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

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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 model 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 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,\textsuperscript{15–19} gender,\textsuperscript{10,11} higher socioeconomic status,\textsuperscript{6,11,16} ethnicity\textsuperscript{12} and residing in urban areas.\textsuperscript{11,15–17,19} Health variables associated with SB include higher body mass index (BMI, \textgtrEq 25 kg/m\textsuperscript{2}),\textsuperscript{5} morbid obesity (\textgtrEq 30 kg/m\textsuperscript{2}),\textsuperscript{14} tobacco use,\textsuperscript{11,14,29} alcohol use,\textsuperscript{21} physical inactivity,\textsuperscript{11,14} hypertension,\textsuperscript{12} diabetes,\textsuperscript{11} stroke,\textsuperscript{12} poorer mental health\textsuperscript{16} and functional disability.\textsuperscript{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)\textsuperscript{22} were analysed; the overall response rate was 95.0\% in 2009, 97.4\% in 2013 and 98.1\% in 2019.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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’\textsuperscript{22} . Anthropometric measurements were taken using the ‘Somatometre-Stanley 04-116’ device and electronic scale ‘GIMA’.\textsuperscript{23–25} Of the three blood pressure measurements using ‘OMRON Model M5 automatic blood pressure monitor’,\textsuperscript{23–25} the last two readings were averaged.\textsuperscript{22}

**Measures**

**Outcome variable**

SB was assessed with one item from the ‘Global Physical Activity Questionnaire’.\textsuperscript{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.\textsuperscript{27}

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

BMI was calculated according to Asian criteria: underweight (<18.5 kg/m\textsuperscript{2}), normal weight (18.5–22.9 kg/m\textsuperscript{2}), overweight (23.0–24.9 kg/m\textsuperscript{2}), class I obesity (25.0–29.9 kg/m\textsuperscript{2}) and class II obesity (\textgtrEq 30.0 kg/m\textsuperscript{2}).\textsuperscript{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’.\textsuperscript{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.\textsuperscript{23–25}

Inadequate fruit/vegetable consumption was defined as <5 servings/day.\textsuperscript{22}

