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SYSTEMATIC REVIEW

Social Media and Depressive Symptoms in Childhood and Adolescence: A Systematic Review

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Abstract Concerns are increasingly raised in academic and lay literature about the impact of the internet on young people's well-being. This systematic review examined empirical research on the relationship between social media use and depressive symptoms in the child and adolescent population. A systematic search of Medline, PsycInfo and Embase databases yielded eleven eligible studies. Relevant results were extracted from each study, with a total sample of 12,646. Analysis revealed a small but statistically significant correlation between social media use and depressive symptoms in young people. However, studies varied widely in methods, sample size and results, making the clinical significance of these findings nuanced. Over half of the studies were cross-sectional, while those of longitudinal design were of limited duration. This review justifies further investigation of this phenomenon, with a need for consensus on variables and measurement.

Keywords Internet · Social media · Adolescence · Depression · Mental health

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Introduction

New technology can transform society, but fears have been raised about its physical, social and psychological consequences. This has historical precedent. In the nineteenth century, many people were diagnosed with "railway sickness", a condition attributed to the unnatural motions of train travel, most frequently observed in passengers who had faced backwards (Shaw-Mackenzie 1895). Perhaps the rapid and universal growth of social media has created a "cyber carriage", in which vast numbers of people are oblivious to their physical surroundings while fixated on the internet, accessed through handheld devices. Is living in the virtual reality of social media harmful to younger people's social and emotional development, well-being and mental health, or are the dangers exaggerated by older generations? This is a significant question, because there are reports of escalating mental health problems in children, and difficulties experienced at this age may have enduring impact. This article presents a systematic review of studies measuring the relationship between social media use and depressive symptoms in young people.

Impact of Social Media Use in Childhood and Adolescence

The internet is a ubiquitous medium for business, information and entertainment, but arguably it has had most profound impact as a means of interpersonal communication. Use of social networking sites grew exponentially after the launch of MySpace and Facebook in 2004. Within a few years, Facebook was being used by four-fifths of internet users aged 13–16 in the UK (Livingstone et al. 2011). Twitter, allowing short messages to be sent to unlimited

recipients, was introduced in 2006 and rapidly gained global popularity. Since the launch of internet-connected smartphones, which overtook sales of cell phones in 2013, instant messaging sites such as Snapchat and WhatsApp have become standard tools of communication. In the USA, recent data show that 93% of people aged 15–17 have mobile internet access through a phone or tablet; while Facebook remains highly popular, Instagram and Twitter are more valued by teenagers (Statista 2016). Whether on conventional computer screen or mobile device, young people use social media in every waking hour, in countries rich and poor.

The internet may be a double-edged sword. Neuroscientist Susan Greenfield (2014) argued in her book *Mind Change* that digital technology has deleterious effects on personality, identity and relationships. Applying Prensky's (2001) distinction between "digital immigrants" and "digital natives", Greenfield explained that whereas the former were schooled in a pre-digital era, now using the internet alongside older media, the latter have known nothing else. According to this conceptualization, digital immigrants confer higher value on face-to-face interaction, sometimes criticising younger people for contravening traditional social norms when focusing on their mobile devices, while digital natives dismiss this as older people's fear of change.

As described in Turkle's book *Alone Together: Why We Expect More from Technology and Less from Each Other* (2011), family relationships are weakened when proximate reality is neglected in favor of online contact. Digital technology may be changing conceptualizations and language of human relationships. Defined as a "dyadic, co-constructed phenomenon characterized by reciprocity, closeness and intimacy" (Amichai-Hamburger et al. 2013: 34), friendship is vital for the well-being of children and adults, but the advent of social media appears to have modified its meaning. For "Generation Wired" (a term used by Tam and Walter 2013), such relationships are increasingly generated and maintained online. Data from the Pew Research Center (Madden et al. 2013) show an average of 300 Facebook friends for teenagers in the United States, but the quality of such relationships is more important than the quantity. With a much larger social circle than in traditional friendships, inevitably much communication is shallow (Grieve et al. 2013). Virtual reality may become the real world for some users, to the extent that friends known only through cyberspace become their closest confiding relationships (McKenna et al. 2002).

Evidence suggests that while people with strong social skills and technological abilities accrue benefit from online interaction, those who are less adept do not fare so well. This exacerbation of differences was portrayed by Kraut and colleagues (2002) as "the rich get richer". By contrast, the social compensation hypothesis postulates that socially-awkward people derive benefit from online contact that they do not find with face-to-face interaction (Valkenburg and Peter 2007; Amichai-Hamburger and Schneider 2014). However, while Dolev-Cohen and Barak (2013) suggested that online communication is supportive for shy, anxious or depressive young people, it may compound their difficulties by reinforcing poor self-esteem (Staksrud et al. 2013).

Concerns have arisen about the mental health impact of internet activity on the young, with frequent coverage of this topic in the mass media. Early evidence of adverse psychological impact was presented by Kraut and colleagues (1998) and by Young and Rodgers (1998), who found that frequent internet use raised the risk of depressive symptoms. Since then, studies have shown correlations of online activity by younger people with low self-esteem (Caplan 2002), loneliness (Clayton et al. 2013), self-harm (Lam et al. 2009) and autistic traits (Finkenauer et al. 2012). However, other studies have indicated higher self-esteem and satisfaction with life, and reduced risk of mental health problems (Valkenburg et al. 2006; Bessièrre et al. 2008; Grieve et al. 2013; Best et al. 2014). Development of supportive social bonds and belongingness can protect against adversities such as loneliness and bullying (Wu et al. 2016).

A high proportion of serious mental health problems in adulthood emerges during adolescence (Kessler et al. 2005; Children Young People's Health Outcomes Forum 2012). Epidemiological data predating mass use of online social media showed a high risk of depression in this age group, with estimates of 2–5% prevalence of major depressive disorder (Costello et al. 2003), but recent reports show an alarming increase in depressed younger people (Office for National Statistics 2014). The internet, and related social trends, may be a major factor in the rise of psychological morbidity in the young.

Various theories have been proposed for the putative link between social media use and psychological problems in younger people. Socialization is crucial to the progression from adolescence to adulthood, and use of social media may have profound influence on this adjustment (Wood et al. 2016). Applying John Bowlby's psychanalytic theory, Oldmeadow and colleagues (2013) found that people with attachment anxiety were more likely to turn to Facebook for emotional support. However, reduced face-to-face contact detracts from a traditional supportive environment that can help young people to manage the challenges of adolescence. Development of self-awareness may be inhibited in young people who lack engagement in reflective interactions with family and friends (Siegel 2014). Empathy is honed through social relationships, which may not be as close and meaningful online, where superficial behavior such as virtue-signalling prevails.

