Digital Media Use and Adolescent Mental Health

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PhD Dissertation

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Preface

My PhD dissertation, titled *Digital Media Use and Adolescent Mental Health* consists of a summary report and the articles listed below. The summary report introduces the dissertation's core research questions and summarises the main results and arguments based on the articles. Details on theories, methods, and analyses are provided in the individual articles, which I refer to as Articles A, B, C, D, E, and F.

Article A: Tølbøll K. B. (2026). Not all screen use is equal: Shifting the focus from screen time to problematic use in child and adolescent well-being research. *Clinical Child and Family Psychology Review*. https://doi.org/10.1007/s10567-026-00577-3

Article B: Tølbøll, K. B. (2026). Review: Social media use and adolescent mental health – an umbrella review and power analysis. *Child and Adolescent Mental Health*. https://doi.org/10.1111/camh.70071

Article C: Tølbøll, K. B., Stead, J., & Plagnol, A. C. (2026). Instagram Passive Active Use Measure (iPAUM): Development, validation and relation to self-esteem. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *20*(1). https://doi.org/10.5817/CP2026-1-10

Article D: Peers or celebrities? Perceived influencer status and social comparison on Instagram (*With Jennifer Stead and Anke Plagnol, Under review)*

Article E: The Slippery Slope of Digital Use (SSDU): A conceptual process framework for understanding transitions into problematic digital media use (*Under review)*

Article F: Dynamic early identification of low compliance in experience sampling method studies *(Under review)*

Chapter 1. Introduction

1.1 Aim of dissertation

Digital media are embedded in most aspects of children's and adolescents' everyday lives. Since the introduction of digital platforms in young people's lives, researchers, policymakers, educators, and parents have debated whether digital media use harms adolescents' health and well-being (Office of the Surgeon General, 2023). This debate has largely been organised around the question: *How much time on screens is too much?*

Screen time has become the default metric and the construct we measure, regulate, and worry about. However, the empirical evidence on the topic is consistently inconsistent (Sanders et al., 2024). Some empirical studies find associations between and effects of time spent on digital media and adverse mental health outcomes. Others find no associations or effects, and a third group even report positive effects of digital media use. Numerous large-scale meta-analyses produce conflicting conclusions (Valkenburg et al., 2022), and researchers argue about whether digital media represent a substantial clinically meaningful threat or whether claims of substantial harm exceed what is supported by the available evidence (Orben & Przybylski, 2019; Twenge et al., 2020).

This dissertation argues that the field has not organised itself around the most informative construct. The central question is not how much time adolescents spend on screens but how they use digital media, why they use it, and under what conditions. Exposure-based metrics treat all engagement as equivalent and cannot distinguish between a teenager scrolling TikTok for entertainment and one compulsively checking notifications to escape feelings of loneliness. It cannot capture the difference between actively chatting with a close friend and passively consuming curated images of influencers who promote different products. Exposure-based measures fall short trying to explain why some adolescents use social media for hours each day without any apparent harm, while others develop patterns of compulsive use that severely interferes with sleep, schoolwork, and social relationships.

The central aim of this dissertation is to explore the link between digital media use and adolescent well-being, including investigating how this link can be assessed robustly. The dissertation synthesises findings from six articles

which examine different dimensions of digital media use and mental health, with particular attention to adolescence.

1.2 Main findings

This dissertation comprises six articles, an overview of which is given in Table 1.1. Together, the work presented across them establishes several key findings.

Overall, time spent on digital media shows small, inconsistent, unrobust, and context-dependent associations with adolescent well-being and mental health. These findings challenge the prevailing narrative and suggest that screen time is not the most meaningful primary predictor of adolescent mental health. When only time spent is measured, important nuances are overlooked. Article C demonstrates that Instagram use can be meaningfully divided into four distinct engagement types. Article D shows that following Instagram influencers and perceiving them as peer-like or celebrity-like is differently associated with social comparison processes.

Problematic digital media use is more consistently and robustly associated with adverse mental health outcomes, including depression, anxiety, stress, and overall reduced well-being. Problematic use is not simply high or frequent use, but is defined by impaired control, compulsion, and preoccupation. If the field is to move beyond static measures of time spent, it must develop new frameworks that specify how digital media use changes over time. Article E addresses this need by describing how slope, friction, and guardrails are proposed to shape the transition from non-problematic to problematic use.

Advancing the research field requires stronger methods capable of testing these more dynamic accounts. Many existing studies are underpowered, meaning that inconsistency in the literature may partly reflect statistical limitations and not only disagreement about the size or direction of the relationship between digital media use and adolescent mental health. At the same time, the intensive longitudinal designs needed to study digital media use as a dynamic process create new methodological challenges, particularly around compliance and retention. Article F shows that final low compliance in an intensive longitudinal study could be identified early during data collection.

The summary report discusses and reflects upon practical implications for research, clinical practice, and policy. For researchers, the discussion raises questions about the adequacy of exposure-based measures and points to the value of measures that capture modes of engagement, motivations, and difficulties in regulating use. Intensive longitudinal methods and designs stand as a potential way forward in this line of research. For clinicians, the discussion suggests that assessments of difficulties surrounding media use should focus on dysregulation and compulsion rather than time. For policymakers, the discussion calls for a shift from individual responsibility to shared responsibility

across institutions, platforms, and governments. Regulation targeting persuasive platform features, school policies that restore offline spaces, and digital literacy campaigns may all have roles to play.

Table 1.1. Overview of articles

Article	Research design and method	Data sources	Research question	Research aim
A	Narrative literature review. Period: 2000-2026.	N = 52 reviews, 35 key individual studies.	What is the nature of the relationship between digital media use and well-being across different domains?	Overarching review of literature on digital media use and child and adolescent health.
B	Systematic umbrella review with study-level power analysis. Period: 2021-2025. PRISMA guideline.	N = 72 reviews; N = 1,070 effect estimates across 452 unique empirical studies.	What does the most recent review-level evidence show about social media use and adolescent mental health, and are the underlying studies adequately powered to detect the relevant effects?	Focused review and power analysis of the literature on social media use and adolescent mental health.
C	Preregistered online questionnaires, two studies (Prolific). Study 1: Exploratory factor analysis; Study 2: Confirmatory factor analysis and multiple regression analysis.	N = 289 (Study 1); N = 297 (Study 2)	Can Instagram use be measured as distinct behavioural dimensions, and are these related to self-esteem?	Development and validating of a psychometric measure of Instagram behaviours and examine its association to self-esteem.
D	Preregistered online questionnaire (Prolific). Multiple regression analysis.	N = 478	How do users' perceptions of influencers, as peers versus celebrities, relate to social comparison and subjective well-being on Instagram?	Explore how subjective perceptions of influencers on Instagram are connected to social comparison processes.
E	Conceptual framework development.	Existing theoretical models and empirical findings on problematic media use.	Under what conditions does non-problematic media use shift into problematic use, and what determines whether the shift persists?	Develop a process-based framework that organises existing theories of problematic media use under a shared set of parameters.
F	Landmark-approach machine learning models (XGBoost and elastic net) and an embedded randomised experiment.	N = 967 (UK-based longitudinal panel).	Who has low compliance, when does it become identifiable, and can study design help reduce it?	Improve intensive longitudinal design studies by detecting developing low compliance and evaluating strategies to support completion.

1.3 Outline of the summary report

The summary report is organised into eight chapters.

Chapter 1 introduces the central claim, summarises the main findings, and provides this roadmap.

Chapter 2 presents a literature review drawing on Article A and B, showing that screen time is a weak predictor of mental health and well-being.

Chapter 3 presents three empirical lines of research that point towards different mechanisms shaping online experiences that cannot be captured exclusively by time spent. Article C demonstrates that Instagram use can distinctly and statistically be categorised into four types of behaviours. Article D highlights the importance of whom users see online by showing that perceived influencer status was differently associated with social comparison frequency and valence. Lastly, findings from Article A and B indicate that problematic media use and time spent are distinct constructs with systematically different outcomes.

Chapter 4 presents the Slippery Slope of Digital Use framework as a response to what Chapters 2 and 3 have demonstrated. The chapter draws on Article E and focuses on three conceptual parameters, i.e., slope, friction, and guardrails, to conceptualise how digital media use may become dysregulated over time.

Chapter 5 examines how research designs can better capture digital media use and well-being over time. Article B identifies low power in parts of the literature, while Article F shows that final low compliance could be identified early from participants' completion behaviour.

Chapter 6 translates the dissertation's findings as a whole into reflections and discussions on clinical practice and policy.

Chapter 7 discusses the dissertation's overall limitations and outlines directions for future research.

Chapter 8 concludes the dissertation by synthesising its main contributions.

Chapter 2.
State of the art

Digital media use and its implication for youths' daily lives have become the focus of a rapidly expanding and highly interdisciplinary field. Across psychology, neuroscience, education, media studies, and public health, researchers have examined whether and how screen-based activities relate to children's and adolescents' cognitive, emotional, physical, and social development. Despite the attention to the field, the evidence base remains difficult to interpret. Findings are often mixed, not only because outcomes differ across studies, but also because the field itself does not constitute a single coherent field. Instead, it brings together fundamentally different constructs, methods, and assumptions under the broad label of digital media use.

Gaining a broad perspective is therefore necessary as a starting point. By not mapping the wider field first, it becomes difficult to determine whether potential inconsistencies reflect genuine contradictions, or whether they emerge because different subfields are studying different behaviours, mechanisms, and risks. Consequently, before narrower questions can be answered convincingly, it is important to establish whether any overall patterns emerge across domains.

Article A does so by taking an overarching view of the current state of the field on digital media use and well-being. In Article A, and throughout the dissertation, digital media use denotes any screen-based activity, including passive, interactive, online, or offline use. Digital media use is applied as a broad umbrella term for engagement with screen-based media. Screen use is sometimes used as a general shorthand for such engagement, whereas screen time and *general use* refer specifically to duration- or frequency-based measures of use. Where specific types of digital use are considered, e.g., social media use, they will be explicitly mentioned. Similarly, well-being is used in its broadest sense as an umbrella term. In Article A, well-being spans cognitive, emotional, physical, and social domains, following the World Health Organisation's conception of well-being as a positive state that cannot be reduced to the mere absence of disease or psychopathology and that is shaped by social, economic, and environmental conditions (WHO, 2021). Throughout the dissertation, well-being is used consistently in this broad, multidimensional sense. Where a specific facet is at stake, for instance satisfaction with life, that facet is named explicitly. In Article A and throughout the dissertation, childhood denotes the pre-pubertal period from infancy through middle childhood (Sawyer et al., 2019), whereas adolescence denotes the phase from the onset of puberty, at

around 10 years, into the mid-twenties, following the expanded 10 to 24 years definition of Sawyer and colleagues (2018). This broad range was chosen because earlier puberty and prolonged brain maturation extend adolescence well beyond conventional cultural boundaries. The dissertation foregrounds adolescence because it is the period in which digital media use becomes most central, and during which maturing systems of reward and self-regulation may heighten susceptibility to platform design (Orben et al., 2022).

A structured narrative review approach was selected for Article A in order to combine systematic search and eligibility procedures with an integrative synthesis of a broad and conceptually heterogeneous evidence base. The literature was searched in PubMed, PsycINFO, and Scopus for peer-reviewed systematic reviews and meta-analyses published from 2000 onwards. This window was chosen to capture the period in which private and personal digital screen use became increasingly embedded in children's and adolescents' everyday lives, while later syntheses were prioritised because the technologies, platforms, and patterns of use have changed rapidly. The search combined terms related to screen use, digital media, social media, well-being, mental health, physical health, cognition, children, and adolescents. The review combined top-down and bottom-up synthesis strategies. The top-down component refers to the structured part of the review, where pre-specified research questions, eligibility criteria, database searches, and a best-evidence approach were used to define the scope and organise the evidence. The bottom-up component refers to the inductive part of the review, where recurring mechanisms, conceptual tensions, and influential individual studies were identified during the synthesis process. Key individual studies were included when they illustrated underexplored topics, were repeatedly cited as seminal or gap-filling, or provided distinctive theoretical or methodological contributions. Using this approach, Article A synthesises evidence from 52 systematic reviews and meta-analyses, along with 35 key individual studies, to assess the current state of the art on youth digital use.

Across domains, the literature converges on a pattern that can be summarised as follows: general digital media use, typically operationalised as screen time or frequency, shows mixed associations with cognitive, physical, and psychosocial outcomes. The mixed results may reflect that the same broad category of screen use contains heterogeneous behaviours that plausibly operate through different mechanisms.

In cognition and learning, studies on average find small negative or null associations between general screen time and cognitive or language outcomes. However, the average associations may mask moderation by content and context. Learning-oriented, developmentally appropriate content can be beneficial, especially when use is interactive and supported by adults. By contrast,

digital distraction and multitasking during learning contexts show more consistent negative associations with performance, emphasising that the cost is not simply "using screens", but using them in ways that interrupt attention and goal-directed activity.

Evidence on brain structure and function similarly illustrates that duration alone is difficult to interpret. Associations have been reported between certain forms of screen exposure and differences in white matter integrity and cortical thickness in early childhood as well as diverse structural correlation patterns in large cohorts. However, neurodevelopmental processes such as cortical thinning can reflect maturation rather than pathology, complicating simple narratives. In adolescence, frequent and prolonged screen time has been linked to alterations in connectivity within cognitive control systems, but the field remains limited by correlational designs and competing interpretations about predisposition versus consequence.

In physical well-being, the evidence again suggests that how and when matter more than aggregate hours. Specifically for sleep, screen time is often associated with poorer sleep outcomes, including later bedtimes, shorter sleep duration, and daytime sleepiness. However, effects vary by the type and timing of use, as interactive engagement, e.g., gaming, messaging, social media, tends to show clearer associations than passive viewing. Proposed pathways include displacement of sleep, content-based arousal, light exposure disrupting circadian rhythms, and late-night checking behaviours. Interventions that reduce screen time show mixed downstream effects on sleep, underscoring that reducing minutes does not automatically change the mechanism that drives poor sleep, such as late-night arousal or compulsive checking. For physical activity, evidence for displacement is mixed and generally small, with meta-analytic work showing small negative correlations for some screen categories and null effects for others, and longitudinal studies differing in whether they detect meaningful displacement over time. A randomised trial suggests that reducing screen time can increase physical activity (Pedersen et al., 2022). However, this does not imply that time is a direct cause but rather indicates that in some contexts, screen time reduction changes routines in ways that make activity more likely. Overall, the physical health literature supports a more specific claim, namely that certain patterns of screen engagement are reliably linked to sleep disruption, sedentary behaviour, and unhealthy eating environments, but duration alone is too blunt to identify which adolescents are at risk and why.

