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HUMAN BIOLOGICAL SURVEY

Objectively measured physical activity and sedentary behaviour of Yakut (Sakha) adults

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Abstract

Background: Circumpolar regions are undergoing social and economic transition, which often corresponds to a behavioural transition. Yet, physical activity and sedentary behaviour are rarely objectively measured within these groups.
Aim: This study aimed to characterize objectively measured physical activity and sedentary behaviour in a sample of indigenous Siberians.
Subjects and methods: Yakut (Sakha) adults ($n = 68$, 32 men) underwent anthropometry, interviews and wore a triaxial accelerometer for two days. Time spent in moderate-to-vigorous physical activity (MVPA) or sedentary behaviour was calculated using a single axis and also all three axes.
Results: Men spent significantly more time in MVPA than women, although no sex difference was found in sedentary behaviour. Participants were far more active and less sedentary when classified using all three axes (vector magnitude) than a single axis. Television viewing time significantly related to sedentary behaviour in men only.
Conclusion: The Yakut have gender differences in amount and predictors of physical activity and sedentary behaviour. Triaxial accelerometry is more sensitive to daily physical activity in free living populations than single axis.

Keywords

Accelerometry, behavioural transition, circumpolar populations, indigenous health, Siberia

History

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Background

With economic and social change comes a transition in behaviour, physical activity levels decreases and sedentary behaviour increases (Katzmarzyk & Mason, 2009). Such a behavioural shift in transitioning populations is thought to be one of the main causes of increasing rates of chronic diseases, which have been strongly linked to reduced physical activity (Leonard, 2008; Mabry et al., 2012; Snodgrass, 2012; WHO/FAO, 2003) and, increasingly, to sedentary behaviour (SB) (Celis-Morales et al., 2012; Edwardson et al., 2012; Koster et al., 2012; Mabry et al., 2012). Therefore, accurate data on physical activity and SB is necessary to characterize the health risks in transitioning populations and devise effective public health strategies to reduce the burden of disease. However, the majority of data on physical activity and SB within transitioning populations (e.g. Yadav & Krishnan, 2008; Dancause et al., 2011; Mabry et al., 2012), including indigenous circumpolar populations (Bjerragaard & Dahl-Petersen, 2011; Hopping et al., 2010; Howard et al., 2010; Young & Katzmarzyk, 2007), has been collected through self-report. Objectively-measured physical activity, such as accelerometer data, contains less error than self-reported physical activity and, as such, provides a more accurate estimate of behaviour in free-living populations (Prince et al., 2008; Snodgrass, 2012). This pilot study examines physical activity within Sakha (Yakut) adults with one day of activity data and as such is exploratory, meant only to describe potential trends within the sample and contribute to the development of testable hypotheses. There is only one other study in indigenous circumpolar populations that utilizes accelerometry to characterize physical activity (Dahl-Petersen et al., 2013) and, as such, even preliminary data can contribute to the literature.

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Sample

The Yakut (Sakha) are an indigenous Siberian group whose subsistence economy has traditionally relied on hunting and fishing in the boreal forest (*taiga*) and pastoralism in the Lena River Valley (Snodgrass et al., 2005). The Yakut have genetic ties to other Indigenous Siberian groups, yet are in the Turkish language family. Soviet collectivization forced Yakut to abandon traditional lands and practices to settle in more centralized collectives. Many individuals raised during the

Soviet period were university educated. The collapse of the Soviet Union forced a re-adaptation of subsistence activities including fishing, gathering, herding and horticulture in the more rural areas and also greatly reduced the Yakut living conditions and health (Snodgrass et al., 2005). Yakut economy is a mixture of traditional subsistence activities, private sector salaries, government wages and pensions. Subsistence activities are practiced by all socioeconomic groups, regardless of income (Jordan & Jordan-Bychkov, 2001; Snodgrass et al., 2006b).

This study is a continuation of research among the Yakut by the Indigenous Siberian Health and Adaptation Project (http://www.bonesandbehavior.org/siberia.html) (Cepon et al., 2011; Snodgrass et al., 2005, 2006a,b, 2007, 2010; Sorensen et al., 2005, 2006, 2009) and other indigenous Siberian populations (Sorensen et al., 1999; Leonard et al., 2002, 2009; Snodgrass et al., 2008).

