


BMJ Open Trends in sedentary behaviour and associated factors among adults in Mongolia: results from national cross-sectional surveys in 2009, 2013 and 2019

Supa Pengpid,^{1,2} Karl Peltzer ^{3,4}

To cite: Pengpid S, Peltzer K. Trends in sedentary behaviour and associated factors among adults in Mongolia: results from national cross-sectional surveys in 2009, 2013 and 2019. *BMJ Open* 2022;**12**:e058330. doi:10.1136/bmjopen-2021-058330

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-058330>).

Received 13 October 2021
Accepted 20 May 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Department of Health Education and Behavioral Sciences, Faculty of Public Health, Mahidol University, Bangkok, Thailand

²Department of Research Administration and Development, University of Limpopo, Sovenga, South Africa

³Department of Psychology, University of the Free State, Bloemfontein, South Africa

⁴Department of Psychology, College of Medical and Health Science, Asia University, Taichung, Taiwan

Correspondence to

Dr Karl Peltzer;
kfpeltzer@gmail.com

ABSTRACT

Objective The study aimed to evaluate trends in the prevalence and correlates of sedentary behaviour (SB) in people aged 15–64 years from 2009 to 2019 in Mongolia.

Design Repeat population-based cross-sectional study.

Setting Nationally representative sample of persons living in the general community aged 15–64 years in Mongolia.

Participants The sample included 17 780 people (15–64 years) who participated in Mongolia STEPS surveys 2009, 2013 or 2019.

Primary and secondary outcome measures: self-reported SB, along with physical measurements, health status and health behaviour, and sociodemographic covariates. Multinomial logistic regression calculated OR with 95% CI for moderate and high SB, with low SB as reference category.

Results Across study years, the proportion of low (<4 hours) SB was 62.3%, moderate (4–<8 hours) SB was 26.4% and high (≥8 hours) SB was 11.3%. Compared to the survey year 2009, in the survey years 2013 and 2019, high SB increased significantly, while moderate SB increased in the survey year 2013 but not in 2019. Urban residence was positively associated with moderate and high SB. Male sex and higher education were positively associated with moderate SB. Current tobacco use, current heavy alcohol use, and obesity class II were positively and high physical activity was negatively associated with moderate and/or high SB. Belonging to the Khalkha ethnic group and hypertension increased the odds of moderate or high SB in 2019 and 2013, respectively. Age, higher number of adults household members and inadequate fruit and vegetable intake were not associated with moderate or high SB.

Conclusion More than 1 in 10 people aged 15 years and older engaged in high SB. Several sociodemographic and health variables associated with moderate and/or high SB were identified that can help guide public interventions.

INTRODUCTION

Sedentary behaviour (SB) has been described as ‘any waking behaviour characterised by an energy expenditure of 1.5 METs or lower while sitting, reclining or lying’.¹ Increasing evidence demonstrated that SB significantly contributes to morbidity (type 2 diabetes, cardiometabolic risks, hypertension, high

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The study used a large nationally representative community-based samples of adults in Mongolia in 2009, 2013 and 2019.
- ⇒ A large number of covariates, including sociodemographic factors, health status, chronic diseases and health behaviour variables, were included in the logistic regression model.
- ⇒ The study assessed sedentary behaviour (SB) by self-report, which may bias the SB prevalence.

cholesterol) and mortality, with physical activity (PA) being an effect modifier.^{2–4} However, there is little information on the epidemiological trends and associated factors of SB, particularly in low-income and middle-income countries, such as Mongolia, which reduces our ability to design effective interventions.⁵

In studies in high-income countries, for example, among adults in Japan, the prevalence of high SB (≥8 hours/day) was 25.3%,⁶ among adults across 28 countries in Europe, the prevalence of high SB (>7.5 hours/day) was 18.5%.⁷ The prevalence of SB (>4 hours 30 min/day) increased from 49.3% in 2002 to 54.3% in 2017 in the European adult,⁸ and in adults in Chile, the prevalence of SB (>4 hours/day) was 35.9%.⁹ In middle-income countries, for example, among adults in Armenia, the prevalence of SB (≥8 hours/day) was 13.2%,¹⁰ in Bhutan, the prevalence of SB was 8.2% (≥6 hours/day)¹¹ and in South Africa, the prevalence of SB was 13.3% (≥8 hours/day).¹² Among adults in China, the prevalence of SB (>4 hours/day) increased from 35.4% in 2002 to 43.0% in 2012¹³ and in six low-and middle-income countries, the prevalence of high SB (≥8 hours/day) was 8.3%.¹⁴

The correlations with SB include socio-demographic, health and environmental factors.¹⁵ Sociodemographic variables

associated with SB include increased age,^{15–19} gender,^{10 11} higher socioeconomic status,^{6 11 16} ethnicity¹² and residing in urban areas.^{11 15–17 19} Health variables associated with SB include higher body mass index (BMI, ≥ 25 kg/m²),⁶ morbid obesity (≥ 30 kg/m²),¹⁴ tobacco use,^{11 14 20} alcohol use,²¹ physical inactivity,^{11 14} hypertension,¹² diabetes,¹¹ stroke,¹² poorer mental health¹⁶ and functional disability.¹⁴ The study aimed to evaluate trends in the prevalence and correlates of SB in people 15 years and older from 2009 to 2019 in Mongolia.