2.1 Social media and mental health

Across the literature reviewed in Article A, the most investigated line of research was the connection between social media and mental health. This

subfield has grown especially rapidly and occupies a central position in both academic debate and public discourse; however, it also reflects many of the broader challenges identified in the literature more generally. As reviewed narratively in Article A, studies vary in their conceptualisation of social media use and of mental health, making it difficult to draw clear and consistent conclusions. While Article A integrates the literature on social media and mental health as a part of a broader cross-domain synthesis, its breadth limits the ability to report inconsistencies within the subfield comprehensively.

Article B narrows the analytical focus to social media use and adolescent mental health. By restricting the scope to a clearer exposure and outcome, it becomes possible to better examine the consistency of findings across reviews in a systematic and comparable way. Using a systematic umbrella review approach, Article B reviews a large body of the recent reviews and meta-analyses to provide a structured and systematic overview of the subfield. This more focused synthesis further allows for an overview of how conclusions can differ across reviews, which to a certain degree draw on overlapping evidence bases. This is relevant given the role reviews can play in informing policy and public understanding of the field.

Article B was preregistered, followed PRISMA reporting guidelines, and used explicit eligibility criteria to define which types of evidence were included. Eligible studies were peer-reviewed reviews, including meta-analyses, systematic reviews, scoping reviews, and narrative reviews, published between January 2021 and April 2025. This recent window was chosen to capture the contemporary evidence base, as social media platforms, patterns of use, and public concern have changed rapidly in recent years. Reviews were included if they focused on adolescents aged 10 to 24, social media use as the primary exposure, and mental health as the primary outcome. Reviews on broader screen time were excluded to avoid combining social media use with conceptually distinct activities such as television viewing, general mobile phone use, or other forms of digital media use.

Following Valkenburg et al. (2022), Article B defines mental health as encompassing both well-being and ill-being. Well-being refers to happiness, positive affect, and life satisfaction. Ill-being comprises clinical psychopathology, such as depression and anxiety disorders, alongside nonclinical symptoms, distress, and negative affect. Because well-being and ill-being are not opposite ends of a single continuum, individuals may score high on both dimensions (Keyes, 2005). For example, an individual may experience anxiety symptoms while simultaneously reporting a high life satisfaction. Article B defines social media use broadly as both active and passive, and private and public use of platforms such as Instagram, Snapchat, Facebook, and TikTok (Valkenburg et al., 2022; Verduyn et al., 2017).

The systematic search was conducted in PubMed, PsycINFO, Web of Science, and Scopus, reflecting the interdisciplinary nature of the field. The search strategy combined terms related to review type, social media use, mental health, and adolescence, and was first conducted in December 2023 and updated in April 2025. Studies were screened and coded using predefined criteria, covering review type, outcome definitions, social media use definitions, main findings, reported gaps, methodological recommendations, moderator analyses, and extracted meta-analytic effect sizes where available. The methodological quality of the included reviews was assessed using a modified AMSTAR 2 protocol, allowing the synthesis to consider not only what reviews concluded, but also the quality and transparency of the evidence on which those conclusions rested.

2.1.1 Evidence from reviews

Article B synthesises 72 recent reviews and meta-analyses published between 2021 and 2025, including 20 meta-analyses, 25 systematic reviews, 16 narrative reviews, and 11 scoping reviews. Across reviews and meta-analyses, general social media use, measured as time spent, frequency, or intensity, was only weakly and inconsistently associated with adolescent mental health. The literature does not converge on a single directional effect but shows a mixture of null findings, small positive associations, and small negative associations. A central feature of this pattern may be the heterogeneity of both exposure and outcome definitions. General social media use aggregates a wide range of behaviours, including passive browsing, active communication, and information seeking, which are likely to have different psychological consequences. At the same time, mental health is operationalised in diverse ways, ranging from life satisfaction and positive affect to depressive symptoms, anxiety, and composite indicators. This conceptual and measurement variability may contribute to the instability of findings and limits the interpretability of aggregate associations.

Across the 72 reviews, the evidence is characterised by persistent inconsistency across both ill-being and well-being outcomes. For well-being, a substantial portion of the literature reports no association between general social media use and outcomes such as life satisfaction and subjective well-being. Other reviews describe mixed findings, while some highlight small positive associations, particularly in contexts involving social interaction, communication, or self-disclosure. Reviews also point to potential benefits for certain groups of adolescents, including those who may use online environments for support, identity exploration, or social connection. For ill-being, including depressive symptoms, anxiety, and stress, the pattern is somewhat more suggestive. Many reviews report associations between general social media use and

higher levels of ill-being, while others find no significant relationship or describe the evidence as mixed. This inconsistency is not limited to specific outcomes or contexts but appears across different adolescent populations, time periods, and study designs.

Taken together, the review literature suggests that general social media use is not consistently associated with either improved well-being or increased mental health problems. Instead, the evidence reflects a combination of weak effects, opposing pathways, and substantial heterogeneity.

2.1.2 Evidence from meta-analyses

A specific focus on meta-analyses reveals a more structured pattern. Across outcomes, meta-analyses tend to report small effect sizes, regardless of direction. For well-being, the meta-analytic evidence remains sparse and inconsistent, with no clear convergence on positive or negative associations. For ill-being, a majority of meta-analyses report statistically significant associations with general social media use. However, these effects are consistently small and explain only a limited proportion of the variance in outcomes.

To explore whether the reported variance in outcomes could be attributed to differences in study design, measurement, and operationalisations, moderator analyses in the meta-analyses were examined. However, the reported moderation analyses do not substantially clarify reported inconsistencies. Across the included meta-analyses, the most commonly examined moderators are age, gender, country or region, and social media platform. The majority of meta-analyses find no significant moderating effects for age, gender, or platform. Country and regional differences are more frequently identified as significant but without a consistent directional pattern. As a result, moderator analyses do not provide a clear explanation for when or for whom general social media use is more strongly associated with mental health outcomes.

The overall distribution of meta-analytic findings, as summarised in Article B, therefore does not support a strong or stable relationship between general social media use and mental health.

2.2 Summary

The evidence reviewed in this chapter suggests that general digital media use is a weak and inconsistent predictor of adolescent mental health and well-being. Across both the broader literature on youth digital media use and the more focused literature on social media and mental health, associations are generally small, mixed, and highly dependent on how both use and outcomes are defined and measured. This does not support a simple conclusion that digital media use is either harmless or harmful. Rather, it suggests that duration-

based measures such as screen time may be too broad to capture the mechanisms through which digital media use may matter. Different forms of use, contexts of engagement, motivations, and individual vulnerabilities are likely to have different implications for young people's daily lives. The central implication is therefore that the field needs to move beyond asking how much time adolescents spend with digital media and instead examine what adolescents do, whom they see, and how this is experienced.

Chapter 3.
If not time, then what?

Chapter 2 established that duration-based measures may be too broad to identify the mechanisms through which digital media use may matter for adolescent health and well-being. This does not imply that time is irrelevant, but that time alone provides limited information about the nature and implications of digital engagement. Chapter 2 points towards a shift in focus from how much time adolescents spend with digital media to more differentiated dimensions of engagement. Three dimensions relating to *what* individuals do online, *whom* they encounter while online, and *how* they experience their online use are examined in turn in Chapter 3.

3.1 The behaviours: passive and active social media use

One of the more qualitative dimensions that has attracted attention and has become a dominant alternative framing to screen time is the distinction between passive and active use. The distinction is intuitive, as not all moments on, for example social media, are psychologically equivalent. Silently consuming others' curated content and actively participating in social exchanges carry different psychological implications.

Passive social media use is defined as the act of observing others' content without direct social exchange, e.g., scrolling through news feeds, viewing photographs and videos, browsing others' profiles without commenting or reacting (Verduyn et al., 2017). Active use, by contrast, encompasses any form of direct interaction with the platform or other users, including posting content, commenting, messaging, liking, and sharing. This broad dichotomy was formalised most influentially by Verduyn et al. (2017), who proposed that passive use was associated with negative social comparison and reduced well-being, while active use, by generating reciprocal social exchange and social connection, was associated with more positive outcomes. The underlying logic is grounded in well-established social psychological principles. Passive consumption exposes users to social information, i.e., others' achievements, relationships, and curated self-presentations, without the buffering effects of reciprocal social engagement, while active use activates the social reward mechanisms associated with genuine interpersonal connection.

Empirical studies offer partial support for this pattern. Experiments manipulating Facebook use show that passive scrolling leads to greater envy and reduced well-being compared to active posting (Verduyn et al., 2015). Survey-

based studies have shown that passive Facebook use is associated with lower life satisfaction and higher levels of negative affect, with social comparison functioning as a mediator. A largescale meta-analysis further found a positive association between active social media use and well-being and positive affect (Godard & Holtzman, 2024). Taken together, these findings appear to offer a compelling account that if screen time studies had failed to find reliable associations with mental health, perhaps the problem was that they had not distinguished between these two fundamentally different modes of engagement.

However, these findings have been challenged by later, more rigorous examination of the evidence base. Valkenburg et al. (2021) conducted a critical scoping review and documented that the field's apparent consensus on passive and active use rests on fragile empirical foundations. They found that approximately 90% of studies examining the active-passive distinction employed unvalidated, self-created operationalisations, meaning that scales were constructed for a specific study and were never subjected to psychometric testing for reliability or validity. The measurement inconsistency means that what counts as "passive" in one study, e.g., scrolling the feed, may differ substantially from another, e.g., reading others' posts without liking them. Similarly, what counts as "active" in one context, e.g., posting a photo, may be conflated with other forms of active engagement, e.g., sending a direct message, in another. Given this, it is perhaps unsurprising that Valkenburg et al. (2022) found that a substantial number of studies did not replicate the expected pattern of passive-negative and active-positive associations with well-being. Passive use sometimes predicted positive outcomes, and active use sometimes predicted negative ones. A review by Meier and Krause (2023) similarly concluded that the claim that passive social media use harms well-being is far less robustly supported than first assumed.

A related limitation of the active-passive dichotomy concerns platform generalisability. One of the most widely used validated measures of passive and active social media use is the Passive Active Use Measure (PAUM) developed by Stead, Plagnol, and Corr (2017). However, the PAUM was developed specifically for Facebook, meaning that its items reflect the specific affordances of Facebook at the time of creation. Compared to many other social media platforms, Facebook is primarily text-based, connections are reciprocal, and the dominant form of social feedback is a mutual "friends" relationship. Instagram, which is a more popular platform among adolescents (Vogels et al., 2022), differs from Facebook in ways that are perhaps most relevant to adolescents' psychological outcomes.

3.1.1 The iPAUM

Article C was designed to address both the measurement gap and the platform-specificity gap. Drawing on and extending the PAUM for Facebook (Gerson et al., 2017), a new validated scale was developed specifically for Instagram, i.e., the Instagram Passive Active Use Measure (iPAUM). Instagram's interface is visual-first, meaning that all content must be presented as image or video, foregrounding appearance-related content and heightening the salience of self-presentational processes. Profiles are public by default, making it effortless to encounter and follow people one does not know personally. Following is typically unidirectional, unlike Facebook friendship, which requires reciprocal consent. This means that users are frequently exposed to the content of strangers, influencers, and celebrities with no established social relationship. Social feedback is quantified and publicly visible through likes, comment counts, and follower numbers. Instagram's algorithmic Explore page serves users content from accounts they do not follow based on engagement patterns, thus creating a curated stream of unfamiliar faces and aspirational lifestyles (Orben et al., 2024). Each design feature has potential psychological implications that are not captured by measures developed for a text-based, socially reciprocal platform.

The iPAUM scale was developed across two independent studies. This two-study design was used as the aim was first to explore how Instagram behaviours clustered empirically, and then to test whether the same structure could be confirmed in a new sample. In Study 1, 289 Instagram users ($M_{age} = 30.4, SD = 10.2$) were recruited and asked to complete a questionnaire about their Instagram behaviours. An exploratory factor analysis was used to examine the latent factor structure of Instagram use. This method was chosen to examine whether Instagram behaviours followed the established passive-active distinction, or whether they formed more specific types of engagement. The exploratory factor analysis resulted in a measure of 18 items which loaded onto four factors.

In Study 2, 297 Instagram users ($M_{age} = 29.6, SD = 9.8$) were recruited in an independent sample and completed the final version of the iPAUM questionnaire. A confirmatory factor analysis was used to validate the factor structure identified in Study 1. A validation of factor structures is important in scale development and validation, as a structure found in one sample may partly reflect sample-specific patterns. Thus, testing the structure in a new sample provides evidence that the iPAUM captures replicable dimensions of Instagram use. Across the two independent studies, all four factors demonstrated good internal reliability and discriminant validity against other measures. Together, these analyses yielded a factor structure that differed from the simple

passive-active dichotomy both theoretically and empirically. Rather than two factors, the iPAUM yielded four: active reacting, active direct social, active creating, and passive use.

Table 3.1. The iPAUM factors

Active reacting: Reactive engagement that requires minimal social effort, i.e., liking or commenting on posts or stories.	**Active direct social:** Interpersonal communication with specific others, i.e., sending direct messages, forwarding content
Active creating: Content production for one's profile, i.e., posting photos, videos, and stories	**Passive:** Viewing content without engaging, i.e., browsing feeds without liking, commenting, or interacting

The iPAUM four-factor structure indicates that active use is not a single construct. Creating content for public display, privately messaging a specific person, and reactively liking others' posts are all technically "active" forms of Instagram engagement, but they implicate different psychological processes, e.g., self-presentation concerns, interpersonal intimacy, and social signalling, respectively. Collapsing these into a single "active" category can obscure differences that are likely to matter for psychological outcomes. Article C further explored whether the four iPAUM factors were associated with self-esteem. The analyses did not show strong or consistent associations across the four types of Instagram use. Passive use, active creating, and active reacting were not consistently related to self-esteem, while active direct social use showed a more conditional association, depending on the percentage of strangers followed. This suggests that even more differentiated measures of use do not map directly onto psychological outcomes in a simple way. Instead, the psychological meaning of a behaviour may depend on the social context in which it takes place, such as whether users mainly follow friends, acquaintances, celebrities, influencers, or strangers.

