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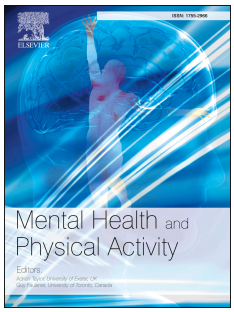

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Asaduzzaman Khan, PhD, Nicola W. Burton, PhD

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Is physical inactivity associated with depressive symptoms among adolescents with high screen time? Evidence from a developing country

Asaduzzaman Khan[1¥], PhD

Nicola W Burton[2], PhD

[1]School of Health and Rehabilitation Sciences, The University of Queensland, Australia

[2]School of Human Movement & Nutrition Sciences, The University of Queensland, Australia

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[¥] Corresponding autor (AK)
School of Health and Rehabilitation Sciences
The University of Queensland
Brisbane, QLD 4072
Australia
Phone: +61 7 3346 7456
Fax: +61 7 3365 1877
Email: a.khan2@uq.edu.au

How is insufficient physical activity associated with depressive symptoms among adolescents with high screen time? Evidence from a developing country

Abstract

Background: Increasing levels of screen use and physical inactivity in developing countries may be deleterious for adolescent mental health. This study aimed to examine how physical activity is associated with concurrent depressive symptoms among adolescents with high recreational screen time in Bangladesh.

Methods: A self-administered survey was conducted among 898 secondary school students of Dhaka city, Bangladesh. High screen-time was assessed using the Adolescent Sedentary Activity Questionnaire (ASAQ), with a cut-off of > 2 hours/day. Scores ≥ 10 on the 10-item Center for Epidemiological Studies Depression Scale (CESD10) suggested depressive symptoms. The Three-Day Physical Activity Recall (3DPAR) instrument was used to estimate physical activity, with those doing ≤60 mins/day of moderate-vigorous physical activity (MVPA) classified as not meeting MVPA recommendations. Of the 599 adolescents who were determined to have high recreational screen time (>2 hours/day), 505 completed the CESD10, and form the basis for this analysis.

Results: Of the adolescents with high recreational screen time, 32% did not meet MVPA recommendations and 25% reported depressive symptoms. Generalized estimating equations modelling on CESD scores showed that depressive symptoms were more prevalent among adolescents with high screen time who also did not meet MVPA recommendations (OR 2.37; 95% CI: 1.23-4.59), after adjusting for a set of confounders including sociodemographic, psychosocial and lifestyle factors.

Conclusions: Adolescents in Dhaka city with high recreational screen time and not meeting physical activity recommendations are also likely to have depressive symptoms. More research is needed to understand the causal directions of these relationships.

Introduction

Due to socio-economic transition and the advancement of technology, screen time (ST) among children and adolescents has increased considerably during the recent past in many economically developing countries (Cui et al., 2011; Khan & Burton, 2016; S. Lee et al., 2015; Paudel et al., 2014; Ravikiran et al., 2014). Screen-based activities can be for academic or recreational purposes, and include e.g., watching television, using a computer/tablet, playing video games, and using social media on a small screen such as a smart-phone. There has also been an increase in the number of people in many low-and-middle income countries not meeting moderate-to-vigorous physical activity (MVPA) recommendations (Hallal et al., 2012; WHO, 2015). This double burden is a major public health concern for many developing countries, given the established links for each of high screen time and physical inactivity with various health problems. Screen-based sedentary behaviour and physical inactivity among adolescents are each adversely associated with multiple chronic health conditions, including cardiovascular diseases, obesity, and mental health problems (Gordon-Larsen et al., 2004; Nuutinen et al., 2013).

