2, that the individual meet at least two dysfunction criteria and at least two harm criteria.

The original scoring of the SMDS (Table 1) is based on DSM criteria but deviates in one important way: it requires 6 out of 9 symptoms parallel to substance use disorder symptoms for diagnosis, rather than 5 out of 9 as in the DSM-5-TR proposed criteria for GD. These thresholds for the respective behavioral additions appear arbitrary because neither one matches the substance use disorder threshold of 2 symptoms or more. If it was applied literally, the confirmatory approach would presumably match the criteria for substance use disorder, allowing a lower threshold than either the SMDS or DSM-5-TR.

Table 1. The nine items of the Social Media Disorder Scale according to DSM-5-TR-based scoring methods and the Harmful Dysfunction Analysis (HDA) categories of dysfunction and harm.

Item content	Factor	DSM-5-TR GD-based	DSM-5-TR SUD-based	HDA category
During the past year, have you...				
1. ... regularly found that you can't think of anything else but the moment that you will be able to use social media again?	Preoccupation	✓	✓	Dysfunction
2. ... regularly felt dissatisfied because you wanted to spend more time on social media?	Tolerance	✓	✓	*Not used*
3. ... often felt bad when you could not use social media?	Withdrawal	✓	✓	Dysfunction
4. ... tried to spend less time on social media, but failed?	Persistence	✓	✓	Dysfunction
5. ... regularly neglected other activities (e.g., hobbies, sport) because you wanted to use social media?	Displacement	✓	✓	Harm
6. ... regularly had arguments with others because of your social media use?	Problem	✓	✓	Harm
7. ... regularly lied to your parents or friends about the amount of time you spend on social media?	Deception	✓	*Not used*	*Not used*
8. ... often used social media to escape from negative feelings?	Escape	✓	*Not used*	*Not used*
9. ... had a serious conflict with your parents, brother(s), or sister(s) because of your social media use?	Conflict	✓	✓	Harm

Note. ✓: item used as an indicator of a criterion according to DSM-5-TR diagnosis.

Dependent variables

In addition to the HDA1 and HDA2 validity tests, we formulated other validators available in the HBSC. Although the HBSC included many measures of well-being, none of them are pathognomonic for disorder or non-disorder. Nonetheless, we selected measures of well-being and health-promoting behaviors that could serve as indirect individually weak validators but that as part of an overall picture could yield revealing correlates with diagnostic status.

Physical health. Physical activity was examined asking respondents to report how many hours a week they usually exercise in their free time ("Outside school hours: how many hours a week do you usually exercise in your free time so much that you get out of breath or sweat?"). Responses were on a seven-point scale (from 1= every day, to 7= never) and were dichotomized as regular physical activity (0= once a week, 2-3 times per week, 4-6 times a week, every day) and no or low physical activity (1= never, less than once a month, once a month).

Body mass index (BMI) was also used and calculated using information on height and weight.

Mental health. The HBSC-Symptom Checklist was used to measure psychosomatic health during the last six months (Heinz et al., 2022). It consists of eight items covering the following eight symptoms: headache, abdominal pain, backache, feeling low, irritability or bad mood, feeling nervous, sleeping difficulties and dizziness. Respondents are asked to answer using a five-point scale from 1 (about

every day) to 5 (rarely or never). Scores were reversed in order that higher total scores indicate higher psychosomatic distress.

Further, life satisfaction was measured using a one-item scale (Cantril, 1965; Levin & Currie, 2014). Respondents rated their life satisfaction using Cantril's ladder [30], ranging from 0 (worst possible life) to 10 (best possible life). Scores were reversed in order that higher scores indicate higher life dissatisfaction.

Not liking school was used as an indicator of school dissatisfaction. Respondents were asked to indicate their feeling about school ("How do you feel about school at present?") using a four-point scale (from 1= I like it a lot, to 4= I do not like it at all) (Boer et al., 2020; Inchley et al., 2016). Responses were dichotomized as liking school (0= like a bit, like a lot) and not-liking school (1= not at all, not very much).

Summary variables. Despite the heterogeneity and non-independence of these five variables, for ease of presentation and to provide a rough sense of global outcome we formulated two summary variables defined as 1) a "composite index" of poor psychophysical health or distress, and 2) different profiles of psychophysical health or distress obtained relying on a latent profile analysis approach. More information is provided below in the paragraph "Statistical analysis" and Supplementary Material.

Covariates

The following sociodemographic information was included as covariates. Gender was explored by asking respondents whether they are boys or girls (1= boy, 2= girl). Age was computed according to respondents' month and year of birth and the date of the survey administration. Socio-economic status (SES) was measured using the Family Affluence Scale III (FAS III) (Torsheim et al., 2016). It consists of six items exploring material assets in the household (e.g., number of bathrooms, family holidays). The raw total score ranges from 6 (low SES) to 19 (high SES). Finally, migration status was obtained using information on respondents' and parents' country of birth and coded into: Swiss (respondent and at least one parent born in Switzerland or both parents born in Switzerland), second-generation immigrant (respondent born in Switzerland and parents born abroad), and first-generation immigrant (both respondent and parents born abroad) (Kjelgaard et al., 2017). During data cleaning and manipulation, it became evident that we failed to consider how to code the migrant status of respondents born abroad but with at least one parent born in Switzerland (n = 114). Those respondents were coded as Swiss.

