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The Effect of COVID-19 Restrictions on Changes in Moderate-to-Vigorous Physical Activity Was "A Double-Edged Sword": It Improved for Some and Worsened for Others

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Abstract: The objective was to determine the contributions to changes in moderate-to-vigorous physical activity (MVPA) during the COVID-19 restrictions by age, gender, education, place of residence, type of work, type of sport, Body Mass Index (BMI), subjective health status, smoking, alcohol consumption, overeating, impulsivity, depression symptoms, stress level, sleep duration and emotional intelligence (EI). We interviewed 6369 people in Lithuania before the COVID-19 pandemic and 2392 during the COVID-19 restrictions, and they were 18–4 years old. The initial COVID-19 restrictions reduced MVPA. This decrease was greater in individuals with lower education levels, higher BMI, higher stress levels and higher self-rated health status. MVPA decreased among those whose self-rated health status was the poorest but increased among those whose self-rated health status was the best. MVPA decreased among young women, women whose work was mostly sedentary and smoking women, and it decreased among overeating men. The particularity of sport, alcohol consumption, sleep duration, EI, impulsivity and depression symptoms did not have a significant effect on changes in MVPA during the COVID-19 restrictions, among either gender or any age group.

Keywords: COVID-19 pandemic lockdown; moderate-to-vigorous physical activity; body mass index; health status; sleep patterns; food and alcohol consumption; stress; impulsivity; age; gender

1. Introduction

In 2018, the World Health Assembly (WHA) adopted a new Global Physical Activity Plan of Action (GAPPA) 2018–2030 [1] and a new voluntary global target to reduce global levels of physical inactivity among adults and adolescents by 15% by 2030 [2]. In recent years, there has been a growing body of evidence-based research showing that various forms and doses of physical activity (PA) are effective in combating chronic disease [3–6]. PA can improve immune function [7–9], increase well-being and mental health [10,11], protect from the onset of depression regardless of age and geographic region [12], protect from symptoms of depression and anxiety disorders [13,14] and reduce all-cause mortality [15,16]. The effects of PA on various bodily functions are specific, i.e., they depend on the intensity, duration and "dose" of muscle work in a nonlinear way [4,17]. The health benefits of PA also depend on age, gender, health status and BMI [4,8,15]. It is well-known that inadequate PA increases obesity and subsequent systemic inflammation, leading to chronic disease [3,17]. Our recently published research shows clearly that physical activity (especially at moderate and vigorous intensity) improves subjects' emotional intelligence and well-being significantly [18].

The novel COVID-19 disease caused by the SARS-CoV-2 virus has become a pandemic with a growing number of cases. The adopted containment strategy has reduced physical activity, which may be detrimental to health. During the COVID-19 pandemic, decisions were made to close gyms and indoor sports and recreation centers, cancel recreational sports and restrict all but the most essential travel, likely resulting in a decrease in PA [1,19–22].

In a study from Poland, the increase in body weight experienced by about half of respondents during the COVID-19 restrictions was associated with a decrease in PA and an increase in the consumption of both total food generally and high-energy-density products specifically [23]. Cheikh et al. analyzed data from Middle Eastern and North African countries during the COVID-19 pandemic and concluded that ∼50% of participants did not consume fruit daily [24]. Other researchers have drawn similar conclusions, showing increased COVID-19-restriction-based snacking and alcohol consumption [25]. These studies have shown that COVID-19 restrictions caused changes in lifestyle health, the main components of which often include healthy eating, PA, sleep, tobacco/alcohol, stress management and relationships [26]. However, some study participants reported an increase in healthy behaviors since the pandemic (i.e., 36% improved their healthy eating behaviors, and 33% improved their PA) in the United States [27]. Nevertheless, they also reported an increase in addictive lifestyle habits, including alcohol use (40%), tobacco use (41%) and vapor use (46%).

Changes in diet, sleep quality and PA have been associated with negative mood during COVID-19 compulsory treatment [28]. Preliminary results suggest that symptoms of anxiety and depression (16–28%) and self-reported stress (8%) are common psychological reactions to the pandemic [29]. PA increased positive mood during COVID-19 in university students, independent of stressful life events during the pandemic [30]. Although quarantine generally negatively impacts mental health [31], PA decreased symptoms of anxiety and depression during COVID-19 [32]. In addition, our recent research has shown that COVID-19 in Lithuania represents "good stress" that makes these people move more and eat less [33].

Despite this cumulative evidence, the main determinants of change in PA during of the pandemic (during which in-person contact was strictly limited) are unclear currently. The goal herein was to identify the contributions to change in MVPA during COVID-19 restrictions by age, gender, education, place of residence, work type, particularity of sport, BMI, subjective health status, smoking, alcohol consumption, overeating, impulsivity, depression symptoms, stress level, sleep duration and EI. In other words, we tried to clarify which (if any) of these indicators had the greatest effect on PA during the COVID-19 constraints. In addition, we hypothesized that the change in PA due to COVID-19 constraints might be mixed, e.g., PA may have decreased among those whose self-rated health was the worst but increased among those whose self-rated health was the best.