Hypertension was assessed ‘based on measured blood pressure (BP) (mean of the last two of three readings) defined as systolic BP\textgtrEq 140 mm Hg and/or diastolic BP\textgtrEq 90 mm Hg or currently on antihypertensive medication’.\textsuperscript{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)’.\textsuperscript{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)’\textsuperscript{23–25} Multinominal logistic regression was used to assess predictors of moderate (4–7 hours) and high (\textgtrEq 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
| Variable                  | Sample SB in hours a day |  |  |  |
|---------------------------|--------------------------|--|--|--|
|                           | N (%)*                  | <4 | 4–<8 | ≥8 |
| **Sociodemographic variables** |                         |    |      |    |
| All                       | 17 780                  | 10 518 (62.3) | 4845 (26.4) | 2296 (11.3) |
| **Study year**            |                         |    |      |    |
| 2009                      | 5438 (30.6)             | 3824 (69.8) | 1424 (26.2) | 163 (4.0) |
| 2013                      | 6013 (33.8)             | 2700 (49.9) | 1963 (31.9) | 1318 (18.2) |
| 2019                      | 6329 (35.6)             | 3994 (65.6) | 1458 (22.9) | 815 (11.5) |
| **Age (years)**           |                         |    |      |    |
| 15–29                     | 5514 (31.0)             | 3126 (69.1) | 2533 (24.6) | 1228 (11.0) |
| 30–44                     | 6794 (38.2)             | 4244 (62.6) | 1672 (27.2) | 841 (10.1) |
| 45–64                     | 5472 (30.8)             | 3148 (57.7) | 1574 (28.6) | 707 (13.7) |
| **Gender**                |                         |    |      |    |
| Female                    | 9999 (56.2)             | 6176 (64.4) | 2533 (24.6) | 1228 (11.0) |
| Male                      | 7781 (43.8)             | 4342 (60.2) | 2312 (28.2) | 1068 (11.6) |
| **Marital status**        |                         |    |      |    |
| Not married               | 5006 (28.2)             | 2800 (62.3) | 1456 (27.2) | 708 (10.5) |
| Married                   | 12 762 (71.8)           | 7713 (62.3) | 3385 (26.1) | 1585 (11.5) |
| **Education (in years)**  |                         |    |      |    |
| 0–9                       | 5088 (28.6)             | 3353 (69.1) | 1192 (22.1) | 486 (8.7) |
| 10–11                     | 5189 (29.2)             | 3084 (62.6) | 1447 (27.2) | 630 (10.1) |
| ≥12                       | 7503 (42.2)             | 4081 (57.7) | 2206 (28.6) | 1180 (13.7) |
| **Adult household members** |                       |    |      |    |
| 0–2                       | 9924 (55.8)             | 5951 (63.0) | 2618 (25.4) | 1286 (11.6) |
| 3 or more                 | 7876 (44.2)             | 4587 (61.9) | 2224 (27.1) | 1010 (10.9) |
| **Ethnic group**          |                         |    |      |    |
| Other                     | 3118 (17.6)             | 1973 (68.0) | 773 (23.4) | 357 (8.7) |
| Khalkha                   | 14 624 (82.4)           | 8518 (61.0) | 4066 (27.1) | 1935 (11.8) |
| **Residence**             |                         |    |      |    |
| Rural                     | 8141 (45.8)             | 5320 (68.9) | 1992 (23.2) | 772 (7.9) |
| Urban                     | 9639 (54.2)             | 5198 (56.8) | 2853 (29.2) | 1524 (14.1) |
| **Health variables**      |                         |    |      |    |
| Body mass index           |                         |    |      |    |
| Normal                    | 5213 (30.1)             | 3150 (64.1) | 1401 (26.1) | 620 (9.8) |
| Underweight               | 642 (3.7)               | 367 (66.1) | 179 (24.4) | 90 (9.5) |
| Overweight                | 2743 (15.9)             | 1689 (65.2) | 720 (24.8) | 319 (10.0) |
| Obesity class I           | 5481 (31.7)             | 3293 (62.4) | 1501 (26.7) | 662 (10.9) |
| Obesity class II          | 3223 (18.6)             | 1776 (56.2) | 905 (28.2) | 524 (15.6) |
| Physical activity         |                         |    |      |    |
| Low                       | 3667 (20.8)             | 1575 (46.8) | 1022 (26.6) | 1029 (26.6) |
| Moderate                  | 3248 (18.5)             | 1587 (53.4) | 1053 (31.5) | 597 (15.1) |
| High                      | 10681 (60.7)            | 7250 (70.0) | 2731 (24.9) | 655 (5.1) |
| Current tobacco use       | 4497 (25.3)             | 2446 (57.5) | 1346 (29.1) | 671 (13.3) |
| Current heavy alcohol use | 3979 (22.5)             | 2187 (56.9) | 1179 (29.8) | 602 (13.2) |
| Inadequate fruit and vegetable intake | 15 266 (87.4) | 9053 (62.7) | 4157 (26.3) | 1971 (11.0) |
| Hypertension              | 4819 (27.3)             | 2835 (59.9) | 1371 (28.5) | 583 (11.6) |

*Unweighted. †Weighted.