Statistical analysis

Responses with missing values on any of the variables of interest were excluded from the analysis. Differences between participants included (i.e., participants with complete responses) and excluded from the analysis were tested.

To analyze convergence between different scoring methods Chi-squared test of independence and Cohen's kappa coefficient were used. Standardized residuals of the cells representing cases overlap were reported to quantify the specific contribution to the Chi-squared test. Regarding summary measures, the composite index representing poor psychophysical health or distress was calculated as the mean of z-scores for the five dependent variables. Also, different profiles of psychophysical health or distress were obtained relying on a latent profile analysis approach (using z-scores for the five dependent variables). For additional information see Supplementary material (p. 4).

Linear regression models were used for group comparisons on continuous dependent variables z-scores (i.e., body mass index, psychosomatic distress, life dissatisfaction and composite index) without and with adjustment for the effects of covariates (i.e., gender, age, SES, and migration status) in the models, respectively. For continuous dependent variables (i.e., BMI, psychosomatic distress, and life dissatisfaction) z-scores were used to interpret effect sizes in terms of standardized mean difference.

Finally, logistic regression models were used to test associations between PSMU and dichotomous dependent variables (i.e., poor physical activity and school dissatisfaction) without and with adjustment for the effects of covariates (i.e., gender, age, SES, and migration status). Multinomial logistic regression models were used to test associations between PSMU and profiles resulting from latent profiles analysis as a dependent variable.

As a sensitivity analysis, the above analysis was re-run with a sample from another country randomly selected from the HBSC dataset. The sample, from Hungary (N= 3,789), was randomly selected on March 29, 2023. Results of sensitivity analysis are presented in the Supplementary Material.

Results

The final sample from Switzerland included in this study was 5,715, corresponding to the number of respondents with no missing value on the variables of interest). Age, number of family cars and holidays, and having his/her bedroom decreased the likelihood of being excluded due to missing values while being born abroad increased the likelihood of being excluded from the study (Supplementary Material, Table S1). However, McFadden's pseudo-R^2 of the model was 0.06. After controlling for the effect of significant covariates, participants excluded and included did not differ in physical and mental health, or symptoms of PSMU. Descriptive statistics for the total sample are

shown in Table 2 whereas results of latent profiles analysis are presented in Figure S1 (Supplementary Material).

PSMU prevalence

Table 2 also reports the characteristics of cases as defined according to the four scoring methods. The lowest prevalence of PSMU cases was 4.23% (95% CI: 3.74-4.79) according to HDA2-based scoring whereas the highest was 33.19% (95% CI: 31.98-34.43) for SUD-based scoring. Intermediate prevalence estimates of PSMU were 9.05% (95% CI: 8.33-9.82) according to the GD-based scoring and 22.20% (95% CI: 21.15-23.30) for HDA1-based scoring.

Table 2. Characteristics of the total sample and samples of cases according to different scoring methods (HBSC data: Switzerland).

Variable	Total sample (*N*= 5,715) n (%)	PSMU GD-based (9.05%, *n*= 517) n (%)	PSMU SUD-based (33.19%, *n*= 1,897) n (%)	PSMU HDA1-based (22.20%, *n*= 1,269) n (%)	PSMU HDA2-based (4.23%, *n*= 242) n (%)
Sociodemographic					
Age *M(SD)*	13.61 (1.55)	13.77 (1.45)	13.79 (1.47)	13.84 (1.47)	13.81 (1.44)
Female	2,846 (49.80)	292 (56.48)	1,078 (56.83)	733 (57.76)	141 (58.26)
SES *M(SD)*	15.89 (1.93)	15.73 (2.26)	15.8 (2.05)	15.78 (2.11)	15.64 (2.27)
Migration status					
Swiss	3,933 (68.82)	286 (55.32)	1,133 (59.73)	760 (59.89)	126 (52.07)
Second-generation immigrant	1,229 (21.50)	144 (27.85)	522 (27.52)	338 (26.64)	72 (29.75)
First-generation immigrant	553 (9.68)	87 (16.83)	242 (12.76)	171 (13.48)	44 (18.18)
Health					
Physical inactivity	514 (8.99)	80 (15.47)	241 (12.70)	172 (13.55)	41 (16.94)
BMI *M(SD)*	19.19 (3.27)	19.78 (3.33)	19.44 (3.32)	19.53 (3.29)	19.75 (3.43)
Psychosomatic symptoms *M(SD)*	16.73 (6.02)	21.04 (6.59)	19.11 (6.25)	19.48 (6.32)	21.91 (7.05)
Life dissatisfaction *M(SD)*	3.35 (1.84)	4.39 (2.14)	3.84 (1.96)	3.93 (1.99)	4.45 (2.24)
Not liking school	1,396 (24.43)	213 (41.20)	592 (31.21)	409 (32.23)	100 (41.32)
Summary					
Composite index *M(SD)*	0 (2.9)	2.19 (3.17)	1.07 (2.97)	1.31 (2.96)	2.46 (3.34)
Latent profiles					
Unhealthy	881 (15.42)	167 (32.30)	435 (22.93)	319 (25.14)	88 (36.36)
Healthy not liking school	895 (15.66)	115 (22.24)	365 (19.24)	242 (19.07)	50 (20.66)
Healthy	1,951 (34.14)	168 (32.50)	697 (36.74)	459 (36.17)	78 (32.23)
Extremely healthy	1,988 (34.79)	67 (12.96)	400 (21.09)	249 (19.62)	26 (10.74)

Note. M: mean, *SD:* standard deviation, *SES:* socio-economic status, *BMI:* body mass index, *PSMU:* problematic social media use, *GD:* gaming disorder, *SUD:* substance use disorder, *HDA:* harmful dysfunction analysis.