2. Methods

2.1. Participants

The study period was October 2019 to June 2020, during which time we interviewed 6369 people (4545 women and 1824 men) pre-COVID-19 and 2392 during COVID-19 restrictions (1856 women and 536 men). Overall, participants were 18–74 years old. Among the participants interviewed before and during the pandemic, 78.3% and 79.5%, respectively, had completed secondary school or university education; 83.4% and 83.1%, respectively, lived in a city; and they were 37.9 $\pm$ 11.8 and 38.4 $\pm$ 12.6 years old, respectively. All the participants lived in Lithuania, and their participation was anonymous. We used an online survey to collect information via the Google Forms platform, the URL for which was distributed through social media (Facebook) and personal contacts (WhatsApp).

The approval of the ethics committee to conduct this study was obtained from the university. We ensured that the study was conducted according to other documents of ethics [34,35].

The purpose of the survey, the introduction and the length of the survey were added to an open web-based e-survey. Successful return of the completed questionnaire was considered as informed consent by the participant. The data of this survey was used to determine BMI, smoking, alcohol consumption, work type and PA details (including the proportion of participants who did not engage in any physical exercise, those who were professional sportspeople, those who engaged in physical exercise independently and those who exercised at a sport or health center).

2.2. Measures

Physical activity. The Danish Physical Activity Questionnaire (DPAQ) was adapted from the International Physical Activity Questionnaire by measuring PA during the previous 24 h on each of seven consecutive days (rather than retrospectively over the previous seven days). Each physical activity level was assessed using a nine-level physical exertion scale (expressed in metabolic units [METs] ranging from sleep or inactivity (0.9 METs) to strenuous activity (>6.0 METs)). Each level (A = 0.9 METs, B = 1.0 METs, 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 > 6.0 METs) was described with examples of specific activities and accompanied by a small drawing. The PA scale was constructed, and the number of minutes (15, 30, or 45 min) and hours (1–10 h) spent at each MET activity level in an average 24 h weekday could be entered. This allowed for the calculation of the total MET time, which included 24 h of sleep, work and leisure time on an average weekday [36].

We calculated the energy (METs) expended daily during sleep, sedentary activity (SB) (0.9 to 1.5 METs), light intensity PA (LPA) (>1.5 to <3 METs), moderate intensity PA (MPA) (3 to <6 METs) and vigorous intensity PA (VPA) (>6 METs). We also combined MPA and VPA (MVPA). In this article, we analyze only the MVPA and duration of sleep.

Subjective health self-assessment. A four-point scale was used, where poor health = 1 point, satisfactory health = 2 points, good health = 3 points and excellent health = 4 points.

Subjective depression self-assessment. A four-point scale (0–3) was used, where no depression = 0 points, depression was higher than before = 1 point, depression was slightly higher than before = 2 points and depression was much higher than before = 3 points.

Perceived Stress. The 10-item Perceived Stress Scale (PSS-10) was used to measure participants' stress levels [37]. In the PSS-10, participants are asked to answer 10 questions about their feelings and thoughts in the past month on a 5-point scale ranging from 0–4. Higher scores indicate higher levels of perceived stress.

Emotional Intelligence. Emotional intelligence (EI) was assessed using the Schutte Self-Report Emotional Intelligence Test [38] (SSREIT). The SSREIT is a 33-item questionnaire 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). Each item is rated on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly agree). Total scores range from 33 to 165, with higher scores indicating higher EI.

Impulsivity. Impulsivity was assessed with the Barratt Impulsiveness Scale, version 11 (BIS -11) [39]. The BIS-11 is a 30-item questionnaire divided into three subscales: attentional impulsivity, rated with 8 items; motor impulsivity, rated with 11 items; and nonplanning impulsivity, rated with 11 items. Each item is rated on a 4-point scale ranging from 1 (rarely/never) to 4 (almost always/always). Total scores range from 30 to 120, with higher scores representing higher impulsivity.

2.3. Statistical Analyses

The interval data are expressed as the mean $\pm$ standard error. All the interval data were confirmed as normally distributed using the Kolmogorov–Smirnov test. A one-way and two-way ANOVA were performed to evaluate the effects of independent variables on the dependent variables of MVPA (METs). The value of the partial eta squared (η_P^2) was estimated as a measure of the effect size. Chi-squared (χ^2) tests were performed to compare differences between the sexes. For all the tests, the statistical significance was defined as $p < 0.05$. Statistical analyses were performed using IBM SPSS Statistics software (version 22; IBM Corp., Armonk, NY, USA).

We divided participating women and men into three age categories: 18 to 25 years (young adult); >26 to 44 years (adult); and ≥45 (middle and old age adult). We analyzed the data based on five BMI categories: under 18 kg/m^2; 18 to 24.9 kg/m^2; 25 to 29.9 kg/m^2; and 30 kg/m^2 and more. We divided EI scores into three categories: up to 125 (low EI); >125 to 150 (average EI); and >150 (high EI). We divided PSS scores into three categories: under 10 (low stress); >10 to 25 (average stress); and >25 (high stress). We divided BIS scores into three categories: under 50 (low impulsivity); 51–75 (average impulsivity); and >75 (high impulsivity). The specificity of depression, health and sports participation were on four scales, so we divided the subjects into four categories.

