Combined effects of physical inactivity and sedentary behaviour on psychological distress among university-based young adults: A one-year prospective study

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Abstract

Insufficient physical activity (PA) and prolonged sedentary behaviour (SB) may have deleterious psychological health consequences. Using one-year prospective data, this study examined the combined effects of PA and SB on psychological distress among university-based young adults in Dhaka, Bangladesh. During Wave 1 (September to December 2015), total 573 undergraduate students (average age: 20.7 ± 1.35 years; 45% female) completed a self-administered survey on PA, SB, psychological distress, health and lifestyle factors and sociodemographics. During Wave 2 (October–November 2016), 395 students (retention rate=69%) completed a sub-set of Wave 2 survey with items on PA, SB and psychological distress. PA and SB were assessed using the Global Physical Activity Questionnaire (GPAQ) and distress with the Kessler 6 Psychological Distress (K6) scale. Generalized Estimating Equations (GEE) with *Gaussian* family and *identity* link under *exchangeable* correlation structure was used to examine the relationships. Multivariable modelling showed that participants with insufficient PA (<150 minutes/week) and high SB (≥ 480 minutes/day) or insufficient PA + low SB had more distress [β : 3.07 (95%CI: 2.12–4.01) and 2.77 (1.86–3.67), respectively] than those who had sufficient PA + low SB, after controlling for gender, sleep difficulties, perceived health, fast food and fresh fruit intake. There was no statistically significant difference for the level of distress between other PA and SB groups. In this one-year prospective study, irrespective of SB, insufficient PA was associated with high psychological distress in university-based young adults in Bangladesh. The protective role of PA should be considered in intervention programs to improve the psychological health of young adults.

Keywords: exercise; health promotion; longitudinal study; mental health; screen use

Introduction

Approximately three-quarters of psychological health problems appear by the age of 20 years [1]. Worldwide, poor psychological health has been reported as the most common cause of disability in adolescents and young adults aged 10-24 years, contributing to 45% of years lost due to disability (YLD) [2]. Globally, unipolar depressive disorders are the leading cause of non-fatal burden of disease in young adults aged 20-24 years, representing approximately 8% of total disability-adjusted life-years (DALYs) lost [2]. Poor psychological health may compromise psychosocial development, increase substance abuse, lower academic performance and achievements, cause unemployment and decrease the quality of life [3-6].

Physical activity (PA) participation has been inversely associated with general young adults' poor psychological health in longitudinal [7] and intervention studies [8-10]. PA can reduce the risk of anxiety and depressive symptoms, and stress; and improve the psychosocial wellbeing of young adults [7-10]. In contrast, sedentary behaviour (SB), defined as waking time spent in sitting or reclining; e.g., watching television (TV), computer use, in travel (e.g., in motorised vehicles), has been positively associated with poor psychological health in young adults [11, 12]. For example, a recent longitudinal study in Chinese college students reported that high screen-time was associated with poor psychological health, and an increase in screen-time was associated with progression of psychological health problems during one-year follow-up [12].

Insufficient PA and high SB may interact to increase psychological health problems [13-17]. For example, a recent cross-sectional study in Chinese college students reported that participants who had insufficient PA (<3 days/week of exercise) and high SB (>2 hours/day screen-time) were more likely to report depression, anxiety, and other psychopathological symptoms than those who had sufficient PA and low SB [16]. However, the strength of this evidence is limited by a cross-sectional study design.

University students may be vulnerable to poor psychological health because of academic and social demands in their day-to-day life [6]. Epidemiological data from around the world suggest a high prevalence of depression and anxiety in this population with 12%-50% meeting criteria for at least one common psychological disorders [6, 5]. Insufficient PA and high level of SB are also common in university-based young adults, and may be associated with poor psychological wellbeing [14, 12, 16]. This study aimed to use one-year prospective data to examine the associations of PA and SB with psychological distress in a university-based sample of young adults in Dhaka City, Bangladesh.

Methods

Study design and population

Data are from a one-year prospective study: Wave 1 (September to December 2015) and Wave 2 (October-November 2016). A convenience sample of first, second and third-year students aged 18 to 24 years was recruited from six (three public and three private) universities based in Dhaka City, Bangladesh. The recruitment procedure can be found elsewhere [18]. Fourth-year students were not included at Wave 1 as they were unlikely to be available for follow-up.

Data were collected using a self-administered survey, which was administered in English. Completion of Wave 1 survey took approximately 40-45 minutes, with questions about PA, SB, psychological distress, health and lifestyle factors, and socio-demographics. Wave 2 survey was a sub-set of Wave 1 survey including items on PA, SB, and psychological distress; this took about 15-20 minutes to complete.

