Skurvydas et al. BMC Public Health (2024) 24:3364
https://doi.org/10.1186/s12889-024-20866-2

BMC Public Health

RESEARCH

Open Access

Men and women choose moderate-to-vigorous physical activity and sedentary behaviors with a "hot" mind rather than a "cold" one

Albertas Skurvydas[1], Natalja Istomina[2], Ruta Dadeliene[1], Dovile Valanciene[3], Ausra Lisinskiene[4], Ieva Egle Jamontaite[1], Asta Sarkauskiene[5] and Daiva Majauskiene[1,6*]

Abstract

Background The primary aim of our study is to explore how moderate-intensity physical activity (MPA), vigorous-intensity physical activity (VPA), moderate-to-vigorous physical activity (MVPA), and sedentary behavior (SB) in men and women (ages 18–74; 4545 females and 1824 males) are associated with age, education, psychological factors (cognitive reflection/"cold" mind, emotional intelligence (E), impulsivity, perceived stress), health behaviors (overeating, breakfast consumption, smoking, alcohol use), body mass index (BMI), and sleep duration.

Methods The information was collected by means of an online survey (https://docs.google.com/forms/) to ensure the anonymity of participation and confidentiality of data.

Results MVPA and SB in men and women are significantly influenced by education, age, BMI, lifestyle, and psychological factors, with some gender differences. Higher education reduces MVPA and increases SB, while age lowers SB and raises MVPA in women. BMI inversely affects MVPA and VPA, and breakfast supports higher activity levels, while overeating and alcohol (in men) are linked to lower MVPA and higher SB. Sleep duration weakly affects activity structure but inversely relates to SB. While Cognitive Reflection Test (CRT) scores—an indicator of logical reasoning—do not show a significant positive impact on physical activity levels (MPA, VPA, or MVPA) in either gender, they are associated with increased sedentary behavior in women. Emotional Intelligence (EI), however, plays a clear and positive role: higher EI is strongly associated with increased VPA and MVPA in both men and women, especially in women, and inversely related to SB in both genders.

Conclusions The results of our study suggest that enhancing EI ("hot" mind) may be more effective than reasoning skills ("cold" mind) in promoting physical activity and reducing sedentary behavior, particularly in women. These findings highlight EI's potential as a key driver of active lifestyles, while logical reasoning appears to have a lesser impact.

Keywords Vigorous physical activity, Emotional intelligence, Cognitive reflection

*Correspondence:
Daiva Majauskiene
daiva.maja@gmail.com
Full list of author information is available at the end of the article

Background

There is growing evidence that Various forms and doses of physical activity (PA) have been proven to be effective in the prevention of many chronic diseases[1–4], strengthening the immune system [5] improvement of mental health and well-being [6–9], lowering all-cause mortality risk [10–13], and increasing life expectancy [14, 15]. It has been clearly demonstrated that irrespective of physical activity, sedentary behavior is the risk factor of comorbidities [11, 16–20]. In addition, sedentary behavior (SB) has been shown to increase all-cause mortality risk in individuals with chronic diseases or high body mass index (BMI), whereas PA is likely to reduce this risk [20].

PA has a specific effect on various body functions as it has a nonlinear relationship with the intensity, duration, and load of muscle work [1, 3, 4, 12, 14, 20–22]. Moreover, individuals of different age, sex, health condition, and BMI experience different benefits of PA [3, 6, 11, 23–26]. For example, one of the recent systematic analyses showed that only in people aged > 50 years, moderate to intense PA (MVPA) improves cognition: this effect is weaker in people of other ages [6].

While the human health benefits of MVPA are well established, there is now ample evidence that both light PA and moderate PA (MPA) (important for minimizing SB) are also highly beneficial in strengthening and maintaining a person's health [3, 4, 19, 20]. For example, increasing the dose of low-intensity PA from 3 to 7 h per day, regardless of MVPA, reduced mortality rates in adults and the elderly [27].

According to almost 2 million reports, physical inactivity of Europeans, both men and women, increased significantly from 2001 to 2016 [27]. Physical activity (PA) choices involve decision-making influenced by various interrelated factors, including demographic characteristics, health behaviors, overall health, social and environmental factors, and psychological determinants relevant to intervention strategies [28–30]. Moreover, our recent research clearly shows that some individuals are more physically active during and after work, while others accumulate higher levels of physical activity during leisure time and on weekends. Those who were more active in their leisure time exhibited better health, improved mood, and higher happiness levels [31, 32]. However, the causal relationship remains unclear—whether happier individuals with better mood and health tend to be more physically active on weekends, or whether those who are less active during weekends may negatively impact their health, mood, and happiness.

Although there are new World Health Organization recommendations for PA [4], a number of uncertainties remain, such as how PA depends on various sociodemographic factors such as gender, age, and ethnicity [33]. In addition, it is necessary to clarify how health is affected by PA in different domains (e.g., the subject's leisure choice, occupation, education, being at home, and/or while commuting to work) and the amount of PA [33]. Human decisions are influenced both by rational and logical thought processes (explicit knowledge), and by emotional intelligence (EI) and impulsivity (implicit knowledge) [34, 35].

Thus, physical activity choices can be both rational, deliberate, and logical—driven by "cold" reasoning ("cold" mind)—or more emotional, intuitive, quick, and impulsive, known as "hot" decision-making. Our previous research indicates that physical activity is more closely associated with emotional intelligence than with logical thinking [36, 37]. To date, we have not found studies that explore how MVPA and SB are influenced not only by sociodemographic, healthy lifestyle, and health indicators but also by "cold" (logical thinking/cognitive reflection) and "hot" thinking (emotional intelligence, impulsivity).