3. Results

3.1. Age-Dependent MVPA Change during COVID-19 Restrictions

We found that MVPA (i.e., METs during MVPA) decreased significantly due to COVID-19 restrictions ($p = 0.026$; $\eta_P^2 = 0.001$). There were also main effects of age ($p < 0.0001$; $\eta_P^2 = 0.005$) and gender ($p < 0.0001$; $\eta_P^2 = 0.02$) and an interaction effect between COVID-19 restrictions and age ($p = 0.379$; $\eta_P^2 < 0.0001$) (Figure 1). Thus, although MVPA decreased due to COVID-19 restrictions irrespective of age, METs during MVPA were significantly lower among 18–25-year-old women during COVID-19 restrictions than pre-pandemic ($p < 0.001$).

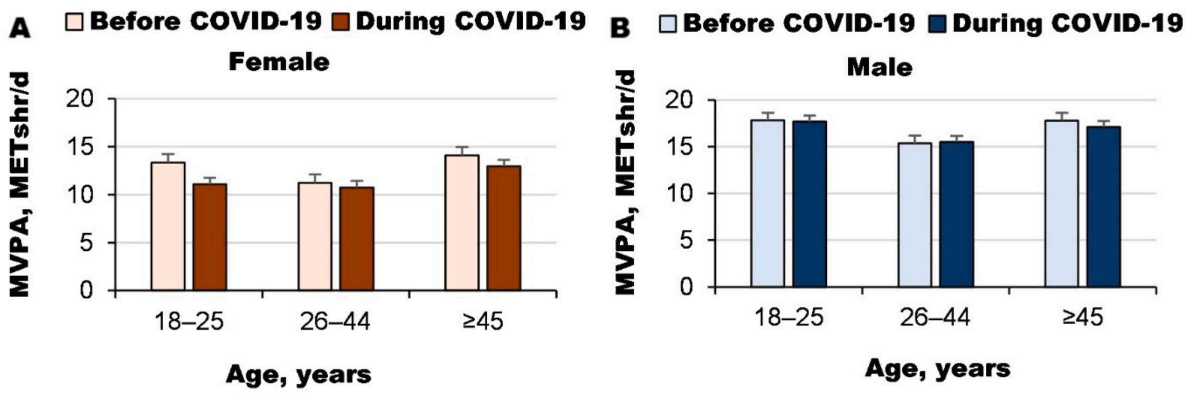

Figure 1. Daily METs during MVPA before and during COVID-19 restrictions among women (**A**) and men (**B**) in different age groups.

3.2. Effects of Residence, Work Type, Education and Sports on MVPA Changes during COVID-19 Restrictions

The results of this research showed that COVID-19 restrictions reduced MVPA more for those who lived in the country than for city dwellers (residence * COVID-19: $p = 0.033$; $\eta_P^2 = 0.001$). The MVPA among those living in the country was higher than among those living in the city ($p < 0.001$; $\eta_P^2 = 0.005$) (Figure 2). We found that MVPA did not depend on the work type ($p = 0.356$; $\eta_P^2 < 0.0001$), and there was no interaction between COVID-19 restrictions and work type (work type * COVID-19: $p = 0.13$; $\eta_P^2 = 0.001$). However, the work type was significant in relation with COVID-19 restrictions by gender interaction ($p = 0.015$; $\eta_P^2 = 0.001$). In other words, COVID-19 restrictions reduced MVPA among women whose work was sedentary and increased MVPA among men whose work required physical activity.

