



Original Article

Adherence to 24-hour movement guidelines and their association with depressive symptoms in adolescents: Evidence from Bangladesh

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ABSTRACT

Healthy movement behaviours are associated with various physical and mental wellbeing; however, little is known about such associations in low- and middle-income countries. The aim of this study was to examine adherence to 24-hour (h) movement guidelines and their relationship with depressive symptoms in adolescents. Data were from 312 Bangladeshi adolescents aged 13–17 years (42% female). Meeting the guidelines was defined as: energy expenditure for physical activity (PA) ≥ 1 680 Metabolic Equivalent of Task (MET)-min/week, ≤ 2 h/day of recreational screen time (ST), and 8–10 h/night of sleep. Depressive symptoms were assessed using the 10-item Center for Epidemiological Studies Depression Scale (CESD-10) with a score of 10 or more indicating high depressive symptoms. Percentage of adolescents meeting the three recommendations was 2.2%, with 17.6% meeting two, and 31.2% meeting one recommendation. Generalized estimating equations showed that odds of having high depressive symptoms was a third (odds ratio [OR] = 0.35, 95% confidence interval [CI], 0.19–0.57) for meeting the PA guidelines, and about a half (OR = 0.47, 95%CI, 0.18–0.87) for meeting the sleep guidelines. Odds of depressive symptoms reduced significantly for meeting PA and sleep (OR = 0.20, 95%CI, 0.09–0.59), or PA and ST (OR = 0.24, 95%CI, 0.08–0.55) guidelines. About half of the adolescents did not meet any recommendations, which underscores the need for public health campaigns to promote adherence to the movement guidelines in this pediatric population. Further longitudinal research with larger sample size is recommended to explore the inter-relationships of these behaviours and their impact on health and wellbeing outcomes of adolescents in Bangladesh.

1. Introduction

Benefits of the healthy movement behaviours, including high physical activity (PA), low screen time (ST), and adequate sleep, in a 24-hour (h) period are well documented among children and adolescents.¹ These behaviours may be mutually exclusive components of the 24-h continuum that, together, affect health and wellbeing. Accumulating evidence suggests that certain combinations of these movement behaviours within a 24-h period may have important health implications for children and adolescents.^{2–6} For instance, meeting more recommendations may be associated with better health outcomes.^{2,5,7} To optimise health and wellbeing, it is recommended that children and adolescents (aged 5–17 years) accumulate at least 60 min/day of moderate-to-vigorous physical activity (MVPA), limit recreational ST to 2 h/day, and acquire

uninterrupted sleep of 9–11 h/night for 5–13 year-olds and 8–10 h/night for 14–17 year-olds.^{1–3} A systematic review showed that only between 4.8% and 10.8% of children, and 1.6% and 9.7% of adolescents met all three recommendations of the guidelines,⁸ while adherence to the three recommendations is likely to be lower in adolescents.⁹ A recent study reported that up to 3% of adolescents from eight Asian countries met all three recommendations.¹⁰ Meeting the 24-h movement guidelines is associated with more favourable health indicators, while meeting all three recommendations can accomplish additional health benefits in adolescents including preventing obesity, promoting social adjustment.⁸

In addition to physical health benefits, meeting the 24-h movement guidelines can contribute to improve mental health in adolescents with better mental health indicators among children and adolescents who meet all three movement behaviour recommendations compared with meeting none of the recommendations.^{11,12} Specifically, meeting the ST