The study set two primary objectives. The first is to identify differences between men and women in sociodemographic factors, health, healthy lifestyle, physical activity levels, sedentary behavior, emotional intelligence, impulsivity, logical thinking, and stress indicators. The second objective is to apply linear regression analysis to investigate how moderate-intensity physical activity (MPA), vigorous-intensity physical activity (VPA), moderate-to-vigorous physical activity (MVPA), and sedentary behavior in men and women are associated with age, education, psychological factors (cognitive reflection, emotional intelligence, impulsivity, perceived stress), health behaviors (overeating, breakfast consumption, smoking, alcohol use), body mass index (BMI), and sleep duration. Our main hypothesis is that physical activity (MVPA) is directly related to cognitive reflection and emotional intelligence, while sedentary behavior (SB) is inversely related to these factors. Conversely, SB is directly associated with perceived stress and impulsivity, while MVPA is inversely associated. In other words, higher emotional intelligence, stronger logical thinking, lower perceived stress, and reduced impulsivity are expected to lead individuals to recognize the benefits of physical activity and the risks of prolonged sitting, encouraging a more active, less sedentary lifestyle. Additionally, we expect that physically active individuals will adopt healthier behaviors (such as eating healthily, avoiding smoking and overeating) and experience better sleep quality. Furthermore, BMI is anticipated to be a strong determinant of physical activity—higher BMI is expected to be associated with lower MVPA and increased sedentary time.

Methods

Participants

A total of 6,369 subjects (4,545 female and 1,824 male), aged 18–74 years and representative of the Lithuanian population, participated in the study, which began in October 2019 and concluded in June 2020. Participants were recruited via social media (Facebook) and researchers' personal networks (WhatsApp) and completed an electronic survey hosted on the Google Forms platform. The survey (https://docs.google.com/forms/) ensured participant anonymity and maintained the confidentiality of data processed by the researchers.

The exclusion criteria for the study on physical activity among healthy Lithuanian adults were thoughtfully developed to ensure the reliability and representativeness of the results. Participants were limited to those aged 18 to 74 years to focus on this adult population segment. Individuals with known chronic illnesses, disabilities, or other medical conditions that might influence physical activity levels were excluded to maintain a focus on a healthy sample. Each response was checked for completeness, and any participants who left survey questions unanswered were removed to ensure data integrity and consistency. Additionally, responses displaying clear signs of random or inconsistent answers were excluded to uphold data quality.

Survey design and procedure

Our study was a cross-sectional survey. The Ethics Committee of the University gave permission to conduct this study (Protocol No. STIMC-BTMEK-08). The purpose of the survey, the introduction, and the duration of the survey were added to the web-based open e-survey. Successful return of the completed survey was taken as consent by the participant. We also ensured that the study was conducted in accordance with the principles of the Declaration of Helsinki [38] and the National ethical guidelines for biomedical and health research involving human participants [39]. The web-based open-ended e-survey had an introduction explaining the purpose of the survey, and indicating the length of the survey. The participant's consent was the successful return of the completed survey.

Sociodemographic and anthropometric data

Participants were asked to provide information on their age, gender, family status, education, place of residence. The body mass index (BMI) was calculated using the height and weight data provided by the respondents.

Instruments

The Danish Physical Activity Questionnaire (DPAQ) adapted from the IPAQ was used. The DPAQ instrument differs from the IPAQ instrument by referring to PA in the past 24 h (for 7 consecutive days) rather than the past 7 days. The participants had to rate the selected activities by physical exertion in metabolic equivalents (METs) on the 9-level PA scale, ranging from sleep or inactivity (0.9 MET) to a very strenuous activity (>6 METs). Each level (A = 0.9 MET, B = 1.0 MET, C = 1.5 METs, D = 2.0 METs, E = 3.0 METs, F = 4.0 METs, G = 5.0 METs, H = 6.0 METs, and I > 6 METs) was described by the examples of specific activities of the respective MET level and by a small drawing. This allowed the researchers to calculate the total MET time covering 24 h of sleep, work, and leisure on an average weekday [40, 41].

We calculated how much energy (in METs) was expended per day during sleep, SB (from 0.9 to 1.5 METs), low-intensity physical activity (LPA) (>1.5<3 METs), moderate intensity physical activity (MPA; 3–6 METs), and vigorous physical activity (VPA) (>6 METs). We also combined MPA with VPA as MVPA. Examples of LPA, MPA, and VPA exercises include walking slowly, brisk walking, and running or jogging, respectively.

Perceived stress scale

PSS-10. The participants' stress levels were measured using the 10-item Perceived Stress Scale (PSS-10) [42]. This instrument has 10 questions about the participants' feelings and thoughts during the past month. The participants have to rate them on a 5-point scale ranging from 0 to 4. Higher scores indicate higher levels of perceived stress. Moderate PSS is defined as a score ranging from 14 to 26, with scores below 14 indicating low stress and scores above 27 indicating high stress.

Assessment of EI

The Schutte Self-Report Emotional Intelligence Test [43, 44] was used for the participants to self-assess their emotional intelligence. The Schutte Self-Report Emotional Intelligence Test instrument consists of 33 items divided into four subscales: perception of emotions (10 items), managing one's own emotions (9 items), managing others' emotions (8 items), and using emotions (5 items). The participants had to rate the statements h on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total score ranges from 33 to 165, with higher scores indicating better emotional intelligence skills.

Impulsivity assessment

Barratt Impulsiveness Scale version 11 (BIS −11) [45] was used to assess the impulsive behaviour of the participants. The BIS-11 questionnaire consists of 30 items divided into three subscales: attentional impulsiveness (8 items); motor impulsiveness (11 items), and non-planning impulsiveness (11 items). The confirmatory factor analysis is done on a 4-point scale ranging from 1 (rarely/never) to 4 (almost always/always). The total score may range from 30 to 120, with higher scores indicating higher impulsivity.

The cognitive processing of the participants was assessed using the questions developed according to the Cognitive Reflection Test *(CRT)* [46]. The author of the CRT claims that this test shows which type of thinking, intuitive or logical, a person uses. Intuitive decision making is implicit and emotional. It is usually automatic, fast, and requires little effort. The logical thinking that is deliberate, effortful, goal-oriented, and slower. The test consists of three questions: (1) A bat and a ball together cost $1.10. The bat costs $1.00 more than the ball. How much does the ball cost? __cents. (2) If it takes 5 machines 5 min to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes. (3) There is a patch of lily pads in a lake. Every day, the size of the stain doubles. If it takes 48 days for the stain to cover the entire lake, how long would it take for the stain to cover half of the lake? _____ days. The score is the total number of correct answers. CRT measures cognitive processing, specifically the tendency to suppress an incorrect, intuitive response and arrive at a more conscious, correct response.