Data collection

Recruitment

The remote conditions and lack of census data prevented random sampling and participants were recruited for a study on health by advertisements in the local media and word of mouth. To reduce the influence of this sampling technique every effort was made to recruit participants that were representative of the community for socio-demographic indicators, age and lifestyle. However, it is possible that this sample is potentially biased toward individuals who are interested in health research. Since physical activity promotion is not prevalent in Yakutia, it is unlikely that this sampling technique will influence the accelerometry data, which are the primary outcomes of this analysis.

Data were collected during July and August of 2009 in the Gorny Regional Medical Centre in Berdygestiakh, Sakha Republic/Yakutia, Russia (62°N, 127°E; pop. 4900). All participants were residents of the isolated, rural town of Berdygestiakh. These data are a sub-sample of the larger-scale study on health within the Yakut.

The Office for Protection of Human Subjects at the University of Oregon approved the study protocol. Informed consent was obtained from all participants.

Data collection

As part of a larger study, anthropometric, metabolic and health data were collected for 281 adults (143 women). Eligible participants were those who did not report any acute or chronic conditions and were not pregnant or lactating. Individuals who self-identified as Yakut were included in the analysis.

Anthropometry

Participants were measured for height, weight, waist circumference and skin-folds (biceps, triceps, subscapular and supra-illiac) using standard methods (Lohman et al., 1988). Bioelectrical impedance analysis was performed using a bioelectrical impedance analysis scale (TBF-300A, Tanita Corporation, Tokyo, Japan).

Interview

Participants were interviewed on basic demographic information including age, birth date, education, occupation and income. Traditional activities were assessed by asking the participants how many days per year they engage in foraging, fishing, hunting and hay-cutting. Participants were also asked to estimate the number of hours per week they spent watching television. For more details on the interview, see Cepon et al. (2011).

Accelerometry

A sub-set of participants ($n = 89$) were asked to wear a tri-axial accelerometer (Actigraph GT3X; Pensacola, FL) for 2 days. The accelerometer collected data in 60-second epochs and was worn on the waist. Participants were instructed to wear the accelerometer on the right hip and were told that they were able to remove the accelerometer at night and while bathing.

Participant feedback

After the interview, anthropometry and biomarkers were measured; participants were given feedback by trained medical personnel on their cardiovascular/metabolic health and lifestyle changes they could make to improve health.

Data management and statistical analysis

Anthropometry

Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in metres. Percentage body fat was calculated using the manufacturer's equation. Individuals were classified as overweight/obese if their BMI exceeded 24.99 (WHO, 2012) and abdominally obese if their waist circumference exceeded 87.99 cm (women) or 101.99 cm (men) (Huxley et al., 2010).

Interview

Education level was reduced to a binary variable: high school or less versus university or higher. Occupation was classified as manual, professional/service and not currently working.

Accelerometer data

The first day of accelerometry data was removed to reduce the impact of reactivity (Clemes & Parker, 2009) and incomplete days of data (Ward et al., 2005). Only the second day of accelerometry data was analysed in this pilot study. Only participants who wore their accelerometer for at least 10 hours (600 minutes) of accelerometry data on the second day were included in the analysis. Wear time was defined as the difference between 24 hours and non-wear time. Non-wear time was defined as sleep time and 60 consecutive minutes or more of 0 counts in any axis with up to 2 minutes of total counts below 100. Accelerometer data cleaning was performed in Microsoft Excel.

Participants who removed their accelerometers at night were identified by at least 5 hours of 0 counts during night time hours. Within this sample, only 29 of the 89 participants removed their accelerometers during the night.

Many participants expressed concern that they would not put the device back on correctly if they took it off, perhaps accounting for the large proportion of participants wearing the accelerometer at night. Although waist accelerometers are not designed to detect sleep (Sadeh, 2011), sleep disruption was easily detectable within the participants who kept the device on all night. We defined a disruption to sleep as at least 2 minutes of accelerometry counts over 100 counts per minute (the cut-off for sedentary behaviour using a single axis) during the night-time hours. This cut-off is intended to indicate when participants are engaged in physical activity at some level and are most likely indicative of the participant being out of bed moving about the house, rather than being awake while remaining in bed. Almost half of participants who kept the accelerometer on had at least five bouts of sleep disruption. It is likely that the long hours of daylight during the Arctic summer contributed to sleep disruption. Regardless, the disrupted sleep made discerning sleep times problematic. Therefore, we imposed sleep times on all participants who did not remove their accelerometer at night. To do this we took the mean wake and sleep times for the participants who removed their accelerometers at night and had 10 hours of wear time. The mean wake time for participants who removed their accelerometer at night and had 10 hours of wear time was 8:17 am. After removing the wake time of the participant whose accelerometry data began after 12 pm, the mean wake time lowered to 8:06 am. A similar method was used to estimate average sleep time. Using only data from participants who had at least 10 hours of wear time and who removed the accelerometer at night, the mean time to sleep began (as determined by the time the accelerometer was removed) was 10:27 pm. After removing the two participants who removed their accelerometers before 8:00 pm, the mean time to sleep was 10:44 pm. The average wake time was rounded to 8:00 am and the average time to sleep was rounded to 10:45 pm. This time frame (8:00 am–10:45 pm) was imposed on all cases that did not remove their accelerometers at night.