There is a general understanding that sedentary behaviour (i.e., screen time) and physical inactivity (i.e., not meeting physical activity recommendations) are separate constructs (Brodersen et al., 2005; Taveras et al., 2007), and are independently associated with poor mental health among adolescents (Iannotti et al., 2009b). One study demonstrated independent associations of self-reported screen time and physical inactivity on measures of psychological distress in adolescents (Ussher et al., 2007). Other evidence suggests that high screen time and low physical activity levels interact to increase psychological problems among adolescents (Hamer et al., 2009; Kremer et al., 2014; Rothon et al., 2010). In contrast, one Australian study found no cross-sectional or longitudinal association between objective or subjective measures of physical activity, sedentary behaviour, and depressive symptoms

among adolescents (Hume et al., 2011). Given that both screen time and physical inactivity are prevalent during adolescence, and can continue into adulthood (Kjønniksen et al., 2008; Telama et al., 1997), understanding how the combination of sedentary behaviour and physical inactivity impact on psychological wellbeing is crucial to minimize the burden of poor mental health (Liu et al., 2016). This is important for developing counties where mental health disorders are fairly common (Steel et al., 2014) and resources for mental health diagnosis, support and treatment are scarce (Demyttenaere et al., 2004).

High screen time, physical inactivity, and depressive symptoms are common in Bangladesh. Four in five adolescents report high (≥2 hours/day) recreational screen time with a median of 4.0 hours/day of screen time (Khan & Burton, 2016), and one in three adolescents do not meet the World Health Organization (WHO) recommendations of 60 mins/day of MVPA (Khan et al., 2017). One recent study found that one in two adolescents in urban Bangladesh has depressive symptoms; this was defined as a score of ≥ 22 using the 20-item Center for Epidemiologic Studies Depression Scale (CESD20) (Billah & Khan, 2014). Understanding the inter-relationships among screen time, physical inactivity, and mental health therefore has significant public health implications in this developing country.

Although a number of studies have demonstrated links between prolonged screen-time or physical inactivity and poor mental health of adolescents in developed countries (Biddle & Asare, 2011), less is known about mental health among adolescents who have high screen time and physical inactivity. The aim of this study was to examine how physical activity was associated with concurrent depressive symptoms among adolescents with high recreational screen time in Dhaka city, Bangladesh.

Methods

A questionnaire survey on health and psychosocial wellbeing was conducted in class time among 898 students of eight secondary schools purposively selected from Dhaka, the capital city of Bangladesh [more details elsewhere (Khan & Burton, 2016)]. Each school had a total of between 61-190 students who participated in the survey. The research project was approved by the Behavioural Social Sciences Ethics Review Committee at The University of Queensland, Australia.

Outcome measure

Depressive symptoms were measured using the 10-item Centre for Epidemiologic Studies Depression Scale (CESD10), which has been shown to be an acceptable self-report tool to screen for depression in adolescents in the community setting (Bradley et al., 2010; Haroz et al., 2014). The internal consistency, measured by Cronbach's alpha coefficient, for this study was 0.81. A total score for each student was obtained by summing the scores across 10 items of CESD10, with an admissible range of 0 to 30. A higher score indicated more depressive symptoms, with a score of ≥ 10 used as cut off for depressive symptoms (Andresen et al., 1994) in the descriptive analysis. Because the cutoff has not been validated in Bangladesh, we used total CESD score as a continuous variable to examine its association with physical inactivity: a similar approach was used in analysis of CESD-20 data in Bangladesh (Black et al., 2009).

Other measures

Students' recreational screen-time was assessed using the Adolescent Sedentary Activity Questionnaire (ASAQ), which has demonstrated reliability and satisfactory reproducibility (Guimarães et al., 2013; Hardy et al., 2007). Students were asked to report time spent on a usual school day and a usual weekend day on each of the following activities: (i) watching

television, (ii) watching DVDs/videos, (iii) using the computer for fun; and (iv) using social media (e.g., Facebook, Twitter). Recreational screen time for a usual school day and a usual weekend day were computed by summing the time spent across the four screen-based activities, and an weighted average was used to derive an average recreational screen-time per day (i.e., {school-day screen time × 5 + weekend-day screen time × 2} /7). High recreational screen time was defined as > 2hours/day, which is consistent with a widely used screen-time recommendation (American Academy of Pediatrics, 2001). Of the 898 students who returned the surveys, 758 completed the ASAQ and 79% of those students (n=599) had high recreational screen time.