METHODS

Secondary data from three cross-sectional STEPS surveys in Mongolia in 2009 (from October to December), 2013 (from May to June) and 2019 (from June to September)²² were analysed; the overall response rate was 95.0% in 2009, 97.4% in 2013 and 98.1% in 2019.^{23–25} A multi-stage stratified sampling process was carried out to randomly select participants from the target population. One individual within the age range of the survey (15–64 years in 2009 and 2013 and 15–69 years in 2019) was selected per household.^{23–25} We restricted our analysis to those aged 15–64 years. The Ministry of Health Medical Ethical Committee, Mongolia, approved the study, and written informed consent was obtained from all participants.^{23–25}

Data collection followed the ‘WHO STEPS methodology: step 1 included administration of a structured questionnaire (sociodemographics, medical history, medication use and health risk behaviour), and step 2 consisted of blood pressure and anthropometric measurements’.²² Anthropometric measurements were taken using the ‘Somatometre-Stanley 04-116’ device and electronic scale ‘GIMA’.^{23–25} Of the three blood pressure measurements using ‘OMRON Model M5 automatic blood pressure monitor’,^{23–25} the last two readings were averaged.²²

Measures

Outcome variable

SB was assessed with one item from the ‘Global Physical Activity Questionnaire’,²⁶ as follows:

‘The following question is about sitting or reclining at work, at home, getting to and from places or with friends, including time spent sitting at a desk, sitting with friends, travelling in car, bus and train, reading, playing cards or watching television, but do not include time spent sleeping. How much time do you usually spend sitting or reclining on a typical day?’ (Hours/minutes). Responses were classified as <4 hours, 4–<8 hours and 8 or more hours per day, following previous classification for all time mortality risk.²⁷

Sociodemographic information included age, education, sex, residence status, marital status, number of adult household members and ethnicity.^{23–25}

Health variables

BMI was calculated according to Asian criteria: underweight (<18.5 kg/m²), normal weight (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), class I obesity (25.0–29.9 kg/m²) and class II obesity (≥ 30.0 kg/m²).²⁸

Physical activity levels were classified into low, moderate and high physical activity (<600, 600–1500 and >1500 MET-min/week, respectively) according to the ‘Global Physical Activity Questionnaire’.²⁶

Current tobacco use was assessed with two questions: (1) ‘Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?’ (Yes/No) and (2) ‘Do you currently use any smokeless tobacco products such as [snuff, chewing tobacco, betel]?’ (Yes/No).

Current heavy alcohol use was assessed in 2009 with the question, ‘During the past 30 days, how many times did you have, for men: five or more, for women: four or more standard alcoholic drinks such as beer, wine, spirits or fermented mare milk or traditional vodka in a single drinking occasion?’ (Number) and in 2013 and 2019, ‘During the past 30 days, how many times did you have six or more standard drinks in a single drinking occasion?’ (Number). A standard drink was defined as any alcoholic drink containing 10 g of pure alcohol, ethanol.^{23–25}

Inadequate fruit/vegetable consumption was defined as <5 servings/day.²²

Hypertension was assessed ‘based on measured blood pressure (BP) (mean of the last two of three readings) defined as systolic BP \geq 140 mm Hg and/or diastolic BP \geq 90 mm Hg or currently on antihypertensive medication’.²⁹

Heart disease or stroke was assessed with the question, ‘Have you ever had a heart attack or chest pain from heart disease (angina) or a stroke (cerebrovascular accident or incident)? (Yes/No)’.²²

Data analysis

Statistical analyses were conducted with Stata software V.15.0. To produce representative data for the targeted population, the study sample was ‘weighted considering the probability of selection at three levels and accounted for participant weight/individual weight), non-response weight and adjustment for participant’s age/sex group (population weight)’.^{23–25} Multinomial logistic regression was used to assess predictors of moderate (4–7 hours) and high (≥ 8 hours) SB, with low (<4 hours) SB as a reference category, for the pooled data, and each study year. Variables found to be significant in the unadjusted analysis were subsequently included in the multivariate model. Covariates included study year, age group, gender, education, number of adult household members, ethnic group, residence status, BMI, physical activity, current tobacco use, current heavy drinking, inadequate fruit and vegetable intake and hypertension. Those individuals with missing data (<2% on any of the study variables) were not included. $P < 0.05$ was accepted as significant. Taylor linearisation methods were applied to all statistical