The findings from Article C add to the field by providing a validated, platform-specific instrument that allows the passive-active distinction to be tested on Instagram with the psychometric rigour that 90% of prior studies have lacked. Additionally, it demonstrates empirically that Instagram use is not a single construct. The four-factor structure of the iPAUM reveals empirically and theoretically meaningful sub-types, suggesting that future research should measure these separately rather than aggregating across them. However, the self-esteem analyses also show that better measurement does not automatically produce simple or strong associations with well-being-related outcomes. This supports the broader argument that the field needs both more precise behavioural measures and more specific theories about when, for

whom, and through which mechanisms different forms of social media use matter.

3.2 The encounters: online social comparisons

While distinctions such as active and passive use focus on what people do on social media, they say less about whom they encounter, e.g., influencers, celebrities, friends, peers, and strangers, and how these encounters potentially shape psychological processes. This is a critical limitation, as social media is not only a set of activities but a social environment structured around exposure to others (boyd, 2014; Nesi, 2020). Understanding its impact therefore requires attention not only to behaviour, but to the social information users are repeatedly exposed to.

One of the central motivations for engaging with social media is access to others. Humans have a fundamental tendency to seek information about their social environment, including how others live, what they value, and how they compare to oneself (Baumeister & Leary, 1995; Festinger, 1954). Social media platforms expand this access, allowing people to observe their immediate peers as well as a much wider and diverse set of individuals than would be available in offline contexts (Nesi et al., 2018; Valkenburg & Peter, 2011). This expansion is particularly relevant during adolescence, as peer relationships and social evaluation become increasingly salient and identity exploration intensifies (Avci et al., 2025; Crone & Dahl, 2012; Somerville, 2013). Social media provides an environment in which these processes are not only present but amplified, as people are continuously exposed to curated representations of others' lives, achievements, and appearance (Burnell et al., 2024; Zillich & Wunderlich, 2024). These conditions make social comparison a central mechanism through which social media may influence well-being (Carraturo et al., 2023; McComb et al., 2023).

Social comparison theory proposes that individuals have a fundamental drive to evaluate their opinions and abilities through comparison with others, particularly those perceived as similar on relevant dimensions (Festinger, 1954). Social media platforms create persistent, low-cost access to information about others' lives, relationships, achievements, and physical appearance, providing a continuous stimulus environment for upward social comparisons, i.e., comparisons to those perceived as doing better, looking better, or living better than oneself. Such comparisons, when frequent and unfavourable, are associated with diminished self-esteem, negative affect, and depressive symptoms (McComb et al., 2023; Schmuck et al., 2019; Verduyn et al., 2020). Research on Instagram, whose visual and appearance-focused design features create a particularly dense environment for appearance-related social comparison, has linked the platform to body dissatisfaction (Pedalino &

Camerini, 2022), lower self-esteem (Saiphoo et al., 2020), and negative affect (Lup et al., 2015).

However, as with the passive-active distinction, the social comparison account of social media effects is nuanced. Not all comparisons are equivalent in their psychological impact, and a growing body of evidence indicates that whom users compare themselves to matters as much as how much they compare, or how frequently they use social media. Festinger (1954) argued that people preferentially compare themselves with similar others, while Tesser (1988) proposed that comparisons to close others are especially consequential when the domain is self-relevant. Together, these accounts suggest that comparisons to peer-like targets, i.e., those perceived as socially or demographically similar, should be more psychologically impactful than comparisons to aspirational figures for whom the social distance is sufficient to buffer against personally relevant self-evaluation. Prior empirical work supports this prediction, e.g., Ho et al. (2016) found that appearance-based social comparisons on social networking sites were more strongly associated with body dissatisfaction among adolescents when the comparison target was a peer rather than a celebrity.

3.2.1 Whom do we compare ourselves to online?

The emergence of social media influencers as a category of comparison target has introduced a unique and theoretically complex element to this picture. Influencers, who are individuals who build large followings through regular, niche-focused content creation, occupy an unclear position in the social landscape that does not map neatly onto either the "peer" or the "celebrity" category assumed in prior research. Unlike traditional celebrities, whose physical and social distance from ordinary users can function as a buffer against personally threatening comparison, influencers are accessible, interactive, and often positioned as relatable and authentic (Jin et al., 2019). Their content documents everyday life, e.g., meals, workouts, relationships, travel, rather than the professionally curated performances of traditional media figures. This appearance of ordinariness may encourage followers to treat influencer content as a realistic benchmark for evaluation rather than an aspirational ideal that, facilitated by recognised social distance, has limited self-evaluative relevance. The concept of "curated realism" captures this dynamic as influencer content is selectively edited and commercially motivated, but its aesthetic of authenticity encourages followers to interpret it as transparent and representative (Schreurs et al., 2023). When this interpretation prevails, the social distance that would normally buffer against comparison to aspirational content collapses. Influencers can vary substantially in scale and perceived relatability. The marketing literature distinguishes macro-influencers, i.e., those

with more than 10,000 followers, from micro-influencers, who maintain smaller but typically more engaged audiences and are perceived as more relatable and peer-like (Djafarova & Trofimenko, 2019; Jin et al., 2019).

Many users develop parasocial relationships with influencers, which are one-way social-emotional bonds in which the follower experiences a sense of familiarity and intimacy with someone who has no corresponding awareness of them (Hoffner & Bond, 2022). Such parasocial relationships can generate positive outcomes, including feelings of community and belonging, but they also carry risks as the felt closeness associated with parasocial attachment may further erode the psychological distance that normally limits the self-evaluative impact of aspirational comparison targets (Zhang et al., 2024).

Article D was designed to examine these dynamics empirically by testing whether and how the perceived status of influencers is connected to social comparison processes on Instagram. For this study, influencer status is understood as the degree to which influencers are perceived more peer-like or more celebrity-like. Article D was preregistered and based on a survey of 478 Instagram users who all followed influencers ($M_{age} = 29.4, SD = 9.6$). Participants were recruited through Prolific and completed an online questionnaire about the types of influencers they followed, how they perceived influencers, their social comparison frequency and direction, social connectedness, and well-being. An online questionnaire was chosen as the study aimed to examine users' own perception of influencers and the comparison processes they experience on Instagram. Whether follower size predicted perceived influencer status was tested using a Welch t-test comparing users who mainly followed macro-influencers against users who mainly followed micro-influencers. The associations between perceived influencer status, comparison outcomes, and well-being were tested using OLS regressions, with social connectedness and perceived influencer status entered as moderators. All models were estimated with and without control variables, and robustness was checked using ordered logistic regressions, neither of which altered the pattern of results.

The findings of Article D suggest that number followed may function as a psychologically meaningful social signal. Users who followed a higher proportion of macro-influencers, defined as influencers with more than 10,000 followers, significantly more often perceived influencers as more celebrity-like, whereas users who followed more micro-influencers perceived them as more peer-like. This suggests that in addition to being a marketing category, the macro versus micro distinction maps onto how users understand and relate to influencers. Furthermore, the findings show that perceived influencer status is asymmetrically associated with comparison outcomes. Perceiving influencers as celebrity-like was significantly associated with more frequent social comparisons on Instagram, while perceiving influencers as peer-like was

significantly associated with more negative self-evaluations when comparisons occurred, although the effects were small. This distinction suggests that different types of influencers may relate to different aspects of social comparison. Celebrity-like influencers may be associated with how frequently users compare themselves, whereas peer-like influencers may be more closely related to how personally relevant and negative those comparisons feel. Social connectedness did not moderate the association between perceived influencer status and social comparison, and perceived influencer status did not moderate the association between social comparison frequency and well-being.

The findings therefore challenge simple assumptions that perceived similarity straightforwardly increases both comparison frequency and comparison negativity. Instead, perceived similarity may be less closely related to how often comparisons occur than to how negative they are when they do occur. The main contributions of Article D are therefore both empirical and conceptual. It provides evidence that influencer exposure should not only be measured as whether users follow influencers, but also in terms of how users perceive the social status and social distance of the influencers they follow.

Perceived influencer status was measured through a single global item aggregated across all followed accounts, which enables comparison across participants who follow different influencers but cannot capture whether a participant's following is homogeneous or spans both peer-like and celebrity-like figures. Future research should therefore examine whether a more precise, validated measure of perceived influencer status can be developed. However, the measure offers a first operationalisation of a distinction the literature had not previously assessed, and the theoretical coherence of the dissociation between comparison frequency and valence suggests that it captures something about how perceived status maps onto comparison dynamics.

3.3 The experience and regulation of use: problematic media use

The two preceding sections examined what users do on social media and whom they encounter while there. This section approaches the same question from a different angle by returning to Articles A and B and asking whether any construct within the existing literature is consistently connected to mental health outcomes. Across both articles, one pattern stands out from the broader inconsistency. Studies that focus on dysregulated forms of digital media use tend to find more consistent associations with mental health than studies that measure digital media use as time, frequency, or general exposure.

In the literature on digital media use, dysregulated forms of engagement are commonly discussed under labels such as problematic media use,

problematic social media use, problematic smartphone use, and problematic internet use (American Psychological Association, 2023; OECD, 2025; WHO, 2024). The term problematic should not be understood tautologically, as digital media use is not defined as problematic merely because it may lead to problems, but refers to the behaviour itself being dysregulated. Consequently, problematic media use does not imply that digital media use is "problematic" because it is frequent, intense, or statistically associated with various problems. Rather, it refers to patterns of use marked by impaired control, difficulty reducing or interrupting use, preoccupation, displacement of important activities, and continued use, despite serious interference with everyday functioning, such as sleep, schoolwork, social relationships, or emotional regulation. This dissertation retains the term problematic media use as it is the established term in the empirical and clinical-facing literature and uses it in this conceptual sense to refer to dysregulated digital media engagement. Throughout the dissertation, dysregulated media use refers to behaviour marked by difficulty controlling, reducing, or stopping digital media use. Problematic media use refers to the longer-term outcome that may develop when this behaviour recurs and consolidates into a persistent pattern of impaired control and interference with important areas of life, consistent with the APA, OECD, and WHO definitions. This distinction between time and regulation reflects a shift in what is being measured. Rather than treating digital media use as a matter of exposure, problematic digital media use captures how adolescents experience and manage their engagement. The focus is not on time spent but on whether use is experienced as controlled or difficult to regulate, whether it becomes a source of preoccupation, and whether it continues although negative consequences are acknowledged (Sun & Zhang, 2021). In this sense, the distinction concerns regulatory processes through which digital media use becomes difficult to manage. For example, one adolescent may spend several hours per day on social media and still use it in a flexible and regulated way. The use can be interrupted, it coexists with sleep, schoolwork, offline relationships, and other activities, and it remains broadly aligned with the adolescent's own intentions. Another adolescent may spend less total time online but still show a dysregulated pattern of use. The issue in such cases is not the number of hours but the extent to which use becomes difficult to control, difficult to postpone, and difficult to disengage from. Dysregulated patterns can be expressed as repeated failed attempts to reduce use, continued use despite intended limits, checking that disrupts sleep or schoolwork, and reliance on digital media to manage distress, boredom, loneliness, or negative affect. In more extreme cases of problematic digital media use, some adolescents plan around digital media restrictions by setting alarms to wake up during the night in order to check their phone, repeatedly and violently attempt to access a device

that has been locked away, or become intensely distressed and aggressive when access is removed.[1] Such behaviour should not be understood as irritation about limits or ordinary adolescent resistance to parental rules. Instead, it reflects a state in which digital media use has become so difficult to regulate that the adolescent organises sleep, attention, relationships, and daily routines around their media use. Consequently, the distinction between non-problematic and problematic digital media use is not between low and high use but between use that remains regulated and use that becomes dysregulated and dysfunctional.

Consistent with this conceptual separation, screen time and problematic use are only weakly correlated (Coyne et al., 2023; Tomczyk & Selmanagic Lizde, 2023; van den Eijnden et al., 2016). In other words, digital media use can be frequent without being problematic, and it can be problematic without being objectively high in total duration. A person can use social media for many hours without meeting any criteria for problematic use, and another can meet all criteria while spending comparatively little time online. Problematic use is not a proxy for high engagement but a separate dimension that captures how use is experienced and regulated.

Problematic media use is typically operationalised through validated instruments assessing impaired control, preoccupation, compulsive or difficult-to-interrupt use, mood regulation, conflict, displacement, and interference with everyday functioning. Problematic media use is not equivalent to a clinical addiction diagnosis, a distinction discussed more fully in Chapter 6 alongside its current diagnostic status. High scores on these instruments should be interpreted as indicators of recurrent dysregulated digital media engagement, not as evidence of a clinically recognised addictive disorder.

3.3.1 Evidence from Article A and B

The distinction between general and problematic use emerged in both Article A and Article B. Synthesising evidence from 52 systematic reviews and meta-analyses and 35 key individual studies across cognitive, physical, and psychosocial domains, Article A identifies that while general digital media use shows mixed effects that vary depending on content, context, and individual characteristics, problematic use is a more consistent correlate of negative outcomes across all domains examined (see Table 3.2).

[1] Clinical observations from physicians at the Clinic for Interactive Media and Internet Disorders (Boston Children's Hospital, MA, USA).

