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## The impact of social networking sites use on health-related outcomes among UK adolescents

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### ABSTRACT

This study theorizes on and examines the impact of social networking sites (SNS) use on health outcomes in adolescents. By using data from the 2015-16 sweep of the Millennium Cohort Study, SNS use and its effects on sleep duration, healthy eating (fruits/vegetables intake, eating breakfast), and self-rated health was evaluated in 11,406 adolescents (13–15 years old). For this, a model was constructed and tested with the PROCESS macro in SPSS. Daily SNS use time was found to be negatively associated with general health; and this effect was fully mediated through decreased sleep duration and reduced healthy eating. Females had a higher risk of being negatively affected by the extent of their SNS use, compared to males. These findings contribute to the understanding of potential social media use effects on adolescents. They further show that established sex differences in sleep hygiene and healthy eating, which have been explained from the psychological and physiological perspective in prior research, can also stem, in part, from differences in social media use patterns. From a practical standpoint, strategies aimed at helping adolescents manage their sleep hygiene and healthy food intake despite their SNS use may be more fruitful than those aimed at assisting them to curb their social media use.

### 1. Introduction

It is undeniable that social networking sites (SNS) have become an irrevocable part of life for many people and, particularly, for adolescents. A decade ago, only around two percent of the world's population used Facebook, but by the year 2019, that number has grown to almost 30% (Ortiz-Ospina, 2019). In 2005, only a small percentage of US adults used social media, while in 2019, this number was 79%. Facebook remains the world's most popular SNS, with 2.38 billion monthly active users, although Instagram (1 billion), WeChat (1 billion), and Twitter (330 million) also boast significant followings (Ortiz-Ospina, 2019). Whereas SNS are popular among all age groups, they have reached the highest penetration rates among adolescents (defined by the World Health Organization as ages 10–19<sup>1</sup>) in developed countries. However, the consequences of SNS penetration within the adolescent user population have been more far-reaching than it was previously imagined, and they differ from those produced by other information technologies (IT) (Adelantado-Renau et al., 2019; Twenge, Martin, & Campbell, 2018). On the one hand, the use of SNS has produced several positive impacts for adolescent

users, including better self-control, positive self-esteem, strengthened social ties, constant self-reflexivity, and improved impression management skills (e.g., see Boyd, 2007; Pujazon-Zazik & Park, 2010). On the other hand, extensive SNS use has resulted in a number of deleterious consequences for adolescents. For example, Berson, Berson, and Ferron (2002) reported that adolescent girls often engage in risky online activities which result in dangerous off-line behaviors. D'Angelo and Moreno (2019) showed that SNS use contributes to collegiate drinking. Brugge-man, Van Hiel, Van Hal, and Van Dongen (2019) and Brailovskaia, Ströse, Schillack, and Margraf (2020) observed that heavy social media use affects adolescents' well-being. Other studies documented a relationship between SNS use and other negative aspects of adolescents' lives, including depression, social anxiety, social delinquency, parent-child relationship conflict, technology addiction, engaging in unsafe activities, and poor academic performance (e.g., see Shapiro & Margolin, 2014; Turel, 2019).

Previous research has already demonstrated that the level of adolescents' engagement and personal investment in SNS could potentially lead to various negative psychological and behavioral effects. At the same

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time, the body of research that focuses on the adolescents' potential physical health effects of SNS use is still not fully developed. Specifically, it is not clear how adolescents' SNS use affects their overall health level. Thus, the present study focuses on the physical health-related outcomes of SNS use among adolescents. It employs the extant literature on sleep regulation and the drivers of unhealthy eating to hypothesize that SNS use may affect adolescents' sleep duration and eating behavior which, in turn, may have harmful effects on their health. To date, the relationships among SNS use, sleep behavior, eating routine, and health have not been fully understood in the context of adolescent SNS users. Because the literature posits that male and female SNS users employ and are affected by SNS differently (Jenkins et al., 2020; Keresteš & Štulhofer, 2020), this study also tests the effect of SNS use on male and female users separately. Not only does this study add credence to the extant literature on the possible effects of social media use in adolescents, but it also has important implications for public health policy and guidelines, as well as for SNS developers and service providers.

### 1.1. Social networking sites and adolescents

By the end of the second decade of the twenty-first century, SNS have become part of life for most people, especially adolescents. SNS are networked communication platforms that possess a number of unique characteristics that make them fundamentally different from other IT (Ellison & boyd, 2013; Obar & Wildman, 2015). First, SNS allow users to create their personal identifiable and publicly available profiles and share them with the other SNS participants which constitutes the backbone of the SNS structure. Second, SNS providers do not generate content stored on the platform; they only offer an IT infrastructure and support services whereas the entire content is user-generated, which has become an informal ideology and lifeblood of SNS. Third, SNS are media-rich artifacts which exclusively rely on interactive Web 2.0 technologies, thereby further facilitating a paradigm shift from a user-as-a-consumer to a user-as-a-participant mode. Fourth, SNS users may directly and indirectly interact with other participants. For instance, they may follow, consume, modify, comment on, and share others' content. Moreover, some SNS also allow users to add and share third-party generated content. Fifth, the SNS-supporting technology is in constant flux; as a result, new types of SNS frequently appear and some of them manage to achieve a critical mass of users sufficient to generate a self-sustained online community. Given an oligopolistic nature of the SNS industry, new entrants tend to differentiate themselves from the incumbents and create niche services which offer new opportunities and keep otherwise bored individuals engaged. Sixth, SNS incorporate extensive socialization features. As a result, they are prone to facilitating the development of technology addiction because the human brain has evolved to derive pleasure from communication, collaboration, and interaction with others (Báez-Mendoza & Schultz, 2013; Serenko & Turel, 2020a). In sum, due to the six idiosyncrasies discussed above, SNS dramatically differ from other IT, and they may produce unique impacts on their users and other stakeholders (Adelantado-Renau et al., 2019; Twenge et al., 2018). Thus, it is critical to specifically study the consequences of SNS use because the recommendations developed in the context of other (non-SNS) technologies may not always apply.