Differences between HDA PSMU cases and non-cases

PSMU group membership based on HDA1 scoring was positively associated with all indicators of poor physical and mental health (except BMI after controlling for the effect of the covariates) (Table 3). Regarding continuous dependent variables, PSMU was associated with life dissatisfaction and composite index with small-to-medium effects size and psychosomatic distress with medium effect size after accounting for covariates. Regarding categorical dependent variables, PSMU cases were more likely to report physical inactivity and not liking school with a small effect size. PSMU cases were also more likely to be members of the unhealthy latent profile compared to non-cases with a small-to-medium effect size.

Overall, the magnitude of effect sizes increased when comparisons were performed using the HDA2 scoring method to identify PSMU cases except for physical health (i.e. a small effect for the difference in physical inactivity and no difference in BMI). After adjustment, a medium effect size was found for the between-group difference in life dissatisfaction and large effect sizes for differences in psychosomatic distress and composite index. A small-to-medium effect size was found for the association between PSMU and not liking school while a large effect size was shown for the association with unhealthy latent profile membership.

Table 3. Results from comparison of z-scores and proportion between PSMU non-cases and cases according to HDA scoring methods (HBSC data: Switzerland).

Dependent variable	Model	*t*-value (df) [a]	*p*-value	OR (95% CI) / SMD (SE)
HDA1				
Physical inactivity	unadjusted	6.354 (5713)	< 0.001	1.88 (1.55, 2.28)
	adjusted	3.733 (5708)	< 0.001	1.47 (1.20, 1.79)
BMI	unadjusted	4.272 (5713)	< 0.001	0.136 (0.032)
	adjusted	1.207 (5708)	0.228	0.035 (0.029)
Psychosomatic symptoms	unadjusted	19.01 (5713)	< 0.001	0.587 (0.031)
	adjusted	17.023 (5708)	< 0.001	0.515 (0.030)
Life dissatisfaction	unadjusted	13.03 (5713)	< 0.001	0.409 (0.031)
	adjusted	10.707 (5708)	< 0.001	0.332 (0.031)
Not liking school	unadjusted	7.289 (5713)	< 0.001	1.67 (1.45, 1.91)
	adjusted	7.150 (5708)	< 0.001	1.67 (1.45, 1.93)
Composite index	unadjusted	18.758 (5713)	< 0.001	0.579 (0.031)
	adjusted	16.010 (5708)	< 0.001	0.460 (0.029)

Latent profiles	unadjusted / adjusted	225.13 (3) / 151.82 (3)	< 0.001 / < 0.001	
Extremely healthy		-	-	reference
Healthy	unadjusted	-	-	2.15 (1.81, 2.54)
	adjusted	-	-	1.95 (1.64, 2.31)
Healthy not liking school	unadjusted	-	-	2.59 (2.12, 3.16)
	adjusted	-	-	2.53 (2.07, 3.10)
Unhealthy	unadjusted	-	-	3.96 (3.27, 4.80)
	adjusted	-	-	3.17 (2.59, 3.88)
HDA2				
Physical inactivity	unadjusted	4.316 (5713)	< 0.001	2.16 (1.50, 3.02)
	adjusted	2.891 (5708)	0.004	1.70 (1.17, 2.42)
BMI	unadjusted	2.734 (5713)	0.006	0.179 (0.066)
	adjusted	1.416 (5708)	0.16	0.084 (0.059)
Psychosomatic symptoms	unadjusted	13.905 (5713)	< 0.001	0.898 (0.065)
	adjusted	13.229 (5708)	< 0.001	0.827 (0.063)
Life dissatisfaction	unadjusted	9.582 (5713)	< 0.001	0.624 (0.065)
	adjusted	8.463 (5708)	< 0.001	0.539 (0.064)
Not liking school	unadjusted	6.099 (5713)	< 0.001	2.27 (1.74, 2.95)
	adjusted	6.161 (5708)	< 0.001	2.34 (1.78, 3.06)
Composite index	unadjusted	13.695 (5713)	< 0.001	0.885 (0.065)
	adjusted	12.932 (5708)	< 0.001	0.766 (0.059)
Latent profiles	unadjusted / adjusted	113.75 (3) / 89.68 (3)	< 0.001 / < 0.001	
Extremely healthy		-	-	reference
Healthy	unadjusted	-	-	3.14 (2.01, 4.92)
	adjusted	-	-	2.93 (1.87, 4.62)
Healthy not liking school	unadjusted	-	-	4.47 (2.76, 7.22)
	adjusted	-	-	4.52 (2.78, 7.35)
Unhealthy	unadjusted	-	-	8.37 (5.37, 13.07)
	adjusted	-	-	7.18 (4.51, 11.45)

Note. df: degree of freedom, *OR:* odds ratio, *CI:* confidence interval, *SMD:* standardized mean difference, *SE:* standard error, *BMI:* body mass index, *PSMU:* problematic social media use, *HDA:* harmful dysfunction analysis. The adjusted model included age, sex, socio-economic status, and migration as covariates. [a]: likelihood ratio test is reported for the multinomial model including latent profiles as the dependent variable., [b]: z-score.