Table 3.2. Summary table from Article A

	General/non-problematic digital media use			Problematic digital media use		
	Significant negative effect	Mixed effects	Significant positive effect	Significant negative effect	Mixed effects	Significant positive effect
Cognition and brain development	Marciano & Camerini (2021); May & Elder (2018); van der Schuur et al. (2015); Calvert & Valkenburg (2013); Singer & Singer (2008)	Adelantado-Renau et al. (2019); Madigan et al. (2020)	Kirkorian (2018); Madigan et al. (2020); Mares & Pan (2013); Takacs et al. (2015); Jing et al. (2023)	Marciano et al. (2021); Cerniglia et al. (2017); Ioannidis et al. (2019); Solly et al. (2022); A. Weinstein & Lejoyeux (2020)		
Physical well-being	Alonzo et al. (2021); Brautsch et al. (2023); Cain & Gradisar (2010); Carter et al. (2016); Hale & Guan (2015); Lund et al. (2021); Stiglic & Viner (2019); Haghjoo et al. (2022); Fioravanti et al. (2022)	Pearson et al. (2014); Brautsch et al. (2023); Hale & Guan (2015)		Carson et al. (2016); Stiglic & Viner (2019); Hinojo-Lucena et al. (2019); Ioannidis et al. (2021); Y. Chen et al. (2026); Alimoradi et al. (2019)		
Psychological well-being	Cunningham et al. (2021); Ghai et al. (2023); Liu et al. (2022); Vahedi & Zannella (2021); Wong et al. (2022); Ferguson et al. (2022); Marciano et al. (2022); Yang et al. (2022)		Huang (2021); Wong et al. (2022); Chu et al. (2023); Berger et al. (2022); Bacaj et al. (2025); Marciano et al. (2024)	Cunningham et al. (2021); Shannon et al. (2022); Vahedi & Zannella (2021); Yigiter et al. (2023); Marciano et al. (2022). Männiko et al. (2020)		

Note: Full references for the studies summarised in this table are given in Article A.

Article A further notes that the direction of causality in this literature remains unclear. Some studies suggest that these problems may precede and predict problematic use, as adolescents with pre-existing mental health vulnerabilities, including social anxiety, ADHD, or depression, may be more likely to gravitate toward compulsive digital engagement as a coping mechanism. Others indicate that compulsive engagement can exacerbate underlying vulnerabilities, creating a feedback loop of deteriorating well-being (Al-Samarraie et al., 2022; Pazdur et al., 2025). The vast majority of studies are cross-sectional, which limits their ability to determine whether problematic use is a cause or a consequence of the associated difficulties (Ioannidis et al., 2019; Rumpf et al., 2019; Solly et al., 2022). What the cross-sectional literature does suggest clearly, however, is the breadth of the association as problematic use co-occurs with a wider range of negative outcomes than general use, regardless of the specific domain examined.

Turning to Article B, which narrows the focus to social media and mental health specifically, the same pattern reappears. Across the 72 reviews, a substantial cluster of contributions examines the correlates of problematic social media use directly. Reviews find that problematic use, unlike general use, is consistently associated with higher levels of depression, anxiety, and stress. Several reviews in Article B further highlight that conflating general and problematic use in the same analysis may itself be a driver of the inconsistency that has characterised the broader literature, because the two constructs are associated with systematically different outcome profiles when examined separately.

To organise findings, Article B applies a 2x2 framework distinguishing between general and specific forms of social media use, such as online social network size or problematic use, on one dimension, and between well-being and ill-being outcomes on the other (see Table 3.3). Within this framework, the link between problematic social media use and ill-being emerges as the most consistent cell. The framework makes visible what aggregate findings tend to obscure, namely that the instability of the general use literature and the stability of the problematic use literature are not contradictions within a single field but reflections of two different constructs being studied under the same broad label.

Table 3.3. 2x2 framework from Article B

	General SMU	**Specific SMU**
Ill-being	**Mixed to weak evidence** of increase in ill-being. Some reviews report associations with depression and anxiety, while others find no clear link.	**Strong evidence** of increased ill-being and problematic SMU. Meta-analyses and reviews consistently show strong links to depression, anxiety, and stress.
Well-being	**No evidence** of a negative or positive impact on well-being. Reviews report no overall relation with life satisfaction or subjective well-being. Some positive effects are reported in subpopulations e.g., LGBTQ+ youth.	**Weak evidence** of increased well-being when use is active, supportive, or socially engaging. Reviews report benefits from self-disclosure, online social support, and active engagement.

When focus is specifically on the meta-analyses included in Article B, the pattern persists. All reviewed meta-analyses on problematic social media use report significant associations with ill-being, including depression, anxiety, and stress. The more consistent associations for problematic media use may partly reflect conceptual overlap between its measures and the mental health outcomes examined. This limitation is discussed further in Chapter 7.

A range of theoretical frameworks has been used to explain why some adolescents are more likely to develop problematic patterns of media use (Sun & Zhang, 2021). The frameworks differ in where they locate the source of problematic media use. Some emphasise motivation and unmet needs, some dispositional vulnerability and lack of self-regulation, and others the affordances of the platforms. Each captures important aspects of problematic media use, but they are hard to bring together, as they work at different levels and are rarely connected to one another (Sun & Zhang, 2021). While many theoretical frameworks converge on a set of recurring mechanisms, they rarely specify how these processes unfold over time or how they combine to produce sustained dysregulation. Consequently, existing theoretical frameworks help explain who is at risk and why digital media may become compelling but offer less guidance on when non-problematic use begins to shift toward problematic use, or how small shifts in engagement translate into persistent patterns of dysregulation. The following chapter addresses this gap by developing a shared vocabulary that organises existing mechanisms into three parameters within a conceptual framework and specifies how non-problematic use transitions toward problematic use.

3.4 Summary

Chapter 3 extends the argument developed in Chapter 2 by examining three dimensions of digital media engagement that duration-based measures cannot capture, namely what individuals do online, whom they encounter, and how they experience and regulate their use. Article C demonstrates both the value and limitations of activity-based distinctions. The iPAUM distinguishes four forms of Instagram engagement and shows that active use is not a single construct. However, these more precise activity categories were not strongly or consistently associated with self-esteem, indicating that behaviour alone may be insufficient to explain differences in well-being. Article D shifts attention to the social environment encountered online. Perceiving influencers as celebrity-like was associated with more frequent comparisons, whereas perceiving them as peer-like was associated with more negative self-evaluations when comparisons occurred. These associations were small and cross-sectional, and perceived influencer status did not clearly alter the association between comparison and well-being. Drawing on Articles A and B, the chapter identifies problematic media use as more consistently associated with adverse mental health outcomes than general use. Problematic use captures impaired control, preoccupation, and interference with daily functioning rather than high volume. Overall, the chapter provides a more differentiated account of digital engagement while highlighting a remaining conceptual gap. Existing theories provide limited insight into the processes through which regulated media use may gradually become dysregulated.

Chapter 4. The transitions from non-problematic to problematic use

The preceding chapters argued that the most consistent correlate of adolescent mental health is not the volume of digital media use but its dysregulation, and Chapter 3 closed by identifying a gap that the existing literature has not resolved. The present chapter responds to that gap by presenting the Slippery Slope of Digital Use (SSDU) framework, developed in Article E as a conceptual account of the transition from non-problematic to problematic use. The framework organises already established mechanisms into a shared vocabulary and specifies how they interact within and across individual episodes of media use.

4.1 The SSDU: slope, friction, and guardrails

Article E is a conceptual process framework that organises the mechanisms suggested in the field into three classes of forces acting within an episode of digital media use. It specifies how their combination shapes the probability that an episode becomes dysregulated and how recurrent dysregulated use may, over time, contribute to the transition from non-problematic to problematic use. The framework takes both its name and its analytical structure from a physical metaphor of a person walking on a slippery hillside near a cliff. Whether that person slides down the hill and off the cliff depends on three interacting forces. The steepness of the slope determines the gravitational pull. The friction between the person and the surface of the hill determines how much grip the person has underfoot. And the presence of guardrails aids walking and can help stop a small slip before it becomes a risky fall downhill. The same person will behave differently on a gentle hill than on a steep one. The same slope will be managed easily by a hiker wearing spiked boots and badly by one in smooth sneakers. A steep, slippery slope with missing guardrails creates a situation in which even a small misstep may produce an uncontrolled slide off the cliff.

Digital media use can be described in the same terms, with each encounter representing a distinct episode on the hill. The cliff marks an episode-specific escalation point in the probability of a dysregulated episode. Approaching the cliff represents an increased probability of dysregulation, while falling represents the realised outcome of the probability of a dysregulated episode. The longer-term transition to problematic media use develops across repeated

dysregulated episodes. Slope towards the cliff is defined as the motivational pull towards starting or continuing media use. It arises from the strength of the user's motives and is amplified by platform features, e.g., likes, notifications, infinite scroll, and algorithmic novelty, that facilitate use and motive. Friction is defined as the user's capacity to stop, delay, or redirect media use. It depends on executive control, metacognitive monitoring, and coping skills, and it is reduced by fluctuating states, e.g., stress, fatigue, and low mood. Guardrails are defined as the external limits and stopping points that constrain access, timing, or continuation of use, e.g., parental rules, phone-free bedrooms, school policies, and app timers. Article E defines the three parameters by the function each performs within a given episode of media use, and a single factor may therefore contribute to more than one parameter through separate pathways.

Table 4.1. SSDU definitions from Article E

Slope	**Friction**	**Guardrails**
The motivational pull towards starting or continuing digital media use.	The user's internal capacity to resist, delay, stop, or redirect digital media use.	External limits and stopping points that constrain access, timing, or continuation of digital media use.

The probability that an episode of digital media use becomes dysregulated is treated as an increasing function of slope and a decreasing function of friction and guardrails. A dysregulated episode becomes more likely when a steep slope, low friction, and weak guardrails converge, and less likely when friction and guardrails are sufficient to counteract the slope. What matters is therefore how the three parameters combine, i.e., a steep slope may not result in a dysregulated episode when friction is high, while low friction and weak guardrails may not result in one when the slope is gentle. Because all three parameters fluctuate across episodes, the same user faces different hills during the day. Late at night, the slope may be steep, friction depleted by fatigue, and guardrails absent, while the following morning presents a more manageable configuration of the same forces. The parameters are asymmetrical and differ in what they are able to offset. Where the slope is steep, friction may prevent dysregulation even if guardrails are weak, since a user who is able to stop does not depend on being stopped. Guardrails alone may not offset a steep slope when friction is low, since a user under strong motivational pull may seek ways around them, e.g., by retrieving a phone that has been removed at bedtime (UNICEF Australia, 2025).

The SSDU is a process framework as what occurs within one episode can alter the conditions under which later episodes unfold. A steep slope may

make disengagement at bedtime more difficult, potentially displacing sleep and lowering friction the following day. Reduced friction then increases the probability of a later dysregulated episode, while repeated use in stable contexts may strengthen cue-response associations and steepen the slope further. Where guardrails are readily bypassed, opportunities to encounter cues and initiate use increase, and repeatedly bypassing them may reduce their practical force. A later episode may therefore begin on a steeper hill, with a more slippery surface and less effective guardrails. Problematic media use is, on this account, a persistent aggregate pattern that may emerge when dysregulated episodes recur and progressively alter the conditions under which later episodes occur.

4.1.1 Existing perspectives organised in the SSDU

The literature offers several, partly overlapping explanations of problematic media use (Sun & Zhang, 2021). These explanations variously foreground motivations and unmet needs, dispositional vulnerabilities and impaired self-regulation, reinforcement through repeated behaviour, and platform affordances. Each explanation identifies mechanisms relevant to part of the process. The SSDU adds a way of relating them, as each mechanism can be assigned to the function it performs within an episode of use, i.e., whether it contributes to the pull towards use, to the internal capacity to resist it, or to the external constraints surrounding it. Article E organises several of the dominant frameworks in the literature in this way. Table 4.2 summarises these different frameworks along with their main focus and their placement within the SSDU framework.

Table 4.2. Overview of Frameworks from Article E.

Theoretical perspective	Main focus	Organisation within SSDU
I-PACE (Brand et al., 2016, 2019, 2025)	Addictive online behaviours arise from interactions among predispositions, affective and cognitions responses, executive control, and situational triggers over time. These interactions change across the development of problematic use.	Mechanisms are organised according to their function. Predispositions that strengthen reward expectancies or responsiveness to cues may contribute to slope, whereas predispositions associated with lower inhibitory and executive control may reduce friction.
Differential susceptibility (DSMM) (Valkenburg & Peter, 2013)	Media selection, responses and effects depend on dispositional, developmental, and social susceptibility. Media effects are mediated by cognitive, affective, and excitatory response states.	Susceptibility factors are organised according to the mechanism through which they operate in a particular episode. They may increase slope, reduce friction or alter guardrails. Transactional media effects correspond to feedback across episodes.
Self-determination theory (SDT) (Ryan & Deci, 2000)	Behaviour and well-being are shaped by satisfaction or frustration of the needs for autonomy, competence and relatedness, as well as by the degree to which motivation is autonomous or controlled.	Need satisfaction and the quality of motivation shape the motives contributing to slope. Need-satisfying experiences may contribute to reward-driven slope, while attempts to respond to unmet needs may contribute to compensation-driven slope.
Uses & gratifications (U&G) (Rubin, 2009; Ruggiero, 2000; Sundar & Limperos, 2013)	Users actively select media to obtain anticipated gratifications such as entertainment, information, social connection, passing time or escape. Digital affordances may also create new forms of gratification.	Anticipated gratifications contribute to slope by shaping the value and pull of a particular digital activity. Desire-oriented outcomes such as entertainment or social connection may contribute to reward-driven slope, while relief-oriented gratifications may contribute to compensation-driven slope.
Compensatory internet use theory (CIUT) (Kardefelt-Winther, 2014)	Difficulties in offline life, such as stress, loneliness or interpersonal problems, can motivate internet use as a way of escaping negative feelings or compensating for unmet needs.	Stress, loneliness and unmet offline needs can increase compensation-driven slope. When digital media provide temporary relief, this response may be reinforced and become more likely in later episodes through feedback loops.

Allostatic/negative-reinforcement views (Koob & Le Moal, 2001)	Repeated addictive behaviour can alter reward and stress systems, making relief from negative affect increasingly important and contributing to persistent compulsive behaviour.	Captured as compensatory increases in slope under strain. Explains why internal states cue use even without prompts.
Incentive-sensitization (IST) & cue-reactivity (Robinson & Berridge, 1993, 2008, 2025).	Repeated reward exposure can sensitise cue-triggered wanting, allowing motivational pull to increase even when the experienced pleasure does not.	Cue-triggered wanting contributes to slope. Repeated cue and reward pairings can steepen slope across episodes due to feedback loops.
Habit formation (Wood & Rünger, 2016).	Repetition in stable contexts creates context-response associations that allow behaviour to be activated automatically, with less dependence on current goals or deliberate choice.	Habitual cue-response associations increase the automatic component of slope and reduce the opportunity for deliberate regulation. Repeated performance under stable conditions strengthens this pathway through feedback across episodes.
Displacement hypothesis (Neuman, 1988)	Time devoted to media may replace activities such as sleep, study, physical activity or face-to-face interaction, with consequences depending on what is displaced.	Displacement is organised primarily as a consequence and feedback pathway. For example, use may displace sleep, which lowers later friction, or displace offline need satisfaction, which may increase compensation-driven slope.
Affordance theory (Bucher & Helmond, 2018; Evans et al., 2017; Orben et al., 2024).	Affordances are possibilities and constraints for action that emerge in the relationship between technological features, users, and contexts. They shape opportunities for visibility, persistence, editability, association, feedback, and continued engagement.	Affordances that increase cue exposure, social feedback, personalisation or continuity may raise slope. Features that introduce stopping points or restrict access may function as guardrails. Their SSDU classification depends on how they operate in a particular episode.