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Abbreviations

ASAQ	Adolescent Sedentary Activity Questionnaire
BMI	body mass index
BUHS	Bangladesh University of Health Sciences
CESD	Center for Epidemiological Studies Depression
CI	confidence interval
DSM-IV-TR	Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision
GEE	generalized estimating equations
h	hours
IPAQ-A	International Physical Activity Questionnaire for Adolescents
MET	metabolic equivalent of task
Min	minutes
MVPA	moderate-to-vigorous physical activity
OR	odds ratio
PA	physical activity
SD	standard deviation
ST	screen time
WHO	World Health Organisation

and sleep duration recommendations are associated with more mental health benefits than meeting the PA recommendation alone.¹² Mental health disorders are major causes of illness and disability among young people as the consequences of failing to address their mental health conditions early can extend to adulthood, impairing both their physical and mental health.¹³ Of the mental health disorders, depression is common among adolescents with a high pooled prevalence of 34% globally with an increase over the past decades: 24% during 2001–2010 and 37% during 2011–2020.¹⁴ This review also reported regional differences in pooled prevalence with adolescents in the Middle East showing the highest prevalence rate (64%), followed by adolescents in Africa (45%) and Asia (40%).¹⁴ There is also evidence suggesting that meeting all three 24-h movement guidelines is associated with lower depression symptoms among adolescents.^{15–17} Meeting other guidelines are also associated with various mental health indicators. For example, adolescents who engaged in sufficient PA (≥ 60 min/day) had lower risks of developing depression symptoms¹⁸, whereas a review found that adolescents who spent more time (> 120 min/day) watching screen had more severe depressive symptoms.¹⁹ Moreover, inadequate sleep duration is associated with the mental health problems of adolescents and has been identified as a contributing factor to depressive symptoms in adolescents.^{18,20} Hence, the interest is growing towards the understanding of how these behaviours collectively relate to health and wellbeing of adolescents. This is particularly crucial in the Asia region, particularly among low- and middle-income countries, where many countries are going through socioeconomic transitions and technological advancements, which has resulted in sedentary lifestyles across different age groups and socioeconomic levels. Also, most of the Asian countries belong to low- and middle-income country category, which represents the majority (41%) of the new cases of non-communicable diseases and mental health conditions attributed to physical inactivity.²¹

Although some studies have examined the guidelines and their relationships with health outcomes in Asian countries,^{10,22,23} no studies have examined the relationship in Bangladesh, which is going through a rapid urbanisation, industrialisation, and mechanisation in domestic and workplace activities, resulting in sedentary lifestyles.²⁴ Although mental health is a much-neglected issue, its prevalence is not negligible among school children in Bangladesh. The first national survey on mental health, conducted in 2009, reported that 21.2% of the participating adolescents aged 12–17 years had mental disorders as diagnosed by psychiatrist interview using the Diagnostic and Statistical Manual of Mental

Disorders, Fourth Edition, Text Revision (DSM-IV-TR) criteria.²⁵ Using 32 published articles, one systematic review reported that the prevalence of mental disorders ranged from 13.4% to 22.9% among children aged 2–16 years in Bangladesh.²⁵ A recent cross-sectional study found that one in four adolescents aged 13–16 years reported some form of depressive symptoms with a higher prevalence among females than males²⁶; however, their behavioural risk factors are yet to be fully explored. It is suggested that activity behaviours are context-specific, and often influenced by varying motivations and needs across cultures, climates, and countries.²⁷ Hence, developing a better understanding about such behaviours from a low- and middle-income Asian setting is crucial not only to promote the health of this population but also to enrich the diversity of the field, which in turn can inform targeted strategies to improve children's activity behaviours globally. The aim of this study was to investigate percentage of adolescents meeting individual and combinations of the 24-h movement guidelines, and their relationship with depressive symptoms.

2. Materials and methods

Data for this study were from the baseline of a trial, conducted in urban high school settings in Bangladesh.²⁸ Thirteen schools of Dhaka city, Bangladesh were purposively invited to participate in the study. A number of schools (both public and private) were approached based on personal relationship with the research team, location and/or accessibility. Eleven schools accepted the intervention, and eight of them were randomly selected for the trial. A minimum of 40 Grade 8/9 students (aged 13–17 years) were recruited from each of the eight selected schools. Of the 320 students who participated in the baseline of the trial, a total of 312 had complete data on the variables of interest and thus formed the analytical sample for the current analysis.