Convergence between distinct scoring methods

Regarding case overlap according to different scoring methods, the threshold of two symptoms to identify PSMU SUD-based cases made this construct highly inclusive. All PSMU cases based on HDA1 and HDA2 scoring were identified as cases by the SUD-based scoring as well (Table 4 and Figure 1). The agreement between SUD-based and HDA1 scorings was substantial ($0.61 \leq k \leq 0.80$) (Landis & Koch, 1977) because 66.9% of SUD-based cases were also identified by HDA1. Due to HDA2's much lower rate of PSMU case identification, overall agreement with SUD-based scoring

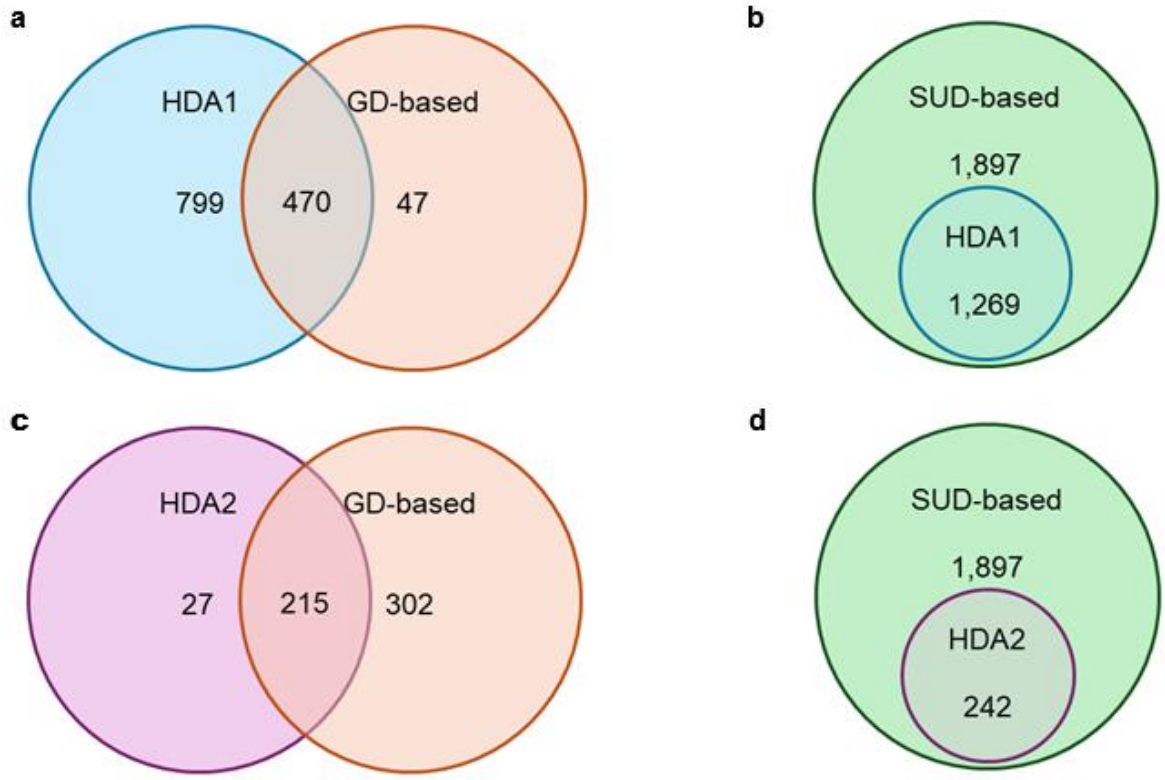
was slight ($0.00 \leq k \leq 0.20$) with only 12.8% of SUD-based cases HDA2 cases. Agreement between GD-based and HDA1 and HDA2 scorings was moderate ($0.41 \leq k \leq 0.60$); of all cases identified as PSMU by either GD-based scoring or HDA1, 35.7% were identified by both, and of those identified by either GD-based or HDA2 scoring, 39.5% were identified by both.

Table 4. PSMU cases overlap according to different scoring methods and the Harmful Dysfunction Analysis (HDA) (HBSC data: Switzerland).

Scoring	Alternative scoring	Cases overlap	Chi-squared test (df), overlap SR	Cohen's *k* coefficient (95% CI)
HDA1 (n= 1,269) vs.	GD-based (n= 517)	470	1548.9 (1)*, 39.41	0.46 (0.43, 0.49)
	SUD-based (n= 1,897)	1,269	3279.2 (1)*, 57.30	0.73 (0.71, 0.75)
HDA2 (n= 242) vs.	GD-based (n= 517)	215	1945.5 (1)*, 44.22	0.54 (0.50, 0.58)
	SUD-based (n= 1,897)	242	505.46 (1)*, 22.55	0.16 (0.14, 0.18)

Note. *df:* degree of freedom, *SR:* standardized residual, *GD:* gaming disorder, *SUD:* substance use disorder. * $p < 0.001$.