4.1.2 Interpreting the empirical patterns

The SSDU organises mechanisms into a shared vocabulary, which offers a lens through which existing findings can be re-read. As reported in Articles A and B, much research has treated the time spent on digital media as the main cause of negative outcomes, assuming that more use means poorer outcomes. However, as discussed throughout the summary report, not all evidence fits this expectation. The SSDU offers a different way of looking at these findings. By separating use into slope, friction, and guardrails, these patterns can be seen in a new way.

Research on media use has mostly explained negative outcomes through the displacement hypothesis. The hypothesis was first applied to television and later extended to computers, videogaming, and social media, which has shaped how the field measures and defines media use (Neuman, 1988; Przybylski & Weinstein, 2017). In addition to displacing time, media has been assumed to affect users through harmful content broadcasted there, e.g., violent video games potentially causing distress. Consequently, if negative outcomes are dependent on exposure, the amount of time spent becomes the main variable to measure. If negative outcomes came from exposure in this way, the heaviest users should also be the most problematic ones. However, research shows that time spent online and problematic use are only weakly related (Coyne et al., 2023; Mahalingham et al., 2023). A person can spend many hours online without losing control (Billieux et al., 2019; Peng & Liao, 2023; Slack et al., 2022). In the SSDU, time spent is a result of the three parameters and not a force on its own. The same three hours may come from a steep slope met with strong friction, or from a gentle slope met with weak friction, so that equal amounts of use can carry very different risks. Problematic use, unlike time, reflects the balance itself, since loss of control suggests that the pull has grown stronger than the user's ability to resist it. Many time-based accounts implicitly follow a dose-response logic borrowed from epidemiology, whereby greater exposure is expected to produce poorer outcomes. However, negative outcomes do not consistently appear to increase steadily with each additional hour of use (Guan et al., 2026; Przybylski et al., 2020). Time online is easy to count as a dose, and well-being would then be expected to drop in step with the hours spent. However, empirical studies find that the pattern is neither linear within or between adolescents (Beyens et al., 2020; Pouwels et al., 2021). In other words, the same number of hours can be unrelated to changes in well-being for one adolescent but associated with poorer well-being for another. The SSDU offers one explanation for this pattern, as the probability of a dysregulated episode is proposed to rise when the pull becomes stronger relative to the user's resistance. The risk of negative outcomes may

remain low while episodes remain regulated but rise as dysregulated episodes recur over time. Where friction and guardrails differ, the same number of hours may therefore reflect different balances between pull and resistance and different patterns of regulation.

A further pattern is that individual vulnerabilities do not behave consistently. Problematic media use is more prevalent among adolescents with ADHD, autism spectrum conditions, and anxiety or depressive disorders (Augner et al., 2023; Fineberg et al., 2022). If these traits were direct causes or predictors, they might be expected to matter to the same degree in every study, yet they appear as main effects in some and only under particular conditions in others (Dekkers & van Hoorn, 2022). The SSDU offers an understanding of such traits as starting points on one of the parameters. Mechanisms associated with ADHD, such as difficulties with inhibitory control, may mean lower friction to begin with, while whether this leads to dysregulated use, and later problematic use depend on the slope and guardrails the person then meets. From this perspective, the effect is conditional, which may be why it is visible in some settings and not in others.

4.1.3 Implications for intervention

The framework also supplies a vocabulary for organising interventions for prevention or treatment of problematic use, as the different measures can be understood by the parameter they target. Guardrails refer to the opportunity structure surrounding use, and interventions targeting them insert stopping points and restrict access at particular times and places. For example, bedtime curfews, phone-free bedrooms, school phone policies, and app timers all work in this way. They can be quick to install and can reduce exposure, but they leave both the pull and the capacity to resist it untouched, and their effects may not persist once they are removed or circumvented (Collis & Eggers, 2022). Friction refers to the capacity to resist the pull toward use, resting on inhibitory control, metacognitive monitoring, emotion regulation, and the capacity to tolerate discomfort without seeking immediate relief. Interventions targeting these processes could include cognitive restructuring and stimulus control, metacognitive and mindfulness training, and the treatment of sleep, mood, and neurodevelopmental difficulties that lower baseline capacity (Lindenberg et al., 2022). Such measures raise the resistance a user can bring to bear, though they depend on continued practice. Slope refers to the strength of the pull toward use. It arises where persuasive design features, such as cue density, variable reward schedules, and continuous feeds, amplify the motivation to use digital media to meet basic psychological needs, such as belonging, stimulation, and relief from boredom or distress. Slope interventions address the design features that trigger or intensify these motivations through

regulation of persuasive design features, such as infinite scroll, autoplay, streaks, and push notifications. Such measures may be slow to achieve, since they depend not on the individual user or the immediate environment but on platform redesign or regulation.

4.2 Summary

Chapter 4 presented the SSDU as a response to the gap identified in Chapter 3. Existing frameworks locate the source of problematic media use in the person, the motive, the learning process, or the platform. They are difficult to reconcile, and they specify the conditions under which dysregulation becomes more probable without specifying the transition itself. Article E organises their mechanisms into three parameters defined by the function each performs within an episode of use. Slope is the motivational pull to use, friction is the internal capacity to resist it, and guardrails are the external constraints that structure use. The probability of a dysregulated episode increases when a steep slope, low friction, and weak guardrails converge, while feedback across episodes can alter the parameters encountered in later episodes. When dysregulated episodes recur, they may consolidate into a persistent pattern of problematic media use. As the parameters vary within person and across occasions, this means that the SSDU framework can best be examined with designs that measure use as it unfolds. Chapter 5 discusses the methodological requirements this imposes.

Chapter 5. Methodological considerations

The preceding chapters argue that adolescents' digital media use is poorly captured by duration, and that the more informative distinctions concern the quality of engagement and the extent to which use becomes difficult to control. Where the earlier chapters asked what should be studied, this chapter asks whether the field is presently able to study it well, and what would have to change for it to do so.

The chapter approaches this question through two related methodological concerns. The first is statistical power. Disagreements in this literature are frequently framed as disputes about what the evidence shows, but a part of the inconsistency may have a simpler source. Many studies are too small or too imprecisely measured to detect the modest associations that are plausible in this field. Drawing on Article B, the first section examines how power is distributed across the field and argues that low power, together with broad and heterogeneous constructs, may contribute to apparent contradiction where none may in fact exist. The second concern is measurement and the designs that more precise measurement requires. The second section examines the shift away from self-reported screen time towards approaches that capture digital behaviour and momentary experience more directly and considers what each approach can and cannot reveal. The approaches point towards intensive longitudinal designs such as experience sampling, which are well suited to study how media use and well-being unfold over time. However, as these designs rely on participants providing repeated responses, maintaining compliance is a central challenge. Drawing on Article F, the final section examines whether participants at risk of low compliance can be identified early and whether aspects of study design may help improve compliance. Overall, the chapter considers the methodological limitations of the current evidence base as well as the conditions under which more robust evidence might be produced.

5.1 Statistical power

Methodological challenges in research on social media use and adolescent mental health are often discussed as disagreements about what the evidence "really shows". A simpler issue may sit underneath many of these disagreements, namely that many studies may not be strong enough to reliably detect the kinds of associations that are plausible in this field. That issue is statistical

power, i.e., the probability that a statistical test detects an effect of a specified size when that effect truly exists (Cohen, 1992).

In Article B, power is defined as the probability that a study design and statistical test can detect a hypothetical effect size of interest. Following Quintana (2023), study-level power was calculated using the standard errors of the individual study estimates across a range of hypothetical effect sizes. It is used as a way to evaluate whether the underlying evidence base is sensitive enough to support confident conclusions. Statistical power depends on several features of a study. Detecting smaller effects requires more information, such as larger sample sizes and more precise measurement. When outcomes are noisy, exposures are measured approximately, or samples are small, the signal can be too weak to separate from random variation. Low statistical power matters since it increases the chance that a real association is missed. This can also make the literature look more contradictory than it really is, because two similarly underpowered studies may produce different results by chance alone. Furthermore, when a study is underpowered, statistically significant findings are more likely to be overestimates of the true effect. This can further contribute to exaggerated impressions and poor reproducibility (Gelman & Carlin, 2014).

Article B provides evidence that statistical power is uneven across the social media and adolescent mental health literature, and that this unevenness aligns with where findings appear most inconsistent. Article B conducted study-level power analyses based on 17 eligible meta-analyses. These meta-analyses contributed 1,070 effect estimates from 452 unique empirical studies. This allowed an assessment of how well-powered the underlying primary studies were to detect associations of the magnitude reported by the meta-analyses. Calculating power at the study level addresses a question that the pooled meta-analytic estimate cannot answer. Although pooling increases the power and precision of the overall estimate, it does not show how likely the individual studies were to detect the association summarised by the meta-analysis. This matters because meta-analyses have reached different conclusions about associations that are generally small. Examining study-level power therefore helps assess whether the underlying primary literature was sufficiently sensitive to detect effects of the reported magnitude consistently, and whether limited power may contribute to the mixed pattern of findings.

Statistical power was computed for each individual primary study and not for the meta-analysis as a whole. For every study within an eligible meta-analysis, the reported effect size and confidence interval were manually extracted and converted to Fisher's z to compare estimates from different studies on the same scale. The individual primary studies' power to detect both a range of hypothetical effect sizes and the observed meta-analytic estimate was then

calculated. The median of these study-level values was summarised across the studies within each meta-analysis.

The power analyses showed that parts of the literature operate in a low-power setting where mixed results should be expected. Evidence appears most consistent in the associations between problematic social media use and adverse mental health outcomes such as stress, depression, and anxiety. In this area, all meta-analyses show very high median study-level power above 99% for detecting the reported meta-analytic effect size. This pattern suggests that the repeated associations between problematic use and negative mental health outcomes are less likely to be driven by studies that are simply too small to detect the relevant effects. It does not, by itself, prove causality, but it provides reassurance that the evidence base in this part of the field is generally capable of detecting the reported associations with high probability. A different pattern appeared for the part of the literature that often fuels disagreement, namely general social media use and adverse mental health outcomes. This category includes 15 meta-analyses, but only four of them reached a median study-level power above 80% to detect the reported meta-analytic effect size. One meta-analyses had a median study-level power of 80%, ten meta-analyses fell below 80%, and eight fell below 50%. A median power below 50% implies that the median study had less than a coin flip's chance of detecting the true effect, even if it existed. In this context, the problem is not only that underpowered studies may fail to detect small associations but also that statistically significant findings, when they occur, may exaggerate the magnitude of the underlying effect (Gelman & Carlin, 2014). Under these conditions, a research field can easily produce a mix of significant and null results without any true contradiction, because random variation often dominates. This helps explain why broad measures of social media use can produce unstable conclusions across studies and across reviews. Article B explicitly argues that weak and inconsistent associations may reflect limited statistical power rather than a genuine absence of effects, particularly for general social media use.

Article B highlights that statistical power cannot be considered independently of how key constructs are defined and measured. Broad measures such as time spent or frequency of use combine qualitatively different experiences, including active interaction, passive consumption, and exposure to upsetting content, while mental health measures range from positive functioning such as life satisfaction to psychopathology such as anxiety or depression. When both exposure and outcome are defined broadly and heterogeneously, the resulting associations are typically small and more difficult to detect reliably. This matters for power because broad or unreliable measures may attenuate observed associations and increase unexplained variation, meaning that larger samples are required to detect effects of a given size. Low power is

therefore a question of sample size, imprecise measurement, and inefficient study designs. The same sample size can be well powered for a clearly defined exposure-outcome pairing and underpowered for a broad, heterogeneous pairing. These issues are reflected in the structure of the reviewed literature. Meta-analyses often aggregate across distinct outcomes or combine well-being and psychopathology in ways that complicate interpretation. Exposure definitions also range from general use to more specific indicators such as network size. Article B suggests that the mixed findings observed in the literature may partly be understood as the result of these combined constraints, as broad and heterogeneous constructs complicate interpretation and many studies lack sufficient power to detect modest associations consistently. The implication for further research is not simply to use larger samples, but to develop research designs that are sensitive enough to detect small associations while also being conceptually specific enough to make those associations interpretable. This further offers a reason why more research of the same kind may not resolve disagreement. If new studies continue to use broad measures and remain underpowered, the field can accumulate more studies and more meta-analyses while still reproducing inconsistency. By contrast, research that pairs clearer constructs with sufficient power is more likely to provide stable, cumulative evidence.

5.2 New approaches for measuring digital use and well-being

In response to concerns about the validity of self-reported digital media use, recent research has increasingly turned to more objective measurement approaches. Log-based data, such as device logs, tracking applications, and screen time dashboards, allow researchers to quantify behaviour with greater precision than retrospective surveys. These measures can capture daily totals, app-level time, and patterns such as device checking. This precision matters as empirical studies show that self-reported estimates are only moderately correlated with such log-based measures, indicating substantial measurement error in traditional approaches (Mahalingham et al., 2023; Parry et al., 2021; Verbeij et al., 2021). Sensor-based and digital phenotyping methods extend this logic further, inferring behavioural and affective states from passively collected signals such as movement, location, or device interaction. The validity of these traces is not without flaws, however, since technical errors and erroneous tracing of applications running in the background can compromise accuracy. While log-based measures improve the accuracy of behavioural traces, they do not resolve the core limitation of time-based metrics. They provide more precise estimates of how long individuals are active on their devices but

say little about what they are exposed to or how they engage with that content. As such, they capture opportunity for exposure rather than exposure itself.