2.1. Ethical approval

Written informed parental consent and student's assent were obtained from all participating students. Ethical approval was obtained from the ethics committee of The University of Queensland, Australia (2018000885, 31 May 2019), and the Bangladesh University of Health Sciences, Bangladesh (BUHS/BIO/EA/18/12, 26 December 2018).

2.2. Movement behaviours

The International Physical Activity Questionnaire for Adolescents (IPAQ-A) was used to assess habitual PA in four domains: school-related PA, transportation, housework/gardening, and leisure-time PA.²⁹ The IPAQ-A was validated with accelerometer data in healthy European adolescents²⁹ and adolescents in Hong Kong.³⁰ Activity data were converted into average metabolic equivalent tasks, MET-min/week, as per the IPAQ guidelines with the MET score of 3.3 for walking, 4.0 for moderate activity and 8.0 for vigorous activity. As per the World Health Organisation (WHO) recommendations for PA for 5–17 years old, total PA was categorised as meeting the guidelines if $\geq 1\ 680$ MET-min/day, which is equivalent to doing 60 min of moderate-to-vigorous activity everyday.^{31,32} The Adolescent Sedentary Activity Questionnaire (ASAQ), which has satisfactory test-retest reliability in Australian adolescents³³, was used to assess recreational ST for a weekday (i.e., school day) and a weekend day for watching television, watching DVDs/videos, using computers for fun, and using social media in different digital platforms.³³ Total recreational ST per day was generated, using a 5:2 weighting for weekdays: weekend days, and was considered as meeting the guidelines if total ST ≤ 2 h/day, based on the movement behaviour guidelines for children and youth.^{1,34} Participants were also asked to report time spent sleeping on a weekday and a weekend day. Total sleep duration was obtained by the sum of sleep duration of weekdays and weekends, using a 5:2 weighting. According to the movement behaviour guidelines for children and youth^{1,34}, sleep duration was categorised as meeting the guidelines if 8–10 h/night.

2.3. Outcome

Depressive symptoms were measured using the 10-item Centre for Epidemiologic Studies Depression Scale (CESD-10), as used previously in Bangladeshi adolescents.²⁶ Response options for each item range from 0 to 3: 0 = rarely or none of the time, 1 = some or little of the time, 2 = moderately or much of the time, 3 = most or almost all the time. The CESD scale has good psychometric properties among children and adolescents in some Asian countries.^{35–37} The internal consistency, measured by Cronbach's α , for the scale was 0.81 for this study. A total score was obtained by summing the 10 graded item scores (range: 0–30) with a score of 10 or more indicating high depressive symptoms.³⁸

2.4. Covariates

A set of covariates was collected including age, sex, school, and family-level data (e.g., mother's education, father's education, family income), based on earlier research.^{28,39} Body mass index (BMI) were computed using objectively collected weight and height data from the participants and their z -scores were computed using age- and sex-specific reference data from the WHO.⁴⁰ Underweight was defined as BMI- z score less than -1 standard deviation (SD), normal weight as BMI- z score between -1 SD and $+1$ SD, and overweight/obese as BMI z -score greater than $+1$ SD.⁴¹

2.5. Statistical analysis

Proportions of adolescents meeting individual and combinations of recommendations (i.e., MVPA only, ST only, sleep only, MVPA + ST, MVPA + sleep, and ST + sleep) and their general combinations (i.e., none, one, two and three) of the guidelines were calculated. Mother's and father's educations were highly correlated, and as such mother's education was only considered in the modelling to avoid any issue of collinearity. To take into account the nested structure of the data (i.e., students nested within school) in the analyses, a series of generalized estimating equations (GEE), adjusted for age, sex, z -scores, mother's education, and family income, with binomial family and logit link were used to examine the associations. GEE estimates were obtained by using the exchangeable working correlation. Model assumptions were checked before finalising the multivariable multilevel models. All analyses are conducted using Stata 17SE, and estimates are presented in odds ratio (OR) and 95% confidence interval (CI).

