Submitted To: ***Sleep Medicine Reviews (SMRV-D-20-00049)***

Interplay Between Social Media Use, Sleep Quality, and Mental Health in Youth: A Systematic Review

Rea Alonzo,[a] Junayd Hussain,[a] Saverio Stranges,[a,c,d] Kelly K. Anderson[a,b]

Departments of [a] Epidemiology & Biostatistics, [b] Psychiatry, and [c] Family Medicine, Schulich School of Medicine & Dentistry, The University of Western Ontario, London Ontario CANADA
[d] Department of Population Health, Luxembourg Institute of Health, Strassen, LUXEMBOURG

Running Head: Social Media, Sleep, and Mental Health in Youth

Corresponding Author: Kelly K. Anderson, PhD, kelly.anderson@schulich.uwo.ca, Mailing address: Department of Epidemiology & Biostatistics, The University of Western Ontario, 1151 Richmond Street, Kresge Building, Room K213, London, ON, N6A 5C1, Phone: +1 (519)-661-2111 ext. 81001, Fax: +1 (519) 661-3766

Conflict of interest: The authors have declared no conflict of interest.

Acknowledgments:
The authors are grateful for Western Libraries for database access and would also like to thank Mrs. Marisa Tippett's assistance in literature search protocols.

SUMMARY

Social media applications are increasingly prominent among youth. This systematic review provides a comprehensive assessment of the literature on the relationship between active social media use, sleep quality, and common mental health outcomes (anxiety, depression, and psychological distress) among youth. MEDLINE, PsychINFO, EMBASE and Scopus were searched for observational studies investigating this relationship among youth (aged 16-25). Thirty-six cross-sectional studies and six prospective cohort studies met the inclusion criteria. Among cross-sectional studies, significant associations between excessive social media use with poor mental health outcomes (n=33), poor sleep quality (n=24), and significant associations between poor sleep quality and negative mental health (n=16) were found. In longitudinal studies, frequent social media use was a risk factor for both poor mental health (n=6) and poor sleep outcomes (n=5). Some studies showed sleep quality mediating the relationship between social media use and negative mental health outcomes in youth. Overall, included evidence links excessive social media use to poor sleep quality and negative mental health in youth. Given the public health implications of sleep problems, excessive social media use warrants further investigation to clarify the directionality and strength of their associations with poor sleep quality and negative mental health outcomes.

Keywords: youth, social media, sleep quality, mental health

Abbreviations:

ADHD	attention deficit hyperactivity disorder
CLARITY	Clinical Advances Through Research and Information Translation
FOMO	fear of missing out
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

INTRODUCTION

Restful sleep is necessary for optimal physical and mental health. However, insufficient sleep is a prevalent and pressing health issue in today's fast-paced connected society.[1] Sleep loss generally refers to sleep duration shorter than the seven to nine hours necessary for restful sleep, whereas sleep disturbance refers to poor sleep quality that hinders daily functioning.[2] Poor sleep is associated with excessive daytime sleepiness, depressed mood, and difficulty concentrating,[3] as well as more insidious, long-term outcomes such as chronic disease.[2] In Canada, 32% of adults (aged 18-64) reported sleeping for fewer than seven hours per night [4] and approximately 70 million adults in the US and around 45 million in Europe are suffering from a chronic sleep disorder.[1,5-7] This is a particularly important issue for youth, as sleep disruption has a negative effect on psychosocial health and may promote risky behaviors such as abuse of nicotine and marijuana.[8] However, the current literature suggests links between sleep hygiene and psychological issues to be bidirectional.[9] Thus, the relationship between poor sleep and emotional and behavioral difficulties in youth should be further investigated.

Recently, there has been a growing body of literature surrounding social media use and its effects on sleep quality and mental health in youth. Social media are defined as Internet-based applications that facilitate exchange and exploration of user-generated content.[10,11] Social media and other internet-based technologies are a pervasive part of today's connected world with the greatest adopters being young adults, 60% of whom report using screens within an hour before bedtime.[12,13] According to a recent report, 81% of youth report use social media.[14] By virtue of being interactive, social media platforms have their benefits (e.g. spreading and engaging in healthy practices) and risks (e.g. sedentary behavior, longer sleep latency, depression).[15] Adolescence is characterized by a need for identity development and peer acceptance, which social

media currently plays a role in facilitating, often at the expense of sleep and sound mental health.[15,16]

The current body of evidence on the directionality and relationships between social media use, mental health, and sleep is inconclusive. It has been suggested that the amount of time spent online can have bidirectional effects on depressive symptoms and attention deficit hyperactivity disorder (ADHD), and this risk is particularly heightened in those with pre-existing poor mental health.[17] Moreover, it has been suggested that social media use closer to bedtime is associated with increased cognitive arousal, leading to delayed sleep latency and difficulties maintaining sleep.[18] Several hypotheses have been posed regarding this relationship, including time spent online "displacing" time spent on sleep and face-to-face interactions, compensating for lack of social skills and inability to sleep, and an obligation to always be available.[18,19] Youth are most prone to peer pressure as they are still developing a sense of self-regulation as they mature. As such, they may be at higher risk for adverse effects of social media use, notably poorer sleep and mental health outcomes.[20,21] Therefore, knowing the effects of social media use on sleep and mental health is important for both informing health policies and personal decisions, as well as assessing social media as a facilitator for health improvement.