There are many well-documented positive impacts of SNS use. First, SNS provide adolescents with an opportunity to practice self-control and self-regulation in what they share online, and how they interact with others (Wise & Hsiao, 2019). Second, SNS can contribute to positive self-esteem development through communication and implicit feedback from peers via online interactions (Kim & Kim, 2019; Pujazon-Zazik & Park, 2010). Third, SNS strengthen offline social networks by facilitating the maintenance of relationships, allow users to gather more information about their peers, foster social creativity, reduce stress, and provide online support (Jenkins, Zaher, Tikkanen, & Ford, 2019; Lee & Borah, 2020; Li & Peng, 2019; Subrahmanyam & Greenfield, 2008). Occasionally, online assistance may evolve into supportive off-line relationships

(Wang, Zhang, & Zeng, 2019). Fourth, SNS are useful tools for developing impression management skills which involve using social cues to adapt one's behavior to his or her environment. Because online environments rely on text, videos, images, and implicit cues to convey information, SNS require users to engage in self-reflexivity and self-monitoring to craft their online identities (Boyd, 2007). Fifth, SNS provide adolescents with an outlet to find others who share common interests, with whom they otherwise would be unable to communicate (Boyd, 2007). Sixth, SNS use may increase adolescents' motivation to engage in physical exercise (Divine, Watson, Baker, & Hall, 2019; Peng, Wu, Chen, & Atkin, 2019) and improve life satisfaction (Kim & Shen, 2020).

At the same time, the negative effects of heavy SNS use in adolescents have also been well identified. These impacts may be separated into three general categories. The first research stream on the extensive SNS use focuses on various cognitive and psychological issues, such as addiction (Seo & Ray, 2019; Zhang, Bai, Jiang, Yang, & Zhou, 2019), schadenfreude (Wei & Liu, 2020), poor psychological well-being (Macrynikola & Miranda, 2019; Wolfers, Festl, & Utz, 2020), mental disorders (Bralovskaia et al., 2020; Lyvers, Cutinho, & Thorberg, 2020), and social overload (Chai et al., 2019). The second research direction explores behavioral dysfunctions from extensive SNS use, including cyber-bullying (Tokunaga, 2010), parent-child relationship conflict (Lee, 2009), compulsive buying (Liu, He, & Li, 2019), diminished academic performance (Shapiro & Margolin, 2014), participation in self-harm challenges (Villani et al., 2019), and alcohol consumption (D'Angelo & Moreno, 2019). The third line of research pertains to the impact of heavy SNS use on adolescents' physical health. Regrettably, despite the previous attempts to shed some light on this topic (e.g., see Holland & Tiggemann, 2016; Rogers & Barber, 2019), this area of inquiry is still underrepresented in the extant literature. Particularly, it is largely unknown whether SNS use has a negative impact on adolescents' physical health outcomes, and through what mechanism it might act to affect adolescents' health.

### 1.2. The effect of adolescents' SNS use on their sleep duration

Sleep duration refers to the number of hours of sleep attained between bedtime and awakening (Meijer & Wittenboer, 2000). It is distinct from sleep quality, which is a subjective measure of how rested and satisfied a person feels with his or her sleep experience (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010). While there is some overlap in the effect a deficiency in either of these areas may have, the variables themselves are not strongly correlated (Meijer & Wittenboer, 2000). Reduced sleep duration is of particular medical importance because it leads to major health issues, such as daytime sleepiness (Arora, Broglia, Thomas, & Taheri, 2014), obesity (Cappuccio et al., 2008), and immune system dysfunction (Friese, Diaz-Arrastia, McBride, Frankel, & Gentilello, 2007).

There is a relationship between adolescents' electronic device use and sleep deprivation (den Bulck, 2004; Nuutinen, Ray, & Roos, 2013). A potential explanation is that the spectrum of light emitted by computer screens falls within the wavelength of blue light (460–480 nm) which has been found to suppress melatonin biosynthesis (Tähhämö, Partonen, & Pesonen, 2019), which, in turn, alters a circadian rhythm, thereby affecting sleepiness (Cajochen et al., 2011).

Human sleep-wake cycles are driven by circadian rhythms, which are internal processes that match cellular outputs in response to external environmental cues. The circadian clock is a biochemical oscillator which facilitates the sleep-wake cycle, and it is responsible for timekeeping, entrainment (synchronization with the external world), and signaling cell outputs (Swan, Golden, LiWang, & Partch, 2018). Light exposure influences melatonin secretion, which regulates the sleep-wake cycle. Melatonin, a hormone produced and secreted by the pineal gland, acts as the body's biological signal of darkness (Gooley et al., 2011). When an organism is exposed to light, melatonin synthesis is suppressed and the circadian rhythm resets. When adolescents use SNS late night, the blue

light emitted by the screens of electronic devices, such as smartphones, laptops, and desktops, replicates the suppressive effects of natural lighting on melatonin which, in turn, resets users' circadian rhythms right before bedtime, making it more difficult to fall asleep.