The internet may be changing the process of identity formation, which psychoanalyst Erik Erikson (1980) emphasized in the adolescent stage of his model of eight stages of the human lifespan. Each stage presents conflict, which must be resolved to advance successfully to the next stage. Most young people overcome the stress and difficulties of adolescence, but some flounder. Successful progress from adolescence to adulthood entails acquisition of social skills, confirmed and rewarded by social acceptance. Self-presentation is tested through display and response. As friendships become more complex in adolescence, with the emergence of romantic intimacy and sexual interest, there is need for privacy, yet social media encourage openness and divulgence of personal information. A review of studies of online identity development by Wängqvist and Frisén (2016) showed that aspects of identity constrained in offline contact are freely expressed online, and that anonymity in internet communication has implications for cohesive identity formation.

As argued in an influential book *Generation Me* by Jean Twenge (2006), narcissism may be increasing in Western society. Twenge and colleagues (2008) found considerably higher scores in this trait in students compared to a group of 20 years earlier. Narcissistic behavior has always been more evident in younger people, who have relatively little responsibility to others while tending to be self-absorbed. The extent is probably exaggerated in the media, as the term is used for people merely taking "selfies": such behavior may be vain, but is socially normative and should not be pathologized if it does not pervasively disrupt daily functioning (Webber 2016). However, the internet has provided more opportunity for expression of narcissistic aspects of personality. People with narcissistic traits are prone to low mood when their high expectations are not fulfilled (Webber 2016). Huprich (2014) described a narcissistic personality pattern including depressive and masochistic tendencies as "malignant self-regard". A depressive reaction to setbacks is a prominent feature of the DSM-V condition of narcissistic personality disorder.

Several socio-cultural theories have emerged on the effect of digital media on mental health. The internet can be a harsh environment for young people, who are heavily influenced by peer pressure. A review by Wu and colleagues (2016) of research on use of the internet for social purposes showed that a major motive for young people is positive reinforcement of their social connectedness. Social media are the forum for the setting and reinforcing of norms. Conformity is rewarded, while a careless remark might result in a person being ostracized. Unrealistic expectations arise as users see the relative popularity of others, as indicated by their number of friends and "likes". A study of college students (Feinstein et al. 2013) showed that negative comparisons with peers on Facebook leads to rumination, which increases the risk of depression. Online self-disclosure may relieve stress, generates supportive messages and raises a person's profile (Tamir and Mitchell 2012), but control of sensitive information is lost. Depressed or anxious young people do not always make sensible decisions about privacy, sometimes revealing personal details in a way that they later regret (McKenna et al. 2002).

Young people are expected to be in perpetual contact, and to project themselves visually as well as verbally. Attractiveness is a major criterion of status and popularity. Young female internet users are particularly keen to choose the most favorable image of themselves on Facebook (Pempek et al. 2009). "Selfies" may be uploaded to seek approval, but an adverse remark may be distressing for someone of delicate self-esteem. Young people are increasingly transmitting sexualized messages or images ("sexting"), with little concern for consent or for exploitation by abusive peers or strangers (Staksrud et al. 2013). Impulsive behavior online may jeopardize future careers, and in some instances children have been criminalized for disseminating sexual images. Aggressive behavior or "trolling" is a common problem in internet use by young people (Ko et al. 2012; Hinduja and Patchin 2013). A review of 113 studies by Kowalski and colleagues (2014) found that cyberbullying correlates with mental health problems in adolescence; in some cases it has led to suicide (Hinduja and Patchin 2010). Bullying may be worse online than in physical proximity, factors being the anonymity of the bully and the inescapable public embarrassment and shame (Slonje et al. 2013). The three most frequent problems arising in counselling sessions provided by ChildLine (a British helpline for children) in 2016 were low self-esteem or unhappiness, family relationships and bullying (online and offline); the latter was the most common reason for counselling in children aged 11 and under, and third in the 12 to 15 years age group (National Society for the Prevention of Cruelty to Children 2016).

Gender differences are an important consideration. Rodgers and colleagues (2013) found that body image concerns correlate with social media use by young female but not male users; such perceptions may lead to eating problems and poorer outcomes of adolescent adjustment. A review of 67 studies of internet use and body image concerns in adolescence by Rodgers and Melioli (2016) described various theoretical perspectives on this link. One theory is self-objectification, which is based on the feminist argument that women are seen as sexual objects under a male gaze. Self-objectification is a form of consciousness manifesting in habitual monitoring of physical appearance, with tendencies for anxiety and shame. Work by Tiggemann and Slater (2013) suggests that self-objectification is a significant cause of psychological problems in

adolescence. The combination of media and peer pressure on girls to be thin and sexually attractive is compounded by the internet. Being constantly connected turns a young person into a commodity, to be compared with others (Gonzales and Hancock 2011). However, a limitation of sociocultural theories is their emphasis on structure over agency, which reduces internet users to passivity.

Research has repeatedly shown that girls use the internet mostly for relational purposes (thus being highest users of social media), while boys tend to use it more for instrumental activities such as video-gaming (Park 2009; Kuss and Griffiths 2012). In a study of Canadian teenagers by Sampasa-Kanyinga and Lewis (2015), 71% of girls used social networks for more than 2 h daily, compared to 29% of boys, which partly explained their finding of a marked gender imbalance in psychological distress. A recent UK government survey of children aged 14–15 (Department of Health and NHS England 2015) showed that girls were more than twice as likely as boys to suffer from symptoms of common mental disorder (37–15%), with the proportion of girls with anxiety or depression rising by 10% since the previous survey 10 years earlier. Among various factors discussed by experts was excessive use of social media (*Times* 22nd August 2016). Gender-related differences in case ascertainment for mental health problems also need consideration, with girls possibly more likely to seek help.

Addictive personality traits may be stimulated by the internet. Soon after the emergence of the worldwide web, psychiatrist Ivan Goldberg (1995) proposed internet addiction as a specific disorder; manifestations are similar to other compulsive behaviors such as gambling, including preoccupation, mood problems, functional impairment and withdrawal effects (Leung 2004). Young (1999) devised the Internet Addiction Scale, which has been used widely in research on internet use. Another instrument is the Facebook Addiction Scale, which measures mood and withdrawal symptoms (Andreassen et al. 2012). Although such addiction was not included by the American Psychiatric Association (2013) in the latest *Diagnostic & Statistical Manual of Mental Disorders*, internet gaming disorder was entered as a condition for further investigation. However, such diagnostic expansion has been criticized as medicalisation of everyday life (Moynihan and Henry 2006).