Table 1 Sample and sedentary behaviour (SB) characteristics

Variable	Sample N (%*)	SB in hours a day		
		<4 N (%†)	4–<8 N (%†)	≥8 N (%†)
Sociodemographic variables				
All	17 780	10 518 (62.3)	4 845 (26.4)	2 296 (11.3)
Study year				
2009	5 438 (30.6)	3 824 (69.8)	1 424 (26.2)	163 (4.0)
2013	6 013 (33.8)	2 700 (49.9)	1 963 (31.9)	1 318 (18.2)
2019	6 329 (35.6)	3 994 (65.6)	1 458 (22.9)	815 (11.5)
Age (years)				
15–29	5 514 (31.0)	3 126 (69.1)	1 599 (22.1)	748 (8.7)
30–44	6 794 (38.2)	4 244 (62.6)	1 672 (27.2)	841 (10.1)
45–64	5 472 (30.8)	3 148 (57.7)	1 574 (28.6)	707 (13.7)
Gender				
Female	9 999 (56.2)	6 176 (64.4)	2 533 (24.6)	1 228 (11.0)
Male	7 781 (43.8)	4 342 (60.2)	2 312 (28.2)	1 068 (11.6)
Marital status				
Not married	5 006 (28.2)	2 800 (62.3)	1 456 (27.2)	708 (10.5)
Married	12 762 (71.8)	7 713 (62.3)	3 385 (26.1)	1 585 (11.5)
Education (in years)				
0–9	5 088 (28.6)	3 353 (69.1)	1 192 (22.1)	486 (8.7)
10–11	5 189 (29.2)	3 084 (62.6)	1 447 (27.2)	630 (10.1)
≥12	7 503 (42.2)	4 081 (57.7)	2 206 (28.6)	1 180 (13.7)
Adult household members				
0–2	9 924 (55.8)	5 951 (63.0)	2 618 (25.4)	1 286 (11.6)
3 or more	7 876 (44.2)	4 587 (61.9)	2 224 (27.1)	1 010 (10.9)
Ethnic group				
Other	3 118 (17.6)	1 973 (68.0)	773 (23.4)	357 (8.7)
Khalkha	14 624 (82.4)	8 518 (61.0)	4 066 (27.1)	1 935 (11.8)
Residence				
Rural	8 141 (45.8)	5 320 (68.9)	1 992 (23.2)	772 (7.9)
Urban	9 639 (54.2)	5 198 (56.8)	2 853 (29.2)	1 524 (14.1)
Health variables				
Body mass index				
Normal	5 213 (30.1)	3 150 (64.1)	1 401 (26.1)	620 (9.8)
Underweight	642 (3.7)	367 (66.1)	179 (24.4)	90 (9.5)
Overweight	2 743 (15.9)	1 689 (65.2)	720 (24.8)	319 (10.0)
Obesity class I	5 481 (31.7)	3 293 (62.4)	1 501 (26.7)	662 (10.9)
Obesity class II	3 223 (18.6)	1 776 (56.2)	905 (28.2)	524 (15.6)
Physical activity				
Low	3 667 (20.8)	1 575 (46.8)	1 022 (26.6)	1 029 (26.6)
Moderate	3 248 (18.5)	1 587 (53.4)	1 053 (31.5)	597 (15.1)
High	10 681 (60.7)	7 250 (70.0)	2 731 (24.9)	655 (5.1)
Current tobacco use	4 497 (25.3)	2 446 (57.5)	1 346 (29.1)	671 (13.3)
Current heavy alcohol use	3 979 (22.5)	2 187 (56.9)	1 179 (29.8)	602 (13.2)
Inadequate fruit and vegetable intake	15 266 (87.4)	9 053 (62.7)	4 157 (26.3)	1 971 (11.0)
Hypertension	4 819 (27.3)	2 835 (59.9)	1 371 (28.5)	583 (11.6)
*Unweighted. †Weighted.				

**Table 2** Associations with 4–7 and 8 or more hours sedentary behaviour (SB) (with <4 hours SB as reference category) among individuals aged 15–64 years in Mongolia, 2009–2019, pooled analysis

Variable	SB in hours a day		SB in hours a day	
	4–<8	≥8	4–<8	≥8
	CRRR (95% CI)	CRRR (95% CI)	ARRR (95% CI)	ARRR (95% CI)
Sociodemographic variables				
Study year				
2009	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
2013	1.70 (1.31 to 2.21)***	6.38 (3.92 to 10.38)***	1.66 (1.25 to 2.20)***	4.77 (2.94 to 7.72)***
2019	0.93 (0.75 to 1.15)	3.05 (1.98 to 4.71)***	0.86 (0.70 to 1.11)	1.69 (1.15 to 2.49)**
Age (years)				
15–29	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
30–44	0.91 (0.80 to 1.04)	1.30 (1.11 to 1.53)***	0.86 (0.74 to 1.00)	0.93 (0.79 to 1.10)
45–64	1.18 (1.04 to 1.34)**	1.44 (1.21 to 1.72)***	1.10 (0.94 to 1.29)	1.01 (0.82 to 1.25)
Gender				
Female	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Male	1.23 (1.12 to 1.35)***	1.13 (0.99 to 1.28)	1.20 (1.06 to 1.36)**	1.10 (0.94 to 1.30)
Education (in years)				
0–9	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
10–11	1.36 (1.19 to 1.56)***	1.29 (1.05 to 1.57)*	1.28 (1.11 to 1.46)***	1.11 (0.92 to 1.34)
≥12	1.55 (1.33 to 1.80)***	1.87 (1.43 to 2.45)***	1.32 (1.15 to 1.53)***	1.27 (0.97 to 1.68)
Adult household members				
0–2	1 (Reference)	1 (Reference)	–	–
3 or more	1.01 (0.91 to 1.12)	0.90 (0.79 to 1.04)		
Ethnic group				
Other	1 (Reference)	1 (Reference)	–	–
Khalkha	1.29 (0.97 to 1.72)	1.52 (0.97 to 2.40)		
Residence				
Rural	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Urban	1.53 (1.27 to 1.84)***	2.15 (1.56 to 2.94)***	1.43 (1.20 to 1.70)***	1.64 (1.14 to 2.37)**
Health variables				
Body mass index				
Normal	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Underweight	0.91 (0.70 to 1.18)	0.94 (0.62 to 1.44)	0.87 (0.66 to 1.14)	0.89 (0.56 to 1.42)
Overweight	0.93 (0.79 to 1.09)	1.00 (0.81 to 1.23)	0.88 (0.74 to 1.04)	0.82 (0.65 to 1.02)
Obesity class I	1.05 (0.92 to 1.20)	1.14 (0.95 to 1.37)	0.99 (0.84 to 1.16)	0.90 (0.74 to 1.11)
Obesity class II	1.23 (1.06 to 1.43)**	1.81 (1.50 to 2.19)***	1.12 (0.96 to 1.32)	1.32 (1.07 to 1.64)*
Physical activity				
Low	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Moderate	1.04 (0.89 to 1.23)	0.50 (0.41 to 9.60)***	0.98 (0.83 to 1.15)	0.47 (0.39 to 0.58)***
High	0.63 (0.54 to 0.74)***	0.13 (0.10 to 0.16)***	0.67 (0.57 to 0.79)***	0.16 (0.12 to 0.21)***
Current tobacco use	1.27 (1.3 to 1.44)***	1.41 (1.25 to 1.59)***	1.20 (1.04 to 1.38)*	1.51 (1.28 to 1.78)***
Current heavy alcohol use	1.32 (1.17 to 1.50)***	1.39 (1.19 to 1.62)***	1.24 (1.09 to 1.42)***	1.31 (1.08 to 1.57)**
Inadequate fruit and vegetable intake	0.88 (0.75 to 1.02)	0.82 (0.64 to 1.06)	–	–
Hypertension	1.16 (1.04 to 1.29)**	1.11 (0.96 to 1.30)	1.21 (1.00 to 1.46)	0.98 (0.83 to 1.17)

