Psychotherapy and Psychosomatics

Clinical Note

Psychother Psychosom 2021;90:200–206
DOI: 10.1159/000514331

Received: November 4, 2020
Accepted: January 8, 2021
Published online: March 10, 2021

Physical Exercise as a Resilience Factor to Mitigate COVID-Related Allostatic Overload

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Keywords
Physical exercise · 312 meridian exercise · Allostatic overload · Resilience · Well-being

Abstract
Introduction: The long-lasting threat of COVID-19 makes it necessary to explore strategies to improve coping skills which enable us to master a balanced life in the face of adversity. ***Objective:*** To unravel the most challenging aspects of COVID-19 in a nonclinical adult population and identify predictors of lost balance and consequent allostatic overload (AO). We examined the role of regular, moderate-intensity formula aerobic exercise (312 meridian exercise) in preventing allostatic overload through increasing well-being. ***Methods:*** An online survey was conducted to measure COVID-related allostatic overload according to clinimetric criteria. The Psychosocial Index (PSI), Kellner's Symptom Questionnaire (KSQ), short Depression Anxiety Stress Scales (DASS-21), Public Health Surveillance Well-Being Scale (PHS-WB), and Whiteley-7 were used to explore mental health characteristics. Univariate statistics logistic regression analysis and a general linear model were used. ***Results:*** According to 442 valid answers, 217 adults practiced physical exercise (PE) frequently (fPE, 3–5 times/every day) while 120 did it less regularly (1–2 times/week), and 105 did not exercise/practiced irregularly (controls). Restriction-related stressors were most challenging, resulting in AO in 29% (n = 128) of the sample. The main predictors were additional stressors (p = 0.005) and anxiety symptoms (p < 0.001). The prevalence of AO was lower (p = 0.018) in the fPE group when compared to controls. KSQ distress symptoms were also lower in fPE (p < 0.0001), while total well-being was increased (p < 0.001) after adjusting for sex, age, and number of chronic diseases. According to the PHS-WB, both physical and mental well-being were higher (p = 0.003 and p = 0.004, respectively) in fPE. ***Conclusions:*** Frequent moderate exercise is associated with better mental and physical well-being and a lower prevalence of AO.

Introduction

The ongoing pandemic of COVID-19 and the related confinements (online suppl. material [OSM]; see www.karger.com/doi/10.1159/000514331 for all online suppl. material) appear as strong stressors result-

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ing in significant changes in socioeconomic and work conditions for many. Additionally, family life has been restructured, with isolation of the elderly, and managing home-office and home-schooling simultaneously. These changes are becoming permanent with the second wave of the epidemic and people need to develop strategies to fight the threat and health consequences of the infection, cope successfully with long-lasting changes, and work up a lifestyle which results in improved resilience and well-being under trying circumstances.

Allostatic Load and Overload

The term allostatic load was coined by McEwen and Stellar [1] in 1993, with the aim of reinterpreting Selye's concept of stress [2]. It stems from the term allostasis [3], which refers to the ability of the human body to sustain homeostasis (to allow pH, blood glucose levels, body temperature, and oxygen supply to remain constant) via changes in other parameters [4, 5]. Elements of the neuroendocrine, autonomic, metabolic, and immune systems act as "mediators" in the process, resulting in adaptations to the physical and psychosocial stressors of everyday life [1, 4, 5]. However, when daily stressors sustain an alarm response, with increased catecholamine, cytokine, and HPA hormone levels for weeks or months, the resulting allostatic load will lead to lost balance and disorganization [5, 6]. The additional load of unpredictable events increases the allostatic load dramatically and can cause allostatic overload (AO), with overuse of mediators in a dysregulated manner [4]. Consequent wear and tear on the regulatory systems of the body leads to the exacerbation of pathophysiologic changes, resulting in myocardial infarction, tumor metastases, metabolic diseases, or health-damaging behaviour [1, 4, 5]. Stressful lifestyle-related unhealthy eating, a lack of physical activity, poor sleep, smoking, and alcohol or drug consumption all act through these same "mediators" to cause lifestyle-diseases [6].

Individual Vulnerability

Vulnerability to stress, or resilience against it, however, are highly individual, differ according to sex [1, 2, 4], and depend on the unique adaptive stress response and behavior determined by an individual's genetically encoded biological constitution as well as the environmental exposures during their lifespan [5, 7, 8]. While biomarkers express the state of the body, underlying individual experiential causes can be explored in clinical settings through structured measures of symptoms, physical signs, and other clinical phenomena [9, 10]. The clinical measurement of allostatic load and AO was established by Fava et al. [11, 12] in 2010 and refined in 2017. The clinimetric assessment defines stressors in social and family circles and at work [8, 12], and measures if the stressor has exceeded individual coping skills, when its full nature and all circumstances have been evaluated [8, 12]. This is followed by an evaluation of physiological and cognitive components of the individual stress response including psychosocial and physical symptoms [8, 12].

Stress Resilience

Resilience may reflect the state of heightened adaptability in the face of acute or chronic adversity [13, 14]. According to the concept of euthymia [15], it can be achieved through an optimal balance of positive and negative cognitions and affects [16]; this notion is supported by novel neurobiological research [14].