Disruption of the body clock may also be a factor in the psychological consequences of internet use. Blue light emitted by digital screens inhibits secretion of melatonin, which is necessary for sleep. A meta-analysis by Carter and colleagues (2016) showed that sleeping beside mobile devices stimulates the brain. Disturbed sleep patterns may cause obesity, weakened immunity and stunted growth. Daytime tiredness and irritability may have social and educational consequences. Change to normal circadian rhythms has known influence on mood (Lewy et al. 1998).

Thus it can be seen that research on the relationship between social media and mental health in young people is multifaceted. Much of the discussion of this topic has occurred in lay media including the popular press, possibly leading to uncritical acceptance of untested ideas and assumptions. Studies indicate benefits as well as harmful effects of internet use, but evidence is complicated by the lack of either causal mechanisms or a certain direction of relationship between variables. Results in one study setting may not be generalizable to young people elsewhere. Whether any increase of psychological distress in adolescence is attributable to online social media activity is not yet understood. A review of relevant peer-reviewed studies was therefore indicated.

Current Review

This review examined empirical research on the relationship between social media use and depressive symptoms in the child and adolescent population, with three objectives. First, we aimed to produce a critique of the design and conclusions of relevant studies. It is apparent that research findings, particularly as reported in the popular media, may lack inferential validity in measuring the impact of social media on mental health. Secondly, the review was to analyze correlations between social media use and depressive symptoms, including a "dose" effect, taking account of limitations considered above. Thirdly, the review investigated the role of gender, as differences between male and female behavior and response to social media use have been highlighted in research.

Method

A systematic literature search was conducted, seeking relevant articles in peer-reviewed journals. Eligible studies had a generic child or adolescent sample, rather than selecting groups by mental health morbidity or vulnerability. Social media were defined as websites used primarily for social interaction: these include social networking sites such as Facebook, instant messaging (e.g., WhatsApp) and image-sharing applications (e.g., Instagram). Excluded were studies measuring depressive symptoms in relation to use of the internet rather than social media specifically. Although the internet is a rapidly changing phenomenon, no time period was applied, or geographical restriction; such limits would be arbitrary and a risk of selection bias (McCrae and Purssell 2015). As there was no resource for translation, only studies in English language were included. The databases Medline, PsychInfo, and Embase were used, with the following search strategy:

Population: child/adolescent aged 5–18
Exposure: social media
Outcome: depression/depressive symptoms

Articles were screened first by title, then by abstract. At the final stage of screening, full articles were read and assessed independently by all three authors, with any differences in verdict followed by discussion to gain consensus. Eligible articles were summarized and assessed for risk of bias, using the Cochrane Collaboration Methods Group Tool to assess risk of bias in cohort studies.

For statistical analysis, the most relevant result was extracted from each study on the relationship between social media use and depressive symptoms. Most studies had a correlational design, but for studies presenting other statistics, these were converted to correlations using the *compute.es* package (Re 2014). These were analyzed and forest plots generated using the *meta* (Schwarzer 2015) and *metafor* (Viechtbauer 2015) packages in R (R Core Team 2016). The *metacor* command was used with Fisher's z transformation for the correlation and the DerSimonian-Laird estimator for τ^2. Because *a-priori* heterogeneity was assumed, a random-effects model was used for the primary analysis; although the fixed-effect equivalent was also calculated as comparison of their differing inferential assumptions can be instructive. The random-effects model provides an unconditional inference about a broader set of studies of which the studies included in the meta-analysis are assumed to be a random sample, while the fixed-effects approach makes an inference based only on and about those studies actually included in the meta-analysis (Viechtbauer 2015).

Results

The computerized search yielded 2357 unique studies with a further 18 from the hand search. After screening by title, 349 abstracts were read. This second stage of screening reduced the total to 134, of which all but one unobtainable article were inspected. Eleven studies fulfilled the eligibility criteria and were included in the analysis (Fig. 1).

Of the 11 studies, six were cross-sectional and five were longitudinal (Table 1). Two studies each were conducted in the United States, Australia and the Netherlands; and one each from Belgium, Spain, Romania, Canada and Taiwan. Overall, the studies had 13,532 participants, although for this review the results applied to a slightly smaller sample of 12,646. In four studies depressive symptoms were the only psychological correlate or outcome variable, while seven studies had two or more such variables (these included social anxiety, stress and suicidal ideation). A variety of different measures were used, the most common being the Children's Depression Inventory, which was used in three studies. DSM criteria for depression were measured in one study.

Risk of bias across studies was high due to the preponderance of cross-sectional studies or longitudinal studies with short follow-up times, lack of exclusion of existing cases of depression, reliance on self-report, and (in some studies) measurement that had not been validated or use of instruments in a different context than originally intended (see Supplementary File 1).

Theoretical Approach

The "rich get richer" and social compensation hypotheses were tested by Selfhout and colleagues (2009), who compared incidence of depression and anxiety between use of internet for communication and other uses in high school pupils. Van der Eijnden and colleagues (2008) studied the relationship between compulsive online communication and psychological well-being, based on previous research indicating that unlike instrumental activities online, use of the internet for social purposes raises the risk of loneliness and depression. The researchers tested several hypotheses to investigate a possible bidirectional relationship.

Self-identity was the theoretical basis for three studies. Social comparison and feedback-seeking are important means of forming a self-identity in adolescence, but Nesi and Prinstein (2015) were interested in how young people may engage in such behaviors in maladaptive ways on the internet. They hypothesized that a high frequency of social comparison and feedback-seeking online would predict depression, although this would be moderated by peer popularity. Neira and Barber (2014) applied self-concept theory in their study of adolescent use of social media. Social comparison and peer feedback are integral to the younger person's self-evaluation, and these are dramatically increased by internet use, thus making a plausible link between social media, self-concept and depressed mood. Dumitrache and colleagues (2012) studied self-image and depressive tendencies in teenage Facebook users. Referring to the contrasting hypotheses of enhancement and compensation, they examined the relationship between positive or negative self-image and the quantity and type of information posted online.