Two classifications for intensity of physical activity were used (Freedson et al., 1998; Carr & Mahar, 2012). Freedson and colleagues used single (vertical) axis data and Carr and Mahar used three axes of data to construct vector magnitude cut-offs. The Freedson et al. (1998) cut-offs for accelerometry counts per minute are: light: $\leq$1951, moderate: 1952–5724, hard: 5725–9498, very hard: $\geq$9499. Sedentary behaviour (SB; aka very light physical activity) is defined as <100 cpm using a single axis cut-off (Atkin et al., 2012). Using the Carr & Mahar (2012) cut-offs for accelerometry counts per minute with vector magnitude (VM), the cut-offs are <150 cpm = sedentary, 150–2689 = light, >2689 = moderate/vigorous. Moderate and vigorous categories within each classification were combined into moderate-to-vigorous physical activity (MVPA). Individuals were categorized as being sufficiently active if they spent at least 30 minutes in MVPA, as per international recommendations (Garber et al., 2011).

Statistical analysis

All continuous variables were checked for normality using kurtosis, skewness and the Kolmogorov-Smirnov test. Several participants had very high, but still plausible, levels of MVPA; therefore, these variables were log transformed. The log of MVPA was normally distributed and was used for all statistical tests. Independent *t*-tests were used to test for sex differences in anthropometry, socio-demographic, lifestyle and accelerometry data. The days engaged in traditional activities were all not normally distributed. Due to the high number of zeros, transformations could not be performed.

Simple linear regressions were performed to compare MVPA and SB. Independent *t*-tests were used to determine whether individuals who spent at least 30 minutes in MVPA spent a different amount of time sedentary compared to those who spent less than 30 minutes in MVPA. Regressions were also used to determine whether SB predicted television viewing time and whether SB or MVPA predicted anthropometric measures (height, weight, BMI, waist circumference and percentage body fat). The relationships between age and MVPA and SB were also tested using linear regressions, as was the relationship between monthly family/household income with MVPA and SB. Independent *t* tests were used to compare education level (high school or less versus university or higher) with MVPA and SB. One-way independent ANOVA was used to compare employment (professional, manual or not working) with MVPA and SB. The Gabriel post-hoc test was used for pairwise comparisons due to unequal sample sizes between employment groups.

Results

The final sample size was 68, with the majority of excluded participants due to incomplete accelerometry data. The mean age of the sample was 50 years, with slightly more women than men (36 versus 32). Men were significantly taller and heavier than women but no significant differences were found in BMI (Table 1). Overall the participants had high levels of adiposity. Within the sample, 50% were overweight/obese and 27% were abdominally obese. Women had significantly higher skin-fold thickness and percentage body fat than men.

The mean monthly family income was close to 30 000 rubles per month (970 USD), with no significant sex difference. The majority of participants had a university education, with women having higher education levels than men using a chi-square test (χ^2 (1) = 5.037, p = 0.025). A majority of participants were engaged in professional or service occupations, while no significant differences between the sexes were found in their occupation type. The non-workers were primarily retired and drawing a pension, although two were disabled and one was a stay-home mother. Women spent more days foraging and fishing than men. Only men hunted and men spent more days cutting hay than women.

On average, the accelerometers were worn for 871 minutes (SD = 81). Men spent significantly more time in MVPA than women, but no sex differences were found in minutes spent in SB (Table 2). The vector magnitude cut-offs decreased time spent in SB by ~100 minutes and increased time spent in MVPA by almost 40 minutes. The vector magnitude cut-off also classified 46% more individuals as appropriately active compared to the single axis cut-offs (54% versus 79%) (Figure 1). Almost all of the time spent in MVPA was spent in

Table 1. Anthropometry, socioeconomic and lifestyle variables of Yakut men and women.