Figure 1. Venn diagrams for PSMU cases according to different scoring methods and the Harmful Dysfunction Analysis (HDA) (HBSC data: Switzerland).



Health differences between non-overlapping groups of cases

Non-overlapping PSMU groups identified by HDA scoring and by GD-based scoring were compared. Regarding HDA1-based scoring, non-overlapping cases were 799 (13.98% of the sample; 62.96% of HDA1-based PSMU cases) for the HDA and only 47 (0.82% of the sample; 9.09% of GD-based PSMU cases) for the GD-based scoring, indicating that requiring only one dysfunction symptom and one harm symptom often did not lead to a condition satisfying the 5-symptom threshold for GD-based diagnosis, whereas endorsing 5 items or more required for GD-based diagnosis usually included both at least one dysfunction and one harm item. The two groups did not differ in physical health (i.e. physical inactivity and BMI), not liking school, and distribution according to latent profile (Table 5). Conversely, differences were shown for psychosomatic distress, life dissatisfaction, and composite index with GD-based PSMU cases reporting higher scores than HDA1-based cases. The effect size of these differences was small-to-medium.

When comparing HDA2- and GD-based scorings, non-overlapping PSMU cases were 27 (0.47% of the sample; 11.16% of HDA2-based cases) for the HDA and 302 (5.28% of the sample; 58.41% of GD-based PSMU cases) for the GD-based scoring, reflecting that most cases that reached the HDA2 threshold of 2 dysfunction and 2 harm symptoms also reached the GD-based 5-symptom threshold, whereas the GD-based 5-symptom threshold was often reached with symptoms that did not include 2 dysfunction and 2 harm symptoms. No difference was found between the two groups in physical and mental health as well as summary variables (Table 5).

A similar comparison between HDA and SUD-based scoring was not possible because the SUD-based scoring identified all PSMU cases based on the HDA scorings as cases (i.e. there were no non-overlapping cases for HDA-based scorings) (see Table 4). Therefore, we decided to conduct an additional analysis - not prespecified in the published Stage 1 protocol - comparing overlapping HDA- and SUD-based PSMU cases with non-overlapping SUD-based cases, with results reported in Table S2 (Supplementary Material). The results showed that overlapping HDA- and SUD-based cases reported poorer mental health than non-overlapping SUD-based cases.

Table 5. Non-overlapping PSMU cases predicting health-related variables (z-scores and proportion) (HBSC data: Switzerland).

Dependent variable	%	%	Model	*t*-value (df) [a]	*p*-value	OR (95% CI) / SMD (SE)
	HDA1	**GD-based**				
Physical inactivity	12.64	19.15	unadjusted	1.276 (844)	0.202	1.64 (0.72, 3.34)
			adjusted	1.270 (839)	0.205	1.66 (0.72, 3.50)
BMI *M(SD)*	19.38 (3.26)	19.63 (3.52)	unadjusted	0.521 (844)	0.602	0.078 (0.150)
			adjusted	0.665 (839)	0.506	0.092 (0.139)
Psychosomatic symptoms *M(SD)*	18.52 (5.92)	20.23 (6.15)	unadjusted	1.931 (844)	0.054	0.289 (0.150)
			adjusted	2.069 (839)	0.039	0.297 (0.144)
Life dissatisfaction *M(SD)*	3.66 (1.85)	4.26 (2.06)	unadjusted	2.138 (844)	0.033	0.320 (0.150)
			adjusted	2.106 (839)	0.036	0.308 (0.146)
Not liking school	26.53	34.04	unadjusted	1.121 (844)	0.263	1.43 (0.75, 2.63)
			adjusted	1.374 (839)	0.170	1.56 (0.81, 2.91)
Composite index *M(SD)*	-0.02 (0.97) [b]	0.33 (1.36) [b]	unadjusted	2.324 (844)	0.020	0.348 (0.150)
			adjusted	2.585 (839)	0.010	0.358 (0.138)
Latent profiles			unadjusted / adjusted	0.675 (3) / 0.481 (3)	0.879 / 0.923	
Extremely healthy	24.16	23.40		-	-	reference
Healthy	38.55	36.17	unadjusted	-	-	0.97 (0.44, 2.11)
			adjusted	-	-	0.96 (0.43, 2.12)
Healthy not liking school	16.77	14.89	unadjusted	-	-	0.92 (0.35, 2.42)
			adjusted	-	-	1.01 (0.38, 2.68)
Unhealthy	20.53	25.53	unadjusted	-	-	1.28 (0.55, 2.99)
			adjusted	-	-	1.26 (0.52, 3.04)
	HDA2	**GD-based**				
Physical inactivity	14.81	14.24	unadjusted	-0.082 (327)	0.935	0.95 (0.35, 3.39)
			adjusted	0.109 (322)	0.913	1.07 (0.37, 3.91)
BMI *M(SD)*	19.08 (3.28)	19.74 (3.25)	unadjusted	1.009 (327)	0.314	0.203 (0.201)
			adjusted	1.193 (322)	0.234	0.229 (0.192)