In a female sample, Tiggemann and Slater (2015) investigated correlations between self-objectification, body shame, dieting and use of various types of media. Internet use was considered as a predictor of self-objectification and its adverse consequences, including depression. Gámez-Gaudix (2014) applied the cognitive-behavioral model to investigate problematic internet use and depressive symptoms in teenagers. In this model, online social

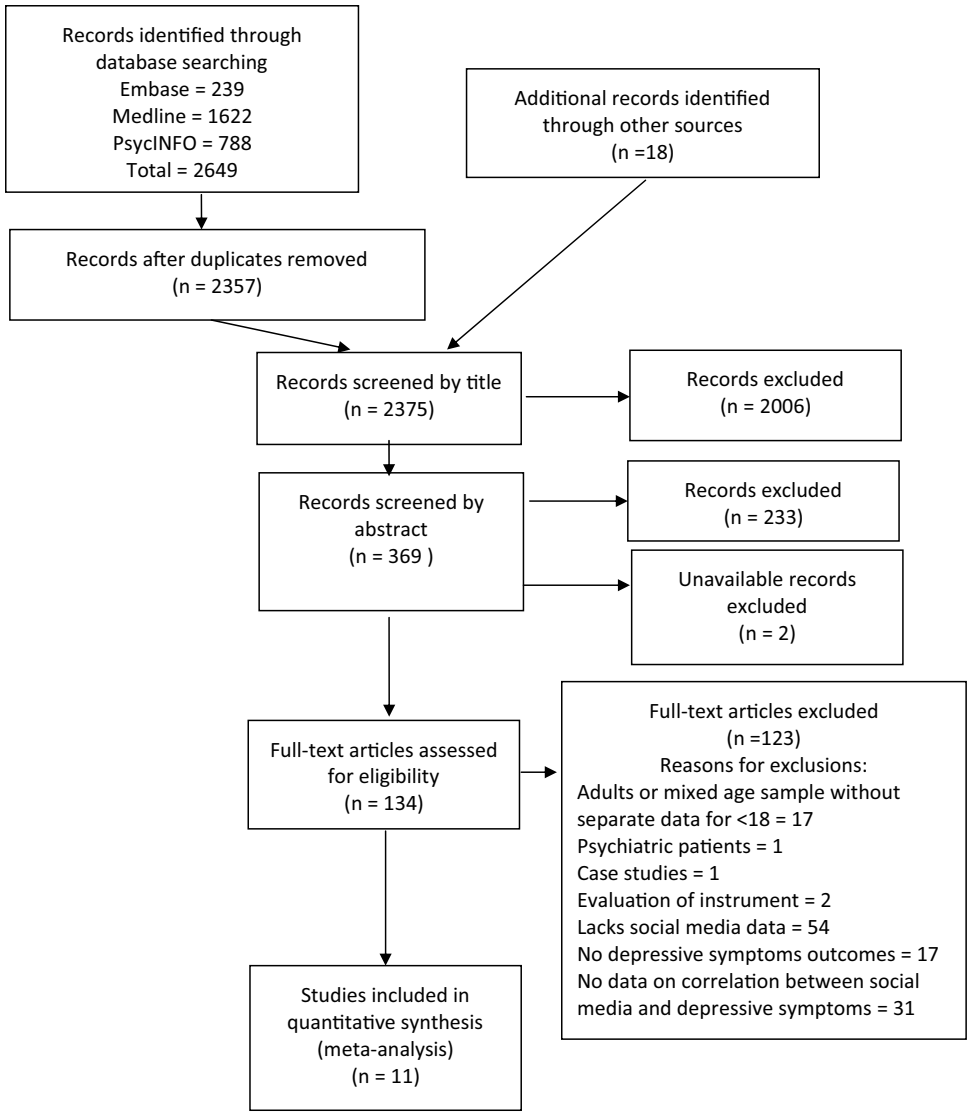


Fig. 1 PRISMA flowchart

communication is less threatening than face-to-face interaction, but this readily available source of emotional support can lead to excessive and dysfunctional use. Online activity may be a maladaptive response to depressive tendencies.

Stress was the focus of two studies. Frison and Eggermont (2015) noted that stress increases in adolescence, due to pressures at school and in family relationships. Coping mechanisms include actively seeking social support and avoidance, which are respectively adaptive and maladaptive. While the internet facilitates social support, friendship on Facebook is often weaker, to the effect that support may not be received, with potentially adverse psychological consequences. The researchers studied relationships between daily stress, seeking and receiving of social support, and depressed mood. A psycho-physiological study by Morin-Major and colleagues (2016) investigated Facebook activity (frequency of use, network size, self-presentation and peer interaction) with basal cortisol level (a measure of stress) and depressive symptoms. It is known that social support is a buffer to biological response to acute stressors.

Hwang and colleagues (2009) considered the internet as a means of social support in the rapidly changing context of Taiwan. In contrast to the individualism of Western societies, Taiwan has a collectivist culture, and young people are subjected to high social pressures in academic performance, sometimes to the detriment of their well-being. Whereas depression has been normalized in American life, it remains stigmatized in Oriental countries, causing double jeopardy for sufferers. The study by Hwang and colleagues was primarily concerned with the online and offline activity of younger people with depressed mood, but it recruited a general adolescent sample and measured the behavioral and psychological variables in a regression model.

The study by Ybarra and colleagues (2005) had no stated theoretical rationale, but they referred to previous research showing differences in use of the internet by young people

Table 1 Summary of studies

Authors (year)	Country	Design	Age	Overall sample	Girls (%)	Mental/behavioural outcome(s)	Instrument for depressive symptoms
Ybarra et al. (2005)	USA	Cross-sectional	10–17	1501	47	Depressive symptoms	Nine symptoms from DSM
van den Eijnden et al. (2008)	Netherlands	Longitudinal cohort	12–15	663	52	Depression, loneliness	Depressive Mood List
Hwang et al. (2009)	Taiwan	Cross-sectional	12–17	6341	51	Mood	Daily Life and Depressive Mood Survey
Selfhout et al. (2009)	Netherlands	Longitudinal cohort	14–17	307	51	Depressive symptoms, social anxiety	Children's Depression Inventory
Gamez-Guadix (2014)	Spain	Longitudinal cohort	13–17	957	61	Depressive symptoms	Brief Symptom Inventory (depression subscale)
Neira and Barber (2014)	Australia	Cross-sectional	13–17	1819	55	Social self-concept, self-esteem, depressed mood	Depressed Mood Scale
Frison and Eggermont (2015)	Belgium	Cross-sectional	High school	910	52	Stress, depressed mood	Centre for Epidemiological Studies Depression Scale for Children (five items)
Nesi and Prinstein (2015)	USA	Cross-sectional	12–16	619	57	Depressive symptoms	Short Mood and Feelings Questionnaire
Tiggemann and Slater (2015)	Australia	Cross-sectional	10–13	204	100	Self-objectification, body shame, dieting, depressive symptoms	Children's Depression Inventory (short form)
Morin-Major et al. (2016)	Canada	Longitudinal cohort	12–17	88	53	Cortisol levels, stress, self-esteem, depressive symptoms	Children's Depression Inventory
Dumitrache et al. (2012)	Romania	Cross-sectional	16–17	123	68	Self-image, depression	Beck's Depression Inventory

in relation to depressive symptoms. Through the Youth Internet Safety Survey they measured online communication, self-disclosure and exposure to sexual content and harassment. Depressive symptoms were assessed using DSM categories of minor and major depressive disorder.