*p<0.05; **p<0.01; ***p<0.001.

ARRR, adjusted relative risk ratio; CRRR, crude relative risk ratio.

Table 3 Associations with 4–7 and 8 or more hours sedentary behaviour (SB) (with <4 hours SB as reference category) among individuals aged 15–64 years in Mongolia, 2009

Variable	SB in hours a day		SB in hours a day	
	4–<8	≥8	4–<8	≥8
	CRRR (95% CI)	CRRR (95% CI)	ARRR (95% CI)	ARRR (95% CI)
Sociodemographic variables				
Age (years)				
15–29	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
30–44	0.85 (0.70 to 1.05)	1.11 (0.80 to 1.56)	0.81 (0.65 to 1.01)	1.05 (0.65 to 1.72)
45–64	1.18 (0.96 to 1.46)	1.91 (1.39 to 2.63)***	1.19 (0.95 to 1.49)	1.51 (0.82 to 2.76)
Gender				
Female	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Male	1.41 (1.12 to 1.79)**	2.10 (1.57 to 2.81)***	1.47 (1.09 to 1.98)*	2.63 (1.73 to 3.98)***
Education (in years)				
0–9	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
10–11	1.88 (1.43 to 2.48)***	1.22 (0.74 to 2.00)	1.67 (1.26 to 2.22)***	0.93 (0.58 to 1.51)
≥12	2.14 (1.57 to 2.90)***	1.16 (0.57 to 2.34)	1.57 (1.13 to 2.18)**	0.59 (0.31 to 1.13)
Adult household members				
0–2	1 (Reference)	1 (Reference)	–	–
3 or more	1.12 (0.96 to 1.32)	1.32 (0.96 to 1.83)		
Ethnic group				
Other	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Khalkha	1.64 (1.16 to 2.31)**	2.51 (1.38 to 4.58)**	1.20 (0.87 to 1.64)	1.58 (0.85 to 2.92)
Residence				
Rural	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Urban	2.38 (1.64 to 3.45)***	2.81 (1.21 to 6.54)*	1.94 (1.33 to 2.84)***	2.07 (0.94 to 4.54)
Health variables				
Body mass index				
Normal	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Underweight	0.85 (0.49 to 1.46)	1.60 (0.43 to 5.95)	0.84 (0.48 to 1.46)	1.70 (0.34 to 8.33)
Overweight	1.01 (0.75 to 1.36)	0.79 (0.46 to 1.37)	1.01 (0.75 to 1.35)	0.89 (0.51 to 1.55)
Obesity class I	1.07 (0.83 to 1.38)	0.67 (0.41 to 1.12)	1.04 (0.80 to 1.37)	0.68 (0.36 to 1.28)
Obesity class II	1.01 (0.78 to 1.30)	1.93 (1.16 to 3.21)*	0.95 (0.71 to 1.27)	1.78 (0.77 to 4.12)
Physical activity				
Low	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Moderate	0.63 (0.43 to 0.92)*	0.21 (0.12 to 0.38)***	0.66 (0.45 to 0.96)*	0.26 (0.15 to 0.45)***
High	0.40 (0.27 to 0.59)***	0.05 (0.03 to 0.09)***	0.48 (0.33 to 0.71)***	0.06 (0.03 to 0.09)***
Current tobacco use	1.34 (1.05 to 1.71)*	1.21 (0.93 to 1.59)	1.13 (0.90 to 1.43)	0.78 (0.50 to 1.19)
Current heavy alcohol use	1.43 (1.09 to 1.87)*	1.53 (0.98 to 2.38)	1.24 (0.94 to 1.63)	1.32 (0.77 to 2.25)
Inadequate fruit and vegetable intake	0.84 (0.65 to 1.07)	1.83 (0.68 to 4.94)	–	–
Hypertension	0.98 (0.82 to 1.17)	1.15 (0.86 to 1.54)	–	–

*p<0.05; **p<0.01; ***p<0.001.
ARRR, adjusted relative risk ratio; CRRR, crude relative risk ratio.

procedures to account for sample weighting and complex study design.

Patient and public involvement

Participants were not involved in the design of the study, recruitment or conduct of the study.

RESULTS

Sample characteristics

The sample included 17 780 (15–64 years), with a mean age of 35.4 years (SD=12.8 years), 5438 in 2009, 6013 in 2013 and 6329 in 2019. Across the study years, the proportion of low (<4 hours) SB was 62.3%, moderate

(4–8 hours) SB was 26.4% and high (≥ 8 hours) SB was 11.3%. Further sociodemographic details and information about health variables are shown in [table 1](#).