Outcome measure - psychological distress

The Kessler Psychological Distress (K6) scale has been shown to be a reliable and validated self-report to assess general psychological health in a community setting [19]. The K6 scale, consisting of six items, coded from 0 to 4 (0 = 'none of the time' to 4 = 'all of the time'), asks how frequently

in the past four weeks respondents had experienced each of the following commonly occurring symptoms: sadness, nervousness, fidgety, hopelessness, effortfulness and worthlessness. The six items were added to generate a total score (range: 0-24) with high scores representing more distress. An exploratory factor analysis with varimax rotation confirmed the unidimensionality of the scale in the current study with a one-factor solution, which accounted for 59% and 62% of the variance respectively during Wave 1 and Wave 2. Cronbach's alpha for the scale in this study was 0.85 at Wave 1 and 0.82 at Wave 2.

Other measures

PA and SB were measured using the Global Physical Activity Questionnaire (GPAQ), which was developed by the World Health Organisation (WHO) for population surveillance in low- and middle-income countries [20]. Reliability and validity of the GPAQ have been assessed among adults aged ≥ 18 years in nine countries, including Bangladesh [20]. It has been used in >100 countries around the world, including Bangladesh, in the STEPwise Approach to Non-communicable Disease Risk-Factor Surveillance (STEPS) program by the WHO [20]. The current study used the self-administered version, which is a relatively inexpensive method with comparable reliability and validity to the interview administration [21]. It consists of 15 items on PA and one on SB [20].

Physical activity

The respondents were asked to report the number of days in a week, and the amount of time in a typical day of the week, they spent doing each of moderate and vigorous PA for work and recreation; and moderate PA for walking or cycling for travel. Consistent with the GPAQ data analysis guideline, all activity data were converted to minutes and were multiplied by the corresponding number of days [22]. Vigorous activity minutes were weighted by two given the higher intensity than moderate activity [22]. The time spent in vigorous activity (weighted) and moderate activity minutes were summed to obtain total PA, which was then dichotomised as

‘sufficient PA’ (≥ 150 minutes/week) and ‘insufficient PA’ (< 150 minutes/week). This is consistent with the WHO’s PA recommendations [22]. As per the GPAQ protocol, four respondents (two at Wave 1 and two at Wave 2) were excluded from the analyses as they provided improbable or out of range PA/SB data during [22]. This has been described in details elsewhere [18].

Sedentary behaviour

The GPAQ asks the participant to report total time spent sitting/reclining (excluding sleeping) during a typical day of the week [20]. As young adults are more sedentary on weekend days than weekdays [23], the single question was split into two for a typical weekday and weekend day using the same response options. Total sedentary time (mins/day) was derived as:

$$\text{Daily sedentary time (mins)} = [(\text{weekday time} \times 5) + (\text{weekend day time} \times 2)] / 2$$

Currently, there is no consensus threshold at which a person to be defined to have high SB. However, sitting for ≥ 8 hrs/day (480 mins/day) has been shown to significantly increase the risk of all-cause mortality [24]. This value was therefore used in the present study with SB dichotomised as ‘low’ (< 480 min/day) and ‘high’, (≥ 480 min/day). This criterion has also been used in other research in Asian adults [25].

Socio-demographics and lifestyle factors

Participants completed survey items to assess: age, gender, height and weight, marital status (married/unmarried), university type (public/private), enrolled program (Science; Humanities; Engineering; and Business), year of study (year 1 to 3), parents’ education level (primary or equivalent; secondary or equivalent; higher-secondary or equivalent; and tertiary or equivalent), mothers’ current occupation (working/non-working), fathers’ current occupation (government or public service; private sector; professional; self-employed/business; and other, which included semi-skilled and unskilled labour, and farmers), monthly gross household income [$\leq 20,000$ Bangladeshi Taka (BDT); 20,001-40,000; 40,001-70,000; $> 70,000$], household composition (living

alone; with parents; with family members other than parents; with friends/classmates), and housing type (own house/flat with family; rented house/flat with family; university accommodation/hall; shared accommodation with friends/classmates). Body mass index (BMI) was computed from self-reported height and weight, which was used as a continuous variable. Participants reported on cigarette smoking (non-smoker, past smoker, occasional smoker, regular smoker); alcohol consumption (I never drink, used to drink previously, drink occasionally, drink regularly); dietary behaviour (e.g., number of servings of each of fast food, fresh fruit, vegetables/green salad during last seven days); frequency of consumption of nonalcoholic carbonated beverages during the past seven days (none, 1-2, 3-4, 5-6, 7-9, 10-13, 14+ glass/cans), and if they had a TV in the bedroom (yes/no). Participants were also asked to rate current health (with five response categories collapsed into poor/fair and good/very good/excellent) and the frequency of experiencing sleep difficulties in the past month (with five response categories collapsed into always/often, sometimes, and rarely/never). Poor health and sleep difficulties have been associated with insufficient PA and poor psychological health in previous research [26, 14].