3. Results

Table 1 describes sample characteristics. Average age of the respondents was 14.3 years and 58% were boys. About 18% of the adolescents were identified as overweight/obese, while eight percent was underweight. Over a quarter of mothers (28%) had tertiary or postgraduate qualification, while 43% of fathers had tertiary or postgraduate qualification. One-fifth of the adolescents (20%) reported experiencing depressive symptoms (CESD-10 score ≥ 10) during the week prior to the survey.

Proportions of adolescents meeting individual and combinations of recommendations of the guidelines are presented in Fig. 1. Meeting the sleep recommendation alone was the most prevalent (32.1%), followed by ST (21.1%) and MVPA (19.8%). Meeting the ST + sleep recommendation was the most prevalent (10.9%) in combination of two recommendations, followed by MVPA + sleep (7.3%), and MVPA + ST (6.0%). About half (49%) of the adolescents did not meet any recommendation, while only 2.2% met all three recommendations of the guidelines.

As shown in Table 2, odds of having high depressive symptoms for adolescents was a third (OR = 0.35, 95% CI, 0.19–0.57) for meeting the PA guidelines, and about a half (OR = 0.47, 95% CI, 0.18–0.87) for meeting the sleep guidelines, after adjusting for the set of covariates. Meeting both MVPA and sleep guidelines reduced the odds to a fifth (OR

Table 1

Characteristics of study participants ($n = 312$).

Characteristics	Mean (SD) n (%)
Average age (SD) years	14.31 (1.04)
Sex	
Boys - n (%)	181 (58.0%)
Girls - n (%)	131 (42.0%)
Weight status	
Under weight - n (%)	26 (8.3%)
Normal weight - n (%)	231 (74.0%)
Overweight/obese - n (%)	55 (17.6%)
Mother education	
Up to primary or equivalent - n (%)	53 (17.0%)
Secondary or equivalent - n (%)	73 (23.4%)
Higher secondary or equivalent - n (%)	99 (31.7%)
Tertiary/graduation or above - n (%)	87 (27.9%)
Father education	
Up to primary or equivalent - n (%)	22 (10.3%)
Secondary or equivalent - n (%)	50 (16.0%)
Higher secondary or equivalent - n (%)	95 (30.5%)
Tertiary/graduation or above - n (%)	135 (43.3%)
Family income (Bangladeshi taka in 1 000) per month	
≤ 30 - n (%)	52 (16.7%)
30–40 - n (%)	133 (42.6%)
> 40 - n (%)	127 (40.7%)
Depressive symptoms (range 0–30)	
High (CESD ≥ 10) - n (%)	62 (19.9%)
Normal (CESD < 10) - n (%)	250 (80.1%)

Total sample size may not be equal to 312 due to missing data.

1 000 Bangladeshi Taka = 9.22 USD as on 14 June 2023.

SD = standard deviation.

CESD = Center for Epidemiological Studies Depression.

= 0.20, 95% CI, 0.09–0.59), while meeting both MVPA and ST reduced the odds to about a quarter (OR = 0.24, 95% CI, 0.08–0.55). Adolescents meeting two/three recommendations, compared to meeting none, had 62% lower odds of having depressive symptoms (OR = 0.38, 95% CI, 0.21–0.91).

4. Discussion

This study is the first to investigate the compliance of the 24-h movement guidelines and whether meeting individual and combinations of the guidelines is associated with adolescents' depressive symptoms in Bangladesh. About 18% of the adolescents met at least two recommendations, while only 2.2% met all the three recommendations. These findings are indeed discouraging, particularly given the low proportion of Bangladeshi adolescents meeting all three guidelines. However, the overall prevalence appears favourable compared to other Asian samples.^{7,10,23} For instance, in a study examining the association between the 24-h movement guidelines adherence and adiposity involving 12 590 adolescents from eight Asian metropolitan cities including Bangkok (Thailand), Hong Kong SAR, Kuala Lumpur (Malaysia), Seoul (South Korea), Shanghai (China), Singapore, Taipei (Taiwan, China), and Tokyo (Japan), percentage of meeting all three recommendations in most cities except Shanghai (3.0%) ranged between 0.0% and 0.8%.¹⁰ However, the findings of our study has contributed to the limited evidence-base in low- and medium-income country settings by providing some insights into how different combinations of movement behaviours are related to depressive symptoms of school aged children, which can potentially inform campaigns to increase adoption of adolescents' healthy behaviours to optimise their wellbeing.