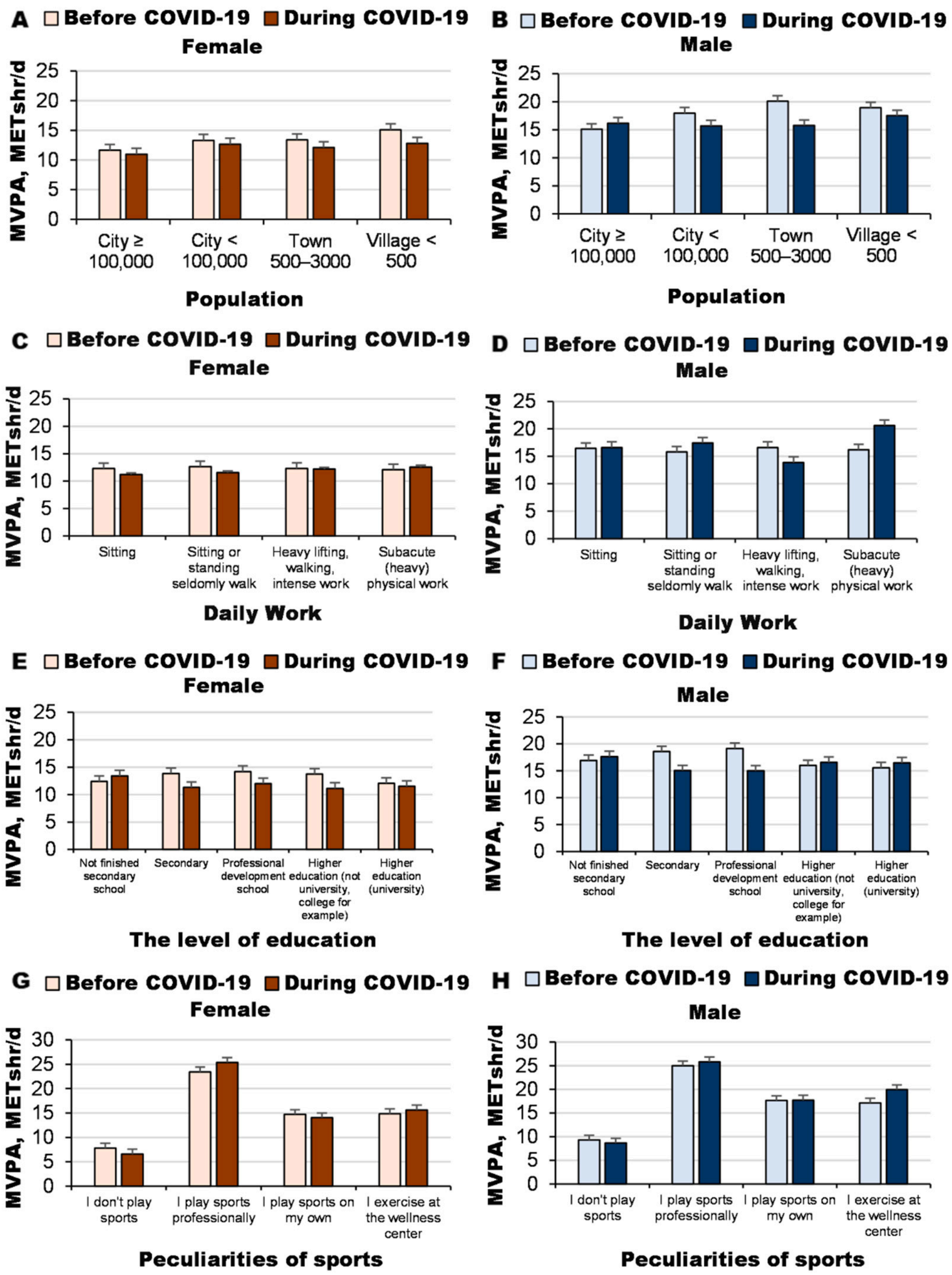

Figure 2. Changes in MVPA with COVID-19 restrictions based on the place of residence (**A**,**B**), work type (**C**,**D**), education (**E**,**F**) and particularity of sports (**G**,**H**).

The changes in MVPA during COVID-19 restrictions also depended significantly on education (education * COVID-19: $p = 0.007$; $\eta_p^2 = 0.002$). However, education did not have a significant main effect on MVPA ($p = 0.25$; $\eta_p^2 < 0.0001$). Thus, MVPA decreased with COVID-19 restrictions more for those with the lowest education attainment.

The results of this research show that the proportion of those who did not exercise did not change during COVID-19 restrictions, although there was a redistribution. The proportion who exercised at sport centers/clubs decreased significantly ($p < 0.001$), and the proportion of those who exercised independently increased ($p < 0.001$). The values for non-exercising women and men were 21.6% and 38.0%, respectively, pre-COVID-19, and 25.7% and 39.2%, respectively, during COVID-19 restrictions. Pre-COVID-19, 48.0%

and 29.6% of women and men, respectively, exercised independently; during COVID-19 restrictions, these values were 58% and 49.5%, respectively. Regarding those who exercised professionally, there were 7.6% and 3.4% of women and men, respectively, pre-COVID-19, and 9.3% and 2.6%, respectively, during COVID-19 restrictions. There were 21.6% of women and 38% of men pre-COVID-19, and there were 6.9% and 8.7%, respectively, during COVID-19 restrictions who exercised at sport clubs.

MVPA depended on the particularity of sport in which the participants engaged ($p < 0.0001$; $\eta_P^2 < 0.099$), although the change in MVPA with COVID-19 restrictions did not depend on this particularity (sport type * COVID-19: $p = 0.055$; $\eta_P^2 = 0.001$) (Figure 2).

3.3. Effects of Subjective Health Status, BMI, Alcohol Consumption, Overeating and Sleep Duration on Changes in MVPA during COVID-19 Restrictions

The results of the study show that the changes in MVPA among women and men during COVID-19 restrictions differed significantly based on health status (health * COVID-19: $p < 0.0001$; $\eta_P^2 = 0.006$) (Figure 3). The effect of health status on MVPA was significant ($p < 0.001$; $\eta_P^2 = 0.007$) irrespective of gender. Thus, the participants with a worse health status had lower MVPA during COVID-19 restrictions; in contrast, MVPA increased among those who assessed their health status at the highest end of the scale. Changes in MVPA during COVID-19 restrictions also depended significantly on BMI (BMI * COVID-19: $p = 0.014$; $\eta_P^2 = 0.001$). During COVID-19 restrictions, MVPA decreased significantly among both women and men whose BMI was >30 kg/m^2 ($p < 0.001$). BMI had a significant effect on MVPA ($p < 0.001$; $\eta_P^2 = 0.005$) irrespective of gender.