In addition, students completed the 3-Day Physical Activity Recall (3DPAR) log, which has demonstrated reliability and validity among Asian adolescents (K. Lee & Trost, 2005). The 3DPAR requires respondents to recall their activities from each of the previous three days, beginning with the most recent day, with each day segmented into 34 30-min blocks from 7:00 am through to 12:00 midnight. For each of the 30-min blocks, students reported the main activity done, from a list of 44 common activities, and rated the intensity of the activity as light, moderate, hard, or very hard. Each 30-min block was assigned a metabolic equivalent (MET) value to derive physical activity level. Students were classified as not meeting MVPA recommendations if they did not average two or more 30 min blocks of physical activity with ≥ 3 METs/day over the 3-day assessment period, which is consistent with WHO guidelines to accumulate ≥ 60 mins/day of moderate-vigorous physical activity (MVPA).

The self-administered questionnaire also included items to assess demographics (e.g., age, gender, socio-demographics, parental education) and life-style factors (e.g., sleep, eating patterns, social activities). Participants responded to items assessing self-perception of weight category (underweight, normal weight, overweight, obese), involved with sports at school

(yes, no), feeling safe at school (never, rarely, sometimes, often, always), life satisfaction (10 point scale with 1=dissatisfied and 10=satisfied), intake of fast food (none, 1-3, 4-6 times/week, 1, 2, 3, 4+times/day), and intake of sugary drinks during the past week (none, 1-2, 3-4, 5-6, 7-9, 10+ cans). Students were also asked to take home a questionnaire for a parent to provide information on mother's occupation, father's occupation, family income, and their child's sleep disturbance during the last month (yes, no).

Students' height and weight were measured by the research team. Obesity was defined as a body mass index (BMI) at or above the 95th percentile for children of the same age and sex; overweight was a BMI between the 85th and 95th percentiles, normal weight was a BMI less than the 85th percentile but at or above the 5th percentile, and underweight was a BMI less than the 5th percentile (Ogden & Flegal, 2010).

Statistical Analysis

The proportion of adolescents with high recreational screen time who also reported depressive symptoms was identified. In order to examine whether not meeting MVPA recommendations was associated with depressive symptoms in adolescents with high recreational screen time, we used Generalized Estimating Equations (GEE) which takes into account the non-independence of students' depressive symptoms nested within their schools. Potential covariates included: age, gender, self-perception of weight category, BMI, involved with sports at school, feeling safe at school, life satisfaction, intake of fast food, intake of sugary drinks, sleep disturbance, mother's education, father's education, mother's occupation, father's occupation, and family income. Variables were included in the multivariable modelling if their univariate associations with depressive symptoms had p-values <0.20; this value has been recommended previously as a cut-off to screen for potential confounders (Maldonado & Greenland, 1993). The variables that did not attain statistical significance at univariate level ($p \geq 0.20$) included: BMI, mother's education, father's

education, mother's occupation, family income, and intake of fast food. The variables significant at univariate level ($p<0.20$) were further examined and no collinearity was identified. Multivariable GEE modelling was used to examine the association between not meeting MVPA recommendations and depressive symptoms of adolescents with high screen time, adjusted for age, gender, self-perception of weight category, feeling safe at school, life satisfaction, intake of sugary drinks, and sleep disturbance. Although father's occupation and involved with sports at school were initially considered in the multivariable model, they were not significantly associated with depressive symptoms, and hence excluded from the final multivariable model. The associations are presented in the form of odds ratios and their 95% confidence intervals. All tests were performed at the 5% level of significance.