Results of Cross-sectional Studies

Ybarra and colleagues (2005) categorized the most frequent purpose of internet use (chatroom, e-mail, instant messaging and others). From an overall sample of 1501, chatroom was used most by 136, of whom 101 were not depressed, 22 had symptoms of minor depressive disorder and 13 of major depressive disorder. The proportion depressed (minor or major) was 34%. For this review an odds ratio for depression was calculated, comparing chatroom users with those in the category of other purposes; the result was a statistically significant excess of depression in the chatroom group. Although not included in statistical analysis in this review, the instant messaging category was also relevant. This was the most common use of internet for 154 participants, of whom 133 were not depressed, 18 had symptoms of minor depressive disorder, and 3 of major depressive disorder; the depressed proportion was 14%. Hwang and colleagues (2009) found a statistically significant relationship between online communication and depressed mood. Overall, the study showed that adolescent participants who reported depressive mood were more likely to use the internet for friendships and to express feelings compared to those who did not report depressive symptoms. From the study by Dumitrache and colleagues (2012) of self-image and depressive tendencies in Facebook users, we extracted the correlation between amount of identity-related items in Facebook profiles and depressive symptoms; this was statistically significant. Overall, the study showed that depressive symptoms correlated with low self-image and identity-type information on Facebook. Extracted from the study by Neira and Barber (2014) was

the correlation between frequency of social network use and depressed mood, which was a statistically significant negative result. However, the study also measured participants' investment in social media, which produced a statistically significant correlation of 0.22. The study showed that although depression reduced with frequency of social network use, it increased with excessive use. Frison and Eggermont (2015) found that stress levels predicted seeking of social support on Facebook. We extracted the correlation between seeking social support and depression, which was statistically significant. While seeking social support increased the risk of depressed mood, actual support decreased it. From the study by Tiggemann and Slater (2015) of correlations between self-objectification, body shame, dieting and use of media, we extracted the result for Facebook and MySpace use and depressive symptoms; this was statistically significant. Statistically significant correlations with social media use were also found with self-objectification, body shame and dieting.

Results of Longitudinal Studies

In the study of social comparison and feedback-seeking and depressive symptoms by Nesi and Prinstein (2015), a statistically significant relationship was found between these online behaviors at baseline and depression 12 months later. Van der Eijnden and colleagues (2008) modelled the relationship between various internet uses, loneliness and depressive symptoms, with two time points (0 and 6 months). The result for instant messaging was extracted, as this was much more widely used by participants (49–55%) than chatrooms (3–5%). For instant messaging at time 1 and depressive symptoms at time 2, the correlation was 0.17, while the result for chatroom use was 0.07 (not statistically significant). Unlike other types of internet use, social media raised the risk of compulsive internet use 6 months later. Selfhout and colleagues (2009) compared incidence of depression and anxiety between use of internet for communication and other uses, with two time points (0 and 12 months). Extracted was the correlation between instant messaging and depression at time 2; the negative result was not statistically significant. Compared to surfing the internet, time spent in socializing online is more beneficial. Participants with lower quality of friendships and who used the internet for purposes other than communication were more likely to become depressed or socially anxious. Gámez-Gaudix (2014) measured temporal relationships between features of problematic internet use and depressive symptoms, with an interval of 12 months. Extracted was the result for preference for online over offline communication (time 1) and depressive symptoms (time 2), which was statistically significant. A bidirectional relationship was found between depression and use of social media: the former at time 1 predicted increase in the latter at time 2, and *vice versa*. Morin-Major and colleagues (2016) modelled the relationship between basal cortisol level, Facebook activity and depressive symptoms, over a period of 3 weeks. Extracted was the correlation between Facebook use frequency and depressive symptoms, which produced a negative but not statistically significant result. Also measured was Facebook peer interaction behaviors and depressive symptoms, producing a negative result (not statistically significant). The study showed that cortisol levels were positively correlated with the number of Facebook friends and negatively with peer interaction; no relationship was found with depressive symptoms.

Gender

Several of the studies found gender differences in the relationship between social media use and depressive symptoms. Nesi and Prinstein (2015) found a stronger correlation of social comparison and feedback-seeking and depressed mood in girls. Neira and Barber (2014) found a similar result with online social networking: girls who invest in social network sites were more susceptible than boys to depressed mood. Frison and Eggermont (2015) found that stress predicted depressed mood in girls but not boys. The study by Ybarra and colleagues (2005) showed that girls with high internet use were 3.8 times more likely to have major depressive symptoms than no symptoms. Other studies found no gender differences, while two studies (Van der Eijnden et al. 2008; Dumitrache et al. 2012) found that girls were less likely to show depressive symptoms than boys. Several studies showed that girls and boys use the internet for different reasons, and that through greater investment in social media, female users derive benefits while also being more prone to adverse consequences. There was imbalance in the sex of study subjects: one study (Tiggemann and Slater 2015) was confined to girls, but this does not account for an overall female sample of 59%.

Statistical Analysis

The overall random effects pooled estimate was 0.13 (0.05, 0.2), $p = 0.001$; $Q = 131.47$, $df = 10$, $p = < 0.0001$, $I^2 = 92.4\%$ (Fig. 2), suggesting a clinically and statistically significant relationship between social media use and depressive symptoms (Table 2). There was little evidence of publication bias: the linear regression test of funnel plot asymmetry showing no evidence to reject the null hypothesis of funnel plot symmetry ($t = 0.3$, $df = 9$, $p = 0.77$); although this measures small study effects rather than bias directly. The funnel plot for this is shown