Psychosomatic symptoms *M(SD)*	19.26 (5.49)	20.19 (6.02)	unadjusted	0.771 (327)	0.442	0.155 (0.201)
			adjusted	1.145 (322)	0.253	0.219 (0.191)
Life dissatisfaction *M(SD)*	3.78 (1.95)	4.28 (2.03)	unadjusted	1.246 (327)	0.214	0.250 (.201)
			adjusted	1.446 (322)	0.149	0.290 (0.200)
Not liking school	25.93	39.74	unadjusted	1.389 (327)	0.166	1.88 (0.80, 4.94)
			adjusted	1.335 (322)	0.183	1.86 (0.78, 4.96)
Composite index *M(SD)*	-0.24 (0.88) [b]	0.02 (1.01) [b]	unadjusted	1.282 (327)	0.201	0.257 (0.201)
			adjusted	1.653 (322)	0.099	0.317 (0.192)
Latent profiles			unadjusted / adjusted	1.620 (3) / 1.533 (3)	0.655 / 0.675	
Extremely healthy	14.81	14.90		-	-	reference
Healthy	44.44	33.77	unadjusted	-	-	0.76 (0.23, 2.47)
			adjusted	-	-	0.80 (0.24, 2.67)
Healthy not liking school	14.81	22.85	unadjusted	-	-	1.53 (0.36, 6.45)
			adjusted	-	-	1.49 (0.35, 6.33)
Unhealthy	25.93	28.48	unadjusted	-	-	1.09 (0.30, 3.93)
			adjusted	-	-	1.32 (0.35, 4.97)

Note. M: mean, *SD:* standard deviation, *df:* degree of freedom, *OR:* odds ratio, *CI:* confidence interval, *SMD:* standardized mean difference, *SE:* standard error, *BMI:* body mass index, *PSMU:* problematic social media use, *GD:* gaming disorder, *HDA:* harmful dysfunction analysis. The adjusted model included age, sex, socio-economic status, and migration as covariates. [a]: likelihood ratio test is reported for the multinomial model including latent profiles as the dependent variable., [b]: z-score.

Sensitivity analysis using HBSC data from Hungary

Overall, sensitivity analysis supported the results of the main analysis (see Supplementary Material, from page 7 on). The lowest prevalence of PSMU cases was 5.35% according to HDA2-based scoring whereas the highest was 36.83% for SUD-based scoring (Table S4). Intermediate prevalence estimates of PSMU were 9.83% according to the GD-based scoring and 24.03% for HDA1-based scoring. PSMU group membership based on HDA scorings was associated with all indicators of poor physical and mental health except BMI (Table S5). The agreement between HDA1 and SUD-based scorings was substantial whereas the agreement between HDA1 and GD-based scorings was moderate (Table S6). Conversely, HDA2 and GD-based scorings showed substantial agreement whereas a slight agreement was found between HDA2 and SUD-based scorings. Regarding differences between non-overlapping cases according to HDA and GD-based scorings, the results demonstrated that the (non-overlapping) groups did not differ in physical, mental, and summary health variables (Table S7). Finally, differences between overlapping HDA- and SUD-based scorings and non-overlapping SUD-based PSMU cases pointed to poorer mental health among members of the former groups compared to those from the latter (Table S8).

Discussion

In this study, we explored the usefulness of the HDA, a widely cited account of what distinguishes a mental disorder from normal-range distress or problems in living, as a theoretical framework for rethinking and improving the validity of diagnostic criteria for addictive disorders that might better distinguish disorder from normal-range high-intensity involvement. To apply the HDA, PSMU criteria were differentiated as indicating dysfunction or harm (or neither), the two fundamental aspects of the definition of a mental disorder in the DSM-5-TR that help to distinguish between mental disorders and other problems. The HDA was compared with other proposed approaches to behavioral addiction disorder validation, specifically the “confirmatory approach” using DSM-5-TR criteria either for SUD requiring two or more symptoms, or the criteria suggested for further research for GD requiring 5 out of 9 symptoms.

The SUD-based scoring led to the highest PSMU prevalence of 33.2% while the GD-based prevalence was 9%. Therefore, if the “confirmatory approach” was strictly applied this would have resulted in a more than threefold increase in PSMU prevalence compared to the threshold of 5 criteria adopted for GD (Petry et al., 2014). HDA1 and HDA2 scorings yielded PSMU prevalence of 22.2% and 4.2% respectively. These differences between the weaker and stronger HDA formulations were somewhat expectable given the less-than-ideal match between the original item formulation and the HDA.