The objective of this systematic review was to describe the association between social media use, sleep quality, and mental health in youth. As a secondary objective, we also sought evidence on the role of these variables as mediators, moderators, or confounders of this relationship.

METHODS

Protocol and Registration

The protocol for this review was registered with the International Prospective Register of Systematic Reviews (Prospero; CRD42019127527) on March 5, 2019. This review follows the reporting guidelines outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[22]

Search strategy

We searched MEDLINE, PsychInfo, EMBASE, and Scopus electronic databases in February 2019 using a combination of controlled vocabulary and keywords, and the search was updated in November 2019. Forwards and backwards citation tracing for included studies was also conducted to identify relevant studies missed by the electronic search strategy, lasting until April 2020. The full search strategy for each database is provided in the online supplement ("See supplementary table S1").

Inclusion and exclusion criteria

We included studies that assessed active social media use, sleep quality, and common mental health conditions, including depression, anxiety, and psychological distress. All three variables must have been reported, with variables for sleep and mental health measured in each study using validated scales (e.g. Pittsburgh Sleep Quality Index, the Beck Depression Inventory, etc.). Although our age group of interest was youth aged 16 to 25 years, we included studies that used an age range of 12 to 30 years to ensure we did not miss any relevant information. Finally, we included observational studies that were published after 1990, which was the year when many social media sites were established.[23,24] We did not impose any restrictions on the language of publication.

We excluded studies if they primarily focused on the use of passive social media (e.g. watching TV, listening to music, etc) and electronic devices not capable of accessing social media (e.g. video games). We also excluded studies assessing clinical sleep disorders (e.g. insomnia, restless legs syndrome, etc.) and those focused on other mental disorders (e.g. psychotic disorders, eating disorders). Studies which were not peer-reviewed and dissertations were not included in our review.

Study selection

Two reviewers (RA & JH) independently retrieved citations and screened titles for inclusion. All selected papers from the title screen were saved on Mendeley reference management software, where both reviewers independently screened and reviewed abstracts using a standard form. Disagreements on selected abstracts were resolved through discussion and consensus between the two reviewers.

Data extraction and risk of bias assessment

Data extraction for eligible studies was conducted independently by one reviewer (RA) using a standard form on Microsoft Excel and was verified by a second reviewer (JH). Data on study authors, publication date, study design (cross-sectional or prospective cohort study), location of study, sample size, source of sample (nationally representative or convenience sample, etc.), the measurement tools employed, and demographic information of the study population were extracted from full-text articles. The main findings – including activity and duration of social media use, sleep quality and duration scores, as well as anxiety, depression and psychological

distress scores – were also extracted. Discrepancies in the extracted data were resolved through discussion with independent reviewers (KA & SS).

The two reviewers (RA & JH) independently conducted risk of bias assessment for all included studies using CLARITY (Clinical Advances Through Research and Information Translation) tools.[25,26] For each study, the CLARITY assessment tools gave a rating of low ("Definitely Yes"), moderate ("Probably Yes" or "Probably No"), or high ("Definitely No") risk of bias for each domain. Any discrepancies between the independent risk of bias assessments was resolved through discussion and consensus.

Data synthesis and analysis

We synthesized the data through narrative discussion and descriptive tables on the associations between social media use, sleep quality, and mental health. We did not conduct a meta-analysis of the findings as measures of association and tools used to assess social media, sleep quality, and mental health problems varied widely among included studies, making it difficult to statistically synthesize the results.[27]

RESULTS

Study Selection

After removing duplicates, 1176 articles were identified from the four databases. Forty-three articles were selected for full-text screening, of which 33 met our inclusion criteria. An updated search was also conducted in which we identified one relevant article. Eight additional studies were identified through forwards and backwards citation tracing for a total of 42 included

studies. An overview of our study selection process, along with reasons for exclusion, is outlined in the PRISMA flowchart (Figure 1).

Study Characteristics

All studies examined relationships between social media use, sleep and mental health ("See table 1"). The paper by Hokby et al. was included as both a cross-sectional and cohort study.[28] Few studies (n=5/42) used nationally representative samples, with the majority (n=29/42) using samples from a specific region or location. Ages of participants ranged from 11 to 29 years old and most studies (n=27/42) included approximately an equal proportion of males and females. All studies assessed symptoms of anxiety, depression and psychological distress. Self-reported sleep quality (n=17/42) and sleep duration, including weekday and weekend bedtime (n=17/42) were most commonly measured. Some studies (n=10/42) also assessed sleep disturbances, including sleep fragmentation, difficulty initiating sleep and sleepiness during the day.

Most cohort studies (n=4/6) focused on symptoms of anxiety and depression, with two also examining symptoms of psychological distress.[28,29] Social media measures were mostly self-reported or assessed using questionnaires and one study[30] used the Young Internet Addiction test. Sleep and mental health were assessed via validated scales or self-reported questionnaires. Among cross-sectional studies, fifteen investigated internet use,[24,28,31-43] fourteen examined mobile phone use,[44–57] and five assessed general social media use.[58–62] Mamun and Griffiths[63] specifically examined Facebook addiction and Wu et al[65] only assessed general computer use including social media use. For mental health and sleep variables, symptoms of depression (n=16/36) and sleep quality (n=16/36) were commonly examined. Social media use,

sleep, and mental health variables were either self-reported or assessed using questionnaires or validated scales.