Fig. 2 Forest plot

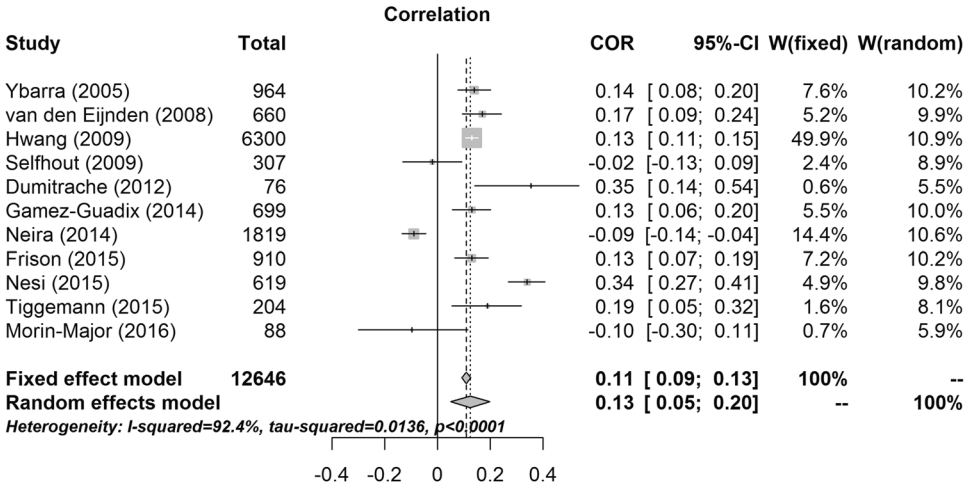


Table 2 Selected study results

Authors (year)	Included sample	Correlates	Correlation result
Ybarra et al. (2005)	1061	Internet used most frequently for chatroom versus other purposes/ depressive symptoms	0.14**
Van der Eijnden et al. (2008)	663	Instant messaging (time 1)/depression (time 2)	0.17**
Hwang et al. (2009)	6341	Online communication/depressed mood	0.13*
Selfhout et al. (2009)	307	Instant messaging (time 1)/depression (time 2)	−0.02
Neira and Barber (2014)	1819	Social media use/depressive symptoms	−0.09*
Gámez-Gaudix (2014)	699	Preference for online social interaction (time 1)/depression (time 2)	0.13*
Frison and Eggermont (2015)	910	Social support seeking on Facebook/depressed mood	0.13**
Nesi and Prinstein (2015)	619	Technology-based social comparison and feedback-seeking (time 1)/ depressive symptoms (time 2)	0.34**
Tiggemann and Slater (2015)	204	Social media use/depressive symptoms	0.19*
Morin-Major et al. (2016)	88	Facebook use/depressive symptoms	−0.097
Dumitrache et al. (2012)	76	Items of identity-related information on Facebook/depression	0.355*

*$p < 0.01$

**$p < 0.001$

in Fig. 3. Additionally the trim and fill analysis showed two outlying studies (Dumitrache et al. 2012; Nesi and Prinstein 2015), trimming and filling of which had some effect in reducing the random effects estimate, r = 0.09 (95% CI 0.01, 0.16), p = 0.03; Q = 180.67, df = 12, p < 0.0001, $I^2 = 93.4\%$ (see Supplementary File 2).

To assess any possible impact from publication type, sub-group analyses were conducted for the two types of study design. The pooled estimate for cross-sectional studies (n = 6) was r = 0.12, (95% CI 0.02, 0.22), Q = 81.01, $I^2 = 93.8\%$; while that for longitudinal studies (n = 5) was r = 0.12, (95% -0.01, 0.25), Q = 38.98, $I^2 = 89.7\%$; suggesting little effect, although the difference between study types was not always marked and the time over which the longitudinal studies were conducted varied widely. Although there was a difference between the two estimates, this is not clinically significant and the test for subgroup difference was not statistically significant (Q = 0.0, df = 1, p = 0.98). In order to try to understand the results Euclidean cluster analysis was undertaken based on the results alone. The agglomerative coefficient was strong (0.94) and showed three main clusters (Fig. 4), suggesting that study outcomes could be broadly put into three groups. Examination of the clusters revealed two groups of outlying studies; one showing small negative correlations and the other large positive effects. However, the third and largest cluster, accounting for the majority of studies, had a limited range of outcomes. Thus although we cannot account for the clusters methodologically, this distribution of results is supportive of our pooled estimate being an accurate reflection of the underlying phenomenon.