	Men	Women	Total
Anthropometry			
n (%)	32 (47.05)	36 (52.94)	68 (100)
Age, mean (SD)	51.13 (13.26)	49.81 (14.17)	50.43 (13.66)
Height, mean (SD)	168.68 (7.23)[a]	154.46 (6.87)[a]	161.15 (10.00)
Weight, mean (SD)	71.69 (16.49)[a]	61.24 (10.61)[a]	66.16 (14.56)
Body mass index, mean (SD)	25.16 (5.33)	25.69 (4.26)	25.44 (4.76)
Waist circumference, mean (SD)	87.71 (13.05)	85.04 (10.64)	86.29 (11.82)
Sum of four skin-folds, mean (SD)	68.81 (39.25)[a]	108.20 (32.78)[a]	89.67 (40.82)
Percentage body fat, mean (SD)	23.56 (8.51)[a]	33.38 (7.58)[a]	28.76 (9.37)
Socioeconomic/lifestyle variables			
Monthly household income (rubles), mean (SD)	30 038 (13 501)	26 776 (12 660)	30 817 (19 090)
Education, *n* (%)			
High school or less	12 (37.6)[b]	5 (29.4)[b]	17 (34.7)
University or higher	20 (62.5)[b]	12 (70.6)[b]	32 (65.3)
Occupation, *n* (%)[e]			
Manual	8 (26.7)	5 (16.1)	13 (21.3)
Professional/service	16 (53.3)	18 (58.1)	34 (55.7)
Not employed	6 (20.0)	8 (25.8)	14 (23.0)
Days engaged in traditional activities, mean (SD)			
Foraging	6.21 (11.56)[c]	10.89 (8.20)[c]	8.55 (7.31)
Hunting	11.56 (15.13)[d]	0 (0)[d]	5.97 (12.26)
Fishing	6.00 (9.04)[d]	10.0 (0.517)[d]	3.35 (7.14)
Hay-cutting	9.22 (12.74)[c]	5.548 (11.43)[c]	7.41 (12.16)

[a]Significant difference between the sexes using an independent *t* test, $p < 0.01$.
[b]Significant difference found between the sexes using a Pearson chi-square test, $p < 0.05$.
[c]Significant difference found between the sexes using Mann–Whitney *U* test, $p < 0.05$.
[d]Significant difference found between the sexes using an Mann–Whitney *U* test, $p < 0.01$.
[e]Data was missing for seven participants. The sample size for occupation was 61.

Table 2. Objectively and subjectively measured moderate-to-vigorous physical activity (MVPA) and sedentary behaviour (SB) and in Yakut adult men and women, mean (SD).

	Men	Women	Total
Min of MVPA, axis 1[a]	59.59 (52.07)[d]	35.39 (38.64)[d]	46.78 (46.72)
Min of MVPA, vector magnitude[b]	100.00 (64.88)[d]	68.11 (56.07)[d]	83.12 (62.03)
SB min, axis 1 (<100 cpm)	432.09 (159.84)	462.03 (122.40)	451.03 (142.19)
SB min, vector magnitude (<150 cpm)	345.66 (136.72)	354.39 (111.37)	350.28 (123.07)
TV hours/week (avg)[c]	22.76 (9.32)	21.96 (18.25)	22.28 (15.22)

[a]MVPA defined as at least 1952 cpm on axis 1 (Freedson et al., 1998).
[b]MVPA defined as at least 2690 cpm on vector magnitude (Carr & Mahar, 2012).
[c]Self-reported hours spent watching television.
[d]Significant difference between the sexes using an independent *t* test, $p < 0.05$.

moderate physical activity. Only five individuals (four men) spent any time at all in vigorous activity, with 4 minutes being the longest time spent in vigorous activity within the sample during the day-long monitoring period.

Overall, within this sample, total time spent in MVPA was significantly, inversely related to SB. Spending 30 minutes in MVPA was significantly associated with decreased SB when defined using vector magnitude ($t = 2.099$ (1), $p = 0.040$), but not single axis ($t = 1.411$ (1), $p = 0.163$) using independent *t*-tests. In simple linear regressions with MVPA as the independent variable and SB as the dependent variable, MVPA strongly and negatively predicted SB in the entire sample in single axis [β(SE) = −103.947 (31.352), R^2 adj = 0.130, $p = 0.001$] and VM [β(SE) = −74.19 (27.852), R^2 adj = 0.083, $p = 0.010$]. When men and women were analysed separately, men had a negative relationship between MVPA and SB using VM [β(SE) = −227.712 (65.400), $R^2 = 0.264$, $p = 0.002$]. Women had a strong and significant relationship when classified using a single axis [β(SE) = −97.466 (37.487), R^2 adj = 0.141, $p = 0.014$].