Risk of Bias Assessment

Most of the studies had a low to moderate risk of bias (Figure 2 and Figure 3). The majority of cohort studies (n=5/6) had a low risk of bias for selecting exposed and non-exposed subjects from the same population. Most studies showed a moderate risk of bias for the assessment of the exposure (n=5/6) and outcome (n=4/6). Three of the six cohort studies had a high risk of bias regarding the presence of the outcome at the beginning of the study. The risk of bias was also low for the assessment of and adjustment for prognostic variables (n=4/6), as well as matching exposed and unexposed variables associated with the outcome of interest (n=4/6). Most of the studies were rated as having moderate risk of bias for providing adequate follow-up (n=5/6), which also raises the possibility of selection bias.[65]

For cross-sectional studies, most (n=31/36) ranged from moderate to poor for obtaining a representative source sample. Some studies used convenience samples and most studies (n=19/36) recruited their samples from academic institutions, thereby reducing the generalizability of the findings.[66] The cross-sectional studies rated well on adequate response rates from participants (n=19/36) and on providing evidence for reliability and validity of the survey instruments (n=17/36). Missing data was rated moderate for risk of bias for most studies as many did not report on this domain (n=24/36). With regards to the clinical sensibility of the questionnaires used to assess social media exposure, fifteen studies of the 36 cross-sectional studies had a low risk of bias and thirteen of the 36 studies ranged from moderate to poor which increases the risk of information bias.[66]

Synthesis of Findings

We synthesized the findings of the longitudinal and cross-sectional studies separately, and assessed findings pertaining to relationships reported between social media use and mental health, social media use and sleep quality, and sleep quality and mental health in youth populations ("See table 2").

Social media and mental health

Across all cohort studies, four found evidence suggesting that high frequency of social media use was a risk factor for poor mental health outcomes at follow up. Liu et al[68] found long-time mobile phone use to be a significant risk factor for depression and anxiety in a sample of college students from China. Another study,[30] using a sample of high-school students in China, reported that the risk of depression was significantly higher among severe and moderate internet users compared to normal internet users. Using longitudinal growth models, Vernon et al[69] observed increases in mobile phone use associated with increases in depression, with sleep mediating the association in youth living in Australia. Hokby et al[31] found that spending time on the internet indirectly predicted changes in poor mental health by predicting changes in sleep loss.

Thirty-three cross-sectional studies observed significant relationships between social media use and poor mental health in youth. Positive associations were observed in studies assessing excessive internet use (n=15), frequent mobile phone use (n=13), and general social media use (n=4), with one study focusing on Facebook addiction.[62] Two studies[50,51] reported

on sex differences in this relationship, and another two [30,54] reported on gender differences. Mixed findings were observed overall.

Sleep quality was reported as a mediator for associations between social media use and depressive symptoms across six cross-sectional studies. Of these studies, three were conducted using a sample of secondary students in China[32,39] and in Switzerland,[58] one study included a sample of undergraduate students in Nepal,[36] another used a convenience sample in the US,[44] and one used a nationally representative sample in South Korea.[59]

Interaction effects were assessed by two cross-sectional studies.[35,46] Park and colleagues[35] examined the moderating effects of depression on the relationship between internet use and sleep quality and observed that a decrease in sleep problems were associated with an increase in internet use among depressed students. Tao et al[46] assessed the interaction effects of social media use and sleep on mental health outcomes in adolescents and found that sleep moderated the association between mobile phone use and negative mental health outcomes.[46]

Social media use and sleep quality

Five cohort studies found excessive social media use at baseline as a risk factor for poor sleep quality at follow up. Two of these studies reported social media use as a risk factor for sleep disturbances: Thomee et al[29] observed an association between excessive computer use and sleep disturbances in men, and Hokby et al[28] reported that time spent on the internet was associated with sleep loss at follow-up among students. Both Rod et al [67] and Liu et al[69] observed mobile phone use as a risk factor for poor sleep outcomes, with Liu et al[69] reporting negative and bidirectional associations between mobile phone use and weekday sleep duration and positive and

bidirectional associations between mobile phone use and weekend sleep duration and compensation.

Significant associations between social media use and sleep quality were observed in twenty-four cross-sectional studies. Of these studies, twenty-three found positive associations between frequent social media use and poor sleep quality, with three studies using nationally representative samples of youth from Europe[30,58] and Asia[58] and another three studies using a convenience sample in China[39], US[44], and Bangladesh.[63] Among high-school students in Switzerland, Lemola et al[59] found that night-time social media use was negatively associated with sleep duration and positively associated with sleep difficulties.

Sleep and mental health

Significant findings pertaining to poor sleep quality and poor mental health outcomes, were observed in three cohort studies. Hokby et al[28] and Thomee et al[29] both reported significant associations between sleep loss due to social media use and mental health outcomes at follow up. Vernon et al[70] found positive associations between increases in poor sleep behavior and depressed mood.