Associations with moderate and high SB, pooled analysis

In the fully adjusted model, compared with the survey year 2009, in the survey years 2013 and 2019, high SB increased significantly, while moderate SB increased in the survey year 2013 but not in 2019. Urban residence was positively associated with moderate and high SB. Male sex and higher education were positively associated with moderate SB. Current tobacco use, current heavy alcohol use and obesity class II were positively and high physical activity was negatively associated with moderate and/or high SB. Age, ethnicity, a higher number of adults household members and hypertension were neither associated with moderate SB nor with high SB (see [table 2](#)).

Associations with moderate and high SB in study years 2009, 2013 and 2019

In fully adjusted models, male sex and higher education were positively associated with moderate and/or high SB in 2009 and 2013 but not in 2019. Higher physical activity decreased the odds of moderate and/or high SB in all study years. Current tobacco use and/or heavy drinking were positively associated with moderate and/or high SB in 2013 and 2019 but not in 2009. Class II obesity and hypertension were positively associated with moderate and/or high SB in 2013 and not in other survey years. Belonging to the Khalkha ethnic group increased the odds of high SB in 2019 only (see [tables 3–5](#)).

DISCUSSION

The current investigation aimed to estimate for the first time trends in the proportion of SB in three national community-based surveys in people aged 15 years and older from 2009 to 2019 in Mongolia. We found that the proportion of high SB (≥ 8 hours/day) significantly increased from 2009 to 2019, while moderate SB (4–8 hours/day) increased from 2009 to 2013. Similar increases in SB were also found in China from 2002 to 2012¹³ and in European adults from 2002 to 2017.⁸ The increase in high SB in Mongolia may be attributed to changes in occupational patterns involving more SB and an increase in less active transportation in both urban and rural areas.⁵ This trend is supported by population changes from the 2009 survey (49.2% urban residence and 35.1% higher education, 12 or more years) to the 2019 survey (63.0% urban residence and 49.9% higher education), since both urban residence and higher education were associated with higher SB. Furthermore, seasonal variation in the data collection of the three surveys could affect SB. For example, during winter in Mongolia (October to March), higher SB may be expected than during non-winter seasons. However, the 2009 survey was conducted in winter, while the 2013 and 2019 surveys were conducted in non-winter periods, emphasising that SB

could have even been higher if the 2013 and 2019 surveys had also been conducted during the winter period.

The study found a prevalence of moderate SB (4–8 hours/day) of 26.4%, high SB (≥ 8 hours/day) of 11.3% and moderate and high SB (≥ 4 hours/day) of 37.7%, which is similar in terms of high SB in low-income and middle-income countries, such as Armenia (≥ 8 hours/day, 13.2%)¹⁰ and South Africa (≥ 8 hours/day, 13.3%),¹² but higher than in Bhutan (≥ 6 hours/day, 8.2%)¹¹ and in six low-income and middle-income countries (≥ 8 hours/day, 8.3%)¹⁴ and lower than in studies in high-income countries, for example, among adults in Japan (≥ 8 hours/day, 25.3%)⁶ and 28 countries in Europe (>7.5 hours/day, 18.5%).⁷ The prevalence of moderate and high SB (≥ 4 hours/day) of 35.7% was similar to China in 2002 (>4 hours/day, 35.4%)¹³ and in Chile (>4 hours/day, 35.9%),⁹ but lower than in China in 2012 (>4 hours/day, 43.3%)¹³ and European adults in 2017 (>4 hours/30 min/day, 54.3%).⁸ It is possible that increases in SB at work and transportation lead to an increase in SB in high-income countries.

Consistent with previous research,^{6 10 11 15–17 19} we found that male sex, urban residence and higher economic status (higher education) were associated with SB, while we did not find any significant differences in the prevalence of SB with increasing age, as found in previous research.^{15–19} It is possible that we did not see an increase in SB with age because in the survey, the age limit was 64 years, meaning that older adults were largely excluded from this study.

In line with former research findings,^{6 11 12 14 20 21} this study found an association between current tobacco use, current heavy alcohol use, hypertension, obesity class II, physical inactivity and moderate and/or high SB. SB may decrease cardiorespiratory fitness and increase the risk of hypertension and coronary heart disease and stroke.³⁰ The use of alcohol and tobacco may involve prolonged sitting.²¹ Person with class II obesity may undergo a process of a decrease in mobility that ‘reduces body energy expenditure leading to weight gain and then weight gain reduces mobility and leads to the adoption of sedentarism’.^{21 31}

The results of the study may have implications for policy and practice on PA and SB among adults in Mongolia. We found that 37.7% of adults engaged in moderate or high SB, implying that a large population is at increased risk of morbidity and all-cause mortality.^{2–4 27} According to WHO guidelines,³²

‘Adults should limit the amount of time spent being sedentary. Replacing sedentary time with physical activity of any intensity (including light intensity) provides health benefits. To help reduce the detrimental effects of high levels of sedentary behaviour on health, adults should aim to do more than the recommended levels of moderate- to vigorous intensity physical activity’.