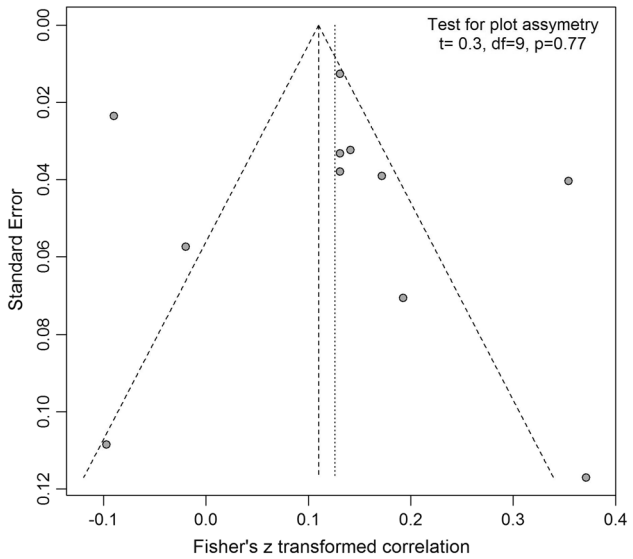


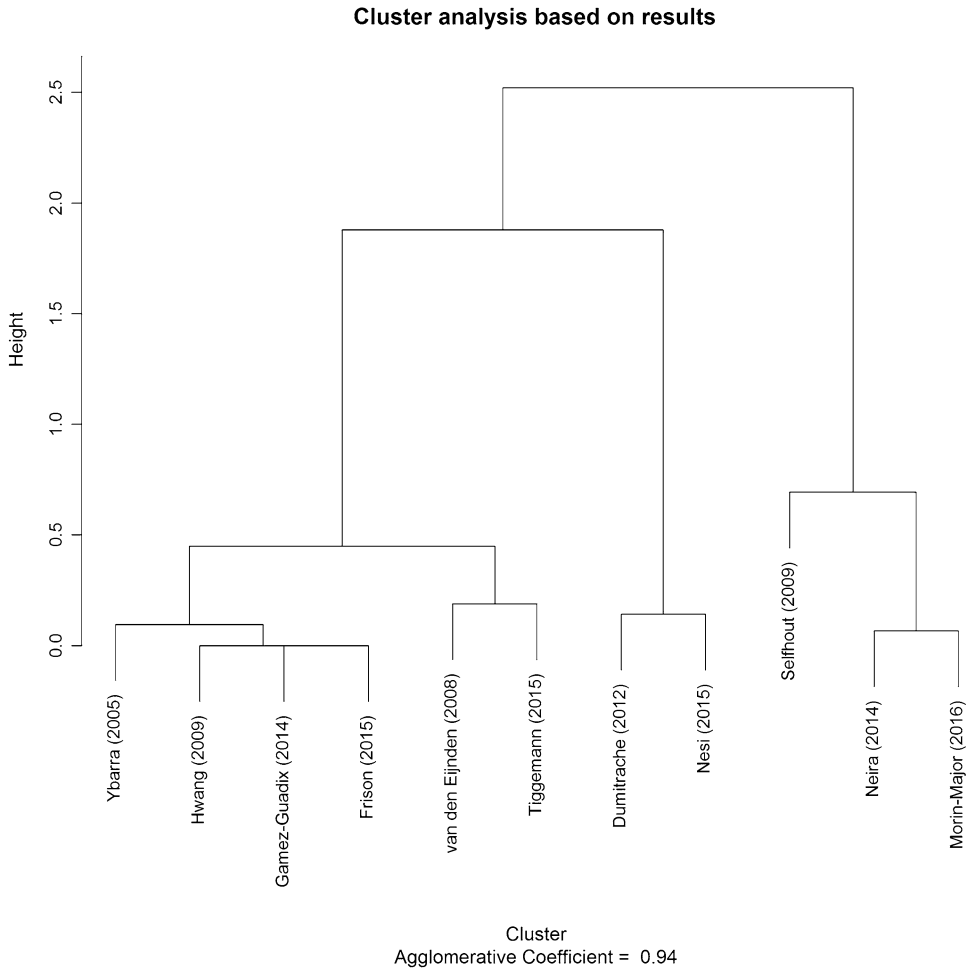
Fig. 3 Funnel plot

Discussion

The internet has transformed lives, with young people now spending several hours per day online. While there are obvious benefits of technological progress, including the communication facility of social media, problematic activity online may detract from the development and well-being of younger people. Mental health problems appear to be increasing in younger people (Office for National Statistics 2014), and use of social media is an important factor to consider. Although the putative depressogenic impact has been investigated by several researchers, it is not yet known whether use of social networking sites and instant messaging are causative, or whether there is a "dose" effect; or if it is an artefact of increased case ascertainment and general societal concern.

This systematic review makes an important contribution to the literature: first, by showing a small but statistically significant correlation between social media use and depressive symptoms in the child and adolescent population; and secondly, by indicating further research goals.

Fig. 4 Cluster analysis



However, there are limitations to consider. Most of the studies were not directly answering the review question, and heterogeneity in design and results with wide confidence intervals temper any conclusion that can be drawn. The number of eligible studies was low, as the majority of research on internet use and mental health problems does not specifically measure the effect of social media on depressive symptoms. Consequently, the amount of evidence collated for this review was modest. Sample size varied widely, and it should be noted that while small studies provide imprecise estimates of the population parameter due to sampling error, large studies can have the opposite effect of producing statistically significant but clinically spurious differences.

Studies of the psychological effects of internet use are often reported in the mass media, but as noted by McConway and Spiegelhalter (2012), methodological weaknesses are scarcely acknowledged. A preponderance of observational designs does not allow proper causal attribution. Over half of the studies reviewed here were cross-sectional, while longitudinal studies had short time periods, with 12 months the longest interval between assessments. Indeed, the fundamental difficulty in research on the impact of internet behavior is the direction of relationship. Building a more robust evidence base is challenging: with the globally pervasive use of social media, there is no naturalistic control group, and historic comparison groups would have dubious validity.

The task for researchers is to measure psychological impact while taking account of the complex, probably bi-directional relationship between habitual social media activity and mental health. In a systematic review of social media use and business management, Ngai and colleagues (2015) proposed a causal-chain framework, pursuing a sophisticated interactional model of the socio-psychological causes and effects of social media activity. In this framework, the relationship between antecedents and outcomes is not simply linear but is interpreted as the product of influence by moderators and mediators. Until more is known on the interplay of variables, straightforward cause-and-effect studies are not fully credible, unless a large sample can be observed and analyzed over a suitably long time period. Furthermore, research should be designed not only on methodological logic, but also informed by theory of child and adolescent development (Amichai-Hamburger et al. 2013).

Notwithstanding these qualifying comments, it would be fair to conclude that some degree of correlation exists between social media use and depressive symptoms in the young. However, it is possible that any increase in mental health problems is temporally but not causally connected to the internet. Fears about the harmful effects of online behavior may be stoked by greater public awareness and concern about mental health problems in young people. Recent government policy in the UK (Department of Health and NHS England 2015) has pledged substantial investment in child and adolescent mental health services, enabling early identification of vulnerable young people, with better access to support and treatment. A recent report highlighted a 54% increase in British children prescribed antidepressant drugs from 2005 to 2012 (Bachmann et al. 2016), but while this coincides with the rapid expansion of social media, this may be due to unrelated patterns in case ascertainment and marketing of these drugs. However, 54% was a relatively small absolute increase, from 0.7 to 1.1%.

Whether the incidence of depression has actually increased is a moot point. Arguably, there are material gains in the expansion of the detection and treatment of mental health problems in the child and adolescent population. Various factors could result in a lowering threshold for diagnosis of depression, including professional and commercial interests. Critics of medical hegemony, most notably Ivan Illich (1975), have alerted society to the concept of disease mongering, which Moynihan and Henry (2006) defined as "the selling of sickness that widens the boundaries of illness and grows the markets for those who sell and deliver treatments". This is particularly apparent in mental health, where standard classifications of illness have expanded with each revised edition. As noted earlier, internet-related disorders have entered the psychiatric taxonomy. O'Keeffe and Clarke-Pearson (2011) proposed "Facebook depression" as a specific illness, but this has been criticized by other scholars who assert the need for hypothesis-driven research questions and robust scientific investigation.

Another possible reason for the rising rates of depression in young people is emotional articulacy and encouragement of expression in online social networks. Gender is an important factor here. As the study by Neira and Barber (2014) showed, social media use may have more adverse psychological impact on girls than on boys, which may simply be due to higher frequency of use. Irrespective of gender, depressed mood was predicted by investment in online communication. Nesi and Prinstein (2015) found a strong relationship between social comparison and depressive symptoms in girls. The impact of negative messages may be compounded by the overlap of online and offline networks. Social media may be triggering narcissistic behavior, as suggested by the amount of "selfies" posted on Facebook and Instagram, and a perhaps excessive emphasis on the presentation of self. Research by Tiggemann and Slater (2013) suggests that Facebook use exacerbates body image distortion in adolescent girls. However, Dumitrache and colleagues (2012) found a lower rate of depressive tendencies in girls than in boys.