While there have been a number of studies on the effect of technology use on sleep, most tend to lump different types of media together (Hale & Guan, 2015) or focus on video games (Turel, Romashkin, & Morrison, 2017; Turel, 2020). However, compared to the other types of media (e.g., multiplayer video games, television), SNS can have the strongest impact on reduced sleep duration (Arora et al., 2014), perhaps because SNS can be easily used right before bed time and via smartphones. Therefore, this study hypothesizes that:

**H1.** Adolescents' extent of use of social networking sites is negatively associated with their sleep duration.

### 1.3. The effect of adolescents' SNS use on their healthy eating behavior

The effect of SNS use on adolescents' eating behavior may be explained by employing the social ecological model as a lens of analysis (Vaterlaus, Patten, Roche, & Young, 2015). This model posits that people make decisions on what to eat based on the influence of four general categories of variables: 1) individual factors, 2) environmental settings, 3) sectors of influence, and 4) social and cultural norms and values (Freeland-Graves & Nitzke, 2013). In the SNS context, the most relevant *individual factors* pertain to psychological dimensions that influence one's choice of nutrition. Evidence suggests that extensive SNS use is associated with neuroticism (Ryan & Xenos, 2011; Xiao & Mou, 2019), which in turn is related to a greater likelihood of developing various eating disorders (MacLaren & Best, 2009).

*Environmental settings* refer to external factors facilitating or inhibiting the consumption of food. SNS use is highly engaging and even addictive (Ponnusamy, Iranmanesh, Foroughi, & Hyun, 2020; Seo & Ray, 2019; Turel & Serenko, 2012). In the adolescent brain, an enhanced response to dopamine results in increased reward sensitivity (Telzer, 2016). Humans have an evolved preference for energy-dense food, and when given a choice between that and other less energy-dense food, they tend to experience a greater motivational response towards the former (Bailey, 2016). This could lead to a greater inclination towards unhealthy food in adolescents. Despite this autonomic response, cues in the environment (such as physical availability of energy-rich food, exposure to media and advertising) can influence the intensity of this reaction. For example, unhealthy ("junk") food is typically faster to consume and poses less interruption to adolescents' SNS use habits compared to healthy meals that include fruits and vegetables, which require preparation and consumption time. Moreover, many adolescents start using SNS (e.g., chatting with their friends) as soon as they wake up, and they may be distracted by their SNS-connecting devices when it is time to have a meal. This, in turn, may make them skip the meal (e.g., breakfast) entirely.

SNS *sectors of influence* are represented by the food and beverage industry which employs SNS as a major advertising channel to reach the population of adolescents. As a result, SNS have become a widely used platform for dietary information, and certain SNS, such as Instagram and Twitter, are particularly popular for sharing food-related content. However, a majority of SNS food and beverage advertisements promote extremely unhealthy energy-dense, nutrient-poor products, such as fast food and sugar-sweetened beverages (Potvin Kent, Pauzé, Roy, de Billy, & Czoli, 2019). Companies often organize competitions, prizes, giveaways, and games to promote their "digital junk" which are directed at all SNS users including adolescents (Freeman et al., 2014). The posts and advertisements featuring unhealthy, yet visually appealing, food choices are popular among adolescents and generate high user engagement in terms of viewing and sharing. As a result, some may select junk food over fruits and vegetables or consume energy drinks instead of having a proper breakfast. To combat this issue, some healthcare organizations tried to leverage SNS as platforms for promoting dietary interventions.

Unfortunately, the efficacy of such programs has never been confirmed (Chang, Chopra, Zhang, & Woolford, 2013; Williams, Hamm, Shulhan, Vandermeer, & Hartling, 2014) suggesting that SNS use generally has a negative impact on adolescents' healthy eating behavior.

Relevant *social and cultural norms and values* pertain to belief systems, priorities, lifestyle, and body image which also influence adolescents' nutritional choices (Freeland-Graves & Nitzke, 2013). The impact of social and cultural norms and values on adolescents' eating behavior may be explained from the perspective of social comparison theory (Festinger, 1954). SNS users have an inner drive to perceive themselves as looking better in relation to others. To determine their relative standing, they actively compare themselves with others in their reference group (Baker, Ferszt, & Breines, 2019; Bue, 2020; Rosenthal-von der Pütten et al., 2019). On SNS, adolescent users compare their photos with the borderline-realistic, heavily edited images of models and celebrities demonstrating "ideal" body types. When they do not look as thin as their idols, they become highly concerned with their negative body image and drive for thinness by any means (Tiggemann & Slater, 2013). Because adolescents are highly susceptible to online social influence (De Jans, Van de Sompel, De Veirman, & Hudders, 2020), they may often accept the cultural norms and values projected by SNS and mimic their "idols" by engaging in extreme dieting and skipping meals. Consequently, a growing body of research attests to the negative impact of SNS use on body image (Gültzow, Guidry, Schneider, & Hoving, 2020; Saiphoo & Vahedi, 2019) leading to disordered eating (Holland & Tiggemann, 2016).

Thus, consistent with the social ecological model, it is hypothesized that due to the presence of the four mechanisms discussed above (i.e., individual factors, environmental settings, sectors of influence, and social and cultural norms and values), SNS use influences adolescents' unhealthy eating behavior:

**H2.** Adolescents' extent of use of social networking sites is negatively associated with their healthy eating behavior.