Sixteen cross-sectional studies found significant associations between poor sleep quality and poor mental health among young adults, with fifteen studies observing positive associations. Brunborg et al[63] reported negative associations between poor mental health and weekday sleep duration. The study by Bhandari et al[37] found an indirect effect between sleep quality and depressive symptoms, with social media use mediating the relationship.

DISCUSSION

This systematic review synthesized prior evidence on the interplay between social media use, sleep quality, and mental health in youth. In the 42 included studies, excessive internet use and mobile phone use were the most commonly examined forms of social media, with depression and anxiety being the most commonly assessed mental health outcomes. The findings of this review suggest an association between excessive social media use and poor mental health – specifically anxiety, depression, and psychological distress – among youth. However, it can be hard to discern whether spending extended periods of time on social media or frequently using such sites leads to poor mental health outcomes, or whether the use of social media might be a maladaptive coping mechanism for pre-existing mental health issues.[45,69]

Regular checking of social media can contribute to anxiety related to "fear of missing out" (FOMO), which in turn can further aggravate compulsions to check social media sites.[70,71] The current COVID-19 lockdown led to prolonged school closures, resulting in youth spending more time at home and on social media platforms. As youth are separated from their peers for an extended period of time, they may experience changes in mental health, particularly an elevated amount of FOMO as a product of increased social media use.[72]

Two included studies investigating social media use relative to bedtime[61,62] found that excessive use before and after bedtime were associated with higher levels of depressive symptoms. This is consistent with suggestions from Bhat and colleagues[73] that longer and more frequent checking of social media before bedtime, can increase general cognitive arousal based on the nature of news and discussions. Such habitual use of social media can also increase feelings of anxiety and distress.[73]

Several of the cross-sectional and longitudinal studies in this review suggest sleep as a potential mediator of relationships between social media use and mental health ("see table 2").

This finding highlights the potential mechanism of association for the three variables in terms of overall adolescent health. From a physiological perspective, extended use of social media at bedtime delays sleep onset and reduces sleep duration. Habitually delayed sleep onset can result in a shift in circadian rhythm, leading to persistent sleep difficulties and reduced mood.[45,74] Exposure to electromagnetic fields from mobile phones – a common portal for social media – may lead to reduced melatonin output, consequently delaying sleep onset and thereby increasing the likelihood of psychiatric symptoms.[75–77] Social media use around bedtime can delay sleep onset and reduce sleep duration, especially due to the constraints of waking early for school or work. When combined with the cognitive and often emotional arousal that arises with social media content appraisal, such reduced sleep can be restless and lead to negative affect when performed habitually.[45,73,77,78]

Sleep disturbances and poor sleep quality may arise from the use of interactive technological activities (particularly social media) due to increased mental stimulation and temporal displacement, compared to more passive activities such as watching television.[69] International studies of youth from various regions have reported adverse effects of social media use on sleep, such as reduced sleep duration, poor sleep quality, and more frequent disturbances.[14,24,36–38,44,67,75,79] In turn, such negative impacts on sleep can have adverse health effects, particularly reduced psychological well-being and cognitive functioning.[80-82] These health impacts are pertinent to youth, who do not always have the ability to compensate for the lack of sleep by simply sleeping longer.[79]

Most studies were conducted in Asia (n=27), followed by Europe (n=9) and North America (n=3). One study was conducted using samples from multiple continents,[32] while another study used an Australian sample.[70] As such, the observed associations between excess

social media use, sleep, and mental health symptoms may be explained to some extent by cultural differences surrounding sleeping habits and perceptions of mental health.[6,83-85] However, inconsistencies in measurement tools and analyses used in the included studies make these cultural differences difficult to confirm.

Our review highlights several gaps in the current evidence base on the interrelationships between social media use, sleep, and mental health. First, most of the included studies used a cross-sectional design, making it difficult to assess temporality in the observed associations. Only six studies used a longitudinal design, of which only one[29] could ascertain that the mental health conditions were not present at baseline. Prior studies were also limited in regard to the representativeness of the study samples, as most were convenience samples recruited from a post-secondary setting. Additionally, all included studies used self-reported measures of sleep duration and quality, as well as social media and technology use. Future studies would benefit from the use of more objective methods of measuring sleep quality and technology use (actigraphy, screen time monitors on smartphones) as well as adopting longitudinal study designs to clearly establish temporality of the observed associations. Furthermore, only six studies examined gender differences in social media use, in relation to sleep quality and mental health, and the findings were equivocal. As such, future studies could explore gender differences in social media use to help clarify associations with sleep and mental health in youth populations.