Harmful habits

To identify harmful habits, the respondents had to indicate their smoking habits on a scale from 1 to 4, where 1 is “I have never smoked”; 2 is “I smoke occasionally”; 3 is “I smoke every day”; 4 is “I used to smoke, but quit”. Alcohol consumption was assessed on a scale from 1 to 7, where 1 is “I don’t drink at all” and 7 is “Daily”.

Determination of sports habits

We asked the respondents, ‘Are you currently exercising?’. The respondents had to indicate their sport habits on a scale of 1 to 4, where 1 is “I don’t exercise”; 2 is “I exercise by myself”; 3 is “I exercise in a gym/health center” and 4 is “I am in professional sports”.

Data analysis

The interval data are presented as mean ± standard deviation. The Kolmogorov–Smirnov test confirmed the normal distribution of all interval data. An independent t-test was used to assess differences in mean values between men and women across various indicators. A two-way analysis of variance (ANOVA) examined the dependence of dependent variables (moderate-to-vigorous physical activity, MVPA) on independent variables, including gender, age, place of residence, work specifics, and exercise habits. Chi-square (χ^2) tests assessed gender differences across various indicators. Linear regression analysis identified relationships between MVPA, sedentary behavior (SB), moderate physical activity (MPA), and vigorous physical activity (VPA) (dependent variables) and healthy lifestyle, health, and psychological indicators (independent variables). The analysis included standardized beta coefficients and significance values. Statistical significance was set at $p < 0.05$ for all tests. IBM SPSS Statistics software (version 22; IBM Corp., Armonk, NY, USA) was used for statistical analysis.

Results

The analysis in Table 1 reveals significant gender differences across demographic, physical, and psychological variables, underscoring distinct characteristics and behaviors between women and men.

Men, on average, have significantly higher BMI ($p<0.001$). Age is slightly higher in women, while educational attainment shows a notable distinction, with a higher percentage of women achieving university and non-university levels ($p<0.05$). Analysis of BMI structure reveals that women are significantly more likely to fall into the “normal weight” (BMI 18.5–24.9) and “underweight” (BMI < 18.5) categories compared to men. Conversely, men show a significantly higher proportion in the “overweight” (BMI 25.0–29.9) category. However, no substantial gender differences were observed in the “obesity I” (BMI 30.0–34.9) and “obesity II & III” (BMI ≥ 35.0) categories, suggesting similar rates of higher obesity levels across both genders.

Men engage more in vigorous and moderate-to-vigorous physical activities (VPA and MVPA), while women report higher low physical activity (LPA), indicating divergent activity patterns (Table 1 and Fig. 1). Total MET scores are higher in men, reflecting overall greater physical exertion ($p<0.001$). Sedentary behavior (SB), however, shows a small but significant increase in men ($p<0.05$).

Emotional Intelligence (EI) is significantly higher among women, suggesting greater emotional awareness and regulation ($p<0.001$). Men score higher on the Cognitive Reflection Test (CRT), indicating a tendency toward greater logical reasoning and reflective thinking ($p<0.001$). Women report higher perceived stress (PSS), contrasting with men’s slightly higher, though non-significant, impulsivity (BIS).

Marked differences appear in lifestyle behaviors, with a significantly higher percentage of women abstaining from smoking and alcohol and engaging in regular exercise ($p<0.05$).

Key Determinants of Moderate Physical Activity (MPA), Vigorous Physical Activity (VPA), Moderate-to-Vigorous Physical Activity (MVPA), and Sedentary Behavior (SB) in Women and Men.

Table 1 Comparison of demographic, health and lifestyle, physical activity and sedentary behavior, sleep, and psychological variables between women and men

Variable	Women (Mean ± SD or %)	Men (Mean ± SD or %)	t-value	*p*-value
Demographic and Physical Characteristics				
Age (yrs)	38.4 ± 12.1	35.7 ± 11.2	8.3	0.000
Higher education of university and non-university level (%)	80.4	72.9		<0.05*
BMI (kg/m²)	24.1 ± 4.5	25.9 ± 3.6	-16.2	0.000
BMI < 18.5 (underweight) (%)	4.3	0.4		<0.05*
BMI 18.5 - 24.9 (normal weight) (%)	62.6	44.6		<0.05*
BMI 25.0 - 29.9 (overweight) (%)	22.7	44.0		<0.05*
BMI 30.0 - 34.9 (obesity I) (%)	7.6	8.8		>0.05*
BMI ≥ 35.0 (obesity II & III) (%)	2.8	2.1		<0.05*
Health and Lifestyle Indicators				
Excellent or good health (%)	24.7	24.1		>0.05*
No exercise (%)	38.1	21.6		<0.05*
Regular breakfast eating (%)	70.6	70.3		>0.05*
Frequently overeating (%)	19.4	16.6		>0.05*
Rarely or never drinks alcohol (%)	45.9	38.3		<0.05*
Never smoked (%)	57.5	45.5		<0.05*
Physical Activity, Sedentary Behavior, and Sleep				
Total MET (hr/day)	40.59 ± 8.7	42.72 ± 9.8	-8.0	0.000
MVPA MET (hr/day)	12.4 ± 5.7	16.3 ± 5.7	-12.8	0.000
Sleep (hr)	7.31 ± 1.0	7.23 ± 0.99	2.8	0.006
SB (hr)	11.02 ± 2.9	11.2 ± 3.0	-2.1	0.031
LPA (hr)	3.3 ± 1.8	2.62 ± 1.7	13.9	0.000
MPA (hr)	2.13 ± 1.7	2.29 ± 1.9	-3.1	0.002
VPA (hr)	0.24 ± 0.5	0.65 ± 0.7	-21.9	0.000
Psychological Attributes				
Emotional Intelligence (EI)	127.4 ± 14.5	123.2 ± 15.4	9.5	0.000
Cognitive Reflection Test (CRT) score	1.07 ± 0.74	1.25 ± 0.45	-5.5	0.000
Barratt Impulsiveness Scale (BIS) score	58.5 ± 8.7	59.6 ± 9.1	-1.0	0.280
Perceived Stress Scale (PSS)	18.0 ± 6.5	16.7 ± 6.2	7.4	0.000