### 1.4. The effect of adolescents' sleep duration and eating behavior on their health

Generally, insufficient sleep duration has been linked to an increase in health complications, such as diabetes, hypertension, cardiovascular disease, stroke, obesity, and overall mortality (Itani, Jike, Watanabe, & Kaneita, 2017). Particularly, in adolescents, shorter sleep duration has been empirically connected to poor academic performance, mental health issues, and reckless behavior. It is thought that adolescents are particularly vulnerable to sleep deprivation, as they are in the midst of a crucial physiological developmental period (Keyes, Maslowsky, Hamilton, & Schulenberg, 2015). There are many bio-physiological mechanisms explicating the effect of insufficient sleep duration on adolescents' health. For example, lack of sleep boosts the activity of the sympathetic nervous system, leading to higher blood pressure (Tochikubo, Ikeda, Miyajima, & Ishii, 1996). Insufficient sleep causes fatigue which reduces adolescents' desire to engage in physical exercise which further leads to exhaustion, stress, and burnout (Söderström, Jeding, Ekstedt, Perski, & Åkerstedt, 2012). Thus:

**H3.** Adolescents' sleep duration is positively associated with their general level of health (and lack of sleep is negatively associated with general health).

Having a good diet is vital for the maintenance of strong health. It is particularly important in adolescence, because a sound diet provides essential nutrients for growth and helps people establish positive eating habits that may last a lifetime (WHO, 2005). Whereas there are many dimensions of a healthy diet for adolescents, two important criteria are what type of food they consume and how they do so. First, it is critical to maintain a diverse diet to avoid micronutrient deficiencies, which presently exist in both developing and developed countries. Adolescents are

highly vulnerable to micronutrient malnutrition because of continuous growth and development, and greater dietary diversity is associated with nutrient adequacy (Steyn, Nel, Nantel, Kennedy, & Labadarios, 2006). Of particular importance is fruit and vegetable intake (Nicklett & Kadell, 2013). Fruits and vegetables contain a wide range of nutrients that have been linked to the prevention of cancer and cardiovascular diseases (van't Veer, Jansen, Klerk, & Kok, 2000), and their fiber content is conducive to the prevention of obesity (Slavin & Lloyd, 2012). Greater fruit and vegetable intake is also linked to higher levels of happiness and psychological well-being (Mujcic & Oswald, 2016), which, in turn, boost one's general level of health.

Second, having regular meals is as important as maintaining dietary diversity. Out of all meals, breakfast occupies perhaps the most salient position because regularly eating breakfast has been linked to positive health outcomes, such as cognitive performance, weight management, and better micronutrient intake (Gibney et al., 2018). A World Health Organization survey of 200,000 schoolchildren in 39 different countries discovered that 39% of 13 year old and 45% of 15 year old children skip breakfast on school days (Currie et al., 2012). Another study revealed that almost one-half of all children do not regularly consume breakfast on weekdays which negatively affects their health (Gibney et al., 2018). Overall, poor eating behavior, including a low intake of fruits and vegetables and having irregular meals deteriorates the general health level of adolescents:

**H4.** Adolescents' healthy eating behavior is positively associated with their general level of health (and unhealthy eating behavior is negatively associated with general health).

Research shows that insufficient sleep is related to adolescents' unhealthy eating behavior (Duraccio, Krietsch, Chardon, Van Dyk, & Beebe, 2019). The mechanism driving this relationship includes meal skipping (Otsuka et al., 2019) and inadequate dietary choices (Tambalis, Panagiotakos, Psarra, & Sidossis, 2018). First, meal skipping has become a common problem among adolescents. Breakfast is the most frequently missed meal which often happens due to a lack of time (Pendergast, Livingstone, Worsley, & McNaughton, 2016). Insufficient sleep time leads to morning fatigue, which makes adolescents less efficient, unorganized, irritable, and slows their routine. They cannot build regular breakfast consumption habits and consistently adhere to them. Those who stay late at night may consume extra snacks which mostly consist of sugar and energy-rich food and they may not feel hungry in the morning. As a result, they skip meals, particularly breakfast. Second, insufficient sleep leads to poor dietary choices. Evidence suggests that adolescents who experience sleep restrictions consume more food with fat (St-Onge et al., 2011) and high carbohydrate content (Nedeltcheva et al., 2009) at the expense of fruits and vegetables (Ferranti et al., 2016). This occurs because shortened sleep hours reduce the amount of time adolescents spend in the rapid eye movement (REM) phase of sleep which imbalances food regulation mechanisms (St-Onge & Shechter, 2013). The following hypothesis is proposed:

**H5.** Adolescents' sleep duration is positively associated with their healthy eating behavior (and lack of sleep is negatively associated with healthy eating behavior).