Limitations

Our systematic review had several limitations. First, only one reviewer extracted the data independently. However, as there was a second reviewer available to verify the data, this may have helped mitigate any potential errors or bias that could have occurred during the data extraction

process. Another limitation was that the terms “youth”, “young adults” and “adolescents” were used interchangeably across all studies. In our review, we defined “youth” as individuals aged 16-25 years old and expanded our inclusion criteria to include groups aged 12-30 years old. Many of the studies simplified the term “youth” to include “adolescent” and “young adult” populations, thereby including an inconsistent categorization of youth which varied by different age ranges. Unless an age range was explicitly provided, it was difficult to ensure that the findings from the studies were consistent with our prespecified definition of youth. We also placed greater focus on youth populations, thereby limiting the generalizability of our findings. Although youth are commonly associated with social media use, given the widespread nature of social media, broadening our search to additional populations, such as older age groups, could help increase the generalizability of our results. Finally, there exists much heterogeneity in measures used in the included studies, precluding a meta-analysis.[27]

CONCLUSIONS

The current review examines the interplay between social media use, sleep quality and duration, and poor mental health. Despite heterogeneity in the included studies, longitudinal studies suggest poor sleep quality and frequent sleep disturbances may partially explain the association between excessive social media use and poor mental health outcomes. Cross-sectional studies, inherent in their design, cite more equivocal and multidirectional effects between the three health variables. Social media use can contribute directly to poorer mental health outcomes, or indirectly through poorer sleep. The directionality and strength of such associations should be further elucidated using prospective cohort studies with representative youth samples. These findings may have

public health implications given the widespread use of social media, the high prevalence of sleep problems, and increasing burden of mental health disorders in current societies.

ACKNOWLEDGEMENTS

The authors are grateful for Western Libraries for database access and would also like to thank Mrs. Marisa Tippett's assistance in literature search protocols.

Practice Points

Awareness of the potential relationships between social media use, sleep quality and mental health may be useful to:

1. improve sleep quality and other sleep outcomes in youth
2. improve mental health outcomes such as anxiety, depression and psychological distress
3. promote self-regulated use of social media applications

Research Agenda

Social media use warrants future studies to:

1. clarify the strength and directionality of relationships between social media use, sleep quality and mental health using a prospective study designs with representative youth samples
2. use objective and consistent measures to quantify sleep quality and social media use
3. examine gender differences in social media use
4. assess these relationships in other technologically literate populations

REFERENCES

1. Chattu V, Manzar M, Kumary S, Burman D, Spence D, Pandi-Perumal S. The Global Problem of Insufficient Sleep and Its Serious Public Health Implications. *Healthcare* 2018; **7**:1-16.

2. Institute of Medicine (US) Committee on Sleep Medicine and Research. Extent and Health Consequences of Chronic Sleep Loss and Sleep Disorders: In Colten HR, Altevogt BM (eds) *Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem*. Washington, DC: Institute of Medicine (US) Committee on Sleep Medicine and Research; 2006:55-136.

3. Goel N, Rao H, Durmer JS, Dinges DF. Neurocognitive Consequences of Sleep Restriction. *Semin Neurol* 2009; **29**: 320-339.

4. Statistics Canada. Mean sleep duration and percentage distribution by sleep duration recommendations, by sex, education and income, household population aged 18 to 64, Canada excluding territories, 2007 to 2013. 2013. https://www150.statcan.gc.ca/n1/pub/82-003-x/2017009/article/54857/tbl/tbl01-eng.htm.

5. Ruiz-Castell M, Makovski TT, Bocquet V, Stranges S. Sleep duration and multimorbidity in Luxembourg: Results from the European Health Examination Survey in Luxembourg, 2013-2015. *BMJ Open* 2019; **9**: 1-10.

*6. Stranges S, Dorn JM, Shipley MJ, Kandala N, Trevisan M, Miller MA, et al. Correlates of short and long sleep duration: A cross-cultural comparison between the United Kingdom and the United States: The Whitehall II Study and the Western New York Health Study. *Am J Epidemiol* 2008; **168**:1353-1364.

7. Stranges S, Tigbe W, Gómez-Olivé XF, Thorogood M, Kandala N-B. Sleep Problems: an Emerging Global Epidemic? Findings from the INDEPTH WHO-SAGE study among over 40,000 older adults from eight countries across Africa and Asia. *Sleep* 2012; **35:**1173–1181.

8. Medic G, Wille M, Hemels MEH. Short- and long-term health consequences of sleep disruption. *Nat Sci Sleep* 2017; **9**:151-161.

*9. Gregory AM, Sadeh A. Sleep, emotional and behavioral difficulties in children and adolescents. *Sleep Med Rev* 2012; **16**:129-136.

10. McGowan BS, Wasko M, Vartabedian BS, Miller RS, Freiherr DD, Abdolrasulnia M. Understanding the factors that influence the adoption and meaningful use of social media by physicians to share medical information. *J Med Internet Res* 2012; **14**: e117.

11. Kaplan AM, Haenlein M. Users of the world, unite! The challenges and opportunities of Social Media. *Bus Horiz* 2010; **53**: 59-68.

12. Yonker LM, Zan S, Scirica C V, Jethwani K, Kinane TB. “Friending” teens: systematic review of social media in adolescent and young adult health care. *J Med Internet Res* 2015; **17**: e4.

13. Hysing M, Pallesen S, Stormark KM, Jakobsen R, Lundervold AJ, Sivertsen B. Sleep and use of electronic devices in adolescence: results from a large population-based study. *BMJ Open* 2015; **5**: e006748-e006748.

14. Madden M, Lenhart A, Cortesi S, et al. Teens, Social Media, and Privacy. 2013: **107**. http://pewinternet.org/Reports/2013/Teens-Social-Media-And-Privacy.aspx.