t-values were calculated based on independent samples

*Significance calculated based on chi-square tests

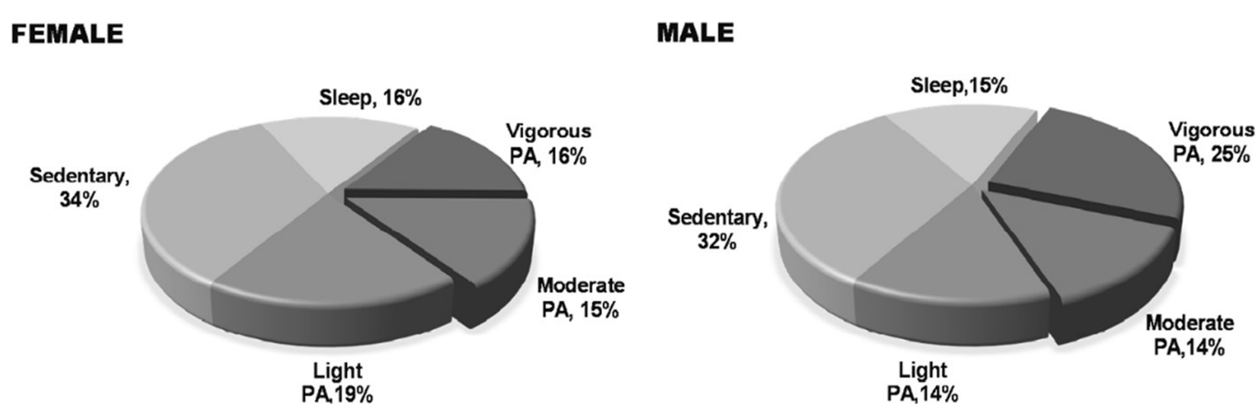

Fig. 1 Distribution of sleep and exercise patterns as percentage of daily METs

Men's and women's MVPA (Moderate to Vigorous Physical Activity) and SB (Sedentary Behavior) significantly depend on education level – as education level increases, MVPA decreases ($p < 0.001$), while SB increases ($p < 0.001$) (Table 2). Additionally, with age, SB decreases ($p < 0.001$) for both men and women, while women's MVPA increases ($p < 0.001$). Interestingly, in both men and women, MPA (Moderate Physical Activity) is directly related to age, whereas VPA (Vigorous Physical Activity) is inversely related ($p < 0.001$). Both MVPA and VPA are significantly inversely correlated with BMI in men and women ($p < 0.001$, with $p < 0.05$ and $p < 0.001$, respectively). Furthermore, VPA and MVPA are positively associated with breakfast consumption and inversely associated with overeating in both genders. Alcohol consumption correlates with increased SB and reduced MVPA exclusively in men ($p < 0.05$). Unexpectedly, sleep duration shows only a weak association with physical activity structure in both men and women, though it has a strong inverse association with SB ($p < 0.001$).

Cognitive Reflection Test (CRT) scores were not significantly positively associated with MPA, VPA, or MVPA in either gender ($p > 0.05$); however, in women, higher CRT scores were linked to higher SB ($p < 0.05$). Emotional Intelligence (EI) was significantly directly associated with VPA and MVPA in both men ($p < 0.05$) and particularly in women ($p < 0.001$). Additionally, EI was strongly inversely associated with SB in both men and women ($p < 0.001$). BIS impulsivity and PSS (Perceived Stress Scale) scores did not significantly impact SB, MPA, VPA, or MVPA in men ($p > 0.05$), but in women, higher stress was associated with lower VPA and MVPA and higher SB ($p < 0.05$).

Discussion

The novelty and originality of our study lie in its comprehensive analysis of how physical activity levels (MVPA, MPA, and VPA) and sedentary behavior (SB) are

Table 2 Relationships between Moderate Physical Activity (MPA), Vigorous Physical Activity (VPA), Sedentary Behavior (SB), and Moderate-to-Vigorous Physical Activity (MVPA) and Demographic, Cognitive, Emotional, and Behavioral Variables (Standardized Beta Coefficients)

Moderate Physical Activity (MPA) and Vigorous Physical Activity (VPA)				
Variable	**MPA Female Beta (Sig.)**	**MPA Male Beta (Sig.)**	**VPA Female Beta (Sig.)**	**VPA Male Beta (Sig.)**
Age	0.272 **	0.231 **	-0.072 **	-0.103 **
Education	-0.126 **	-0.142 **	-0.065 **	-0.042
Cognitive Reflection Test (CRT) score	-0.023	-0.026	-0.028	0.020
Emotional Intelligence (EI)	0.086 **	0.036	0.119 **	0.087 *
Perceived Stress Scale (PSS)	-0.024	-0.043	-0.043 *	-0.011
Barratt Impulsiveness Scale (BIS) score	-0.008	0.022	-0.014	-0.032
Regular Breakfast	0.016	-0.003	0.036 *	0.095 **
Overeating	-0.044 *	0.010	-0.071 **	-0.067 *
BMI	0.007	-0.100 **	-0.105 **	-0.064 *
Alcohol drinking	-0.032	-0.035	0.013	-0.056*
Smoking	-0.038*	0.021	-0.01	-0.018
Sleeping	-0.038*	-0.072*	-0.021	-0.001
Sedentary Behavior (SB) and Moderate-to-Vigorous Physical Activity (MVPA)				
Variable	**SB Female Beta (Sig.)**	**SB Male Beta (Sig.)**	**MVPA Female Beta (Sig.)**	**MVPA Male Beta (Sig.)**
Age	-0.100 **	-0.128 **	0.113 **	0.058
Education	0.134 **	0.208 **	-0.121 **	-0.115 **
Cognitive Reflection Test (CRT) score	0.044 *	0.007	-0.034	0.000
Emotional Intelligence (EI)	-0.118 **	-0.102 **	0.136 **	0.087 *
Perceived Stress Scale (PSS)	0.048 *	0.041	-0.045 *	-0.033
Barratt Impulsiveness Scale (BIS) score	0.030	-0.032	-0.015	-0.012
Regular Breakfast	-0.062 **	-0.084 *	0.035 *	0.070 *
Overeating	0.065 **	0.014	-0.077 **	-0.065 *
BMI	0.025	0.030	-0.070 **	-0.107 **
Alcohol drinking	0.032	0.067*	-0.01	-0.062*
Smoking	0.005	-0.041	-0.03	-0.002
Sleeping	-0.288**	-0.245**	-0.038*	-0.043