Statistical analyses

Dichotomous PA (sufficient and insufficient) and SB (high and low) variables were used to create a 2×2 variable of combinations of PA and SB: sufficient PA+low SB; sufficient PA+high SB; insufficient PA+low SB; and insufficient PA+high SB. The outcome variable (K6 score) was normally distributed, hence the Generalized Estimating Equations (GEE) with *Gaussian* family and *identity* link under *exchangeable* correlation structure was used to examine combined effects of PA and SB with the total K6 scores. In this analysis, GEE took into account the non-independence of students' psychological distress nested within two waves. The following potential covariates assessed at Wave 1 were considered as potential confounders: age, gender, marital status, BMI, parental education and occupation, monthly gross household income, household composition, housing type, television (TV) in bedroom, perceived health, sleep difficulties, smoking, alcohol consumption, fast food intake, fresh fruit and vegetable intake, nonalcoholic carbonated beverage

intake, university type, enrolled program, and year of study. Potential confounding variables which had univariate associations with the K6 score at $p < .20$ [as recommended elsewhere [27]] were identified and examined for collinearity. BMI, mother's education, father's occupation, household composition and housing type were initially considered in the multivariable model, but were not significantly associated with the K6 score in the multivariable model and were excluded. Gender, sleep difficulties, perceived health, fast food and fresh fruit intake were significantly associated with the K6 score in the final multivariable GEE model.

A number of sensitivity analysis were conducted: a) unlike PA, there is no established cut-off value for high SB. Hence, three different cut-offs were used to define high SB (≥ 420 min/day, ≥ 540 min/day, and ≥ 600 min/day) to examine the impact of categorisation on results; b) a complete case analysis with only completers those provided valid data during both assessment waves was run to examine possible bias from dropouts; and c) the associations were examined using multilevel generalised structural equation modelling (SEM) to see if such modelling changed the results. Multilevel generalised SEM took into account the nesting of the participants across the two waves.

Outliers and other assumptions of the models were checked and model fit was assessed before finalising the models. The associations are presented in the form of regression coefficients with their 95% confidence intervals. All analyses were performed in STATA version 14 (StataCorp LP., College Station, Texas) with statistical significance set at $p < .05$.

Results

Of the 573 students (response rate: 91.6%) who participated in Wave 1 survey, 397 completed the Wave 2 survey (retention rate: 68.6%). Two respondents were excluded as they provided incomplete data – thus, the analytical sample of this study is 395. At baseline, the average age of the participants was 20.7 years ($SD=1.35$) and 45% were female. Table 1 summarises the baseline characteristics of the participants.

The sociodemographic characteristics of Wave 2 respondents were comparable to Wave 1 participants for gender (females 45% vs 48% during Wave 1 and Wave 2, respectively), BMI ($21.6 \pm 3.3 \text{ kg/m}^2$ vs $22.1 \pm 2.9 \text{ kg/m}^2$), being single (94% vs 92%), living with parents (47% vs 52%) and type of university (public 48% vs 42%).

Table 1 Baseline characteristics of the participating university-based young adults in Dhaka City, Bangladesh (N=573), 2015

Characteristics		n [‡]	%
Age (years)			
	Mean 20.7 (SD =1.35)	-	-
Gender			
	Male	313	54.6
	Female	260	45.4
BMI (kg/m ²)			
	Normal range	353	61.7
	Underweight	139	24.3
	Overweight	80	14.0
University type			
	Public	277	48.3
	Private	296	51.7
Year of study			
	First year	184	32.1
	Second year	223	38.9
	Third year	166	29.0
Mother's educational qualification			
	Primary or equivalent	111	19.4
	Secondary (or equivalent)	147	25.7
	Higher secondary (or equivalent)	125	21.9
	Tertiary (or equivalent)	188	32.9
Father's educational qualification			
	Primary or equivalent	53	9.3
	Secondary (or equivalent)	64	11.2
	Higher secondary (or equivalent)	102	17.9
	Tertiary (or equivalent)	352	61.7
Monthly gross family income (in BDT)*			
	≤20,000	115	20.3
	20,001-40,000	162	28.6
	40,001-70,000	172	30.4
	>70,000	117	20.7
Household composition			
	Living alone	24	4.2
	Living with parents	270	47.2
	Living with family members other than parents	46	8.4
	Living with friends/classmates	232	40.6
Housing type			
	Own house/flat with family	181	31.6
	Rented house/flat with family	176	30.7
	University accommodation/hall	146	25.5
	Shared accommodation with friends/classmates	70	12.2