Objectively-measured SB positively and significantly predicted self-reported hours spent watching television per week in the entire sample with single axis [β(SE) = 0.0017 (0.008), R^2 adj = 0.005, $p = 0.039$] and VM [β(SE) = 0.019 (0.009), R^2 adj = 0.052, $p = 0.043$]. In sex-specific regressions, only the men's SB significantly predicted television viewing time [single axis: β(SE) = 0.021 (0.009), R^2 adj = 0.145, $p = 0.022$, vector magnitude: β(SE) = 0.027 (0.010), R^2 adj = 0.171. $p = 0.013$].

MVPA measured with a single axis negatively predicted most measures of adiposity in men and the entire sample (Table 3). Yet, vector magnitude only predicted the %BF of the entire sample. Stature was positively correlated with both classifications of MVPA. SB did not predict any anthropometric measures in these Yakut adults (results not shown).

Within this sample of Yakut adults, age significantly predicted MVPA measured by a single axis in women [β(SE) = −0.014 (0.006), R^2 adj = 0.121, $p = 0.021$] and the entire sample [β(SE) = −0.013 (0.004), R^2 adj = 0.099, $p = 0.005$]. Yet, age did not predict either measure of SB or MVPA measured by vector magnitude.

Employment appears to be the primary socioeconomic determinant of physical activity within this sample. In one-way independent ANOVAs, type of employment was significantly related to MVPA in women [single axis: $F(2, 29) = 5.561$, $p = 0.009$; VM: $F(2,29) = 4.428$, $p = 0.022$] and SB as measured by VM in men [$F(2,60) = 3.615$, $p = 0.041$]. Gabriel post-hoc tests found that women working in a manual labour job spent significantly more time in MVPA than those employed in the professional or service industry ($p = 0.013$). In men, manual workers were significantly less sedentary than non-workers using a Gabriel post-hoc test ($p = 0.038$). Neither education level nor days spent in any traditional activity (hunting, fishing, foraging and hay cutting) significantly related to MVPA or SB in these Yakut men or women (results not shown).

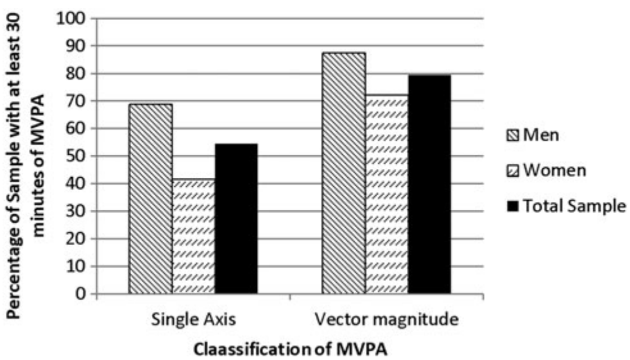

Figure 1. Percentage of sample achieving at least 30 minutes of moderate-to-vigorous physical activity (MVPA) using two classifications. Single axis MVPA defined by Freedson et al. (1998) cut-offs for axis 1 (vertical axis). MVPA defined as at least 1952 cpm. Vector magnitude: MVPA defined by Carr & Mahar (2012) cut-offs for vector magnitude. MVPA Defined as at least 2690 cpm.

Monthly family income did not predict minutes spent in MVPA (results not shown). Monthly family income significantly and negatively predicted SB measured with a single axis in the entire sample, but only trended toward significance ($p < 0.10$) when measured using VM (Table 4).

Comment

These data indicate that these Yakut adults are physically active and have strong gender differences in physical activity and SB. The vast majority of these Yakut met the international recommendations for daily MVPA, indicating that most of this sample is sufficiently active to gain health benefits (Garber et al., 2011). Yet it does not seem as though participation in traditional activity predicts activity levels in these Yakut. This may be due to a combination of the measurement of traditional activities (recall over the past year) and the short duration of objective physical activity monitoring, which has been used in other publications (Matthews et al., 2008). The gender difference in physical activity among the Yakut is consistent with research among other indigenous Siberians and other circumpolar groups (Dahl-Petersen et al., 2011; Leonard et al., 2002; Shephard, 1974; Shephard & Rode, 1996; Snodgrass et al., 2006b). Such gender roles seem to have appeared within the Yakut during the Soviet era (Snodgrass et al., 2006b). Type of employment predicted MVPA in the expected direction; manual occupation predicted higher MVPA, while family income was the only socio-demographic predictor of SB. It is likely that the mixed economic and social strategies employed by the Yakut

Table 3. Simple linear regression of anthropometry and accelerometry.