*$p < 0.05$, **$p < 0.001$

influenced by a range of demographic, behavioral, and psychological factors, revealing unique and significant patterns. Our study showed that men had advantages over women ($p < 0.0001$) in the following cognitive, psychological, health, and health behavior determinants: the more they exercised, the more their work was demanding of physical effort with less stress and depression; the better they valued their health, the better their logical/rational thinking. Our findings demonstrate a significant association between Emotional Intelligence (EI) and physical activity levels, particularly vigorous physical activity (VPA) and moderate to vigorous physical activity (MVPA), in both men and especially women. Higheer EI scores correlate with increased VPA and MVPA, and inversely with sedentary behavior (SB). This suggests that individuals with higher EI are more likely to engage in physical activities and less likely to lead sedentary lifestyles. Conversely, our findings indicate that Cognitive Reflection Test (CRT) scores, which assess logical thinking („cold thinking ") do not significantly correlate with MPA, VPA, or MVPA in either gender. However, in women, higher CRT scores are associated with increased SB. This implies that while logical thinking abilities may not directly influence physical activity levels, they could be linked to more sedentary behaviors, especially in women.

As far as we know, this is the first study to show that PA and SB is not related to reflective cognition (CRT) ("cold" mind but to emotional intelligence ("hot" mind). Therefore, it can be said that both women and men in this study preferred to engage in PA warm hearted rather than cool headed. ("cold" mind but to emotional intelligence ("hot" mind). Therefore, it can be said that both women and men in this study preferred to engage in PA due to a "hot" mind rather than a "cold" mind. In addition, we found that women had higher EI than men and that men had higher levels of LT (cognitive reflection). This conclusion is related to other findings that EI is associated with health conditions [44, 47], PA [7, 48], athletic motivation [49], and decision making speed [50]. The assessment of cognitive reflection [46] showed that unlike EI, cognitive reflection was not associated with MVPA in the subjects tested. Therefore, we believe that of the two systems involved in decision making [34], choice based on intuition and EI rather than logical/rational decisions is more related to the choice of PA and perhaps to components of a healthy lifestyle other than a healthy diet, such as avoiding smoking and alcohol consumption, avoiding sleep deprivation, and managing stress.

For both women and men, greater use of MVPA was directly associated with a rural life, participation in sports, lower educational level, more PA at work, optimal BMI (neither too high nor too low), good health and low depression, low stress, more frequent breakfasts and less frequent overeating, avoiding alcohol use, and older age (especially in women), but was not associated with smoking habit. Our findings give a better comprehension of various determinants of PA [28–30].

PA of humans is influenced by a number of complex factors, but the most important factors are hard to identify [28, 51]. Moreover, it is quite difficult to distinguish causes and consequences because they may be interrelated with other factors, such as good health or low depression that stimulate PA, which in turn improves health and reduces depression [3, 4, 20, 21, 52]. One of the most interesting findings in our study is the significant impact of age on PA and SB. Specifically, we found that as age increases, MVPA also rises in both men and women, while VPA decreases. This suggests that younger people tend to prefer VPA, while older adults engage more in MPA. Additionally, age has an inverse effect on SB—the older the individual, the less time they spend sitting each day. Thus, age could be a protective factor against prolonged sitting, which has a known negative impact on health (19–21). Interestingly, we also found that sleep plays a key role in reducing sitting time—individuals who get adequate sleep tend to sit less throughout the day. Unfortunately, the effect of sleep on MPA is inverse. Our previous studies have also clearly shown that sleep is not a significant determinant for increasing physical activity levels during work or leisure time [31].

We found that MVPA was most strongly associated with the following determinants regardless of gender: occupational activity, athletic fields, health level, EI, and depression level. Thus, individuals whose EI was highest, whose occupation involved heavy physical labour, who exercised more, who rated their health better, and who felt less depressed had the highest MVPA. It should be also noted that occupation PA was a significant determinant of MVPA in our study, which significantly affects human health, as shown by a recent study [53].

Quite unexpectedly, in our case, men's BMI was higher than women's, which contradicts the worldwide trend [54, 55]. Our research clearly showed an inverse relationship between BMI and MVPA in both women and men, especially for vigorous physical activity (VPA). These data support findings from our previous research, indicating that BMI is not a significant determinant influencing MVPA during work and leisure time [31]. Interestingly, other researchers have shown that there is a linear relationship between impulsivity and BMI [56].

Limitations

PA questionnaire was the main limitation in our study because it could have easily overestimated PA. The analysis of research conducted in Denmark using the same PA scale that we used showed that the time spent on LPA, MPA, and VPA was overestimated and the time spent on SB was underestimated [57]. Other researchers have also noted that it is quite difficult to compare the PA data between different studies because the methods used are very different [3, 4, 12].