Table 1 Sample and sedentary behaviour (SB) characteristics
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 | ARRR (95% CI) | ARRR (95% CI) |
|---------------------------------|-------------------|-------------------|---------------|---------------|
|                                 | 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.
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), 5,438 in 2009, 6,013 in 2013 and 6,329 in 2019. Across the study years, the proportion of low (<4 hours) SB was 62.3%, moderate

| 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                                                                                           | 4–<8                                                                               |
|         | CRRR (95% CI)                                                                                   | ARRR (95% CI)                                                                        |
| Sociodemographic variables |                                                                                               |                                                                                     |
| Age (years) |                                                                                               |                                                                                     |
| 15–29 | 1 (Reference)                                                                                   | 1 (Reference)                                                                        |
| 30–44 | 0.85 (0.70 to 1.05)                                                                            | 1.11 (0.80 to 1.56)                                                                |
| 45–64 | 1.18 (0.96 to 1.46)                                                                            | 1.91 (1.39 to 2.63)**                                                                |
| Gender |                                                                                               |                                                                                     |
| Female | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| Male | 1.41 (1.12 to 1.79)**                                                                           | 2.10 (1.57 to 2.81)**                                                                |
| Education (in years) |                                                                                               |                                                                                     |
| 0–9  | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| 10–11 | 1.88 (1.43 to 2.48)**                                                                           | 1.22 (0.74 to 2.00)                                                                |
| ≥12  | 2.14 (1.57 to 2.90)**                                                                           | 1.16 (0.57 to 2.34)                                                                |
| Adult household members |                                                                                               |                                                                                     |
| 0–2 | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| 3 or more |                                                                                               |                                                                                     |
| Ethnic group |                                                                                               |                                                                                     |
| Other | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| Khalkha | 1.64 (1.16 to 2.31)**                                                                          | 2.51 (1.38 to 4.58)**                                                                |
| Residence |                                                                                               |                                                                                     |
| Rural | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| Urban | 2.38 (1.64 to 3.45)**                                                                          | 2.81 (1.21 to 6.54)*                                                                |
| Health variables |                                                                                               |                                                                                     |
| Body mass index |                                                                                               |                                                                                     |
| Normal | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| Underweight | 0.85 (0.49 to 1.46)                                                                           | 1.60 (0.43 to 5.95)                                                                |
| Overweight | 1.01 (0.75 to 1.36)                                                                           | 0.79 (0.46 to 1.37)                                                                |
| Obesity class I | 1.07 (0.83 to 1.38)                                                                           | 0.67 (0.41 to 1.12)                                                                |
| Obesity class II | 1.01 (0.78 to 1.30)                                                                          | 1.93 (1.16 to 3.21)*                                                                |
| Physical activity |                                                                                               |                                                                                     |
| Low | 1 (Reference)                                                                                  | 1 (Reference)                                                                        |
| Moderate | 0.63 (0.43 to 0.92)**                                                                          | 0.21 (0.12 to 0.38)**                                                                |
| High | 0.40 (0.27 to 0.59)**                                                                           | 0.05 (0.03 to 0.09)**                                                                |
| Current tobacco use | 1.34 (1.05 to 1.71)*                                                                          | 1.21 (0.93 to 1.59)                                                                |
| Current heavy alcohol use | 1.43 (1.09 to 1.87)*                                                                          | 1.53 (0.98 to 2.38)                                                                |
| 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.
(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 2012 and in European adults from 2002 to 2017. 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. 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 (≥8 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%) and South Africa (≥8 hours/day, 13.3%), but higher than in Bhutan (≥8 hours/day, 8.2%) and in six low-income and middle-income countries (≥8 hours/day, 8.3%) and lower than in studies in high-income countries, for example, among adults in Japan (≥8 hours/day, 25.3%) and 28 countries in Europe (>7.5 hours/day, 18.5%). The prevalence of moderate and high SB (≥4 hours/day) of 35.7% was similar to China in 2002 (>4 hours/day, 35.4%) and in Chile (>4 hours/day, 35.9%), but lower than in China in 2012 (>4 hours/day, 43.3%) and European adults in 2017 (>4 hours 30 min/day, 54.3%). 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, 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. 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, 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. The use of alcohol and tobacco may involve prolonged sitting. 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’. 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’.

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. According to WHO guidelines, ‘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...
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.

**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)    | ARRR (95% CI)    | CRRR (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.

**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.
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.

### 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 0.36)** | 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.
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