Results

Of the 599 adolescents who were determined to have high recreational screen time (>2 hours/day), 505 completed the CESD10 and formed the analytic sample for this study (n=505). The average age of the study participants was 14.3 (SD 1.12; range 12-17) years. About half (47%) of the adolescents were male (Table 1).

Table 1 about here

Among the adolescents with high recreational screen time, about a quarter (24.6%) reported depressive symptoms. A higher proportion of females with high screen time than males reported depressive symptoms (29% vs. 20%). Nearly a third (32%) of the adolescents with high screen time did not meet MVPA recommendations. Figure 1 shows that among adolescents with high screen time, depressive symptoms were more common among those who did not meet MVPA recommendations than those who did (29% vs. 21%). After adjusting for the set of potential confounders, adolescents with high screen time who did not meet MVPA recommendations had more than twice the odds of reporting depressive

symptoms than their counterparts who met MVPA recommendations (OR 2.37; 95% CIs 1.23-4.59) [Table 2].

Table 2 about here

Additional analyses indicated that there were no significant associations between meeting MVPA recommendations and depressive symptoms for those adolescents with low recreational screen time (<2 hours/day).

Discussion

The findings of this study suggests that among Bangladeshi adolescents with high recreational screen time, depressive symptoms are more common among those who do not meet physical activity recommendations than those who do. Participants who reported both >2 hours/day of recreational screen time and <60 mins/day of MVPA were over two times as likely to also report depressive symptoms than adolescents who reported >2 hours/day of recreational screen time and >60 mins/day of MVPA. Among those adolescents with <2 hours/day of recreational screen time, there was no significant association between physical activity and depressive symptoms. We are unaware of any studies to date that have examined associations between physical activity and psychological distress of adolescents who had high screen time. This is particularly important for developing countries where increasing access to technology is resulting in increasing screen use and inactivity. In Bangladesh, high screen time is ubiquitous with 80% of adolescents in Dhaka city reporting >2 hours/day (Khan & Burton, 2016) and about a third of adolescents are not meeting physical activity recommendations (Khan et al., 2017). These results may also be relevant for adolescents in other developed countries.

Previous studies have also demonstrated independent associations of high screen time and physical inactivity with psychological distress (Biddle & Asare, 2011; Cao et al., 2011; Wu et al., 2015), and interaction effects of screen time and physical inactivity on poor mental health (Trinh et al., 2015). A study that found no cross-sectional association between physical activity, sedentary behaviour, and depressive symptoms among adolescents (Hume et al., 2011) used different measures from our study. Those researchers used self-reported television viewing time and participation in organised sports, and objective measures of total sedentary behaviour and physical activity. We used self-reported measures of screen time (which included television, computer use, watching DVDs/videos, and social media devices) and physical activity (which could have included activities other than organised sports, such as walking), and no objective measures.

One quarter of the Bangladeshi adolescents with high screen time reported depressive symptoms (CESD10 score $\geq$10). This is the same as for Bangladeshi adolescents generally (i.e. regardless of screen time) (Khan & Burton, 2017). Other studies using different measures of depressive symptoms, adolescents of varying age ranges, and including adolescents from regional areas have reported prevalence of depressive symptoms ranging from 14% (Nasreen et al., 2016) to 49% (Billah & Khan, 2014), and from 36% (Rodrigo et al., 2010) to 59% (Verma et al., 2014) in other Asian countries. Just under a third of those with high screen time did not meet physical activity recommendations. Compared to adolescents generally (i.e. regardless of screen time), this is comparable for those in Dhaka City (Khan et al., 2017), slightly lower than a Singaporean study that reported 37% (K. Lee & Trost, 2006), and much lower than the 59% identified from the recent WHO surveys in Bangladesh and neighbouring countries such as India (70%), Pakistan (84%) and Sri Lanka (86%) (WHO, 2015).