Previous work showed that more favourable 24-h movement behaviour compositions are generally observed in low- and middle-income countries compared to, for example, high-income countries.^{42,43} However, this does not overrule the absolute, low adherence to the movement guidelines among the contemporary adolescents in Bangladesh, particularly given that there is also a lack of resources for healthcare, while

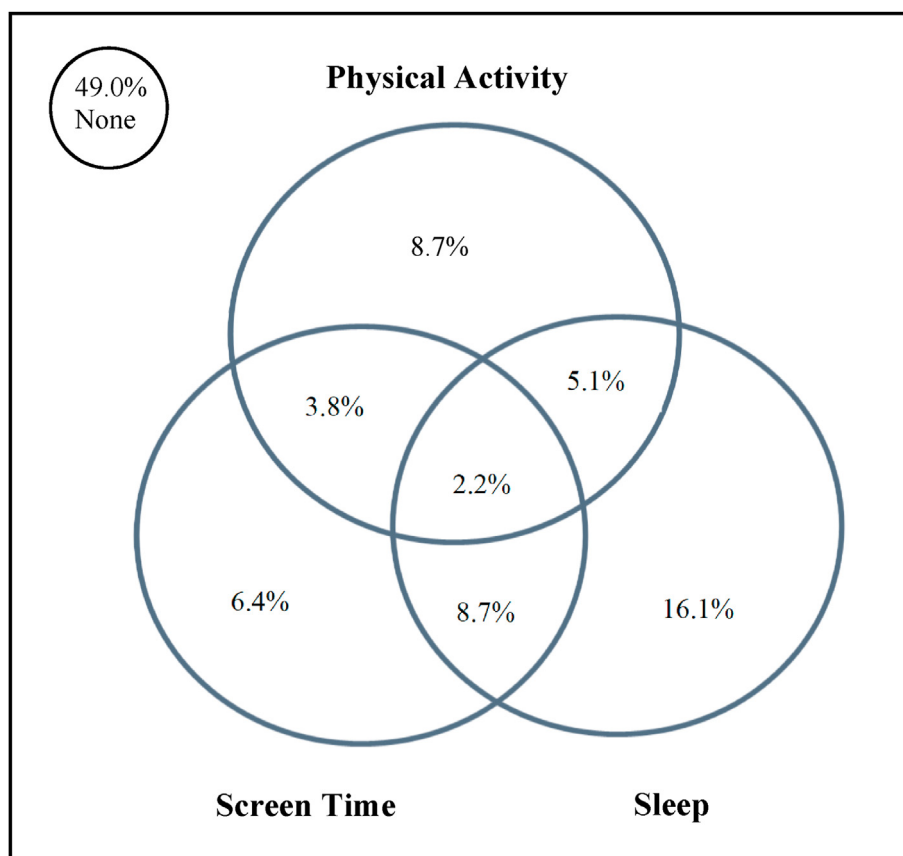


Fig. 1. Venn diagram showing the proportions (%) of adolescents (aged 13–17 years) meeting the 24-h movement guidelines and no recommendation ($n = 312$). Here, meeting physical activity guidelines means accumulating at least 1 680 metabolic equivalent of task (MET-min/week), meeting screen time guidelines means no more than 2 h/day of recreational screen time, and meeting sleep guidelines means getting 8–10 h of sleep per night.

Table 2

Associations between meeting the physical activity, screen time, and sleep recommendations and combinations of these recommendations with high depressive symptoms in adolescents.