A recent policy review in Mongolia suggests that the existing national strategy on physical activity should be

Table 4 Associations with 4–7 and 8 or more hours sedentary behaviour (SB) (with <4 hours SB as reference category) among individuals aged 15–64 years in Mongolia, 2013

Variable	SB in hours a day		SB in hours a day	
	4–<8	≥8	4–<8	≥8
	CRRR (95% CI)	CRRR (95% CI)	ARRR (95% CI)	ARRR (95% CI)
Sociodemographic variables				
Age (years)				
15–29	1 (Reference)	1 (Reference)	–	–
30–44	0.92 (0.79 to 1.07)	1.16 (0.97 to 1.39)		
45–64	1.15 (0.98 to 1.34)	1.17 (0.97 to 1.42)		
Gender				
Female	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Male	1.25 (1.05 to 1.49)*	1.24 (1.02 to 1.51)*	1.23 (1.02 to 1.49)*	1.25 (0.98 to 1.61)
Education (in years)				
0–9	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
10–11	1.26 (1.05 to 1.52)*	1.60 (1.21 to 2.10)***	1.25 (1.03 to 1.51)*	1.48 (1.15 to 1.90)**
≥12	1.30 (1.01 to 1.66)*	2.06 (1.25 to 3.38)**	1.28 (0.98 to 1.66)	1.78 (1.12 to 2.83)*
Adult household members				
0–2	1 (Reference)	1 (Reference)	–	–
3 or more	1.18 (0.97 to 1.43)	0.92 (0.76 to 1.12)		
Ethnic group				
Other	1 (Reference)	1 (Reference)	–	–
Khalkha	1.05 (0.58 to 1.91)	1.10 (0.55 to 2.23)		
Residence				
Rural	1 (Reference)	1 (Reference)	–	–
Urban	1.22 (0.84 to 1.76)	1.92 (0.94 to 3.93)		
Health variables				
Body mass index				
Normal	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Underweight	1.07 (0.77 to 1.50)	0.89 (0.62 to 1.27)	1.04 (0.73 to 1.48)	0.84 (0.56 to 1.25)
Overweight	1.03 (0.77 to 1.38)	0.95 (0.69 to 1.31)	1.04 (0.76 to 1.42)	0.84 (0.58 to 1.22)
Obesity class I	0.96 (0.75 to 1.24)	0.95 (0.72 to 1.24)	0.96 (0.72 to 1.28)	0.83 (0.62 to 1.10)
Obesity class II	1.49 (1.18 to 1.88)***	1.59 (1.21 to 2.10)***	1.45 (1.12 to 1.89)**	1.38 (1.03 to 1.86)*
Physical activity				
Low	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Moderate	0.90 (0.68 to 1.20)	0.40 (0.30 to 0.53)***	0.90 (0.67 to 1.20)	0.40 (0.30 to 0.53)***
High	0.55 (0.39 to 0.76)***	0.08 (0.05 to 0.13)***	0.56 (0.39 to 0.78)***	0.09 (0.05 to 0.14)***
Current tobacco use	1.18 (0.94 to 1.48)	1.53 (1.27 to 1.85)***	1.15 (0.90 to 1.47)	1.64 (1.34 to 2.00)***
Current heavy alcohol use	1.32 (1.12 to 1.56)***	1.35 (1.07 to 1.70)*	1.18 (0.95 to 1.45)	0.97 (0.72 to 1.30)
Inadequate fruit and vegetable intake	0.89 (0.68 to 1.15)	0.79 (0.56 to 1.11)	–	–
Hypertension	1.35 (1.10 to 1.67)**	1.30 (1.04 to 1.62)*	1.26 (1.03 to 1.50)*	1.23 (0.95 to 1.59)

*p<0.05; **p<0.01; ***p<0.001.
ARRR, adjusted relative risk ratio; CRRR, crude relative risk ratio.

reinforced with additional strategies and added physical activity guidelines.³³

Our results suggest that target groups for interventions addressing SB and PA in Mongolia may include men, those living in urban areas, those with higher education, obesity, those with low PA and current tobacco and heavy alcohol users.

Study limitations

The cross-sectional repeat survey design hinders us to draw causative conclusions. Some of the data were assessed by self-report, such as SB, which may have biased some responses and probably underestimated the SB time.³⁴ Biomarkers of glucose and cholesterol were only evaluated in a subsample of the study population in 2009

Table 5 Associations with 4–7 and 8 or more hours sedentary behaviour (SB) (with <4 hours SB as reference category) among individuals aged 15–64 years in Mongolia, 2019