*15. Reid-Chassiakos Y, Radesky J, Christakis D, Moreno MA, Cross C. Children and Adolescents and Digital Media. *Pediatrics* 2016; **138**: e20162593.

16. George MJ, Odgers CL. Seven Fears and the Science of How Mobile Technologies May Be Influencing Adolescents in the Digital Age. *Perspect Psychol Sci* 2015; **10**: 832-851.

17. George MJ, Russell MA, Piontak JR, Odgers CL. Concurrent and Subsequent Associations Between Daily Digital Technology Use and High-Risk Adolescents’ Mental Health Symptoms. *Child Dev* 2018; **89**: 78-88.

*18. Thomee S, Dellve L, Härenstam A, Hagberg M. Perceived connections between information and communication technology use and mental symptoms among young adults - A qualitative study. *BMC Public Health* 2010; **10**: 66.

*19. Vahedi Z, Saiphoo A. The association between smartphone use, stress, and anxiety: A meta-analytic review. *Stress Heal* 2018; **34**: 347-358.

20. Keles B, McCrae N, Grealish A. A systematic review: the influence of social media on depression, anxiety and psychological distress in adolescents. *Int J Adolesc Youth* 2019; **1**: 79-93.

21. Orth U, Maes J, Schmitt M. Self-esteem development across the life span: A longitudinal study with a large sample from Germany. *Dev Psychol* 2015; 51: 248-259.

22. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 2009; **6**: e1000097.

23. Edosomwan S, Prakasan SK, Kouame D, Watson J, Seymour T. The history of social media and its impact on business. *J Appl Manag Entrep* 2011; **16**: 79-91.

24. Ye YL, Wang PG, Qu GC, Yuan S, Phongsavan P, He QQ. Associations between multiple health risk behaviors and mental health among Chinese college students. *Psychol Heal Med* 2016; **21**:377-385.

25. CLARITY Group at McMaster University. *Risk of Bias Instrument for Cross-Sectional Surveys of Attitudes and Practices*. 2017. https://www.evidencepartners.com/wp-content/uploads/2017/09/Risk-of-Bias-Instrument-for-Cross-Sectional-Surveys-of-Attitudes-and-Practices.pdf. Accessed August 15, 2019.

26. CLARITY Group at McMaster University. *Tool to Assess Risk of Bias in Cohort Studies*. 2017.https://www.evidencepartners.com/wp-content/uploads/2017/09/Tool-to-Assess-Risk-of-Bias-in-Cohort-Studies.pdf.

27. Ioannidis JPA, Patsopoulos NA, Rothstein HR. Reasons or excuses for avoiding meta-analysis in forest plots. *BMJ* 2008; **336**:1413-1415.

28. Hökby S, Hadlaczky G, Westerlund J, et al. Are Mental Health Effects of Internet Use Attributable to the Web-Based Content or Perceived Consequences of Usage? A Longitudinal Study of European Adolescents. *JMIR Ment Heal* 2016; **3**: e31.

29. Thomée S, Härenstam A, Hagberg M. Computer use and stress, sleep disturbances, and symptoms of depression among young adults – a prospective cohort study. *BMC Psychiatry* 2012; **12**:176.

30. Lam LT, Peng ZW. Effect of pathological use of the internet on adolescent mental health: A prospective study. *Arch Pediatr Adolesc Med* 2010; **164**: 901-906.

31. Belanger RE, Akre C, Berchtold A, Michaud P-A. A U-Shaped Association Between Intensity of Internet Use and Adolescent Health. *Pediatrics* 2011; **127**: e330-e335.

32. Peltzer K, Pengpid S. Depressive symptoms and social demographic, stress and health risk behaviour among university students in 26 low-, middle- and high-income countries. *Int J Psychiatry Clin Pract* 2015; **19**: 259-265.

33. Cheung LM, Wong WS. The effects of insomnia and internet addiction on depression in Hong Kong Chinese adolescents: An exploratory cross-sectional analysis. *J Sleep Res* 2011; **20**: 311-317.

34. Do YK, Shin E, Bautista MA, Foo K. The associations between self-reported sleep duration and adolescent health outcomes: What is the role of time spent on Internet use? *Sleep Med* 2013; **14**: 195-200.

35. Kitazawa M, Yoshimura M, Murata M, et al. Associations between problematic Internet use and psychiatric symptoms among university students in Japan. *Psychiatry Clin Neurosci* 2018; **72**: 531-539.

36. Park MH, Park S, Jung KI, Kim JI, Cho SC, Kim BN. Moderating effects of depressive symptoms on the relationship between problematic use of the Internet and sleep problems in Korean adolescents. *BMC Psychiatry* 2018; **18**: e184-e185.

37. Bhandari PM, Neupane D, Rijal S, Thapa K, Mishra SR, Poudyal AK. Sleep quality,

internet addiction and depressive symptoms among undergraduate students in Nepal. *BMC Psychiatry* 2017; **17**: 106.

38. Kootesh BR, Raisi M, Ziapour A. Investigation of the relationship between internet addiction with mental health and quality sleep in students. *Acta Medica Mediterr* 2016; **32**:1921-1925.