Recommendations	%	High depressive symptoms ^a
		OR (95% CI) ^b
Specific combinations		
At least MVPA		
Not met	80.1	1.00 (Reference)
Met	19.9	0.35 (0.19–0.57)
At least ST		
Not met	78.8	1.00 (Reference)
Met	21.1	0.45 (0.20–1.02)
At least sleep		
Not met	67.9	1.00 (Reference)
Met	32.1	0.47 (0.18–0.87)
MVPA + ST		
Not met	94.0	1.00 (Reference)
Met	6.0	0.24 (0.08–0.55)
MVPA + Sleep		
Not met	99.2	1.00 (Reference)
Met	7.3	0.20 (0.09–0.59)
ST + Sleep		
Not met	89.1	1.00 (Reference)
Met	10.9	0.36 (0.13–0.88)
General combinations		
None	49.0	1.00 (Reference)
One	31.2	0.53 (0.22–1.02)
Two or three	19.8	0.38 (0.21–0.91)

MVPA = Moderate to vigorous physical activity; ST: Screen time.

OR = odds ratio; CI = confidence interval.

^a CESD (Center for Epidemiological Studies Depression) ≥ 10 .

^b Adjusted for age, sex, z-scores, mother's education and family income.

experiencing rapid urbanization and economic development.²⁴ Various factors may also contribute to these negative patterns of health and health behaviours among adolescents in Bangladesh, including technology-based entertainment, use of social media, motorized travel and sedentary lifestyles, all of which are prevalent and concerning public health problems in most of the low- and middle-income countries.⁴⁴ Given the well-documented benefits of the healthy movement behaviour composition, the first public health action that can be taken is to strengthen surveillance efforts. In 2018 Bangladesh Report Card on Physical Activity for Children and Youth, only three behavioural indicators and one sources of influence indicator were evaluated out of 10 indicators the Report Card team attempted to assign a grade.⁴⁵ Such data gap in low- and middle-income settings is identified as a challenge in global PA research.⁴⁶

Although the association was not evident for ST alone, meeting MVPA or sleep recommendation alone was associated with lower odds of depressive symptoms. Statistically insignificant association between meeting the ST recommendation and depressive symptoms may partly be due to the assessment of screen use, which did not differentiate between passive and active ST or context of screen use. Previous research suggested that different types or domains of ST may yield different health outcomes.^{47,48} For example, passive (e.g., television) and mentally active (e.g., electronic games, computer use) ST are adversely associated with psychosomatic complaints in a dose-dependent manner; however, the association estimates are slightly stronger for active than passive ST.⁴⁷ As a single behaviour, meeting the MVPA recommendation was found to be more strongly associated with lower odds of reporting depressive symptoms than meeting the sleep recommendation. Although it is evident that meeting more recommendations may yield the favourable outcomes of health and wellbeing among adolescents, providing more

opportunities for MVPA in school and community setting can be an effective strategy for promoting mental health among adolescents in Bangladesh.

When the movement recommendations were considered in combination, meeting both MVPA and sleep recommendations within the guidelines had the strongest protective effects of reducing the odds of depressive symptoms by 80%, which was followed by a protective effect of a reduction of 76% for meeting both MVPA and ST recommendations. These findings are supported by earlier research, although the estimates are slightly stronger in the current study than the earlier estimates, which were based on a large sample of Chinese students.¹⁸ In addition to MVPA, another behaviour that can be promoted for adolescent wellbeing in Bangladesh is to support adolescents to obtain adequate sleep. Given that the proportion of meeting individual recommendation was the highest for sleep (31%) compared to MVPA (20%) or ST (21%), promotion of healthy sleep could be another effective strategy in low- and middle-income settings.