Variable	SB in hours a day		SB in hours a day	
	4–<8	≥8	4–<8	≥8
	CRRR (95% CI)	CRRR (95% CI)	ARRR (95% CI)	ARRR (95% CI)
Sociodemographic variables				
Age (years)				
15–29	1 (Reference)	1 (Reference)	–	–
30–44	0.91 (0.76 to 1.09)	1.09 (0.85 to 1.39)		
45–64	1.00 (0.82 to 1.21)	1.07 (0.83 to 1.37)		
Gender				
Female	1 (Reference)	1 (Reference)	–	–
Male	1.11 (0.96 to 1.28)	0.90 (0.75 to 1.09)		
Education (in years)				
0–9	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
10–11	1.07 (0.87 to 1.32)	0.89 (0.67 to 1.18)	1.02 (0.81 to 1.27)	0.76 (0.55 to 1.06)
≥12	1.47 (1.21 to 1.79)***	1.61 (1.23 to 2.12)***	1.14 (0.91 to 1.43)	1.08 (0.80 to 1.46)
Adult household members				
0–2	1 (Reference)	1 (Reference)	–	–
3 or more	1.07 (0.92 to 1.26)	0.88 (0.72 to 1.07)		
Ethnic group				
Other	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Khalkha	1.47 (1.14 to 1.88)**	2.56 (1.78 to 3.67)***	1.29 (0.98 to 1.70)	1.77 (1.23 to 2.54)**
Residence				
Rural	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Urban	1.61 (1.29 to 2.01)***	2.51 (1.83 to 3.46)***	1.47 (1.16 to 1.88)**	2.04 (1.42 to 2.91)***
Health variables				
Body mass index				
Normal	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Underweight	0.85 (0.54 to 1.32)	0.78 (0.40 to 1.53)	0.78 (0.49 to 1.25)	0.78 (0.39 to 1.58)
Overweight	0.75 (0.58 to 0.96)*	1.01 (0.83 to 1.24)	0.64 (0.49 to 0.84)	0.78 (0.55 to 1.09)
Obesity class I	1.01 (0.83 to 1.24)	1.14 (0.86 to 1.50)	0.92 (0.73 to 1.15)	1.02 (0.76 to 1.36)
Obesity class II	1.05 (0.82 to 1.34)	1.50 (1.12 to 2.01)**	0.89 (0.69 to 1.15)	1.29 (0.94 to 1.77)
Physical activity				
Low	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Moderate	1.09 (0.86 to 1.38)	0.56 (0.42 to 0.76)***	1.14 (0.88 to 1.47)	0.56 (0.41 to 0.77)***
High	0.69 (0.57 to 0.85)***	0.29 (0.23 to 0.38)***	0.55 (0.39 to 0.78)***	0.33 (0.25 to 0.43)***
Current tobacco use	1.30 (1.11 to 1.53)***	1.42 (1.16 to 1.75)***	1.27 (1.03 to 1.56)*	1.62 (1.24 to 2.11)***
Current heavy alcohol use	1.23 (1.04 to 1.46)*	1.60 (1.30 to 1.98)***	1.22 (1.01 to 1.49)*	1.64 (1.29 to 2.09)***
Inadequate fruit and vegetable intake	0.72 (0.58 to 0.89)**	0.63 (0.48 to 0.83)***	–	–
Hypertension	1.13 (0.96 to 1.34)	0.99 (0.79 to 1.24)	–	–

*p<0.05; **p<0.01; ***p<0.001.

ARRR, adjusted relative risk ratio; CRRR, crude relative risk ratio.

and 2013, and in the variable of household income more than 10% were missing, therefore these variables were excluded from this article. Possible differences in survey design across the three surveys in 2009 (60 clusters), 2013 (65 clusters) and 2019 (377 clusters) may have affected the results. Future studies should investigate the type (work, travel, leisure time) and time (weekday/weekend) of SB to be able to develop more specific intervention strategies.

CONCLUSION

We found that the proportion of high SB (≥8 hours/day) significantly increased from 2009 to 2019. More than 1 in 10 persons aged 15 years and older engaged in high SB. Several sociodemographic variables, such as male sex and higher education, and health variables, including obesity, hypertension, physical inactivity, tobacco use and heavy alcohol use, were identified associated with moderate and/or high SB that can help guide public interventions.

Acknowledgements The data source, the World Health Organization NCD Microdata Repository (<https://extranet.who.int/ncdsmicrodata/index.php/catalog>), is hereby acknowledged.

Contributors Both authors conceived and designed the research, performed statistical analysis, drafted the manuscript, made critical revision of the manuscript for key intellectual content, read and approved the final version of the manuscript and have agreed to authorship and order of authorship for this manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Participants gave informed consent to participate in the study before taking part.

Ethics approval This study involves human participants and was approved by the Ministry of Health Medical Ethical Committee, Mongolia.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement The data on which this analysis was based are publicly available at the World Health Organization NCD Microdata Repository: <https://extranet.who.int/ncdsmicrodata/index.php/catalog>.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Karl Peltzer <http://orcid.org/0000-0002-5980-0876>