We compared the set of cases resulting from the use of two forms of the HDA approach to the cases resulting from using the GD and SUD approaches, evaluating the validity of the results using a set of validators concerning aspects of mental and physical well-being. Our results suggest that, relative to SUD criteria, the use of HDA-based criteria substantially reduces PSMU prevalence while increasing validator levels. The study's most basic finding is that the HDA approach yields significant differences between cases and non-cases on almost all of our physical and mental well-being outcomes in the direction of cases suffering worse outcomes and increased validation as cases. The more demanding HDA2 criteria yielded larger differences between cases and non-cases than the weaker HDA1 reflecting more clinically meaningful results as a PSMU scoring method. To provide an idea of the putative real-world impact of these differences, we compared our findings - i.e., adjusted effects of HDA-based PSMU compared to non-cases on psychosomatic symptoms (standardized mean difference of 0.52 for HDA1 and 0.83 for HDA2) and life dissatisfaction (0.33 for HDA1 and 0.54 for HDA2) - to previous findings on life satisfaction and psychosomatic symptoms in samples of children/adolescents. The effects of HDA-based PSMU on life satisfaction and psychosomatic symptoms are larger than the effects exerted by physical activity on the same outcomes (Cohen's d between 0.16 and 0.22) (Molcho et al., 2021). The effects we found are also larger than the effects exerted by school pressure on life satisfaction (Cohen's d of 0.18) and bullying on life satisfaction and psychosomatic symptoms (Cohen's d of 0.33 and 0.24, respectively), and at least of equal magnitude to the effect of school pressure on psychosomatic symptoms (Cohen's d of 0.45) (Skoric et al., 2023). In addition, the effects we found are larger than the effect of language/cultural background on life satisfaction (Cohen's d from 0.04 to 0.40) and of similar magnitude to the effect of adult and peer support (Cohen's d from 0.50 to 1.1) (Emerson et al., 2018). These comparisons seem robust as they were replicated in the analysis of a very large database (Ottová-Jordan et al., 2015). It is worth mentioning that if we compare our effect sizes with the average effect reported in the psychological literature (Funder & Ozer, 2019), the effect sizes we found are larger than the median effect size in preregistered studies (r = 0.16 or Cohen's d = 0.32) (Schäfer & Schwarz, 2019). Moreover, HDA cases (of either variant) displayed higher validation than SUD cases that were not also HDA, so even within SUD cases the HDA provided additional validator discrimination power. These basic findings make the HDA an important candidate method for further consideration in identifying cases or in supplementing other case identification methods, such as the existing SUD and GD approaches, in identifying pathology.

These findings suggest that the HDA approach, as it is designed to do, might eliminate~~s~~ false positive diagnoses that display distress or problems in living resulting from high-intensity but not pathological social media use and that are commonly mistaken for a mental disorder, in line with previously

expressed concerns about high diagnostic rates (Martin et al., 2011; Wakefield & Schmitz, 2014a, 2015). However, not exclusive of the above explanation, it remains possible that the HDA approach in some instances selects more severe cases of disorder and eliminates some less severe but still truly pathological cases, thus increasing false negatives. This is a danger when case numbers are substantially reduced, which could happen if either HDA1 or HDA2 were to be used instead of SUD scoring, or if HDA2 were to replace GD scoring. Detailed analysis of this issue goes beyond this study's scope. However, this is a priority area for further research with a richer set of more revealing validators than were available for this study.

The HDA is based on a conceptual analysis of the necessary and sufficient conditions for disorder and an elaboration of the DSM definition of disorder, and it has been fruitfully applied to alcohol use disorder (Wakefield & Schmitz, 2014a, 2015), major depression (Wakefield & Schmitz, 2013, 2014b, 2014c), conduct disorder (Wakefield et al., 2002), social anxiety (Wakefield et al., 2005) and tentatively to GD (Amendola, 2023b). The most rigorous alternative examined here, the GD-based alternative, was not empirically determined but "conservatively chosen in the DSM-5, because low thresholds will inflate diagnoses and result in classifying individuals who have not suffered significant clinical impairment" (Petry et al., 2014, p. 1404). "Significant clinical impairment" was thus assumed to accompany the presence of 5 (or more) criteria but not less despite no criteria reflecting clinical impairment being mandatory for diagnosis—an arbitrary decision also at odds with strict application of the confirmatory approach which should reflect SUD criteria and thresholds. Distinct (i.e. non-overlapping) HDA- and GD-based cases did not differ substantially, as also indicated by sensitivity analysis. This indicates that the conservative choice of a higher threshold for GD than for SUD led to the identification of individuals presenting substantial distress. The high threshold of at least 5 out of 9 symptoms guaranteed that most individuals endorsed items reflecting harm and dysfunction. However, GD-based scoring also identified respondents not showing either dysfunction or harm as cases and missed those respondents reporting both dysfunction and harm but less than 5 symptoms. Therefore, despite being more conservative than the SUD-based scoring, GD-based scoring may not correctly uncover addictive disorders because it does not require both dysfunction and harm criteria for diagnosis. The HDA may thus represent a valid conceptual alternative, with the conservative HDA2 scoring method improving the identification of severely impaired cases displaying pathological addictive behaviors.

Future directions in applying HDA to PSMU and addictive disorders

In the present study, we used existing data collected using items on social media that were not developed according to the HDA. We thus offer some suggestions for encouraging future research efforts to apply HDA to the study of PSMU and addictive disorders in general.