39. Kojima R, Sato M, Akiyama Y, et al. Problematic Internet use and its associations with health-related symptoms and lifestyle habits among rural Japanese adolescents. *Psychiatry Clin Neurosci* 2019; **73**: 20-26.

40. Li J-B, Lau JTF, Mo PKH, et al. Insomnia partially mediated the association between problematic Internet use and depression among secondary school students in China. *J Behav Addict* 2017; **6**: 554-563.

41. Tan Y, Chen Y, Lu Y, Li L. Exploring associations between problematic internet use, depressive symptoms and sleep disturbance among southern chinese adolescents. *Int J Environ Res Public Health* 2016; **13**: 1-12.

42. Islam MA, Hossin MZ. Prevalence and risk factors of problematic internet use and the associated psychological distress among graduate students of Bangladesh. *Asian J Gambl Issues Public Heal* 2016; **6**: 1-14.

43. Mamun MA, Hossain MS, Siddique AB, Sikder MT, Kuss DJ, Griffiths MD. Problematic internet use in Bangladeshi students: The role of socio-demographic factors, depression, anxiety, and stress. *Asian J Psychiatr* 2019; **44**: 48-54.

44. Demirci K, Akgönül M, Akpinar A. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *J Behav Addict* 2015; **4**: 85-92.

45. Adams SK, Kisler TS. Sleep quality as a mediator between technology-related sleep quality, depression, and anxiety. *Cyberpsychol Behav Soc Netw* 2013; **16**: 25-30.

46. Rosen L, Carrier LM, Miller A, Rokkum J, Ruiz A. Sleeping with technology: Cognitive, affective, and technology usage predictors of sleep problems among college students. *Sleep Heal* 2016; **2**: 49-56.

47. Tao S, Wu X, Zhang Y, Zhang S, Tong S, Tao F. Effects of sleep quality on the association between problematic mobile phone use and mental health symptoms in Chinese college students. *Int J Environ Res Public Health* 2017; **14**: 185.

48. Višnjić A, Veličković V, Sokolović D, et al. Relationship between the manner of mobile phone use and depression, anxiety, and stress in university students. *Int J Environ Res Public Health* 2018; **15**: 697.

49. Volungis AM, Kalpidou M, Popores C, Joyce M. Smartphone Addiction and Its

Relationship with Indices of Social-Emotional Distress and Personality. *Int J Ment Health Addict* 2019; **17:** 1-17.

50. Soni R, Upadhyay R, Jain M. Prevalence of smart phone addiction, sleep quality and associated behaviour problems in adolescents. *Int J Res Med Sci* 2017; **5**: 515.

51. Nishida T, Tamura H, Sakakibara H. The association of smartphone use and depression in Japanese adolescents. *Psychiatry Res* 2019; **273**: 523-527.

52. Ikeda K, Nakamura K. Association between mobile phone use and depressed mood in Japanese adolescents: A cross-sectional study. *Environ Health Prev Med* 2014; **19**:187-193.

53. Tamura H, Nishida T, Tsuji A, Sakakibara H. Association between excessive use of mobile phone and insomnia and depression among Japanese adolescents. *Int J Environ Res Public Health* 2017; **14**: 701.

54. Boumosleh JM, Jaalouk D. Depression, anxiety, and smartphone addiction in university students- A cross sectional study. Hayashi N, ed. *PLoS One* 2017; **12**: e0182239.

55. Chen B, Liu F, Ding S, Ying X, Wang L, Wen Y. Gender differences in factors associated with smartphone addiction: A cross-sectional study among medical college students. *BMC Psychiatry* 2017; **17**: 341.

56. Dewi RK, Efendi F, Has EMM, Gunawan J. Adolescents' smartphone use at night, sleep disturbance and depressive symptoms. *Int J Adolesc Med Health* 2018; **44:** 405-418

57. Eyvazlou M, Zarei E, Rahimi A, Abazari M. Association between overuse of mobile phones on quality of sleep and general health among occupational health and safety students. *Chronobiol Int* 2016; **33**: 293-300.

58. Kadam YR, Patil SR, Waghachavare V, Gore AD. Influence of various lifestyle and psychosocial factors on sleep disturbances among the college students: A cross-sectional study from an urban area of India. *JKIMSU* 2016; **5**: 51-60.

59. Lange K, Cohrs S, Skarupke C, Görke M, Szagun B, Schlack R. Electronic media use and insomnia complaints in German adolescents: gender differences in use patterns and sleep problems. *J Neural Transm* 2017; **124**: 79-87.

60. Lemola S, Perkinson-Gloor N, Brand S, Dewald-Kaufmann JF, Grob A. Adolescents' Electronic Media Use at Night, Sleep Disturbance, and Depressive Symptoms in the Smartphone Age. *J Youth Adolesc* 2014; **44**: 405-418.

61. Seo JH, Kim JH, Yang KI, Hong SB. Late use of electronic media and its association with sleep, depression, and suicidality among Korean adolescents. *Sleep Med* 2017; **29**: 76-80.

62. Woods HC, Scott H. #Sleepyteens: Social media use in adolescence is associated with poor sleep quality, anxiety, depression and low self-esteem. *J Adolesc* 2016; **51**: 41-49.

63. Brunborg GS, Mentzoni RA, Molde H, et al. The relationship between media use in the bedroom, sleep habits and symptoms of insomnia. *J Sleep Res* 2011; **20**: 569-575.