Our study was not able to investigate the potential advantage of meeting three guidelines for depressive symptoms due to small cell frequencies. However, an earlier Asian study showed that meeting any two of the recommendations was as effective as meeting all three recommendations in relation to reducing children's depressive symptoms and anxiety.¹⁸ Also, it may be easier for children to meet two guidelines than meet all three, which is likely to improve compliance. In contrast, there is evidence to suggest that meeting all three recommendations of the 24-h movement guidelines could lead to additional health benefits.^{12,49} Considering the various trade-off of the movement behaviours, future public health initiatives should target multiple behaviours, at least two as opposed to single behaviour, to offer a healthy 24-h period to children and adolescents in order to achieve better health outcomes across the lifespan.⁸

This study has several limitations including small and non-representative sample and self-report of data. Depressive symptoms were assessed using the self-reported CESD-10 scale which has acceptable psychometrics but has not been validated among Bangladeshi adolescents. Although instruments used to measure movement behaviours (e.g., IPAQ-A, ASAQ) have satisfactory reliability/validity in Asian and non-Asian adolescents, psychometrics of these scales are yet to be established in Bangladeshi adolescents. The cross-sectional nature of this study precludes determining causality of the relationships. However, the current analysis using GEE modelling considered nested structure of the data and was adjusted for multiple potential confounders, including BMI z-scores and family socioeconomic position. Given that evidence from all countries/regions is equally valuable, our study provides an excellent opportunity to understand adherence to healthy movement behaviours from an Asian, low- and middle-income country, which is likely to contribute towards improving equitable representation of the research in the field, as suggested by experts.^{27,50}

Our key findings that one in two of the adolescents not meeting any recommendation of the 24-h movement guidelines underscore the need for public health strategies to promote adaptation of these movement guidelines. The results also indicate that a combination of MVPA with sleep or ST recommendation has the potential to reduce depressive symptoms among adolescents. This further emphasises the importance of adopting multiple movement behaviours, with a minimum of two guidelines met, which could be considered a behavioural approach to optimise mental wellbeing or treat mental health problems in this population group. Nonetheless, properly designed longitudinal studies are warranted to understand the inter-relationships of these behaviours, particularly by PA settings (e.g., indoors vs outdoors) and ST types (e.g., active vs passive, use of smartphone, social media), and their causal link with various health outcomes in this paediatric population. More work from the low- and middle-income settings should be built on our findings to fill the data gaps that exist.⁴³

In conclusion, this study found that a small proportion of adolescents met all three recommendations, indicating a low compliance rate.

Meeting MVPA and sleep recommendations yielded the best outcome in terms of depressive symptoms; therefore, promoting MVPA in schools and communities, and supporting adolescents in obtaining adequate sleep could be a suggested strategy for improving mental health of adolescents in Bangladesh. Given the scarcity of research on movement behaviours in low- and middle-income settings, the current study uniquely contributes valuable evidence and emphasises the need for public health strategies to promote adherence to the movement guidelines, which has the potential to enhance mental well-being among adolescents. Further longitudinal research with larger sample size is recommended to explore the inter-relationships of these behaviours as well as different domains of each behaviour and their impact on health and wellbeing outcomes in this population. Moreover, monitoring and surveillance efforts on health behaviours can better support the development and evaluation of health promotion strategies in Bangladesh and countries with similar socio-economic and cultural structure.

Ethical approval statement

Informed consent was obtained from each participant, and the study was reviewed and approval by the ethics committee of The University of Queensland, Australia (2018000885, 31 May 2019), and the Bangladesh University of Health Sciences, Bangladesh (BUHS/BIO/EA/18/12, 26 December 2018).

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Authors' contributions

AK led the conceptualization, formal analysis, interpretation, and writing and reviewing the manuscript. KRA and AK collected the data. KRA and EYL contributed to writing, interpretation of results and reviewing the manuscript. All the authors have approved the manuscript being submitted to the journal.

Submission statement

All authors have read and agree with manuscript content. The manuscript will not be submitted elsewhere for review and publication.

Conflict of interest

The authors declare that they have no direct or indirect interests that are in direct conflict with the conduction of the study.

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