To address this, alternative approaches have attempted to move closer to the content and context of use. Data donation leverages the data-download packages that platforms are required to provide under data access rights (Boeschoten et al., 2022). This allows participants to share platform-generated records of their activity with researchers, providing more detailed information on interactions and content exposure. Similarly, screenshot-based methods capture what is actually visible on the screen, enabling analysis of content, social feedback, and rapid switching between platforms (Ram et al., 2020). These approaches bring measurement closer to the processes that are assumed to link digital media use to well-being (Sultan et al., 2023). At the same time, they introduce substantial practical and conceptual challenges. Data donation is constrained by what platforms choose to store and export, and participation is selective, raising concerns about representativeness. Further, no single data donation can capture the interplay between platforms. Screenshot-based methods generate highly sensitive data, often including private messages and identifiable information, which creates significant privacy and governance challenges. They are also resource-intensive to process and interpret. Importantly, none of these approaches captures why a person opened an application, what they felt while using it, how they interpreted what they saw, or how those experiences unfolded over time.

This measurement limitation is particularly important in the study of mental health and well-being, which are increasingly understood as dynamic processes rather than stable states (Keyes, 2002) . Daily life involves continuous fluctuations in mood, cognition, and behaviour, and these short-term changes are often central to understanding how digital environments relate to well-being. Methods that rely on aggregated or retrospective measures are not well suited to capturing this variability. Intensive diary studies, such as the Experience Sampling Method (ESM) and Ecological Momentary Assessment (EMA), address this gap by collecting repeated reports in real time. Participants are prompted multiple times per day over extended periods, allowing researchers to capture experiences as they occur in natural contexts (Myin-Germeys et al., 2018; Shiffman et al., 2008). This reduces recall bias and provides a detailed view of within-person variation that is not accessible through traditional survey designs (Schwarz, 2007). As a result, these methods make it possible to link digital behaviour to momentary experiences and to study how these relationships evolve over time. However, this increased temporal resolution comes at a cost. Repeated prompting places substantial demands on participants, and sustained engagement is required to obtain usable data for robust statistical analyses. As a result, the feasibility of intensive

longitudinal design studies depends critically on participants' willingness and ability to comply with intensive protocols over time.

5.3 Participant compliance in intensive longitudinal studies

As part of the dissertation, a pilot study was conducted on students in a Danish primary school setting. The aims were to 1) explore whether intensive diary methods could be implemented effectively in a Danish school context, 2) examine the relationship between momentary social media use and momentary well-being in adolescents, and 3) test whether it is possible to implement a behavioural intervention targeting changes in social media use. The pilot study was designed as an app-delivered randomised controlled trial combined with experience sampling. Participants were randomly assigned to different conditions, where the treatment differed in the information participants received on social media and the reflection tasks they were asked to complete. The design consisted of pre- and post-surveys measuring well-being, social media use, and attitudes toward social media, while the ESM part consisted of a short daily survey on their current mood and whether they had used social media. Following an intensive recruitment strategy with more than 100 schools contacted, 276 Danish students signed up. Over the 14 days, only seven participants completed the full protocol. Following the substantial drop-out, it was not possible to conduct any planned statistical analyses robustly.

Participant retention is generally a central constraint in intensive diary designs such as the ESM. These designs collect repeated reports in daily life, which increases ecological validity but also creates participant burden. When the burden is high, compliance varies across individuals and over time, reducing the number of usable observations and, in some cases, limiting what analyses can be conducted (de Vries et al., 2021). While there is no single threshold for acceptable data quality, compliance levels around 70% to 80% are often used as a practical benchmark, with higher requirements for models that rely on continuous within-person data, such as lagged or dynamic analyses (Asparouhov et al., 2018; Howard & Lamb, 2024; Mölsä et al., 2022; Stone & Shiffman, 2002).

These challenges are amplified in intensive longitudinal designs because effective sample size depends not only on the number of participants but also on the number and continuity of observations within each participant. Compliance to study protocols therefore affects both feasibility and inference. It reduces statistical power and can introduce bias when missingness is systematically related to the outcomes being measured (de Vries et al., 2021; Heron & Smyth, 2010). This is a particular concern in ESM, where non-response may

occur during periods of stress, fatigue, or low motivation, which are often central to the research question. In such cases, missing data may be non-random omissions but may reflect the very processes under study.

Prior research has attempted to explain low compliance rates using baseline characteristics such as age, gender, and socioeconomic status. Although some patterns have been reported, findings are often inconsistent and weak, limiting their usefulness for identifying participants at risk of disengaging during the study period (Courvoisier et al., 2012; de Vries et al., 2021; Marciano et al., 2023). Similarly, design strategies intended to improve retention, such as shortening surveys or varying incentive structures, show mixed effects (de Vries et al., 2021; Jäckle et al., 2023). Taken together, this suggests that compliance is not well captured by static baseline variables alone but instead unfolds over time and may be shaped by participants' ongoing experiences within the study.

5.3.1 Early identification of low compliance

Article F builds on this perspective by treating low compliance as something that can be detected from the study's own data as it is being generated. Response rates are typically highest at the beginning of an ESM study and decline over time as participants experience fatigue or become overwhelmed by repeated prompts, often described as a wear-out effect (Fritz et al., 2024; Howard & Lamb, 2024; Rintala et al., 2019, 2020). This decline is unlikely to be the same for everyone. It may interact with short-term changes in participants' daily lives, such as periods of increased stress, which can reduce the capacity or willingness to respond (Napa Scollon et al., 2009). Because such changes occur after the study has begun, they may not be captured by information collected at baseline. They may instead become visible in participants' early response patterns.

To examine this, Article F utilises machine learning models based on baseline characteristics and with models based on ESM-derived indicators computed from early responses. Machine learning was used because the analysis included a large set of potentially correlated indicators whose associations with compliance could be non-linear or depend on interactions with other characteristics. XGBoost provided a flexible classification model that could accommodate these non-linear relationships, interactions, and missing information.

The analysis draws on a UK-based probability panel sample from the Understanding Society Innovation Panel, where 2,152 respondents were eligible to complete a 14-day survey protocol via a mobile app. Of these, 967 participated in the study protocol and formed the analytic sample. Questionnaires were available each evening with reminders, and participants received £1 per

completed day. The design also included an experimental component that varied questionnaire length and incentive structures. Low compliance was defined as a participation rate below 70%, which reflects a threshold near the lower end of compliance rates commonly recommended in ESM research (Howard & Lamb, 2024; Mölsä et al., 2022; Stone & Shiffman, 2002).

A landmark-based approach examined how early final 14-day low compliance could be identified. Separate machine learning models used information available by the end of study day 3, 5, or 7. Three cumulative information blocks were compared. The first contained demographic, socioeconomic, household, health, and technology-related background information. The second added early completion behaviour, including the number of completed questionnaires and sequences of missed days. The third added average and within-person variability of ESM responses in stress, mood, sleep, physical health, mental well-being, and mobile-phone use. Variability estimates based on few responses were adjusted towards the average variability in the training data to reduce their instability. Model development and evaluation were separated at the household level, ensuring that members of the same household could not appear in both the training and test datasets.

The results of Article F illustrated that background information alone provided limited identification of low compliance. Adding early completion behaviour produced a substantial improvement at all three landmarks. Meaningful differences in final compliance were already visible by day 3, and identification became stronger as a longer completion history became available. Stronger identification at later landmarks reflected both additional completion history and, by day 7, the fact that some participants could no longer reach the compliance threshold. Adding average ESM responses and within-person variability produced little further improvement once completion behaviour was included. Daily experiences may still be associated with compliance, but they contributed little additional information for identifying individual participants after their completion history was known.

Table 5.1. Selected held-out classification results from Article F

Information available	Day 3 ROC-AUC	Day 5 ROC-AUC	Day 7 ROC-AUC
Background characteristics	.568	.568	.568
Background characteristics and completion behaviour	.745	.876	.892
Background characteristics, completion behaviour, ESM response levels, and within-person variability	.747	.877	.887

Note: The background model was identical across landmarks because it did not contain information collected during the ESM period.

The descriptive analyses showed why demographic targeting can be difficult. Participants with low compliance were, on average, younger and had more children living in their household. They also reported modestly higher stress and poorer scores on some early ESM measures. However, education, employment, self-rated health, and psychological distress showed no clear differences. In other words, low compliance was not concentrated within a clearly defined demographic group.

Article F further examined whether randomised study-design features were associated with low compliance. Households were assigned to either a two-minute or a ten-minute daily questionnaire and to no bonus, a £10 bonus conditional on completing all 14 days, or a £2.50 bonus on each of four randomly selected days. Article F showed that questionnaire length was not clearly associated with low compliance. The random-days bonus was associated with an estimated 8.7 percentage-point lower rate of low compliance than the no-bonus condition, although this contrast did not remain statistically significant after correction for multiple comparisons. The experimental findings therefore do not provide conclusive evidence that the incentive conditions reduced low compliance. Nevertheless, even modest improvements in compliance could increase the effective sample size and preserve the continuity of individual time series, as each additional completed day contributes further information.

Overall, Article F suggests that low compliance in intensive diary studies is a developing participation process rather than a stable predictable trait. Low compliance could be identified early using information from the study itself. This positions low compliance as an ongoing process that can be monitored as it develops, rather than as a fixed limitation of study design. It also points toward the potential for a more adaptive approach to data collection, in which future studies could test whether study protocols can respond effectively to emerging patterns of engagement over time.

5.4 Summary

This chapter has argued that progress in the field depends not only on better theory, but also on the methodological conditions under which such theory can be tested. The contribution of the dissertation to these conditions is threefold. First, the power analyses in Article B indicate that some of the inconsistency in the literature, particularly for general social media use, may reflect insufficient statistical power rather than a genuine absence of effects. Confident conclusions require designs that pair clearer constructs with sufficient sensitivity rather than accumulating more studies of the same kind. Second, the review of emerging measurement approaches indicates that the move beyond self-reported screen time brings measurement closer to the processes

assumed to link digital media use to well-being. However, these new approaches also introduce new constraints around content, context, privacy, and participant burden. Finally, Article F shows that final 14-day low compliance could be identified from participants' early completion behaviour, but whether changes to study design can improve compliance remains unresolved. Taken together, these contributions point towards three features that may help strengthen future research, namely greater statistical power, more conceptual precision, and a better capacity to sustain intensive data collection over time.

Chapter 6. Discussion and reflections on clinical practice and policy

The preceding chapters have shown that problematic media use is consistently associated with a wide range of negative outcomes. They displayed what problematic media use is and how robustly it relates to adverse outcomes, and the present chapter turns from understanding the phenomenon to responding to it. Chapter 6 asks how problematic media use can be addressed and how it might be prevented. It reflects on this across two settings, first clinical practice, where the concern is the individual adolescent already in difficulty, and policy, where the focus widens to the environments in which problematic media use develops. Unlike the preceding chapters, this chapter does not draw on material from the dissertation's articles but offers instead a broader discussion and reflection informed by the dissertation as a whole.

6.1 Clinical practice

Digital media use has become increasingly relevant to clinical practice, as adolescents and families seek help with problems concerning phones, social media, gaming, or online interaction. These problems may manifest in various ways, including sleep disruption, school difficulties, family conflict, social withdrawal, compulsive checking, distress when access is removed, or difficulty disengaging from online environments. The clinician who first encounters them is often not a specialist but a general practitioner, a school psychologist, a paediatrician, or a clinician in general mental health services (Sussman et al., 2025). To make sense of the reported media-related problems, the clinicians need enough understanding of adolescents' digital environment to ask meaningful questions. They need to know what kind of media use is involved, how it fits into the specific adolescent's daily life, and why it has become a concern for the adolescent or the family. A substantial difficulty is that demands for help have emerged quickly and on a considerable scale (Rich, 2017). Services are still learning what problematic media use is, whom it affects, and how it can be addressed. Clinicians therefore lack an agreed diagnosis to use, a clear evidence base to draw on, and an established treatment to offer. The result is that they have to respond with the limited tools that are currently available, while research is still evolving (American Academy of Pediatrics, 2025).

The first task for the clinician is to distinguish problematic media use from frequent, heavy, and intense use. Problematic media use is a dysregulated pattern of digital media engagement characterised by impaired control over use, preoccupation with digital media when offline, difficulty disengaging, continued engagement despite recognised negative consequences, and serious interference with central areas of functioning such as sleep, school, family life, emotional regulation, and social relationships (American Academy of Pediatrics, 2025; American Psychiatric Association, 2022; WHO, 2024). The clinical concern is therefore not liking digital media, having online friendships, gaming intensely, using social media every day, watching videos, or having ordinary conflicts with parents about screen rules, but whether media use has become difficult to control and functionally impairing (Kardefelt-Winther et al., 2017).

The adolescents whom clinicians meet rarely show problematic media behaviours in isolation. Problematic media use tends to co-occur with other difficulties and is especially common among adolescents with neurodevelopmental disorders and other mental health difficulties. Adolescents with ADHD are especially overrepresented among those with presenting problematic media use, and greater ADHD symptom severity has been associated with more severe problematic media use (Bickham, 2021; Tsappis et al., 2025). This may partly reflect that digital environments provide immediate reward, stimulation, variable rewards, and relief from boredom, while the same features can make disengagement more difficult for adolescents with ADHD (Tsappis et al., 2025). Autism spectrum disorder (ASD) is also repeatedly co-occurring, particularly where the adolescent reports that their digital environments provide structure, predictability, restricted interests, or less demanding forms of social contact (Bickham, 2021; Fineberg et al., 2025). The same pattern of dysregulated use may therefore reflect different underlying difficulties and motivations and consequently require different clinical responses. Depression, anxiety, social anxiety, obsessive-compulsive symptoms, loneliness, aggression, self-injurious behaviour, and suicidal ideation are also often reported alongside problematic use (Fineberg et al., 2022; González-Bueso et al., 2018). However, neurodevelopmental disorders or other mental health difficulties do not directly imply problematic media use, but these difficulties are often part of the broader clinical picture in problematic media use. Treatment of the media-related problem may therefore also require treatment of other difficulties that can make digital engagement difficult to regulate (Bickham, 2021).