64. Mamun MAA, Griffiths MD. The association between Facebook addiction and depression: A pilot survey study among Bangladeshi students. *Psychiatry Res* 2019; **271**: 628-633.

65. Wu X, Tao S, Zhang Y, Zhang S, Tao F. Low physical activity and high screen time can increase the risks of mental health problems and poor sleep quality among Chinese college students. *PLoS One* 2015; **10**: 1-10.

66. Ramirez-Santana M. Limitations and Biases in Cohort Studies. In Barria RM (ed) *Cohort Studies in Health Sciences*. London: InTech 2018: 29-45.

67. Rod NH, Dissing AS, Clark A, Gerds TA, Lund R. Overnight smartphone use: A new public health challenge? A novel study design based on high-resolution smartphone data. *PLoS One* 2018; **13**: e0204811.

68. Yu I, Tse S. Sources of Bias in Cross-Sectional Studies; Summary on Sources of Bias for Different Study Designs. *Hong Kong Med J* 2012; **18**: 226-227.

*69. Liu S, Wing YK, Hao Y, Li W, Zhang J, Zhang B. The associations of long-time mobile phone use with sleep disturbances and mental distress in technical college students: A prospective cohort study. *Sleep* 2019; **42**: 1-10.

70. Vernon L, Modecki KL, Barber BL. Mobile Phones in the Bedroom: Trajectories of Sleep Habits and Subsequent Adolescent Psychosocial Development. *Child Dev* 2018; **89**: 66-77.

*71. LeBourgeois MK, Hale L, Chang A-M, Akacem LD, Montgomery-Downs HE, Buxton OM. Digital Media and Sleep in Childhood and Adolescence. *Pediatrics* 2017; **140**: S92-S96.

72. Oosterhoff B, Palmer CA, Wilson J, Shook N. Adolescents' Motivations to Engage in Social Distancing During the COVID-19 Pandemic: Associations With Mental and Social Health. *J Adolesc Health* 2020; https://doi.org/10.1016/j.jadohealth.2020.05.004.

*73. Bhat S, Pinto-Zipp G, Upadhyay H, Polos PG. "To sleep, perchance to tweet": in-bed electronic social media use and its associations with insomnia, daytime sleepiness, mood, and sleep duration in adults. *Sleep Heal* 2018; **4**:166-173.

74. Griffiths MD. Social Networking Addiction: Emerging Themes and Issues. *Addict Res Ther* 2013; **4**:118-119.

75. Harbard E, Allen NB, Trinder J, Bei B. What's Keeping Teenagers Up? Prebedtime Behaviors and Actigraphy-Assessed Sleep Over School and Vacation. *J Adolesc Heal* 2016; **58**: 426-432.

76. Sampasa-Kanyinga H, Hamilton HA, Chaput J-P. Use of social media is associated with short sleep duration in a dose-response manner in students aged 11 to 20 years. *Acta Paediatr* 2018; **107**: 694-700.

*77. Munezawa T, Kaneita Y, Osaki Y, et al. The association between use of mobile phones after lights out and sleep disturbances among Japanese adolescents: a nationwide cross-sectional survey. *Sleep* 2011; **34**: 1013-1020.

78. Wood AW, Loughran SP, Stough C. Does evening exposure to mobile phone radiation affect subsequent melatonin production? *Int J Radiat Biol* 2006; **82**: 69-76.

*79. Levenson JC, Shensa A, Sidani JE, Colditz JB, Primack BA. The association between social media use and sleep disturbance among young adults. *Prev Med (Baltim)* 2016; **85**: 36-41.

80. Hale L, Guan S. Screen Time and Sleep among School-Aged Children and Adolescents: A Systematic Literature Review. *Sleep Med Rev* 2015; **21**: 50.

81. Basner M, Spaeth AM, Dinges DF. Sociodemographic Characteristics and Waking Activities and their Role in Timing and Duration of Sleep. *Sleep* 2014; **37**: 1889-1906.

82. Falbe J, Davison KK, Franckle RL, Ganter C, Gortmaker SL, Smith L, et al. Sleep Duration, Restfulness, and Screens in the Sleep Environment. *Pediatrics* 2015; **135:** e367-e375.

83. Beebe DW. Cognitive, Behavioral, and Functional Consequences of Inadequate Sleep in Children and Adolescents. *Pediatr Clin North Am* 2011; **58**: 649-665.

84. Jenni OG, O'Connor BB. Children's Sleep: An Interplay Between Culture and Biology. *Pediatrics* 2005; **115:** 204-216.

85. Gopalkrishnan N. Cultural Diversity and Mental Health: Considerations for Policy and Practice. *Front Public Health* 2018; **6:** 179.

Table and Figure Legends:

Figure 1. PRISMA flowchart outlining study selection

Figure 2. Findings from the risk of bias assessment in thirty-six cross-sectional studies using the *CLARITY Risk of Bias Instrument for Cross-Sectional Surveys of Attitudes and Practices*.[24]

Figure 3. Findings from the risk of bias assessment in six prospective studies using the *CLARITY Tool to Assess Risk of Bias in Cohort Studies*.[25]