Our results suggest that physical activity may offer a protective effect against depressive symptoms for adolescents who have high screen time. Possible underlying mechanisms for this include biological pathways and psychosocial factors (Sund et al., 2011), and well as behavioural and cognitive processes. Prolonged exposure to screens has been shown to cause various maladaptive psycho-physiological responses such as arousal of the central system and can also affect sleep patterns (Wang & Perry, 2006), which in turn can facilitate the development of depressive symptoms. Screen time may also promote isolation and limit face to face social interactions. To offset this, physical activity may enhance monoamines (noradrenalin and serotonin) through increased neurotransmitter activities and increased levels of endorphins (Martinsen, 1994). Physical activity may also improve depressive symptoms and hormonal responses to stress through moderate activation of the limbic system and reduced levels of cortisol secretion (Nabkasorn et al., 2006). Psychosocial factors linking physical activity and positive mental health can include affirmative attitudes from positive peer influences (Iannotti et al., 2009a), or social connectedness from group activities such as sport (Paluska & Schwenk, 2000). Physical activity may promote a sense of mastering the body, self-esteem, self-efficacy, and enhance positive cognitions that counteract the development of depression (Simon et al., 2004; Sund et al., 2011). Physical activity may increase time spent with family or friends (Sund et al., 2011). Conversely, lack of activity might precipitate low levels of monoamines and endorphins which can result in depressive feelings (Sund et al., 2011). Inactivity can also promote rumination, which is associated with onset (Just & Alloy, 1997) and the duration of depressive symptoms (Nolen-Hoeksema et al., 1993).

To promote physical activity in adolescents, much of the evidence is from developed countries with limited transferability to developing countries which have different socio-cultural, geo-political and environmental conditions. Developing countries in transition such

as Bangladesh, are characterised by rapid urbanization which is accompanied by excessively high levels of concentration of urban population in large cities. Such urbanization can result in minimising open space and increasing traffic which reduces safe and convenient opportunities for physical activity and active transport (Bell et al., 2002; Sobngwi et al., 2003). Furthermore, schools in developing countries can differ markedly from those in developed countries, in terms of e.g., access to facilities, play areas, and non-compulsory physical education classes and activities. It has therefore been argued that physical activity promotion programs in developing countries need to use comprehensive approaches that take into account various domains for physical activity (e.g., recreational, domestic, occupation, and transport), socio-economic and socio-cultural characteristics, the built environment infrastructure and climate, and their impact on everyday "active living" (Gomez et al., 2005; Hallal et al., 2003).

There are some limitations to the present study. Screen time, physical activity and depressive symptoms were assessed using self-report instruments. Although the instruments have acceptable reliability and validity, they have not been validated among Bangladeshi adolescents. The cross-sectional design of the present study cannot establish any causal relationships, and the relationships can be bi-directional. The non-random selection of schools from Dhaka city is unlikely to represent all high schools of the country, particularly those in regional areas, and as such, generalization is limited. Only interested students of the participating schools completed the survey, which may have provided a volunteer bias. Despite these limitations, the present study provides insights on the important public health issue of high recreational screen time and mental health of adolescents.

Conclusions

This study highlights the double burden of high recreational screen time and low physical activity which was associated with depressive symptoms in adolescents. This has important

public health implications for developing countries, such as Bangladesh, that are now demonstrating increasing rates of recreational screen use and inactivity as access to technology improves. The results suggest that encouraging adolescents with high recreational screen time to *also* engage in physical activity may have concurrent benefits for positive mental health and well-being. Longitudinal research is needed to further investigate the relationship between recreational screen use, physical activity and depressive symptoms, and to help establish causal directions, and to inform intervention strategies.