REFERENCES

- 1 WHO. World Health Organization (WHO) guidelines on physical activity and sedentary behaviour. Licence: CC BY-NC-SA 3.0 IGO, 2020. Available: [file:///C:/Users/user/Downloads/9789240015128-eng%20\(2\).pdf](file:///C:/Users/user/Downloads/9789240015128-eng%20(2).pdf)
- 2 Chau JY, Grunseit AC, Chey T, *et al*. Daily sitting time and all-cause mortality: a meta-analysis. *PLoS One* 2013;8:e80000.
- 3 de Rezende LFM, Rey-López JP, Matsudo VKR, *et al*. Sedentary behavior and health outcomes among older adults: a systematic review. *BMC Public Health* 2014;14:333.
- 4 Thorp AA, Owen N, Neuhaus M, *et al*. Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996-2011. *Am J Prev Med* 2011;41:207-15.
- 5 Dashzeveg D, Nakamura K, Seino K, *et al*. Changes in the configuration and patterns of physical activity among Mongolian adults, 2005-2013. *J Rural Med* 2018;13:151-9.
- 6 Kitayama A, Koohsari MJ, Ishii K, *et al*. Sedentary time in a nationally representative sample of adults in Japan: prevalence and sociodemographic correlates. *Prev Med Rep* 2021;23:101439.
- 7 Loyen A, van der Ploeg HP, Bauman A, *et al*. European sitting Championship: prevalence and correlates of self-reported sitting time in the 28 European Union member states. *PLoS One* 2016;11:e0149320.
- 8 López-Valenciano A, Mayo X, Liguori G, *et al*. Changes in sedentary behaviour in European Union adults between 2002 and 2017. *BMC Public Health* 2020;20:1206.
- 9 Celis-Morales C, Salas C, Alduhishy A, *et al*. Socio-Demographic patterns of physical activity and sedentary behaviour in Chile: results from the National health survey 2009-2010. *J Public Health* 2016;38:e98-105.
- 10 Tcymbal A, Andreasyan D, Whiting S, *et al*. Prevalence of physical inactivity and sedentary behavior among adults in Armenia. *Front Public Health* 2020;8:157.
- 11 Dendup T, Zhao Y, Edi Putra IGN, *et al*. Correlates of sedentary behavior among Bhutanese adults: findings from the 2014 Bhutan steps survey data. *Korean J Fam Med* 2021;42:288-96.
- 12 Peltzer K, Phaswana-Mafuya PS. Prevalence and correlates of sedentary behaviour among a national sample of 15-98 years old individuals in South Africa. *AJPHEs* 2018;24:286-98.
- 13 Ding C, Feng G, Yuan F, *et al*. Temporal trends and recent correlates in sedentary behaviors among Chinese adults from 2002 to 2010-2012. *Int J Environ Res Public Health* 2019;17:158.
- 14 Koyanagi A, Stubbs B, Vancampfort D. Correlates of sedentary behavior in the general population: a cross-sectional study using nationally representative data from six low- and middle-income countries. *PLoS One* 2018;13:e0202222.
- 15 Prince SA, Reed JL, McFetridge C, *et al*. Correlates of sedentary behaviour in adults: a systematic review. *Obes Rev* 2017;18:915-35.
- 16 Müller AM, Chen B, Wang NX, *et al*. Correlates of sedentary behaviour in Asian adults: a systematic review. *Obes Rev* 2020;21:e12976.
- 17 Chastin SFM, Buck C, Freiburger E, *et al*. Systematic literature review of determinants of sedentary behaviour in older adults: a DEDIPAC study. *Int J Behav Nutr Phys Act* 2015;12:127.
- 18 O'Donoghue G, Perchoux C, Mensah K, *et al*. A systematic review of correlates of sedentary behaviour in adults aged 18-65 years: a socio-ecological approach. *BMC Public Health* 2016;16:163.
- 19 Stierlin AS, De Lepeleere S, Cardon G, *et al*. A systematic review of determinants of sedentary behaviour in youth: a DEDIPAC-study. *Int J Behav Nutr Phys Act* 2015;12:133.
- 20 Bennie JA, Pedisic Z, van Uffelen JGZ, *et al*. The descriptive epidemiology of total physical activity, muscle-strengthening exercises and sedentary behaviour among Australian adults--results from the National Nutrition and Physical Activity Survey. *BMC Public Health* 2016;16:73.
- 21 Motuma A, Gobena T, Roba KT, *et al*. Sedentary behavior and associated factors among working adults in eastern Ethiopia. *Front Public Health* 2021;9:693176.
- 22 World Health Organization. NCD Microdata Repository. Data from 2009, 2013, and 2019 Mongolia STEPS surveys, January 11, 2022. Available: <https://extranet.who.int/ncdsmicrodata/index.php/catalog>
- 23 World Health Organization. Mongolian STEPS survey on the prevalence of noncommunicable disease and injury risk factors - 2009, 2010. Manila, Philippines World Health Organization, Regional Office for the Western Pacific; 2021. <https://extranet.who.int/ncdsmicrodata/index.php/catalog/619/related-materials> [Accessed 5 Aug 2021].
- 24 Public Health Institute of the Ministry of Health and Sports, Mongolia. Third national STEPS survey on the prevalence of noncommunicable disease and injury risk Factors-2013, 2014. Ulaanbaatar Public Health Institute; 2021. <https://extranet.who.int/ncdsmicrodata/index.php/catalog/615/related-materials> [Accessed 5 Aug 2021].
- 25 National Centre for Public Health. Fourth national STEPS survey on prevalence of non-communicable disease and injury risk factors-2019, 2020. Available: <https://extranet.who.int/ncdsmicrodata/index.php/catalog/836/related-materials> [Accessed 5 Aug 2021].
- 26 Armstrong T, Bull F. Development of the world Health organization global physical activity questionnaire (GPAQ). *J Public Health* 2006;14:66-70.
- 27 van der Ploeg HP, Chey T, Korda RJ, *et al*. Sitting time and all-cause mortality risk in 222 497 Australian adults. *Arch Intern Med* 2012;172:494-500.
- 28 Wen CP, David Cheng TY, Tsai SP, *et al*. Are Asians at greater mortality risks for being overweight than Caucasians? Redefining obesity for Asians. *Public Health Nutr* 2009;12:497-506.
- 29 Chobanian AV, Bakris GL, Black HR, *et al*. Seventh report of the joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. *Hypertension* 2003;42:1206-52.
- 30 World Health Organization (WHO). Physical activity, 2018. Available: <https://www.who.int/newsroom/fact-sheets/detail/physical-activity> [Accessed 2 May 2021].
- 31 Middelbeek L, Breda J. Obesity and sedentarism: reviewing the current situation within the WHO European region. *Curr Obes Rep* 2013;2:42-9.
- 32 WHO. WHO guidelines on physical activity and sedentary behaviour. Geneva World Health Organization; 2020.
- 33 Chimeddamba O, Peeters A, Walls HL, *et al*. Noncommunicable disease prevention and control in Mongolia: a policy analysis. *BMC Public Health* 2015;15:660.
- 34 Van Cauwenberg J, Van Holle V, De Bourdeaudhuij I, *et al*. Older adults' reporting of specific sedentary behaviors: validity and reliability. *BMC Public Health* 2014;14:734.