Since our study data were collected using a planned survey method, this may have affected the accuracy of certain data, such as BMI and others. As this study is cross-sectional, it captures data at a single point in time, which limits the ability to establish causation between variables, particularly in understanding the influence of factors like education, Emotional Intelligence (EI), and Cognitive Reflection Test (CRT) scores on physical activity levels. Another limitation of our study is that we did not specify when physical activity was performed—primarily during work, after work, or in leisure time. Another limitation of our study is that participants completed the surveys in different seasons—autumn, winter, spring, and summer—which may have influenced their physical activity levels. Our recent published studies indicate that the health and well-being benefits of physical activity performed during leisure time are the most substantial [31, 32]. These limitations suggest that future research could benefit from longitudinal methods, more detailed psychological assessments, and diverse sample populations to enhance understanding of the relationships between cognitive, emotional, and behavioral factors in physical activity engagement. Despite these limitations, we are confident that we obtained reliable evidence on how MVPA and SB depend on various sociodemographic, health, healthy behavior, and psychological factors.

Conclusions

In conclusion, MVPA and SB in men and women are influenced by education, age, BMI, lifestyle, and psychological factors, with some gender differences. Higher education reduces MVPA and increases SB, while age lowers SB and raises MVPA in women. BMI inversely affects MVPA and VPA, and breakfast supports higher activity levels, while overeating and alcohol (in men) are linked to lower MVPA and higher SB. Sleep duration weakly affects activity structure but inversely relates to SB. While Cognitive Reflection Test (CRT) scores—an indicator of logical reasoning—do not show a significant positive impact on physical activity levels (MPA, VPA, or MVPA) in either gender, they are associated with increased sedentary behavior in women. Emotional Intelligence (EI), however, plays a clear and positive role: higher EI is strongly associated with increased VPA and MVPA in both men and women, especially in women, and inversely related to SB in both genders. These findings underscore EI's potential as a key facilitator for active lifestyles, while logical reasoning may be less impactful. Together, they suggest that enhancing EI could be more effective than reasoning skills in promoting physical activity, particularly in women, and in reducing sedentary behaviors across populations.

Abbreviations

ANOVA	Analysis of variance
BIS	Barratt Impulsiveness Scale
BMI	Body mass index
EI	Emotional intelligence
LPA	Light physical activity
LT	Logical thinking/"cold" mind
MET	Metabolic equivalent
MPA	Moderate physical activity
MVPA	Moderate to vigorous physical activity
PA	Physical activity
SB	Sedentary behaviour
p	The level of marginal significance within a statistical hypothesis test

Acknowledgements

The authors would like to thank all participants, who provided data for this study.

Authors' contributions

AS (Skurvydas) participated in the design of the study and contributed to data collection, contributed to data reduction/analysis and contributed to data analysis. AS (Skurvydas), IEJ, DM, DV interpretation of results. AL, RD, NI, contributed to data reduction/analysis. DM, DV, AS (Sarkauskiene), IEJ, participated in the design of the study and contributed to data collection.

Funding

This research received no external funding.

Data availability

The data that support the findings of this study are available on request from the corresponding author. However, the data cannot be accessed publicly due to certain limitations, such as containing sensitive information that could potentially violate the privacy of the research participants.

Declarations

Ethics approval and consent to participate

Informed consent was obtained from all participants. All participants were informed about the goals of the study, the anonymity of their participation, and the option to cancel their participation at any time. The survey was conducted in accordance with the Declaration of Helsinki, and the survey protocol was approved by Klaipėda University (Protocol No. STIMC-BTMEK-08).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Rehabilitation, Physical and Sports Medicine, Faculty of Medicine, Institute of Health Sciences, Vilnius University, 21/27 M.K. Ciurlionio St, Vilnius 03101, Lithuania. [2]Institute of Health Sciences, Faculty of Medicine, Vilnius University, 21/27 M.K. Ciurlionio Street, Vilnius 03101, Lithuania. [3]Faculty of Law, Vilnius University, Sauletekio Al. 9, Vilnius 10221, Lithuania. [4]Institute of Education Studies, Education Academy, Vytautas Magnus University, K. Donelaicio Street 58, Kaunas 44248, Lithuania. [5]Department of Sports, Recreation and Tourism, Klaipeda University, Herkaus Manto Street 84, Klaipeda 92294, Lithuania. [6]Education Academy, Vytautas Magnus University, K. Donelaicio Street 58, 44248 Kaunas, Lithuania.

Received: 10 March 2024 Accepted: 26 November 2024
Published online: 03 December 2024