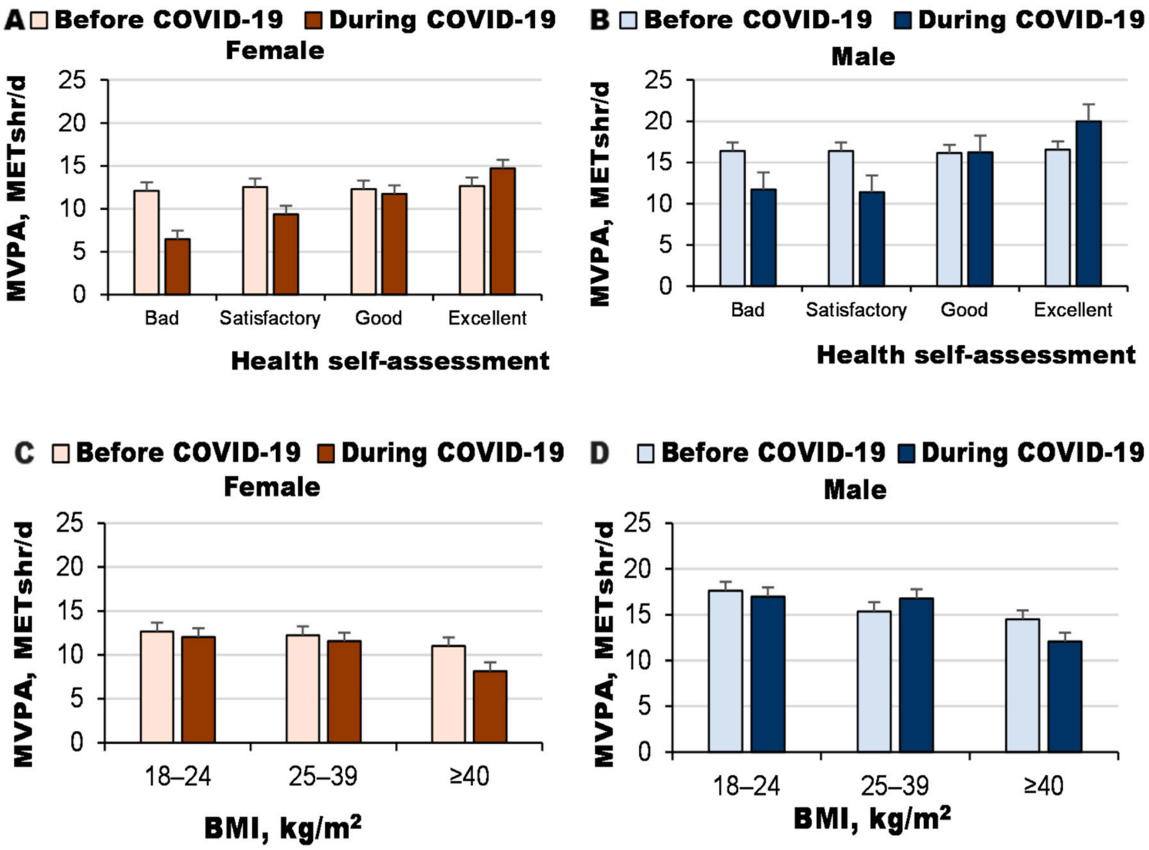

Figure 3. *Cont.*

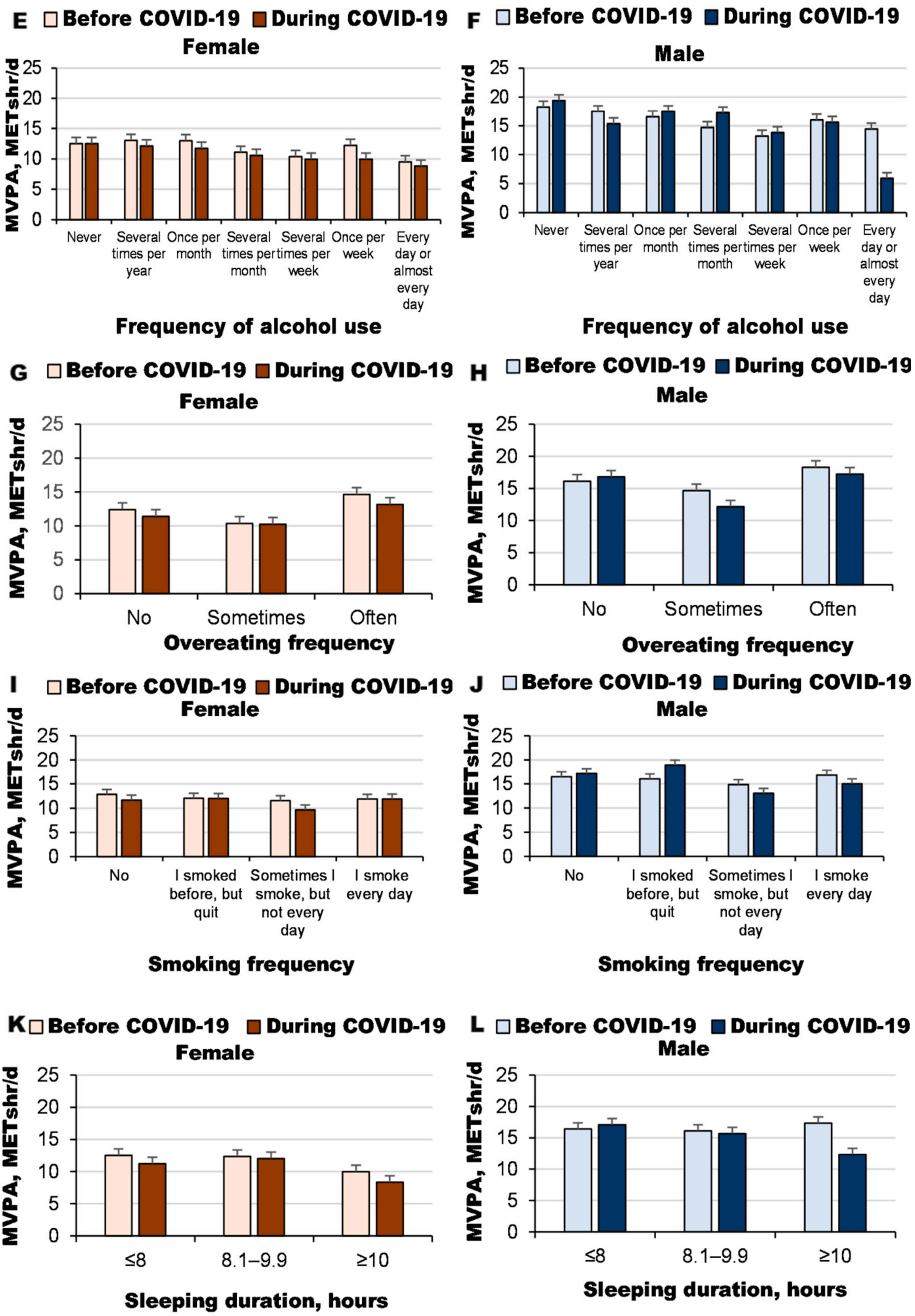

Figure 3. Changes in MVPA with COVID-19 restrictions based on health status (**A**,**B**), BMI (**C**,**D**), alcohol consumption (**E**,**F**), overeating (**G**,**H**), smoking (**I**,**J**) and sleep duration (**K**,**L**).

Those who consumed more alcohol had lower MVPA values ($p < 0.0001$; $\eta_P^2 = 0.007$). However, the interaction effect between alcohol use and COVID-19 restrictions on MVPA was not significant (alcohol use * COVID-19: $p = 0.065$; $\eta_P^2 = 0.001$). Those who reported overeating more often had lower MVPA values ($p < 0.0001$; $\eta_P^2 = 0.006$). However, the interaction effect of overeating and COVID-19 restrictions on MVPA was not significant (overeating * COVID-19: $p = 0.226$; $\eta_P^2 < 0.0001$), although MVPA among men who reported overeating more often during COVID-19 restrictions was lower than it was pre-COVID-19 ($p < 0.01$). Smoking had a significant effect on MVPA ($p < 0.00010$; $\eta_P^2 = 0.003$). Changes in MVPA due to COVID-19 restrictions depended on smoking and gender (COVID-19 * smoking * gender: p=0.047; $\eta_P^2 = 0.001$).