Evidence suggests that there are differences in how males and females interact on social media (Todd & Melancon, 2019). For instance, females are more likely to use emoji (Jones, Wurm, Norville, & Mullins, 2020), post photos and selfies (Shane-Simpson, Schwartz, Abi-Habib, Tohme, & Obeid, 2020), use instant messaging, visit blogs (Pujazon-Zazik & Park, 2010), give and receive social support (Tifferet, 2020), and express privacy concerns (Tifferet, 2019) than males. On SNS, male adolescents are more likely to make posts referencing violence, while females are more likely to reference sexual behavior (Moreno, Parks, Zimmerman, Brito, & Christakis, 2009). Males are also more prone to technology addiction than females (Su, Han, Jin, Yan, & Potenza, 2019). Most importantly, males and females respond to the extent of SNS use differently. For instance, Keresteš and Stulhofer (2020) report that high SNS use has an

effect on females' life satisfaction but not on males', and Jenkins et al. (2020) show that SNS contribute to a lower health-related quality of life of females but not of males. Given that there are differences in how males and females use, perceive, and are affected by SNS, it may be worth exploring whether these differences lead to any divergence in the impact of SNS use on adolescents' health outcomes. Due to inconsistencies in the extant literature, it is impossible to predict how sex affects the relationships proposed in the hypotheses above. Thus, a general research question instead of hypotheses is suggested:

Research Question: how does sex affect the strengths of the relationships proposed in H1-H5?

Overall, this study proposes five hypotheses and one research question in the context of adolescents' SNS use. The hypotheses explore the association of adolescents' SNS use with their sleep duration and eating behavior, which, in turn, impact their general health level. In other words, in order to maintain a good level of health, adolescents are supposed to get an adequate amount of sleep and maintain an adequate diet, but these factors may be affected by their extent of SNS use. Consistent with the literature, it is also hypothesized that adolescents' sleep duration is positively associated with their healthy eating behavior – in order to maintain a healthy diet, it is necessary to obtain a sufficient amount of sleep. In addition, considering well-documented differences between males' and females' use of and response to social media, this study explores whether the proposed relationships are affected by adolescents' sex. It is hoped that by answering the hypotheses and the research question above, important theoretical insights may be obtained leading to essential practical recommendations with the goal to help adolescents improve their general health level. The findings may also have important societal implications because SNS have become an irrevocable part of many people's lives, but they may have a (presumably negative) impact on people's health. Presently, health issues have expanded into many aspects of our society because the healthcare system represents a major part of most countries' Gross Domestic Product and people's personal expenses. As a society, we also have a moral responsibility to assist adolescents in making proper decisions on their use of technology.

## 2. Methodology

Data were collected by the Centre for Longitudinal Studies, London, UK for the UK Millennium Cohort Study (MCS) and shared with the authors of this study. All research ethics issues were handled during data collection. MCS is a longitudinal study that tracks a sample of people born in 2000–2002. The original cohort included 18,818 babies selected from England, Scotland, Wales, and Northern Ireland but due to attrition reduced to 11,884 by 2016 (University of London, 2020). The sample was drawn from the entire UK population from children by relying on the list provided by the Child Benefit (CB) register which contained the names of all children receiving the UK CB. The target population was stratified by UK country (England, Wales, Scotland, and Northern Ireland) to achieve an adequate representation of the population yet to ensure the inclusion of the key sub-groups (for detail, refer to Plewis, Calderwood, Hawkes, Hughes, & Joshi, 2007). Non-response occurred when the researchers were not able to reach the family (e.g., they recently moved at another address or emigrated). The non-response bias, however, was unlikely to affect the results (for detail, refer to Hansen et al., 2014). COVID-19 did not have an impact on data quality because the data collection process was completed much earlier.

All constructs were operationalized based on the extant literature and the commonly employed measurement techniques. The use of SNS was operationalized as the average number of hours the respondent uses various SNS per week (i.e., the measure captured the total use of any SNS that an adolescent had access to). This was originally reported on a 1 (zero) to 8 (7 h or more) Likert-type scale. To avoid artificial distancing between points, all values were converted to estimated hours. For example, the value 5 on the Likert-type scale indicated 2 to 3 h, and was accordingly recorded as 2.5 h. Sleep duration (in hours) was

operationalized as the weighted average of school-day sleep (5/7) and weekend/non-school day sleep (2/7) durations. These were calculated as the differences between the self-reported wake up time and the time the respondent goes to sleep 1) when there is school next day; and 2) when there is no school next day. Healthy eating was operationalized as the average of three indicators: 1) how often the respondent eats at least two portions of fruit per day; 2) how often the respondent eats at least two portions of vegetables per day; and 3) how often the respondent eats breakfast. They were measured on a three-point scale: 1 = “never”; 2 = “some days, but not all days”; to 3 = “every day.” These operationalization items were selected because sleep duration, fruit and vegetable intake, and eating breakfast have been frequently employed in other studies (Huang, Hu, Fan, Liao, & Tsai, 2010; Itani et al., 2017; Nicklett & Kadell, 2013). The health outcomes were operationalized as a single-item self-reported measure of the respondent’s overall health, measured on a scale from 1 (poor) to 5 (excellent), which is a common approach in health science research (e.g., see McGee, Liao, Cao, & Cooper, 1999).

The analytical plan included running a MANOVA model to examine potential differences between males and females. The hypothesized model, which included an independent variable, a dependent variable, and two mediators, was tested as model #6 in the PROCESS macro in SPSS 27 by following the recommendations of Preacher and Hayes (2004). In addition, as an exploratory step, the moderating role of sex on the paths in the model was tested with model #92 in the PROCESS macro in SPSS 27 (for detail, see Preacher & Hayes, 2004). All models included age and sex as covariates, given possible age and sex differences in social media and offline behaviors. Significance of direct paths was evaluated with *p*-values, and that of mediated paths (indirect effects) was estimated through 95% bias-corrected confidence intervals.