[‡]Total for each variable may not be equal to n=573 due to missing values

*BDT = Bangladeshi Taka (local currency), 10,000 BDT = 118.69 US\$ as of 12 Oct. 2018

After adjusting for gender, sleep difficulties, perceived health, fast food and fresh fruit intake, GEE modelling showed that participants with insufficient PA+high SB had a significantly higher level of psychological distress than those who had sufficient PA+low SB [adjusted β : 3.07, 95% CI: 2.12-4.01, $p < .001$]. Participants who had insufficient PA+low SB also reported more psychological distress than young adults did with sufficient PA+low SB [2.77 (1.90-3.71), $p < .001$] after adjusting for the confounders. There was no statistically significant difference for the level of psychological distress between participants with sufficient PA+high SB, and those with sufficient PA+low SB ($p = .362$) (Table 2).

Table 2 Associations of physical activity and sedentary behaviour with psychological distress scores of university-based young adults in Dhaka City, Bangladesh (N=395), 2015/16[†]

PA and SB categorise	<i>Unadjusted estimates</i>		<i>Adjusted estimates*</i>	
	β (95% CI)	<i>p-value</i>	β (95% CI)	<i>p-value</i>
Sufficient PA + low SB	Reference		Reference	
Sufficient PA + high SB	-0.67 (-2.00 to 0.66)	.322	-0.59 (-1.86 to 0.68)	.362
Insufficient PA + low SB	3.42 (2.51 to 4.34)	<.001	2.77 (1.86 to 3.67)	<.001
Insufficient PA + high SB	3.92 (2.97 to 4.86)	<.001	3.07 (2.12-4.01)	<.001

Values in bold indicate p-value of 0.05 or lower.

[†]Estimates are based on Generalized Estimating Equations (GEE) with the K6 psychological distress scores as dependent variable

*Adjusted for gender, sleep difficulties, perceived health, frequency of fast food and fresh fruit consumption

Abbreviations: CI = confidence intervals; PA = physical activity; SB = sedentary behaviour

Additionally, there was no statistically significant difference for the level of psychological distress between participants with insufficient PA+high SB, and those with

insufficient PA+low SB ($p=.336$). However, compared to sufficient PA+high SB, participants with insufficient PA+high SB [3.66 (2.50-4.81); $p<.001$], and insufficient PA+low SB [3.36 (2.23-4.48); $p<.001$] had a higher level of psychological distress (results are not shown in the table) after adjusting for the confounders. High SB was not independently associated with psychological distress ($p=.638$) after adjusting for the same set of confounders (results are not shown in the table).

Results from the sensitivity analysis on GEE platform using different cut-off values for SB did not change the overall results, which suggests that SB categorisation did not affect the results. Findings of the complete case analysis with those provided data on both assessment points did not influence the results; and therefore suggests that findings are not influenced by dropouts. Findings of the multilevel generalised SEM did not change the results suggesting stability of the findings across different modelling platforms.

Discussion

The main finding of this one-year prospective study is that insufficient PA (i.e., >150 mins/week) was associated with high psychological distress irrespective of SB, after controlling for a set of potential confounders. Findings suggest that insufficient PA and high SB increased psychological distress significantly compared to sufficient PA and low SB in the study participants. This is understandable given other research indicating the deleterious effects of each of low PA and high SB [8, 9, 28, 11, 10, 12]. Insufficient PA and low SB also significantly increased psychological distress, which is also consistent with an expected adverse impact of low PA. However, there were no significant differences in distress between sufficient PA and high SB, and sufficient PA and low SB. This is inconsistent with other research demonstrating adverse effects of high SB [12] and suggests that PA may provide protective effects or have a stronger association with psychological health than SB.