References

1. Pedersen BK, Saltin B. Exercise as medicine—Evidence for prescribing exercise as therapy in 26 different chronic diseases. Scand J Med Sci Sports. 2019;25:1–72. https://doi.org/10.1111/sms.12581.
2. Luan X, Tian X, Zhang H, et al. Exercise as a prescription for patients with various diseases. J Sport Health Sci. 2019;8(5):422–41. https://doi.org/10.1016/j.jshs.2019.04.002.
3. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behavior. Br J Sports Med. 2020;54:1451–62. https://doi.org/10.1136/bjsports-2020-102955.
4. World Health Organization. WHO Guidelines on Physical Activity and Sedentary Behaviour: Web Annex: Evidence Profiles. 2020. Available online: https://apps.who.int/iris/handle/10665/336657.
5. Nieman DC, Wentz LM. The compelling link between physical activity and the body's defense system. J Sport Health Sci. 2019;8(3):201–17. https://doi.org/10.1016/j.jshs.2018.09.009.
6. Erickson KI, Hillman C, Stillman CM, et al. Physical activity, cognition, and brain outcomes: a review of the 2018 physical activity guidelines. Med Sci Sports Exerc. 2019;51:1242. https://doi.org/10.1249/MSS.0000000000001936.
7. Acebes-Sánchez J, Diez-Vega I, Esteban-Gonzalo S, et al. Physical activity and emotional intelligence among undergraduate students: a correlational study. BMC Public Health. 2019;19(1):1241. https://doi.org/10.1186/s12889-019-7576-5.
8. Zlibinaite L, Skurvydas A, Kilikeviciene S, et al. Two months of using global recommendations for physical activity had no impact on cognitive or motor functions in overweight and obese middle-aged women. J Phys Act Health. 2020;18(1):52–60. https://doi.org/10.1123/jpah.2020-0055.
9. Žlibinaitė L, Solianik R, Vizbaraitė D, et al. The effect of combined aerobic exercise and calorie restriction on mood, cognition, and motor behavior in overweight and obese women. J Phys Act Health. 2020;17(2):204–10. https://doi.org/10.1123/jpah.2019-0373.
10. Lear SA, Hu W, Rangarajan S, et al. The effect of physical activity on mortality and cardiovascular disease in 130 000 people from 17 high-income, middle-income, and low-income countries: the PURE study. Lancet. 2017;390(10113):2643–54. https://doi.org/10.1016/S0140-6736(17)31634-3.
11. Ekelund U, Tarp J, Steene-Johannessen J, et al. Dose-response associations between accelerometry measured physical activity and sedentary time and all cause mortality: systematic review and harmonised meta-analysis. BMJ. 2019;366:l4570. https://doi.org/10.1136/bmj.l4570.
12. Lopez JPR, Sabag A, Juan MM, et al. Do vigorous-intensity and moderate-intensity physical activities reduce mortality to the same extent? A systematic review and meta-analysis. BMJ Open Sport Exerc Med. 2020;6(1):e000775. https://doi.org/10.1136/bmjsem-2020-000775.
13. Ku PW, Hamer M, Liao Y, et al. Device-measured light-intensity physical activity and mortality: a meta-analysis. Scand J Med Sci Sports. 2020;30(1):13–24. https://doi.org/10.1111/sms.13557.
14. Moore SC, Patel AV, Matthews CE, et al. Leisure time physical activity of moderate to vigorous intensity and mortality: a large pooled cohort analysis. PLoS Med. 2012;9(11):e1001335. https://doi.org/10.1371/journal.pmed.1001335.
15. O'Keefe EL, Torres-Acosta N, O'Keefe JH, et al. Training for longevity: the reverse J-curve for exercise. Mo Med. 2020;117(4):355–61. PMID: 32848273; PMCID: PMC7431070.
16. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. Ann Intern Med. 2015;162(2):123–32. https://doi.org/10.7326/M14-1651.
17. Booth FW, Roberts CK, Thyfault JP, et al. Role of inactivity in chronic diseases: evolutionary insight and pathophysiological mechanisms. Physiol Rev. 2017;97:1351–402. https://doi.org/10.1152/physrev.00019.2016.
18. Dempsey PC, Biddle SJ, Buman MP, et al. New global guidelines on sedentary behaviour and health for adults: broadening the behavioural targets. Int J Behav Nutr Phys Act. 2020;17(1):151. https://doi.org/10.1186/s12966-020-01044-0.
19. Rojer AG, Ramsey KA, Trappenburg MC, et al. Instrumented measures of sedentary behaviour and physical activity are associated with mortality in community-dwelling older adults: a systematic review, meta-analysis and meta-regression analysis. Ageing Res Rev. 2020;61:101061. https://doi.org/10.1016/j.arr.2020.101061.
20. Zhao R, Bu W, Chen Y, et al. The dose-response associations of sedentary time with chronic diseases and the risk for all-cause mortality affected by different health status: a systematic review and meta-analysis. J Nutr Health Aging. 2020;24:63–70. https://doi.org/10.1007/s12603-019-1298-3.
21. Skurvydas A, Mamkus G, Kamandulis S, et al. Mechanisms of force depression caused by different types of physical exercise studied by direct electrical stimulation of human quadriceps muscle. Eur J Appl Physiol. 2016;116:2215–24. https://doi.org/10.1007/s00421-016-3473-0.
22. Li Y, Gu M, Jing F, et al. Association between physical activity and all cancer mortality: dose–response meta-analysis of cohort studies. Int J Cancer. 2016;138(4):818–32. https://doi.org/10.1002/ijc.29828.
23. Van Uffelen JGZ, Khan A, Burton NW. Gender differences in physical activity motivators and context preferences: a population-based study in people in their sixties. BMC Public Health. 2017;17(1):624. https://doi.org/10.1186/s12889-017-4540-0.
24. Bennie JA, De Cocker K, Teychenne MJ, et al. The epidemiology of aerobic physical activity and muscle-strengthening activity guideline adherence among 383,928 U.S. adults. Int J Behav Nutr Phys Act. 2019;16(1):34. https://doi.org/10.1186/s12966-019-0797-2.
25. Skurvydas A, Lisinskiene A, Lochbaum M, et al. Physical activity, stress, depression, emotional intelligence, logical thinking, and overall health in a large Lithuanian from October 2019 to June 2020: age and gender differences adult sample. Int J Environ Res Public Health. 2021;18(23):12809. https://doi.org/10.3390/ijerph182312809.
26. Skurvydas A, Lisinskiene A, Lochbaum M, et al. Did COVID-19 pandemic change people's physical activity distribution, eating, and alcohol consumption habits as well as body mass index? Int J Environ Res Public Health. 2021;18(23):12405. https://doi.org/10.3390/ijerph182312405.
27. Guthold R, Stevens GA, Riley LM, et al. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. Lancet Glob Health. 2018;6(10):e1077–86. https://doi.org/10.1016/S2214-109X(18)30357-7.
28. Kelly MP, Barker M. Why is changing health-related behaviour so difficult? Public Health. 2016;136:109–16. https://doi.org/10.1016/j.puhe.2016.03.030.
29. Aleksovska K, Puggina A, Giraldi L, et al. Biological determinants of physical activity across the life course: a "Determinants of Diet and Physical Activity" (DEDIPAC) umbrella systematic literature review. Sports Med Open. 2019;5(1):1–18. https://doi.org/10.1186/s40798-018-0173-9.
30. Koeneman MA, Verheijden MW, Chinapaw MJ, et al. Determinants of physical activity and exercise in healthy older adults: a systematic review. Int J Behav Nutr Phys Act. 2011;8:142. https://doi.org/10.1186/1479-5868-8-142.
31. Skurvydas A, Istomina N, Dadeliene R, et al. Leisure-time physical activity improves happiness, health, and mood profile better than work-related physical activity. PLoS One. 2024;19(7):e0307744. https://doi.org/10.1371/journal.pone.0307744.
32. Skurvydas A, Istomina N, Dadeliene R, et al. Mood profile in men and women of all ages is improved by leisure-time physical activity rather than work-related physical activity. BMC Public Health. 2024;24(1):546. https://doi.org/10.1186/s12889-024-17806-5.
33. DiPietro L, Al-Ansari SS, Biddle SJ, et al. Advancing the global physical activity agenda: recommendations for future research by the 2020 WHO physical activity and sedentary behavior guidelines development group. Int J Behav Nutr Phys Act. 2020;17(1):1–11. https://doi.org/10.1186/s12966-020-01042-2.
34. Evans JSB. Dual-processing accounts of reasoning, judgment, and social cognition. Ann Rev Psychol. 2008;59:255–78. https://doi.org/10.1146/annurev.psych.59.103006.093629.
35. Maxwell AL, Gardiner E, Loxton NJ. Investigating the relationship between reward sensitivity, impulsivity, and food addiction: a systematic review. Eur Eat Disord Rev. 2020;28(4):368–84. https://doi.org/10.1002/erv.2732.
36. Skurvydas A, Lisinskiene A, Majauskiene D, et al. What types of exercise are best for emotional intelligence and logical thinking? Int J Environ