Despite being understudied, the importance of impaired control over behavior has been acknowledged as a primary factor indicating pathology in the ICD-11 definition of GD and in previous research (Fillmore, 2003; Kahler et al., 1995; Leeman et al., 2012, 2014; Sripada, 2022), reflecting the HDA dysfunction requirement. However, the HDA perspective may guide validity assessment of the ICD-11 GD definition. For example, despite trying to capture loss of control over the behavior, the essential feature "Increasing priority given to gaming behaviour to the extent that gaming takes precedence over other life interests and daily activities" might not necessarily reflect dysfunction and/or harm. Furthermore, the essential features "Continuation or escalation of gaming behaviour despite negative consequences" and "The pattern of gaming behaviour results in significant distress or impairment in personal, family, social, educational, occupational, or other important areas of functioning," are not sufficiently differentiated and may relate to harm that is not clearly a result of a dysfunction but may be socially generated. The attempt at specifying dysfunction via the "impaired control over gaming behavior" also warrants exploration, because habituated behavior supported by a social context can become difficult to moderate in normal as well as disordered conditions. In sum, the adoption of the HDA can raise novel questions about validity that suggest possible improvements in criteria, increasing precision in diagnostic conceptualization.

Available definitions of addictive disorders are limited by dysfunction and/or harm criteria that lack specificity. We thus believe that the examination of more articulated symptoms of impaired control representing behavioral aspects (e.g., inhibition such as resistance to and stopping the behavior) (Fillmore, 2003; Kahler et al., 1995; Kowalik et al., 2024) and psychological aspects related to cognition and affect (e.g., salience, preoccupation, distortions, negative urgency and craving) (Fillmore, 2003; Gonçalves et al., 2024; Leeman et al., 2014; Quintero et al., 2020; Sripada, 2022) may advance our understanding of dysfunction in addictive disorders. This would be consistent with the HDA focus on dysfunction in self-regulation and desire/deliberation/choice system (Wakefield, 2009, 2013, 2017a, 2017b) or motivation (Wakefield, 2018, 2020). ~~Similarly, t~~The study of dysfunctional factors specific to PSMU could explore fear of missing out as an additional symptom of impaired control in affect regulation (for example, see findings from Brailovskaia et al. (2021) and Li et al.(2024)). Additionally, harm conceptualization and operationalization should be enhanced through the investigation of other informative aspects such as relational, performance, health, financial, and, possibly, existential harms (Karhulahti et al., 2023). Importantly, future research

should deepen our understanding of body image dissatisfaction as a potential harm of PSMU evident in self-injury and anorexia (Logrieco et al., 2021) and invasive cosmetic and plastic surgery procedures (Jenny et al., 2020; Laughter et al., 2023; Montemurro et al., 2015; Oregi et al., 2024). ~~Similarly, the study of dysfunctional factors specific to PSMU could explore fear of missing out as an additional symptom of impaired control in affect regulation (for example, see findings from Brailovskaia et al. (2021) and Li et al.(2024)).~~ Qualitative study findings may represent a valuable starting point for such an exploratory investigation.

Also, as the literature develops, a broader network of probabilistic validators (e.g., seeking help from mental health professionals, referral to outpatient clinics due to social media use) could be tapped to offer a more complex and comprehensive test of validity as in earlier HDA studies of alcohol use disorder (Wakefield & Schmitz, 2015).

Limitations of this study

Some limitations of the current analysis should be considered for proper contextualization of the study findings. First, the present analysis used data from adolescents aged 11-15 years. PSMU has been mainly studied in young people (Cheng et al., 2021). However, adolescents show a greater propensity towards impulsive and risky behaviors and are more attracted to novel stimuli than other age groups (Dayan et al., 2010; Gladwin et al., 2011). Therefore, considering both harm and dysfunction and the more conservative criterion, HDA2, requiring at least two dysfunction criteria and at least two harm criteria for PSMU, allowed the identification of the most impaired users by differentiating them from highly involved non-problematic users, mitigating the risk of over-medicalization.

Second, our analysis benefited from existing data not tailored for investigating the usefulness of the HDA for the conceptualization of behavioral addictions. As a consequence, seven predefined self-report items that derive from the component model of addiction were used. Third, related to the previous, the use of self-report items leads to harm inference being self-reported. However, it needs to be considered that the items used are arguably indicative in the sampled culture of objective harm. Fourth, and related to all the above, additional potential theory-driven dysfunction and harm must be investigated in future research as detailed in the previous section.

Finally, in our analysis, we focused on addictive disorders of social media use at the individual level of analysis. However, social media use is inevitably related to the context in which it occurs and can also be analyzed in terms of social and cultural perspectives (Karlsen, 2016) that may render these activities unproblematic and pleasurable (Costello & Edmonds, 2007). Moreover, the structural characteristics of social media (e.g, like-button, read-receipt functions, endless scrolling, personalization of content, push notifications, time restrictions of content) may influence users' behaviors independently of pathology/nonpathology, prolonging time spent using them (Flayelle et

al., 2023; Montag et al., 2019; Montag & Elhai, 2023). These social media mechanics may thus pose additional challenges to the application of the HDA in distinguishing dysfunction from contextually amplified normal variation. The effects of design elements have been more investigated for gaming (Flayelle et al., 2023; Griffiths & Nuyens, 2017) whereas research is in its infancy for social media use (Alutaybi et al., 2019; Montag & Elhai, 2023; Purohit et al., 2020). As in gaming research, future research on social media use, adopting a wider perspective incorporating both social and structural mechanisms, will fill a relevant gap in the literature (Karlsen, 2016).

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