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Table 1: Demographics of participating adolescents of Dhaka city, Bangladesh (n=505)

Characteristics	**n**[¥]	**%**
Gender		
Female	267	52.9
Male	238	47.1
Age in year		
13	119	23.6
14	174	34.4
15	140	27.7
16	72	14.3
Mother education		
Up-to primary or equivalent	47	9.4
Secondary or equivalent	58	11.6
Higher secondary or equivalent	88	17.7
Tertiary (graduation) or above	305	61.2
Mother occupation		
Employed	120	27.8
Not employed	311	72.2
Father education		
Up-to primary or equivalent	32	6.4
Secondary or equivalent	30	6.0
Higher secondary or equivalent	47	9.5
Tertiary (graduation) or above	389	78.1
Father occupation		
Public service	113	25.9
Professionals	71	16.2
Private service	123	28.2
Business-trade	130	29.7
Family income (BD Taka) per month*		
< 30 000	91	19.3
30 000 – <50 000	114	24.2
50 000 – <100 000	146	31.0
100 000 or more	120	25.5

[¥] Total for each variable may not be equal to n=505 due to missing values.

* BD Taka 1000 = US $ 12.44

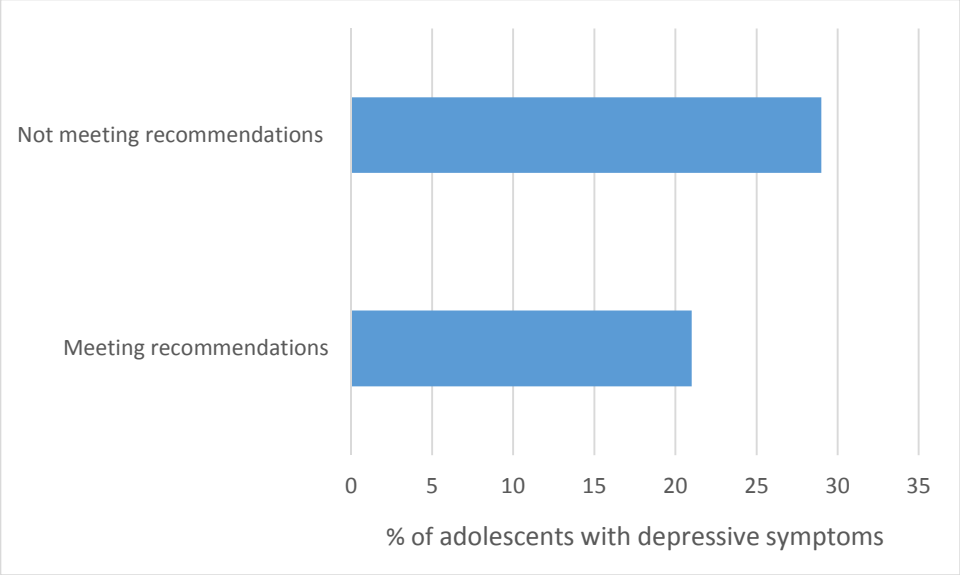

Figure 1: Percentage of adolescents with high recreational screen time reporting depressive symptoms for those meeting and those not meeting physical activity recommendations

Table 2: Association between reported physical activity and depressive symptoms among adolescents with high recreational screen time in Dhaka city, Bangladesh[•]

Physical Activity	Unadjusted estimates			Adjusted estimates[¥]		
	Odds ratio	95% CIs	p-value	Odds ratio	95% CIs	p-value
Meeting the activity recommendations[#]	1			1		
Not meeting the activity recommendations	3.06	1.34 – 6.99	0.008	2.37	1.23 – 4.59	0.01

[•] *Estimates are based on generalized estimating equations (GEEs) with CESD scores as dependent variable.*
[#] *Reference*
[¥] *Adjusted for age, gender, self-perception of weight category, feeling safe at school, life satisfaction, intake of sugary drinks, and sleep disturbance, which are not presented in this table.*

Is physical inactivity associated with depressive symptoms among adolescents with high screen time? Evidence from a developing country

Highlights:

- 25% of adolescents with high screen time reported depressive symptoms
- 32% of adolescents with high screen time did not meet the activity recommendations
- Odds of depression was double for high screen time with insuffcient activity