Our findings are consistent with a previous cross-sectional study with adolescents that reported insufficient PA increased depressive symptomology, though the combination of insufficient PA and high SB did not [29]. These findings, however, are inconsistent with previous cross-sectional studies reporting higher odds of anxiety, depression and other psychopathological problems in university students with high SB and insufficient PA than those with low SB and sufficient PA [14, 12]. The inconsistency may be due to the different measures used to examine the relationships. For example, the study in Chinese college students which found that students with insufficient PA and high SB had poorer psychological health than those who had sufficient PA and low SB used the Self-rating Anxiety Scale, Centre for Epidemiologic Studies Depression Scale and Multidimensional Sub-health Questionnaire for Adolescents [16], and this study used a brief composite measure of general psychological distress. The other study used frequency of participation as a measure of PA [16], whereas this study used time spent in PA. Sedentary behaviour was assessed as time spent using a computer and watching TV/video in the other study [16] and a global measure of time spent sitting/reclining that could have included behaviours other than screen time was used in this current study. A recent meta-analysis of 101 studies found no relationship between video gaming and psychological health problems in youth [30]. Thus, it is possible that not all types of SB are associated with poor psychological health, and that the association depends on the contexts of SB. Future research could examine how different types of SB might interact with PA to influence the psychological health of young adults.

Findings of this study suggest that insufficient PA has significant negative effects on psychological health of university-based young adults, regardless of SB. The underlying mechanism by which PA influences psychological health may involve biological, psychosocial, and/or common cause mechanisms [31]. Regular PA has a beneficial effect on the hypothalamic-pituitary-adrenal (HPA) system. Dysregulation of the HPA-axis and

hypersecretion of cortisol may have an adverse effect on psychological health [32]. PA may act as a moderator to activate the limbic system and reduce cortisol secretion level [33]. Insufficient PA may interfere with the HPA functioning system, change serum cortisol level, and cause psychological distress. Dysregulation of the HPA system and sympathetic adrenal medullary, which is caused by insufficient PA may also be responsible for the cardiometabolic syndrome [34] and increase metabolic disease risk [35], which have been linked to poor psychological health [34]. It is also plausible that insufficient PA may interfere with a number of growth factors such as brain-derived neurotrophins and insulin-like growth factor, which are enhanced by exercise, and offer therapeutic and protective effects against depression [32]. PA may augment brain aminergic synaptic transmission of monoamines such as norepinephrine, dopamine and serotonin and may also activate β -endorphin secretion, which may subsequently improve psychological health [36].

Psychosocial factors may also explain the relationship. Regular PA may promote self-esteem, a positive body image and health perceptions [37], increase social support, positive emotions [38] and overall life satisfaction [39]. Insufficient PA may have a negative impact on psychosocial resources such as social support and purpose in life [38], and may increase depression and anxiety [40, 41].

It is possible that the relationship between poor psychological health and PA is bidirectional [42]. To explore the possibility of bi-directionality, additional modelling was conducted considering each of PA and SB as dependent variable and K6 scores as an independent variable. The results demonstrated that psychological distress was significantly associated with insufficient PA; however, the association was not significant with SB (results not presented). While insufficient PA may have an adverse effect on psychological health, it is also possible that poor psychological health negatively influences PA participation [42,

31]. For example, depression may negatively influence PA through a range of affective symptoms such as low mood and sadness, anhedonia, and low self-esteem, and somatic symptoms such as lethargy [31].

The relationship between insufficient PA and poor psychological health may also be explained by common cause hypothesis [31]. For example, insufficient PA and depression may share a range of factors including genetic makeup, socioeconomic status, the neighbourhood where an individual resides and parenteral rearing style [31, 43], which may influence both PA and psychological health. It is possible that PA participants are, in general, more satisfied with their lives and are happier than non-PA participants [43].

To our knowledge, this is the first study that examined the combined effects of PA and SB on psychological health in young adults using prospective data. This study used PA and SB measures, which have been validated in Bangladeshi adults, and adjusted the relationships for multiple covariates including sleep difficulties and subjective health of the participants to minimise possible confounding. A moderately large, heterogeneous sample of students from both public and private universities with a balanced representation of both sexes was used. This study followed-up the participants over one year with two assessment points, which did not allow examination of how the effect(s) of PA and SB on psychological health evolves over the long term. Self-reported measures were used to assess PA, SB and psychological distress, which are vulnerable to social desirability and recall bias. Though the K6 scale has good reliability and validity in other countries, it has not been validated in a Bangladeshi population. As a non-random convenience sample of university students from a metropolitan city was used, findings may have limited generalisability, and may not be transferable to all young adults.

Conclusions

In this one-year prospective study, insufficient PA was associated with high psychological distress irrespective of SB in a university-based young adult population in Dhaka City, Bangladesh. Our findings reinforce the importance of PA participation during young adulthood to mitigate possible psychological health risks. Our study findings do not suggest any unique combined effect of insufficient PA and low SB on the psychological health of young adults in urban Bangladesh. More long-term prospective studies are needed to further investigate the independent and interactive effects of PA and different types of SB on psychological health to advance our current understanding of these relationships.

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