The diagnostic landscape remains contested, and this uncertainty has consequences for clinical practice. The World Health Organization included gaming disorder in the ICD-11 as a formal diagnosis, defining it through impaired control over the behaviour, increasingly prioritising it over other activities,

and continuation or escalation despite negative consequences, with the pattern being severe enough to impair personal, family, social, or educational functioning over a period of twelve months (WHO, 2022). Internet gaming disorder is described in the DSM-5-TR as a condition for further study, requiring five of nine features, including preoccupation, withdrawal, failed attempts to cut down, loss of interest in other activities, continued use despite problems, deceiving others about gaming behaviour, and jeopardising or losing a significant relationship, job, or educational or career opportunity because of gaming (American Psychiatric Association, 2022).

No equivalent category exists yet for generalised media use disorder or generalised internet use disorder, and they currently fall under a residual ICD-11 category (Fineberg et al., 2025). This inconsistency across diagnostic systems reflects an uncertainty in the field about whether problematic use of different digital media types should be conceptualised as a unified disorder or as contextually distinct syndromes. A number of validated questionnaires are used to identify problematic use, including the Bergen Social Media Addiction Scale (Andreassen et al., 2012), the Social Media Disorder Scale (van den Eijnden et al., 2016), Generalized Problematic Internet Use scale (Caplan, 2010), and gaming-specific tools such as the Internet Gaming Disorder Scale (Pontes & Griffiths, 2015). Because there is no single agreed standard for deciding when use has crossed from functional to disordered, prevalence estimates vary widely. Reviews place the global prevalence of problematic media use at somewhere between roughly 6% and 12% (Boniel-Nissim et al., 2024; Burkauskas et al., 2022; Casale et al., 2023), and between roughly 3% and 12% for gaming disorder among adolescents, with higher rates among boys (Boniel-Nissim et al., 2024; Fam, 2018; Stevens et al., 2021).

Treatment does not follow one standardised approach, and multiple methods are currently being used. Cognitive-behavioural therapy (CBT) adapted for behavioural addictions appears to be one of the better-supported approaches, with meta-analyses showing significant reductions in compulsive use, preoccupation, and distress (Kurnaz & Koçtürk, 2024; Lindenberg et al., 2022; Reangsing et al., 2025). CBT techniques can help adolescents notice their own engagement patterns, reduce reliance on digital media for immediate emotional relief, and build alternative behavioural repertoires. Motivational approaches are also important as many adolescents do not experience their media use itself as the primary problem (Alluhidan et al., 2024; Nagata et al., 2025; Sahin & Ayaz-Alkaya, 2026). Consequently, a treatment plan based only on restriction may increase conflict and reduce cooperation, particularly among older adolescents, while more active and autonomy-supportive forms of mediation may help preserve communication and engagement (Geurts et al., 2025; Hernandez et al., 2024; Peebles & Chen, 2024). Family

involvement is often relevant, since use is also shaped by household routines, access to devices, parent-child conflict, parental modelling, school demands, and the availability of offline alternatives (Vossen et al., 2024). Family work can help parents move towards more predictable expectations around when, where, and how media can be used (Bonnaire & Phan, 2017; Tsappis et al., 2025). Digital detox and abstinence-based approaches show less robust and less durable effects (Lemahieu et al., 2025; Plackett et al., 2023), potentially because they target access or quantity while leaving motivational and regulatory mechanisms unchanged. Temporary abstinence or strong restriction may be useful in some cases, however, these strategies should be understood as short-term supports for treatment rather than as the treatment goal (Sussman et al., 2025). Because digital media is now part of education, communication, social participation, and ordinary adolescent life, the broader aim should be sustainable self-regulation rather than permanent avoidance (Radtke et al., 2022; Sussman et al., 2025).

The evidence base for prevention efforts remains limited, yet several broad principles appear useful (Romero Saletti et al., 2021). At the household level, prevention efforts appear to be effective when they do not focus on restrictions implemented after problems have emerged but on early expectations, visible and structured media use, the protection of sleep, varied offline activities, and parental modelling of balanced media habits (Munzer et al., 2026; Vossen et al., 2024). Children and adolescents need support to learn how to use digital media as a beneficial tool (Sussman et al., 2025). In addition, schools play an important role, since school-based programmes can reach children and adolescents without requiring them or their families to seek help or knowledge themselves. Overall, school-based prevention efforts are promising. School-based interventions report moderate to large reductions in problematic media use, and existing programmes commonly combine psychoeducation, media literacy, self-monitoring, reflection on use patterns, problem-solving skills, emotion regulation, and social competence training (Wang & Zhang, 2025; Zmavc et al., 2025). Digital literacy education appears particularly beneficial as it helps adolescents recognise persuasive design, understand algorithmic curation, and reflect on their own motivations for use (Feijoo et al., 2023; Hobbs, 2022; Schreurs et al., 2023). Taken together, clinical treatment, family guidance, and school-based prevention are valuable tools that help children who are already struggling. However, these efforts mainly respond to problems after they appear and do not target the environments that facilitate them.

6.2 Policy implications

Problematic media use does not arise simply from individual weakness or from inattentive parenting. Most individuals and families navigate these

environments with great care, and the difficulties they face are structural rather than personal. Digital platforms are designed around notifications, likes, algorithmic recommendation, intermittent reward, and prolonged engagement to optimise use (Montag et al., 2019). They are in this sense architectures of influence, meaning they are built to capture and sustain attention through well-documented cognitive mechanisms (Fogg, 2003). Individual treatment, family guidance, and school-based efforts are therefore only one level of response. To reduce problematic use at a population level, prevention also requires corporate responsibility and legal regulation of the digital environments in which children and adolescents develop their media habits (Fineberg et al., 2025).

A dominant framing in both public discourse and parts of the scientific literature treats digital well-being as primarily a matter of individual self-control (Docherty, 2021). This framing is difficult to sustain, because the environments in question are built to make disengagement hard. Infinite scroll, autoplay, variable reward schedules, and algorithmic personalisation are commonly analysed as persuasive or engagement-prolonging design features, structurally aligned with platforms' commercial incentives to maximise user engagement rather than as merely incidental properties of digital technology (Chen et al., 2025). When users struggle to disengage from systems designed to sustain engagement, this is a predictable outcome of human cognitive systems, including those of adolescents still undergoing development, to environments optimised for engagement, rather than a failure of personal willpower. Recommendations to take breaks, be mindful, or set limits place the burden of regulating professionally designed behavioural systems on the individuals, who often lack the necessary resources, expertise, or developmental maturity. This dynamic has been described as responsibilisation, i.e., structural risks are reframed as individual obligations (Docherty, 2021). Platforms offering optional screen-time dashboards while retaining engagement-maximising design illustrate this pattern, since these features signal concern for well-being without altering the underlying incentive structure.

If these risks are produced by design, then responsibility for addressing them lies first with the actors who design these systems. A useful way to capture this is the concept of a duty of care, which holds that providers must take reasonable steps to anticipate and mitigate the foreseeable harms their design choices create for minors (Woods & Perrin, 2019). The significance of this concept is that it reframes online harm as a risk generated by platform design and incentives rather than as an isolated incident or user failure. It places responsibility with the provider rather than treating the platform as a neutral medium for content it merely hosts. Design features that sustain prolonged engagement also generate substantial revenue from young users. Social media

companies have been estimated to earn around eleven billion dollars annually in advertising revenue from minors in the United States alone (Raffoul et al., 2023). The engagement that produces this revenue is the same engagement that makes disengagement difficult, so the measures that would most reduce negative effects would also reduce the income on which the business model rests. Given these incentive structures, it cannot be assumed, then, that platforms will address these mechanisms through voluntary self-regulation (Raffoul et al., 2023).

Consequently, recent regulation has been putting pressure on the companies to take responsibility. The European Union's Digital Services Act (2022) and Digital Markets Act (2022) introduce requirements concerning transparency, recommender systems, and protections for minors, and the California Age-Appropriate Design Code (2022) mandates child-appropriate defaults. The same logic is visible in litigation, as a Los Angeles jury in March 2026 found Meta and Google liable for the design of Instagram and YouTube and for harms related to addictive and compulsive use (Reuters, 2026). Across these developments, the governance logic moves away from treating digital media as neutral tools whose misuse is the user's responsibility, and towards recognising them as engineered systems whose foreseeable risks their designers are obliged to reduce.

This way of thinking shifts where the burden of justification falls. The debate about children and digital media is usually framed around whether children should have access to platforms, which treats the child as the thing to be managed and exclusion as the remedy. A duty of care points the other way, asking what a platform must show about its design before it may operate in spaces where children are present. The question then becomes less whether children should be granted access to platforms than whether platforms should be granted access to children. Australia's decision to ban users under sixteen from major social media platforms, which took effect in December 2025, moves the obligation onto companies rather than onto young people or their families, and in that respect reflects the shift (eSafety Commissioner, 2026b). Australia enforces this obligation through financial penalty rather than through a duty on children or families, as platforms that fail to take reasonable steps to remove users under sixteen face substantial civil fines, a cap the government proposed to move to roughly double within months of the ban taking effect (Australian Government, Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts, 2026). Whether such penalties are large enough to alter behaviour is difficult to determine, since their deterrent value depends on how they compare with the revenue that engagement by minors generates, and that comparison is not made transparent. Other jurisdictions are moving in the same direction, with the United

Kingdom announcing a comparable under-sixteen ban modelled on the Australian law (Department for Science, Innovation and Technology (UK), 2026), and countries including Denmark developing similar measures (Digitaliseringsministeriet, 2025). However, early enforcement has proved incomplete, as regulator data indicate that around seven in ten under-sixteens who held an account before the Australian ban retained some access in the months that followed (eSafety Commissioner, 2026a).

Access-based approaches have a clear limitation, however. Age restrictions may reduce access for some children, but they do not solve the underlying design problem. If enforcement is incomplete, some children will remain present in environments that have not been made safer for them. Moreover, if platform responsibility is defined primarily as keeping children out, the pressure to change the design structures that make these environments risky in the first place is weakened. Access restrictions should therefore be understood as a temporary protective measure, not as the endpoint of policy. The more important goal is to make digital environments safer for everyone, so that exclusion is not the only protection available.

A shift of responsibility towards providers will not be immediate, and in the meantime, responsibility necessarily remains distributed across individuals, families, and institutions. The difficulty is that this distribution asks most of those least able to bear it. Self-regulation varies systematically across individuals, adolescents have less developed executive control than adults, and individuals experiencing chronic stress, attentional difficulties, or mental health problems may have a reduced capacity to resist persistent engagement cues. When responsibility for regulation rests on the individual, those with the fewest internal resources may therefore carry the greatest burden. In addition, the external supports that might compensate are themselves also unevenly available. Households can establish routines such as keeping devices out of bedrooms or limiting use during meals, and schools can introduce shared constraints such as restrictions on phone use during the day, for which there is evidence of reduced distraction and improved academic outcomes (Barwick et al., 2025; Figlio & Özek, 2025). However, these efforts depend on parental time, knowledge, and capacity, which not all families have in equal measure, and it asks schools to police boundaries that the design of the platforms is actively working to undermine. Responsibility should therefore lie more with those who design these systems. This is both a matter of principle and public health, as it helps prevent the most vulnerable from bearing the greatest costs of systems they did not design and cannot control.

6.3 Summary

The findings reviewed in this chapter suggest that problematic media use requires responses at more than one level. In clinical practice, the key challenge is distinguishing dysregulated use from frequent but functional engagement and recognising that clinical presentations rarely appear in isolation from broader psychiatric and neurodevelopmental difficulties. Available treatments, particularly cognitive-behavioural approaches, show meaningful effects, though the evidence base remains limited, and no single pathway fits all presentations. In policy, the chapter argued that framing digital well-being as a matter of individual self-control mislocates the problem, since the environments in question are deliberately designed to maximise engagement. The central implication is that responsibility cannot rest with individuals and families alone, and that reducing problematic use at a population level requires regulatory frameworks that hold the designers of these environments accountable for foreseeable risks.

Chapter 7. Limitations and directions for future research

During the three years in which the PhD project was conducted, the relation between digital media use and adolescent mental health has changed from an active research area to an urgent public health, legal, and regulatory concern. In 2023, the U.S. Surgeon General issued an advisory on social media and youth mental health, a format reserved only for the most significant public health challenges requiring immediate awareness and action (Office of the Surgeon General, 2023). Since then, concern about young people's digital media use has increasingly been translated into policy and regulation, including Australia's age restrictions for social media accounts among users under 16 and European efforts to strengthen protection of minors online. Social media companies have become subject to intensified litigation and public scrutiny over youth safety, addictive design, and negative mental health outcomes. These developments matter because the object of study has not remained stable. Digital platforms have changed as new formats, recommender systems, safety features, monetisation practices, and patterns of youth engagement have emerged. Consequently, the limitations of this dissertation reflect weaknesses in individual studies and showcase a broader learning process within a field that is still trying to define its central constructs while the object of study itself continues to change.

A central limitation concerns whether the contrast between the consistent associations for problematic media use and the mixed associations for general use reflects an artefact of how the two constructs are measured. Problematic media use is operationalised through instruments that capture preoccupation, loss of control, continued use despite harm, distress, and serious interference with daily functioning. Several of these dimensions are conceptually close to some of the adverse outcomes that problematic use is expected to predict. The greater consistency found for problematic use in Articles A and B may therefore partly reflect the conceptual similarity. This may also help explain why studies of problematic social media use appeared better powered than studies of general use in Article B. The higher power could partly follow from larger observed associations, which may themselves reflect some overlap between the constructs being measured. However, this overlap does not necessarily make problematic use a circular concept. Problematic use concerns impaired control over and difficulty regulating media use, whereas the outcomes it is

often used to predict concern broader aspects of mental health and well-being. The constructs are therefore not the same, even though they may often co-occur. Consequently, the literature in Articles A and B highlights that features of dysregulation may be more consistently associated with adverse mental health outcomes than duration. Nevertheless, the dissertation cannot fully determine whether problematic use shows larger effects because dysregulated media use is genuinely more consequential, or because measures of problematic use are closer to the outcomes they are used to explain. This uncertainty also affects the SSDU framework developed in Article E, as problematic use constitutes the endpoint of the transition it seeks to explain. If problematic media use is difficult to define and conceptually partly overlaps with the adverse outcomes associated with it, it also becomes difficult to specify what a transition towards problematic media use entails. Future empirical tests of the SSDU will therefore require clear diagnostic criteria that distinguish dysregulation of media use from the broader outcomes with which it may be associated.