### 3. Results

The full sample included 11,884 respondents, but some records had missing values. After removing these records, we retained an operational sample of *n* = 11,406. 49.9% were females. The average age was 13.77 years old (standard deviation = 0.45), ranging from 13 to 15 years old. Table 1 presents descriptive statistics of the variables used to test the proposed hypotheses and the research question. The results of a MANOVA test revealed statistically significant differences between male and female respondents on all items (Wilks’ Lambda = 0.890, *p* < 0.0005; all pairs were different at *p* < 0.05). Overall, it showed that female respondents use SNS to a larger degree, perhaps at the expense of sleep when there is school next day. To compensate for the lack of sleep, they sleep longer on days when there is no school in the morning. On the one hand, females tend to eat two portions of fruits and vegetables more often, but they skip breakfast more often than males. Despite that, females report a higher level of general health.

**Table 1**  
The variables.

Variable	Male		Female		Overall	
	Mean	SD	Mean	SD	Mean	SD
Weekly SNS use (hours)	2.00	2.04	3.15	2.33	2.58	2.27
Sleep duration – school next day (hours)	8.70	1.04	8.55	1.05	8.62	1.04
Sleep duration – no school next day (hours)	10.46	1.27	10.60	1.20	10.53	1.23
How often the respondent eats at least two portions of fruits per day (scale)	2.21	0.59	2.24	0.58	2.22	0.59
How often the respondent eats at least two portions of vegetables per day (scale)	2.26	0.61	2.33	0.60	2.29	0.61
How often the respondent eats breakfast (scale)	2.57	0.59	2.33	0.68	2.45	0.65
The general level of health (scale)	2.42	0.92	2.63	0.90	2.53	0.92

The proposed hypotheses imply that the effect of SNS use on one’s general health level is at least partially mediated through sleep duration and healthy eating. Hence, the model was tested with the PROCESS macro in SPSS by Preacher and Hayes (2004). The hypothesized mediation model (two mediators, model #6 in PROCESS) was tested first, after controlling for age and sex. Fig. 1 indicates that all hypotheses (i.e., H1-H5) were confirmed. The results support full mediation because the direct effect of SNS use on general health is not significant. Only the effects mediated through sleep (95% CI: [-0.0080;-0.0045]), healthy eating (95% CI: [-0.0304;-0.0245]) and through both sleep and healthy eating (95% CI: [-0.0039;-0.0026]) are significant. The mediated effect through sleep duration was significantly smaller than that through healthy eating (95% CI for difference: [0.0177; 0.0247]).

We next tested the presumed moderating role of sex in the model, by including sex (0 = female, 1 = male) as a moderator of all paths in the hypothesized model (model #92 in the PROCESS macro). Several differences in the strength of the tested relationships were observed. First, the negative effect of SNS use on sleep duration was significantly more negative for females (conditional  $\beta = -0.0957, p = 0.0001$ ) than for males (conditional  $\beta = -0.0778, p = 0.0001$ ). Second, the negative effect of SNS use on healthy eating was, again, stronger for females (conditional  $\beta = -0.0500, p = 0.0001$ ) than for males (conditional  $\beta = -0.0297, p = 0.0001$ ). Third, the positive effect of sleep duration on general health was significantly more positive for females (conditional  $\beta = 0.1005, p = 0.0001$ ) than for males (conditional  $\beta = 0.0396, p = 0.0046$ ). Last, the positive effect of healthy eating on general health was significantly positive for males (conditional  $\beta = 0.022, p = 0.0004$ ) but it was not observed for females (conditional  $\beta = -0.0054, p = 0.3041$ ). Thus, because three out of four relationships were stronger for females, it is concluded that SNS use has a stronger negative impact on female than male adolescents.

### 4. Discussion

This study’s findings lead to several important theoretical implications. First, it was confirmed that the use of SNS is associated with shorter sleep duration for both male and female adolescents – adolescents who use SNS more tend to go to sleep later and/or wake up earlier (this is how sleep duration was operationalized in this study). This finding supports previously documented conclusions explicating the impact of electronic device use on adolescents’ sleep deprivation (den Bulck, 2004; Nuutinen et al., 2013). SNS may directly impinge upon sleep hygiene by encouraging adolescents to postpone sleep in favor of staying engaged with online social activities. SNS can also affect sleep hygiene by creating distractions and a sense of urgency to check notifications when an adolescent is trying to asleep. Some users may also want to wake up earlier in order to check the recent SNS messages, notifications, and happenings. It is also possible that later wake times could be attributed to adolescents whose circadian rhythms are imbalanced by the light emitted from the screens of their electronic devices, which makes them fall asleep later than the norm but still wake up on time for school.

The relationship between SNS use and sleep duration was found to be stronger for females than for males. Females also use SNS more at the expense of breakfast and sleep when there is school next day. Prior research shows that females tend to use SNS more frequently and intensively than males, which can require them to spend extra time online at the expense of sleep (Herring & Kapidz, 2015). Thus, females have a higher risk of being negatively affected by social media use, at least in terms of sleep, compared to males. This adds to the body of knowledge regarding sex differences in sleep problems. Adolescent females tend to have more sleep problems compared to males, due, in part, to hormonal fluctuations, psychological factors (as per the established links between puberty, depressive thoughts, and insomnia), and physical factors such as a higher tendency for overactive bladder compared to males (Mallampalli & Carter, 2014). We show that another contributing factor is SNS use, the duration of which tends to be higher in female adolescents compared to in male adolescents (Bradbury, Turel, & Morrison, 2019).