Res Public Health. 2022;19(16):10076. https://doi.org/10.3390/ijerph191610076.
37. Skurvydas A, Lisinskiene A, Majauskiene D, et al. Do physical activity, BMI, and wellbeing affect logical thinking? Int J Environ Res Public Health. 2022;19(11):6631. https://doi.org/10.3390/ijerph19116631.
38. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191–4.
39. Behera SK, Das S, Xavier AS, et al. Indian council of medical research's national ethical guidelines for biomedical and health research involving human participants: the way forward from 2006 to 2017. Perspect Clin Res. 2019;10:108–14. https://doi.org/10.4103/picr.PICR_10_18.
40. Aadahl M, Jørgensen T. Validation of a new self-report instrument for measuring physical activity. Med Sci Sports Exerc. 2003;35:1196–202. https://doi.org/10.1249/01.MSS.0000074446.02192.14.
41. Matthiessen J, Biltoft-Jensen A, Rasmussen LB, et al. Comparison of the Danish physical activity questionnaire with a validated position and motion instrument. Eur J Epidemiol. 2008;23:311–22. https://doi.org/10.1007/s10654-008-9228-4.
42. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Journal of health and social behavior. 1983;24:385–96.
43. Schutte NS, Malouff JM, Hall LE, et al. Development and validation of a measure of emotional intelligence. Personality and individual differences 1998;25(2):167–177. vidual differences 1998;25(2):167–177. https://doi.org/10.1016/S0191-8869(98)00001-4.
44. Schutte NS, Malouff JM, Thorsteinsson EB, et al. A meta-analytic investigation of the relationship between emotional intelligence and health. Personality Individ Differ. 2007;42(6):921–33. https://doi.org/10.1016/j.paid.2006.09.003.
45. Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt impulsiveness scale. J Clin Psychol. 1995;51(6):768–74. https://doi.org/10.1002/1097-4679(199511)51:6<768::aid-jclp2270510607>3.0.co;2-1.
46. Frederick S. Cognitive reflection and decision making. J Econ Perspect. 2005;19:25–42.
47. Sarrionandia A, Mikolajczak M. A meta-analysis of the possible behavioural and biological variables linking trait emotional intelligence to health. Health Psychol Rev. 2020;14(2):220–44. https://doi.org/10.1080/17437199.2019.1641423.
48. Laborde S, Dosseville F, Allen MS. Emotional intelligence in sport and exercise: a systematic review. Scand J Med Sci Sports. 2016;26(8):862–74. https://doi.org/10.1111/sms.12510.
49. Castro-Sánchez M, Chacón-Cuberos R, Zurita-Ortega F, et al. Emotional intelligence and motivation in athletes of different modalities. J Human Sport Exerc. 2018;13(2proc):S162–77. https://doi.org/10.14198/jhse.2018.13.Proc2.01.
50. Mayer JD, Roberts RD, Barsade SG. Human abilities: emotional intelligence. Ann Rev Psychol. 2008;59:507–36. https://doi.org/10.1146/annurev.psych.59.103006.093646.
51. Zhang CQ, Zhang R, Schwarzer R, et al. A meta-analysis of the health action process approach. Health Psychol. 2019;38(7):623–37. https://doi.org/10.1037/hea0000728.
52. Schuch FB, Stubbs B, Meyer J, et al. Physical activity protects from incident anxiety: a meta-analysis of prospective cohort studies. Depress Anxiety. 2019;36(9):846–58. https://doi.org/10.1002/da.22915.
53. Cillekens B, Lang M, van Mechelen W, et al. How does occupational physical activity influence health? An umbrella review of 23 health outcomes across 158 observational studies. Br J Sports Med. 2020;54(24):1474–81. https://doi.org/10.1136/bjsports-2020-102587.
54. Abarca-Gómez L, Abdeen ZA, Hamid ZA, et al. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. Lancet. 2017;390(10113):2627–2642. https://doi.org/10.1016/S0140-6736(17)32129-3.
55. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. Metabolism. 2019;92:6–10. https://doi.org/10.1016/j.metabol.2018.09.005.
56. Thamotharan S, Lange K, Zale EL, et al. The role of impulsivity in pediatric obesity and weight status: a meta-analytic review. Clin Psychol Rev. 2013;33(2):253–62. https://doi.org/10.1016/j.cpr.2012.12.001.
57. Pedersen ESL, Mortensen LH, Brage S, et al. Criterion validity of the Physical Activity Scale (PAS2) in Danish adults. Scand J Public Health. 2018;46(7):726–34. https://doi.org/10.1177/1403494817738470.