	Men		Women		All	
Dependent variable	β(SE)	p	β(SE)	p	β(SE)	p
MVPA 1 axis (log)[a]						
Height	0.013 (0.012)	0.296	0.025 (0.012)	0.046	0.020 (0.020)	0.001
R^2 adj	0.004		0.086		0.136	
Weight	−0.009 (0005)	0.083	0.002 (0.008)	0.815	−0.001 (0.004)	0.812
R^2 adj	0.066		−0.028		−0.014	
BMI	−0.037 (0.015)	0.019	−0.013 (0.021)	0.533	−0.028 (0.013)	0.030
R^2 adj	0.143		−0.018		0.055	
Waist circumference	−0.014 (0.006)	0.028	−0.003 (0.008)	0.720	−0.008 (0.005)	0.145
R^2 adj	0.123		−0.025		0.017	
Percentage body fat	−0.022 (0.009)	0.022	3.49e-6 (0.012)	1.00	−0.017 (0.006)	0.011
R^2 adj	0.135		−0.029		0.081	
MVPA VM (log)[b]						
Height	0.005 (0.008)	0.565	0.003 (0.009)	0.737	0.008 (0.004)	0.064
R^2 adj	−0.022		−0.028		0.038	
Weight	−0.004 (0.004)	0.292	−0.001 (0.006)	0.884	−0.001 (0.003)	0.851
R^2 adj	0.005		−0.031		−0.015	
BMI	−0.015 (0.011)	0.160	−0.003 (0.014)	0.815	−0.012 (0.009)	0.193
R^2 adj	0.034		−0.029		0.011	
Waist circumference	−0.007 (0.004)	0.124	0.001 (0.006)	0.911	−0.003 (0.004)	0.421
R^2 adj	0.046		−0.031		−0.005	
Percentage body fat	−0.010 (0.007)	0.135	−0.007 (0.008)	0.381	−0.011 (0.004)	0.012
R^2 adj	0.042		−0.006		0.080	

[a]MVPA defined as at least 1952 cpm on axis 1 (Freedson et al., 1998).
[b]MVPA defined as at least 2690 cpm on vector magnitude (Carr & Mahar, 2012).

Table 4. Simple linear regressions of monthly family income predicting minutes spent in sedentary behaviour (SB) using different classifications for accelerometry.

	Men		Women		All	
Dependent variable	β(SE)	p	β(SE)	p	β(SE)	p
SB 1 axis[a]	−0.003 (0.002)	0.115	−0.002 (0.002)	0.202	−0.003 (0.001)	0.030
R^2 adj	0.052		0.024		0.061	
SB VM[b]	−0.003 (0.002)	0.135	−0.002 (0.002)	0.270	−0.002 (0.001)	0.056
R^2 adj	0.044		0.009		0.045	

[a]SB defined as less than 100 cpm on axis 1 (Atkin et al., 2012).
[b]SB defined as less than 150 cpm on vector magnitude (Carr & Mahar, 2012).

complicate the relationship between socio-demographic indicators and activity patterns. Traditional herding activities are performed by all income levels and in some cases a higher income may provide the opportunity to engage in traditional subsistence activities and/or keep animals.

This pilot study highlights considerations to be made when assessing physical activity and sedentary behaviour in the Yakut and circumpolar populations. First, predictors of physical activity and SB may be differentiated by gender within the Yakut, as has been found in other indigenous Siberian and circumpolar populations. Future studies should consider gender differences in social predictors of behaviour of physical activity. Second, television viewing time may potentially be an estimate of SB in Yakut men, not women, with the understanding that it likely under-estimates SB (Sugiyama et al., 2008). Third, and most generally, researchers should be aware that selecting tri-axial and single axial accelerometry can have a large impact on the activity levels of free living populations, which has been found in other studies as well (Ridgers & Fairclough, 2011). These data highlight how important objective measurement of physical activity is in transitioning populations.

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Declaration of interest

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