Changes in MVPA with COVID-19 restrictions did not differ significantly based on sleep duration (COVID-19 * sleep: $p = 0.41$; $\eta_P^2 < 0.0001$).

3.4. Effects of EI, Stress, Impulsivity and Depression Symptoms on Changes in MVPA during COVID-19 Restrictions

The effect of EI on MVPA was significant ($p < 0.001$; $\eta_P^2 = 0.009$) irrespective of gender, and a change in MVPA due to COVID-19 restrictions did not depend on EI (EI * COVID-19: $p = 0.94$; $\eta_P^2 < 0.0001$) (Figure 4). Higher stress was related to lower MVPA ($p < 0.0001$; $\eta_P^2 = 0.007$) irrespective of gender and depended on COVID-19 restrictions (stress * COVID-19: $p = 0.046$; $\eta_P^2 = 0.001$). We found that impulsivity did not affect MVPA for either gender ($p = 0.36$; $\eta_P^2 < 0.0001$), and changes in MVPA due to COVID-19 restrictions did not depend on impulsivity (impulsivity * COVID-19: $p = 0.97$; $\eta_P^2 < 0.0001$). Overall MVPA was lower with more severe depression symptoms ($p < 0.0001$; $\eta_P^2 = 0.007$) independent of COVID-19 restrictions (depression symptoms * COVID-19: $p = 0.87$; $\eta_P^2 < 0.0001$).