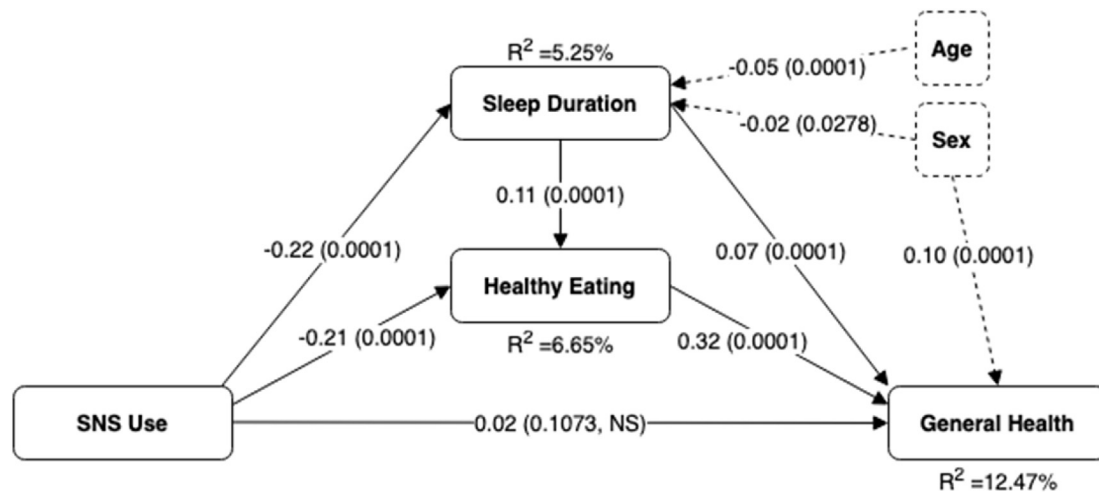


Fig. 1. The Model\*

\*  $p$ -values are in parentheses; Control variables are indicated by the dashed lines (only significant effects are included); NS = non-significant.

Second, the findings indicate that SNS use has a negative association with healthy eating behavior, and this relationship is stronger (more negative) for female adolescents. One factor explaining this sex-based disparity is that in general, not only do girls tend to have higher levels of dissatisfaction with their bodies, but they also base their self-image on interpersonal communication and with popular, admired people (Golan, Hagay, & Tamir, 2014) referred to as influencers, who dominate many SNS, particularly Instagram. Many influencers often project unrealistic images of “idealized” bodies and drive young girls’ desire to be thin who, in turn, are more likely to resort to skipping breakfast as a way of trying to lose weight than males are (Shaw, 1998). SNS use may also affect healthy food intake through the reduced sleep it induces. People simply cannot make smart food choices even after minimal sleep disturbances (Broussard & Van Cauter, 2016). Prior research showed that a smaller percentage of female adolescents compared to male adolescents consume the recommended grain intake, but more females than males consume the recommended intake of fruits and vegetables (Neumark-Sztainer, Story, Hannan, & Croll, 2002). Our findings are in line with such insights, in that in our sample too, females had a higher consumption of fruits and vegetables, but still had worse healthy eating habits compared to those of males. Our results contribute to existing research on sex differences in healthy eating by showing that observed differences in healthy intake of foods may be in part due to SNS use which perhaps instills more body image issues in females, and the stronger disturbance it exerts on females’ sleep compared to males’ sleep.

Third, adequate sleep duration and healthy eating behavior are positively associated with good health. This finding supports much of the previous literature and health guidelines emphasizing the importance of sleep and proper diet (e.g., see Wickham, Amarasekara, Bartonicek, & Conner, 2020). To maintain a good level of general health, it is vital for adolescents to get enough sleep, never skip breakfast, and consume a sufficient amount of fruits and vegetables. The direct effect of sleep on health level was much lower than that of healthy eating ( $\beta = 0.07$  for sleep vs.  $\beta = 0.32$  for healthy eating). However, the effect of sleep on health is partially mediated through healthy eating, which suggests that sleep also negatively affects adolescents’ eating behavior by making them skip meals and make poor dietary choices (e.g., see Kruger, Reither, Peppard, Krueger, & Hale, 2014). Thus, the role of sleep should not be underemphasized in the context of health. Since the use of IT (including SNS) can be associated with reduced sleep hygiene and unhealthy food consumption habits, more research on the effect of IT use on health should be conducted. Last, it may seem that the proposed model has a low predictive power because it explains only 12.47% of the variance in the dependent construct. However, it is critical to consider the nature of the

dependent construct in this study: the overall level of one’s health. Thus, the finding that SNS use, through sleep and eating behavior, contributes to 12.47% of one’s overall health level is, in fact, a very significant discovery.

In addition to the findings above, it was discovered that the negative impact of SNS use on adolescents’ general health level is fully mediated through sleep duration and healthy eating. This shows that by itself, SNS use does not directly affect adolescents’ health. Instead, it is the consequences of heavy SNS use, including insufficient sleep and unhealthy eating, that deteriorate adolescents’ general health level. This suggests that special attention should be paid to the mediating factors triggered by SNS overuse that negatively affect adolescents’ general health. In fact, those adolescents, who engage in heavy SNS use but find ways to ensure that they devote a sufficient amount of time to sleep and manage their diet so that they regularly have breakfast and consume fruits and vegetables, may minimize and even eliminate a potentially negative effect of their SNS use. Ultimately, the findings show that the extent of SNS use is generally negatively associated with health outcomes, and that this effect is fully mediated through the sleep and eating disturbances that SNS use drives.