Social media offer tremendous opportunities for interaction, unbounded by the constraints of face-to-face contact, but they also have antisocial uses. The internet reflects society, but it may exacerbate darker sides of human nature as shown by online bullying and abuse. This phenomenon may be similar to "road rage", whereby people behave aggressively to other drivers, shielded from normal social restraint. Several studies here showed higher correlations of social media use and depressive symptoms in young people with psychological vulnerability. Gámez-Gaudix (2014) found prior psychological problems to be a predictor and outcome of problematic internet use, with academic and social impairment raising the risk of depressive symptoms. A factor may be limited access to reliable support in offline relationships. Ybarra and colleagues (2005) found that young people with depressed mood were less likely to have face-to-face interaction, communicating instead with virtual friends.

This could be explained in part by the nature of depressed mood, where symptoms can include lethargy and reduced interest in usual social activity; socializing online may be preferred as a substitute to interacting face-to-face, which may require more effort including travel. Furthermore, symptoms of depression can include irritability, and teenagers may have some predisposition to impulsivity (Siegel 2014); if these factors influence online communication they could post comments that they later regret, possibly detracting from their popularity. Online friends not already known sufficiently well offline may be less forgiving of an online *faux pas*, and may not be aware or sympathetic to another social network user's psychological difficulties. Social media use in this situation could have negative consequences for a young person with depressive symptoms.

Online friendships lack some of the benefits of physical contact: interaction is often superficial, and lacking in genuine interest. Hwang and colleagues (2009) showed that depressed young people find difficulty in making friends face-to-face and instead seek friendship on the internet; two-fifths of participants with depressive symptoms expressed thoughts and feelings online that they could not do otherwise. Although this suggests social media as a valuable resource, there is a danger of reinforcing negative beliefs and behavior. Young people struggling with stress turn to Facebook for social support, but as Neira and Barber (2014) reported, as much as 80% of requests for support were unanswered, raising the risk of depressive symptoms. Attachment theory would be relevant to such findings.

The "rich get richer" hypothesis is supported by studies in this review. For most internet users, online interaction reinforces friendships, rather than replacing one set of friends with another. That young people with fewer proximate friends derive less benefit from social media may not be a problem, as quality of close relationships should trump quantity of online contacts. However, as Nesi and Prinstein (2015) indicated, the online environment facilitates social comparison and feedback-seeking, and less confident young people may be more likely to use social media for such purpose. The cluster analysis indicated three groups; however, there was no clear pattern to this that would explain why study results had clustered in this way. Depressive symptoms are perpetuated by negative online experiences. Much of the socialization process in childhood development now occurs through social media, and mood problems may be a temporary feature of the transition to adolescence. However, as many psychiatric disorders of adulthood first appear in adolescence, vulnerability in this developmental stage is high and protective factors such as positive friendships offline and positive relationships with caring adults therefore gain importance for young people to build resilience.

Various interventions have been devised to prevent harm to young people online, including policies to tackle cyberbullying in schools (e.g., Childnet International 2015). Also, more awareness of the hazards of social media is needed in parents: "digital immigrants" may not be fully alert to the rapidly changing patterns of internet use by young people. Facebook was not designed for use by children, and does not adequately protect their identity and privacy. Lack of parental guidance on internet use exposes children to potential harm from reckless or malevolent communication, as well as from violent or pornographic content (O'Keeffe and Clarke-Pearson 2011). However, controlling use of the internet is difficult, particularly with teenagers, who use online media for educational as well as interactional purposes. Meanwhile, some parents are not good role models for internet use, posting pictures of their children on Facebook which may later cause embarrassment. While schools teach about sex and relationships, such education must be updated regularly in relation to trends of online activity by young people. In the context of an expanding virtual reality, more facilities should be provided for children to meet friends in physical proximity. Instead of focusing on the negative effects of internet use, the benefits of face-to-face contact should be accentuated.

Young people are not a homogenous group in relation to internet use. Most of the studies reviewed here had a wide age range, mixing pre-pubescent children with imminent school-leavers. Data from the Pew Research Center show differences in how younger compared to older children use social media; many teenagers lose interest in Facebook as they seek privacy for aspects of their personal lives (Madden et al. 2013). Meanwhile, social media platforms are continually developing and new risks and harms may arise with each functional advance. Current trends will not continue forever, and social media may be used differently or

abandoned in the near future. Today, typed communication prevails while oral communication has declined, as the "mobile telephone" has become a misnomer. However, keypads could soon be outmoded by devices that enable users to communicate without the need for manual input.

Vast data obtained from social networking sites can be used for marketing purposes and by potential employers. Exploration of its use in a healthcare context would be beneficial. If a degree of "profiling" from online communication is possible, there may be a moral argument towards considering using such data in a risk assessment context. For example, a sophisticated screening mechanism could potentially identify patterns suggesting concern (around a person's wellbeing, e.g., suicidal ideation) and an offer of support could be "triggered" for the social media user with a view to preventing escalation of difficulties they might be experiencing or to even put them in touch with services that could help.

The influence of the functionality of the social media platform requires further exploration in this context, e.g., the perceived reward systems involved. Exploration of the young person's expectation from online communication, and coping mechanisms they have if they encounter unwanted outcomes from using social media would help to gain more in-depth understanding of the relationship between social media and young people's mental health. Some examination of the change in relationship with social media through developmental stages and as the young social media user's experience grows would also be informative. The social communication needs of young people could be better provided for through involving young people in the design and development of social networking sites. Similarly, improved safeguards could be integrated into platform functionality if appropriate.

Hyperbole should be avoided in discussing the impact of internet use by young people. Observing moral panic as a recurring reaction to social change, Furedi (2015) described how the emergence of commercial publishing in the eighteenth century led to popular novels being blamed for "fevers". *The Sorrows of Young Werther* was banned in parts of Europe because readers identified strongly with a self-destructive character, allegedly causing a spate of suicide. More recently, the term "Werther effect" was used by American sociologist Dave Phillips (1974) for uncritical belief in media-stimulated imitations of suicidal behavior. Perhaps the same phenomenon has arisen with digital media.

Conclusion

A degree of correlation is found between social media use and depressive symptoms in young people. However, causality is not clear, and further development is needed in research on this topic. Researchers have lacked consensus on the phenomena for investigation, resulting in limited replication. Qualitative methods also have an important part to play in understanding the phenomenon of mental health impact of internet use from young people's perspectives. Such enquiry would help to develop explanatory models and hypotheses for inferential studies. The cyber carriage continues to speed along the tracks, and it is not yet understood whether it causes sickness for its passengers.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

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