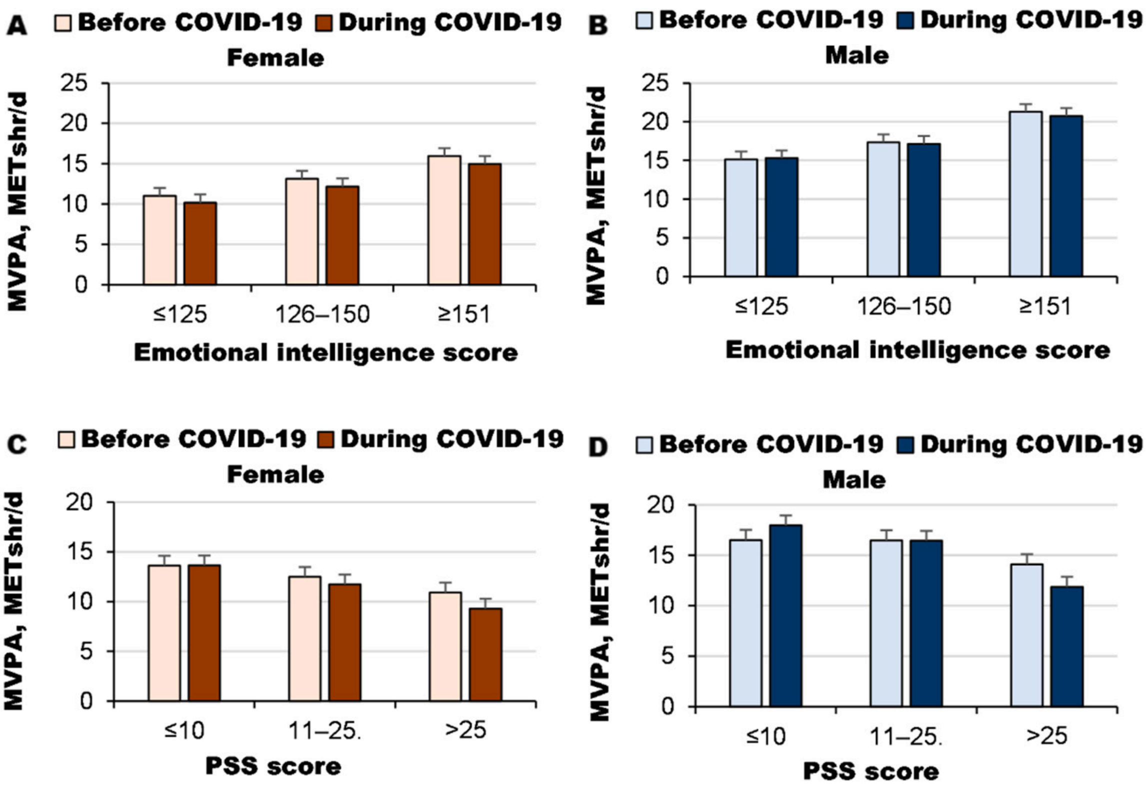

Figure 4. *Cont.*

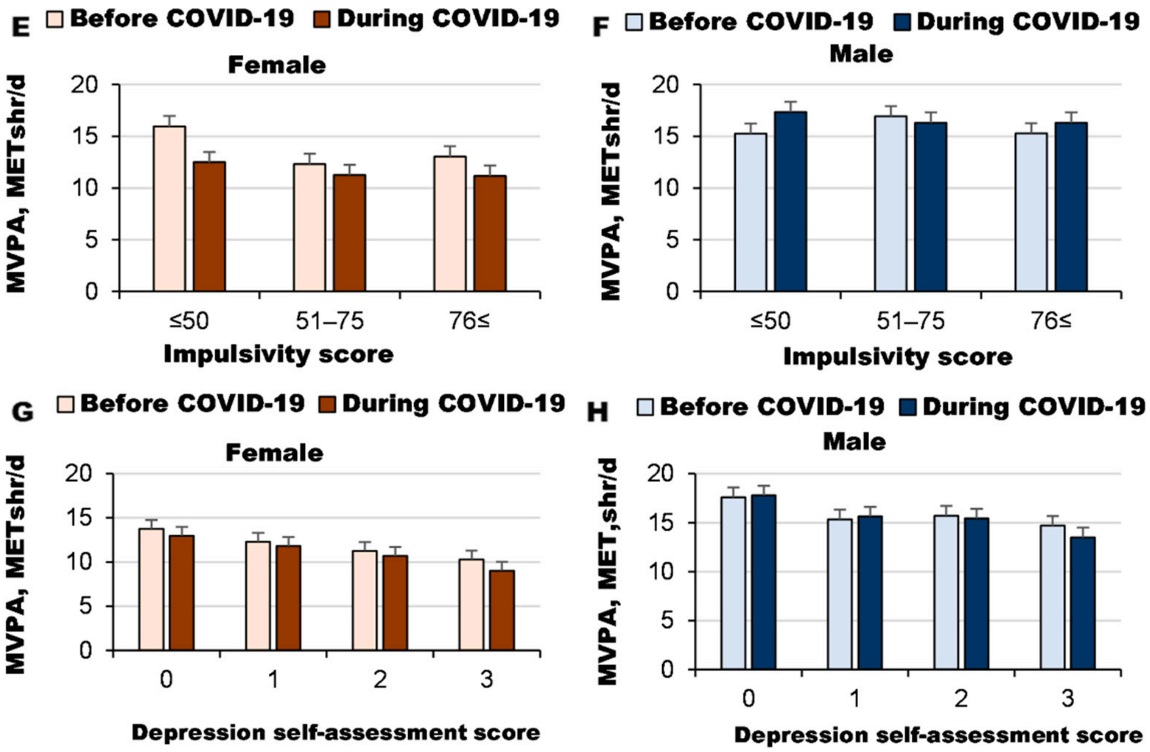

Figure 4. Changes in MVPA with COVID-19 restrictions based on EI (**A**,**B**), stress (**C**,**D**), impulsivity (**E**,**F**), and depression symptoms (**G**,**H**).