A second limitation is whether detailed measures of media use remain valid as platforms change. This limitation is especially visible in Articles C and D, which generate new empirical data from specific platform contexts. These studies are cross-sectional, rely on self-reported data, and focus on particular forms of media use at a particular moment on a particular platform. Their findings provide useful snapshots, as they capture how users reported using and experiencing social media within the platform features available at the time. However, the findings cannot be treated as evidence of processes that will remain stable across platforms, platform redesigns, and developmental contexts. This limitation is particularly relevant for the iPAUM developed in Article C. As Instagram is moving more toward recommender feeds, creator content, short-form video, commerce, and more parasocial modes of attention, the iPAUM may become less useful over time. Overall, activity-based and platform-specific measures may have a short conceptual lifespan as the behaviours they distinguish are tied to platform features that can be redesigned or removed. This also points to a broader limitation in activity-based accounts of digital media use. Even when activities are measured more precisely, the same behavioural category may not carry the same psychological meaning across users or situations. What one person experiences as aspirational or entertaining may provoke anxiety or inadequacy in another, depending on their current psychological state, social circumstances, and the personal relevance of what they are viewing. The same person may also engage with similar content differently depending on mood, life circumstances, or developmental stage. The consequences of digital media use may therefore depend not only on what users do, but also on what they encounter, and how they interpret it. The findings

from Articles C and D should be read in this light. The absence of consistent associations between the iPAUM factors and self-esteem in Article C suggests that activity categories alone may not reliably predict aspects of well-being. Similarly, perceived influencer status did not moderate the association between social comparison and well-being in Article D. These findings may reflect self-reported and cross-sectional measurement limitations, but they may also indicate that broad measures of well-being do not capture the short-term processes through which content becomes personally consequential. In addition, Articles C and D were based on adult samples as they examined platform-specific measures and processes that were not conceptualised as unique to adolescence. Although adjustment for age did not alter the main findings within these samples, this does not establish their applicability to adolescents, whose platform use and social comparison processes may differ from those of adults. Future research should therefore examine these processes directly in adolescent samples and at a temporal scale that captures how they unfold. Doing so may require intensive longitudinal designs, but these designs introduce further limitations. Repeated assessments increase participant burden, and those who remain in the studies may differ systematically from those who disengage. Article F examined this problem by exploring compliance rates from an experience sampling study. More intensive measurement can therefore improve temporal precision but also introduce selection bias and reduce representativeness. This means that collecting more detailed longitudinal data does not necessarily always produce better evidence.

Taken together, these limitations point to a broader reflection about the development of the dissertation itself, which traces a conceptual movement from treating digital media use as measurable exposure toward understanding it as a dynamic and co-produced process. At an early stage, and supported by the findings from Articles A and B, it seemed plausible that progress in the field could come from replacing broad measures of screen time with more differentiated measures of use. Articles C and D followed this approach by examining specific activities and comparison dynamics. Their findings suggest that greater detail can improve the description of media use, but this added precision does not fully capture the processes through which digital media use becomes consequential for well-being. This highlights that the next steps may not simply be even more granularity, but a focus on the processes and configurations of users, platforms, and the surrounding environments, as conceptualised in Article E. If digital media use is better understood as a co-produced process rather than exposure that can be measured, this calls for reflections on causality. Research on digital media and mental health commonly assumes, implicitly or explicitly, a structure in which a defined type of exposure precedes and produces a later outcome. Experimental and longitudinal

designs are necessary for establishing temporal ordering, ruling out alternative explanations, and estimating effects under specified conditions. However, this logic may become incomplete when applied to digital environments that are adaptive, personalised, and recursively shaped by use. For example, a social media feed is not a stable treatment delivered to a passive user but is generated together with the user through prior actions, inferred preferences, pauses, searches, likes, and skips. The user and the platform interact, as the platform structures the possibilities for action, attention, comparison, reward, and disengagement, while the user, through those same actions, helps produce the version of the platform that is encountered. The central question is therefore not only whether social media use affects well-being, but how particular user-platform configurations shape well-being outcomes over time. The mutual user-platform shaping does not make causal inference impossible, but it does require greater precision about the level at which causality is assessed. Future research should explore when particular configurations of person, platform, content, motive, and context become more or less likely to produce dysregulated, beneficial, or neutral patterns of media use. Micro-randomised trials may offer one way to isolate causal processes within these evolving configurations. Rather than assigning each participant to a single fixed condition, they repeatedly randomise whether a specific intervention or design feature is present at multiple decision points during everyday use. This makes it possible to estimate the feature's immediate effects and examine whether these effects depend on the user's current state, context, or prior behaviour (Klasnja et al., 2015).

Chapter 8. Conclusion

This dissertation reconsiders a question that has dominated public and scientific debate for more than a decade, namely whether the amount of time adolescents spend on digital media affects their mental health negatively. However, a more informative account concerns how digital media is used, why it is used, and under which conditions use becomes difficult to regulate. The central contributions of the dissertation are to show that volume alone cannot adequately answer this question and to develop a new conceptual framework that positions dysregulation as central to understanding when and why digital media use may affect well-being. What emerges across the six articles is not that digital media is harmless or uniformly harmful, but that the mechanisms linking use to well-being may operate at the level of engagement and control rather than duration alone.

Article A demonstrated that across cognitive, physical, and psychological domains, general media use shows small, mixed, and context-dependent associations, whereas problematic use is more consistently associated with adverse outcomes. Article B confirmed this pattern specifically for social media and adolescent mental health through a systematic umbrella review and further showed that many primary studies examining general use are under-powered, potentially making inconsistency in the literature a partly statistical artefact. Article C demonstrated that Instagram is not a single activity and produced a validated instrument that distinguishes between four Instagram engagement types. Article D showed that how Instagram users perceive influencers is associated with different aspects of social comparison, with peer-like perceptions linked to more negative comparisons and celebrity-like perceptions linked to more frequent comparison. Article E developed the SSDU framework as a response to the empirical findings, organising established mechanisms into an account of how non-problematic use transitions into problematic use. Article F addressed a methodological challenge involved in testing a process-based account, showing that machine-learning models could identify developing low compliance during intensive longitudinal studies.

Taken together, these contributions indicate that the field should move away from exposure and toward understanding the processes through which media use may evolve into dysregulation. The recurring finding is not that any single behaviour or metric determines well-being, but that the same use can carry different consequences depending on its mode, its motivation, and the degree of control the user retains. This reorientation carries modest but

concrete implications, suggesting that research may benefit from process-based measures rather than volume, and that clinical attention may be better directed at dysregulation than at duration.

Summary

This dissertation examines the link between digital media and adolescents' mental health and well-being. Public and scientific debate has often focused on screen time and on how many hours of use should be considered too much. This dissertation argues that time alone cannot answer this question. Counting hours tells us how much digital media a person uses, but not what they do, why they do it, what they experience, or whether they remain in control.

The dissertation brings together articles that examine digital media use from different perspectives. Across six articles, the dissertation examines existing evidence, different forms of digital engagement, the development of problematic use, and the methods needed to study these processes. Reviews of existing research show that associations between digital media use and adolescent well-being are usually small, mixed, and dependent on the context. Some studies report negative associations, others find no clear association, and some report positive ones. Part of the disagreement in the field may also reflect statistical uncertainty, as many studies have not had enough statistical power to detect the small effects they were looking for. These findings do not show that digital media is harmless but that the amount of use is too broad a measure to explain when and for whom problems arise. A clearer pattern is found for problematic media use. Problematic use is not the same as frequent or prolonged use but describes use that has become difficult to control, preoccupation with digital media, and continued use despite serious interference with sleep, school, relationships, or other parts of daily life. A young person can spend many hours online with no sign of problematic use, while another can spend far less time and show all the signs. This type of use is more consistently associated with poorer mental health and well-being.

The dissertation also examines why digital media use should not be treated as a single activity. Studies of Instagram users show that they exhibit different forms of engagement, including viewing content, reacting to posts, communicating directly with others, and creating content, and that their experiences may depend on whom they encounter and compare themselves with online. The studies further show that measuring activities in greater detail does not automatically explain their relationship with well-being. This suggests that the association with digital media may differ based on the person, the purpose of use, and the situation. To explain how media use may gradually become difficult to control, the dissertation introduces the Slippery Slope of Digital Use framework. The framework organises existing explanations around three factors: the pull towards using digital media, the person's ability to stop or choose

another activity, and external limits and support from families, schools, platforms, and regulation. The probability of a dysregulated episode may increase when the pull is strong, the capacity to stop is reduced, and external limits and support are weak. Repeated dysregulated episodes may, over time, contribute to problematic media use. These factors can change across situations and influence one another over time. Studying these processes requires research that follows people over time. However, intensive studies place considerable demands on participants and often struggle with low compliance rates. The dissertation shows that early response patterns can help identify participants at risk of having low compliance rates.

Together, the findings of the dissertation offer practical implications. Frequent media use should not in itself be treated as evidence of a problem. Clinical attention should focus on whether use has become difficult to control, why the person uses digital media, and how it affects daily functioning. Families and schools can provide support and boundaries, but responsibility cannot rest with adolescents and families alone. Platforms and policymakers also shape the environments in which digital habits develop.

Overall, the dissertation does not conclude that digital media is either uniformly harmful or harmless. Its central conclusion is that hours alone may provide an incomplete picture. Understanding digital media use requires attention to what adolescents do online, why they use it, and the conditions under which use becomes difficult to regulate and control.

Dansk resumé

Denne afhandling undersøger sammenhængen mellem digitale medier og unges mentale helbred og trivsel. Den offentlige og den videnskabelige debat fokuserer ofte på skærmtid og på, hvor mange timers brug der er for meget. Afhandlingen argumenterer for, at tid alene ikke kan besvare dette spørgsmål. Antallet af timer fortæller, hvor meget en person bruger digitale medier, men ikke hvad personen laver, hvorfor medierne bruges, hvad personen oplever, eller om personen bevarer kontrollen over sin brug.

Afhandlingen samler artikler, der undersøger brugen af digitale medier fra forskellige perspektiver. På tværs af seks artikler undersøges den eksisterende forskning, forskellige former for brug af digitale medier, udviklingen af problematisk mediebrug og de metoder, der er nødvendige for at undersøge disse processer. Gennemgange af den eksisterende forskning viser, at sammenhængene mellem brug af digitale medier og unges trivsel som regel er små, blandede og kontekstafhængige. Nogle studier finder negative sammenhænge, nogle finder ingen tydelig sammenhæng, og nogle finder positive sammenhænge. En del af uenigheden på forskningsområdet kan også skyldes statistisk usikkerhed, da mange studier ikke har haft nok statistisk styrke til at finde de små effekter, de ledte efter. Disse resultater viser ikke, at digitale medier er harmløse, men at mængden af brug er et for groft mål til at forklare, hvornår og for hvem problemer opstår. Der tegner sig et tydeligere mønster for problematisk mediebrug. Problematisk mediebrug er ikke det samme som hyppig eller langvarig brug. Det beskriver et brugsmønster, som er blevet vanskeligt at kontrollere, hvor personen bliver stærkt optaget af digitale medier og fortsætter brugen, selvom den i alvorlig grad går ud over søvn, skole, relationer eller andre dele af hverdagen. En ung person kan bruge mange timer online uden tegn på problematisk brug, mens en anden kan bruge langt mindre tid og alligevel vise alle tegnene. Denne form for brug er mere konsekvent forbundet med dårligere mentalt helbred og trivsel.

Afhandlingen undersøger også, hvorfor brugen af digitale medier ikke bør betragtes som én enkelt aktivitet. Studier af Instagrambrugere viser, at brugen af Instagram kan omfatte forskellige former for engagement, herunder passivt at se indhold, reagere på opslag, kommunikere direkte med andre og skabe indhold. Studierne viser også, at brugernes oplevelser kan afhænge af, hvem de møder og sammenligner sig med online. Desuden viser studierne, at mere detaljerede målinger af aktiviteter ikke automatisk kan forklare deres sammenhæng med trivsel. Det tyder på, at sammenhængen med digitale medier kan variere med personen, formålet med brugen og situationen. For at

forklare hvordan mediebrug gradvist kan blive vanskelig at kontrollere, introducerer afhandlingen rammeværket Slippery Slope of Digital Use, som samler eksisterende forklaringer i tre faktorer: tiltrækningen ved at bruge digitale medier, personens evne til at stoppe eller vælge en anden aktivitet samt ydre grænser og støtte fra familier, skoler, platforme og regulering. Sandsynligheden for en dysreguleret brugsepisode kan stige, når tiltrækningen er stærk, evnen til at stoppe er reduceret, og de ydre grænser og støttemekanismer er svage. Gentagne dysregulerede episoder kan over tid bidrage til problematisk mediebrug. Disse faktorer kan ændre sig på tværs af situationer og påvirke hinanden over tid. Studiet af disse processer kræver forskning, der følger mennesker over tid. Intensive studier stiller imidlertid store krav til deltagerne og har ofte problemer med frafald. Afhandlingen viser, at tidlige svarmønstre kan hjælpe med at identificere deltagere, der vil have lav efterlevelse af studieprotokollen.

Afhandlingens samlede resultater har også betydning for praksis. Hyppig brug af digitale medier bør ikke i sig selv betragtes som tegn på et problem. I klinisk praksis bør fokus være på, om brugen er blevet vanskelig at kontrollere, hvorfor personen bruger digitale medier, og hvordan brugen påvirker personens evne til at fungere i hverdagen. Familier og skoler kan bidrage med støtte og grænser, men ansvaret kan ikke alene placeres hos unge og deres familier. Platforme og beslutningstagere er også med til at forme de miljøer, hvor digitale vaner udvikles. Samlet konkluderer afhandlingen, at digitale medier hverken er ensartet skadelige eller harmløse. Afhandlingens centrale konklusion er, at antal timer alene kan give et ufuldstændigt billede. En forståelse af brugen af digitale medier kræver opmærksomhed på, hvad unge laver online, hvorfor de bruger digitale medier, og under hvilke betingelser brugen bliver vanskelig at regulere og kontrollere.

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