The findings also have practical implications. Academic and practitioner literature on SNS use generally emphasizes the negative aspects of this technology and advocates limiting the amount of time devoted to SNS (Turel, 2019; Turel & Ferguson, 2020). The present study also identified a negative effect of SNS use. Based on the findings and consistent with H1 and H2, it seems reasonable to suggest that adolescents should be recommended to limit the extent of their SNS use. In reality, it is unlikely that adolescents may alter their SNS use habits because for them, this technology has become a key communication medium and part of the cultural fabric of the contemporary society (Orben, 2020; Turel, Matt, Trenz, & Cheung, 2020). Through SNS, adolescents keep in touch with their family and friends, communicate with them, schedule events, and share news, happenings, and various digital content. Frequently, SNS apps are the last thing they check before falling asleep and the first one they access after waking up (Scott & Woods, 2018). As such, it may be virtually impossible to substantially minimize their SNS use time. However, this study’s findings offer a different perspective on how to approach this issue by relying on the fact that the negative impact of SNS use on health is fully mediated through sleep duration and healthy eating behavior. Thus, if adolescents learn how to suppress the negative effect of SNS use on their sleeping and eating habits (i.e., suppress the relationships explicated in H1 and H2), the overall (negative) indirect impact of SNS use on health would be minimized. Thus, it is less important how much time adolescents spend on SNS; what

is important is whether they can manage their sleeping and eating habits, despite spending time on social media. In other words, if adolescents find ways to manage their sleeping and eating behavior by suppressing the associations explicated in H1 and H2, the amount of SNS use would not affect their overall health level.

Thus, teaching adolescents (especially females) how to avoid social media use before bedtime and during mealtime or how to become more aware of the importance of sleep hygiene may be more fruitful strategies compared to eliminating or generally reducing social media use. For example, educators and policymakers may need to develop intervention programs and approaches to inform adolescents about the health-related harm associated with heavy SNS use and, most importantly, to emphasize that this negative impact is due to their inadequate sleeping and eating hygiene. The key objective of these intervention programs should be to teach adolescents how to properly manage their sleeping and eating routine despite their SNS use. In addition, parents, teachers, and health professionals should more closely monitor SNS use in adolescents and pay attention to how SNS impact their health. Adolescents should not only realize the negative changes in their sleeping and eating routine but also actively develop and implement approaches for improving them, for example through mindfulness training (Elhai, Levine, O'Brien, & Armour, 2018) or developing implementation intentions (Gollwitzer, 1999). Again, these approaches would reduce the negative impact of SNS use on their sleeping and eating routine and, as a result, on their general health level.

On the one hand, this study had several strengths. First, it employed a large sample size which allowed to accurately capture the phenomenon of interest. Second, it focused on a very important technology (i.e., SNS) that plays a vital role in the lives of contemporary adolescents. Third, studying health outcomes has always been of particular interest to various stakeholders because they lead to people's happiness and physical and psychological well-being. On the other hand, despite its contribution, this study had several limitations. First, heavy SNS use may lead to other undesirable outcomes, including school, family, and relationships problems which were omitted in this study. Thus, these issues are worth exploring in future research. Second, this study relied on data collected in a single country (i.e., the UK). However, since national culture may influence people's behaviors, perceptions, and technology use (Palvia et al., 2017), this study's findings should be replicated in other cultural contexts. Third, this study relied on self-reported measures which may be affected by various personal biases. To avoid this issue, future researchers are recommended to employ implicit measures that indirectly capture the constructs of interest (Serenko & Turel, 2020b; Serenko & Turel, 2021; Turel & Serenko, 2020). Fourth, it is unknown whether the negative impact of SNS use disappears as adolescents get older. It is possible that as they mature, they exhibit more control over their SNS use habits and eventually reduce its use. In fact, it is very important not to overpathologize people's behavior that may not produce negative long-term impacts (Billieux, Schimmenti, Khazaal, Maurage, & Heeren, 2015). Fifth, there may be other variables – for instance, ethnicity and socio-economic status – that may be tested as predictors of adolescents' health. We hence call for future research to further examine this proposition.

## 5. Conclusion

The purpose of this study was to evaluate whether adolescents' SNS use has an impact on their health outcomes. By using data from the Millennium Cohort Study, we were able to ascertain how adolescents' general health is related to their extent of SNS use. The results show that the overall effect of SNS use on adolescents' general health is fully mediated through their sleeping and eating behavior, and that sleeping also affects eating habits. The effect of SNS on health is stronger for female than for male adolescent users which shows that females should be more careful with their use of SNS. Currently, it may be difficult to make adolescents reduce their degree of SNS use due to a high level of SNS

penetration and adolescents' dependence on the use of SNS as a major communications medium. However, the findings suggest that the negative impact of SNS use on health may be reduced if adolescents learn how to manage their sleeping and eating hygiene regardless of the number of hours that they spend on SNS. Thus, with SNS use becoming a cornerstone of adolescent life, it is important that policymakers create solutions to deal with the health and psychosocial effects that can arise from its use. Public health interventions can teach adolescents how to better balance SNS use with the rest of their lives and, particularly, with their sleeping and eating routine. Special attention should be paid to female adolescents and some interventions should be focused on them specifically. More research should be done to evaluate which specific types of SNS are related to unhealthy eating behaviors.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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