4. Discussion

Our findings show that COVID-19 restrictions reduced MVPA and that this change depended (for both genders) on their place of residence (MVPA decreased more among country residents than among the city residents), education (those with lower education attainment had a larger reduction in MVPA), BMI (those with higher BMI had a greater MVPA decrease), stress (those with higher stress levels had lower MVPA) and health status. MVPA decreased among those who assessed their health status as the lowest level but increased among those who assessed their health status as the highest level (i.e., the effect of COVID-19 restrictions on changes in MVPA was inverse; it improved for some and worsened for others). These results also show that the effect of COVID-19 restrictions on MVPA depended on gender; MVPA decreased among young women (aged 18–25 years), women whose work was primarily sedentary, smoking women and men who reported overeating more often. Although surprising, these data did not reveal that particularity of sport, alcohol consumption, sleep duration, EI, impulsivity or depression symptoms differed significantly based on changes in MVPA during COVID-19 restrictions, in either gender or any age group. To our knowledge, this is the first study to show how 14 main health indicators (including sociodemographic, health status and lifestyle) have affected changes in MVPA due to COVID-19 restrictions, and how these factors depended on age and gender. Thus, we have added to the findings of other researchers who have shown that COVID-19 restrictions reduce PA [40,41]. The most interesting finding herein is that the most significant predictor of changes in MVPA with COVID-19 restrictions was subjective health; both the women and men who felt healthier pre-COVID-19 took greater care of their health at the beginning of the pandemic, in that they started exercising independently. This suggests that the COVID-19 restrictions may have been a form of 'good stress' for those with the highest self-assessed health status; it encouraged these individuals to exercise independently and to not decrease MVPA. This is the most important form of movement (except among young women), as it is the main way of guaranteeing health improvement [4,34], especially in the context of COVID-19 [32]. Stefan et al. [42] have shown that increased BMI during the pandemic increased the risk of severe COVID-19. Our data supplement this finding; those with higher BMI values experienced a greater decrease in MVPA with COVID-19 restrictions. Although surprising, because others have shown that EI is related to both health level p [43] and PA [44], herein, EI was not found to impact changes in MVPA with COVID-19 restrictions significantly.

PA is certainly influenced not by one, but by many complex factors, of which it is difficult to single out one or two of the most important [45]. It is also difficult to distinguish between a cause and a consequence, as these factors may be linked by relationships, such as how good health or low depression symptoms may stimulate further PA, and how higher PA improves health and further reduces depression [4,46].

5. Limitations and Directions for Future Research

The main limitation of our study is that the PA questionnaire may have somewhat overestimated PA. Danish research has shown that the PA scale we used overestimated the time spent on light, moderate and vigorous PA and underestimated the time spent on SB [47]. In addition, other researchers have noted that it is difficult to compare data from PA because different methods are used for measurement [4,45,48]. Finally, we could not survey the same individuals before and during the pandemic. Another limitation is the different sample size when interviewed before and after COVID-19.

6. Conclusions

We determined that COVID-19 restrictions reduced MVPA, and this decrease depended (for women and men) on the place of residence (MVPA decreased for country residents more than for the city residents), education (as education lowered, the decrease became bigger), BMI (as BMI increased, the decrease became bigger), stress (as stress increased, the decrease became bigger) and assessment of health (MVPA decreased for the women and men who assessed their health status as the worst, but it increased for those who assessed it as the best). Our data do not support the notion that particularity of sport, alcohol consumption, sleep duration, EI, impulsivity or depression symptoms affected changes in MVPA significantly, in either gender or any age group sampled herein. The effect of COVID-19 restrictions on MVPA was gender-dependent; MVPA decreased for young women (aged 18–25 years), women who mostly performed sedentary work, smoking women, and men who reported overeating. We expect our findings to contribute to a clearer understanding of different PA determinants and choices, especially under conditions such as those experienced under COVID-19.

Author Contributions: A.S. (Albertas Skurvydas): Investigation, Conceptualization, Methodology, Data curation, Writing—Original draft preparation and Formal analysis. A.L.: Data curation and Writing—Review and Editing. N.I.: Data curation, Editing and Writing—Review and Editing. R.D.: Data curation, Editing and Writing—Review and Editing. A.S. (Asta Sarkauskiene): Data curation and Writing—Review and Editing. D.M.: Visualization and Writing—Review and Editing. D.V.: Project administration, Investigation and Data curation. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The Ethics Committee of the University of Klaipeda granted permission to conduct this study (Protocol No. STIMC-BTMEK -08). This study was conducted according to the guidelines of the Declaration of Helsinki (Re-vised 2013) and the National Guidelines for Biomedical and Health Research with Human Participants (2017).

Informed Consent Statement: The purpose of the survey, the introduction and the length of the survey were added to an open web-based e-survey. Successful return of the completed survey was considered informed consent by the participant.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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