The Role of Physical Exercise in Boosting Resilience

To adapt to ongoing stress and promote well-being and resilience, especially when facing chronic stressors, lifestyle interventions play a pivotal role [17, 18]. Physical exercise (PE) has been obtaining attention for decades as a tangible and highly effective nonpharmacological tool to boost resilience by preventing chronic diseases, enhancing cognitive functioning and mental health, delaying the gradual loss of functional reserve associated with the aging process, improving immunity, reducing inflammation, and positively affecting mood states like anxiety and depression [19–24]. Exercise is a planned, structured, and repetitive physical activity targeted at improving health- or skill-related attributes [25]. Regular, moderate-intensity exercise [26] promotes stress coping mechanisms, and has antidepressant-like effects by buffering of the HPA axis response to novel stress and increasing dopamine levels of the medial prefrontal cortex via elevated basal cortisol levels [20]. Moreover, PE modulates the epigenetic processes, positively influencing the development and course of inflammatory and cancer diseases as well as the aging process [23]. COVID-19-related stress and isolation easily result in decreased physical activity, thereby increasing the burden of chronic stress on coping strategies and the capacity of the immune system [27]. According to expert opinion, moderate-intensity exercise is recommended to improve the immune response and mitigate the negative effects of stress, anxiety, and sedentarism [28].

Factors for COVID-19-Related AO and Stress Resilience

Medical health workers in China and worldwide developed mental health problems (anxiety, depression, and obsessive-compulsive symptoms) as well as insomnia during the first wave of the pandemic [29, 30]. Organic disease was an independent risk factor [29]. COVID-19-related physical and psychological support was deemed effective in keeping emotional distress and burnout at a tolerable level [31]. Recent research into the factors of stress resistance showed that a higher preoutbreak sense of coherence predicted fewer psychopathological symptoms during the first outbreak of the pandemic [32].

We aimed to explore the role of regular, moderate-intensity formula aerobic exercise in coping with COVID-19-related stress and resilience in a general population sample. We postulate that the infection itself and the related confinements contribute equally to stress, in addition to increased age-related chronic diseases and the consequent reliance on the health care system. We examined if those who practice regular PE, with the aim of health preservation, maintain better mental and physical health than those who do not. Additionally, we aimed to explore if PE might contribute to a more effective coping style, thereby reducing allostatic load and increasing well-being.

Materials and Methods

Study Design and Sample Recruitment

We performed a voluntary and anonymous online survey between 21 May and 1 September 2020, enrolling 750 certified 312 meridian exercise [33] instructors and their (n = 7–30) member communities. The instructors' contacts who had never practiced meridian exercise served as controls. This 30-min aerobic medium-strength exercise series has no contraindications and can be easily performed by the elderly. Its moderate intensity and duration meet the recommendations of the WHO [34] (see OSM).

Measures

We applied a mixed-method design. By using qualitative content analysis [35], we specified the most challenging life-situations our participants had dealt with in relation to the pandemic to code free-text answers and arranged them into categories (see OSM).

Stress Load

COVID-19-related AO was measured according to Fava's definition based on the Diagnostic Criteria for Psychosomatic Research (DCPR) [8] and the Psychosocial Index (PSI) [36, 37]: A1 (stressor – COVID-19) + A2 (stressor exceeding coping strategies: "During the time of the restrictions, did you feel that the changes caused by the coronavirus epidemic were testing or exceeding your capacity?") + B1 (at least 2 distress symptoms – PSI 37–51)/B2 (deterioration of work, home, or human relationships – PSI 23–30)/B3 (everyday challenges – PSI 33–34). AO was diagnosed in case of A1, A2, and, additionally, either one of the B criteria were realized. To measure stress load independent of COVID-19, we applied PSI items 13–20 and 22–30.

Mental Health and Somatization

Mental health was measured with Kellner's Symptom Questionnaire (KSQ) [38], the short Depression Anxiety Stress Scales (DASS-21) [39–41], and the Public Health Surveillance Well-Being Scale (PHS-WB) [42], and somatization was measured with Whiteley-7 [43] (see OSM).

Statistical Analyses

The χ^2 test was used for categorical data, and the two-tailed t test and Kruskal-Wallis test for normally and nonnormally distributed continuous variables, respectively. Dunn's pairwise tests with Bonferroni adjustment for multiple comparisons were carried out for the 3 pairs of groups. Normality of data was assessed using the Kolmogorov-Smirnov test. Step forward likelihood ratio logistic regression was applied to identify predictors of AO and a general linear model was used to measure the effect of PE groups on KSQ total well-being by adjusting for sex, age, and the number of chronic diseases. In all cases, $p < 0.05$ was considered statistically significant. We applied SPSS v24.0 software (SPSS Inc., Armonk, NY, USA).

Results

Sample Characteristics

Altogether, 442 people completed the survey, 406 of whom were women with a mean age of 62 ± 10.6 years (males were aged 63.5 ± 11.5 years); 267 (55%) were retired, 77 (16%) went to their workplace, and 51 (11%) worked in home-office. Regarding chronic diseases, 213 (48%) had none, 184 (41.6%) had 1–2, 31 (7.0%) had 3–5, and 14 (3.2%) had >5. During the quarantine period, 45 people (10.2%) developed 1 acute condition and 6 (1.4%) developed 2 acute conditions. Ninety-nine people (22.4%) needed the health care system and 66 of these could use it. The proportion of acute and chronic conditions were distributed equally in this group. Altogether 20 persons (4.6%) reported having psychiatric disease.

COVID-19-Related Stressors

Among the participants, 23 (5%) indicated no challenges related to the pandemic and quarantine, while 419 (95%) specified ≥1 stressors (Fig. 1). Details of the qualitative analysis are reported in the OSM.

Allostatic Overload

Altogether 148 people (33.5%) reported that COVID-19-related changes exceeded their coping resources. AO,

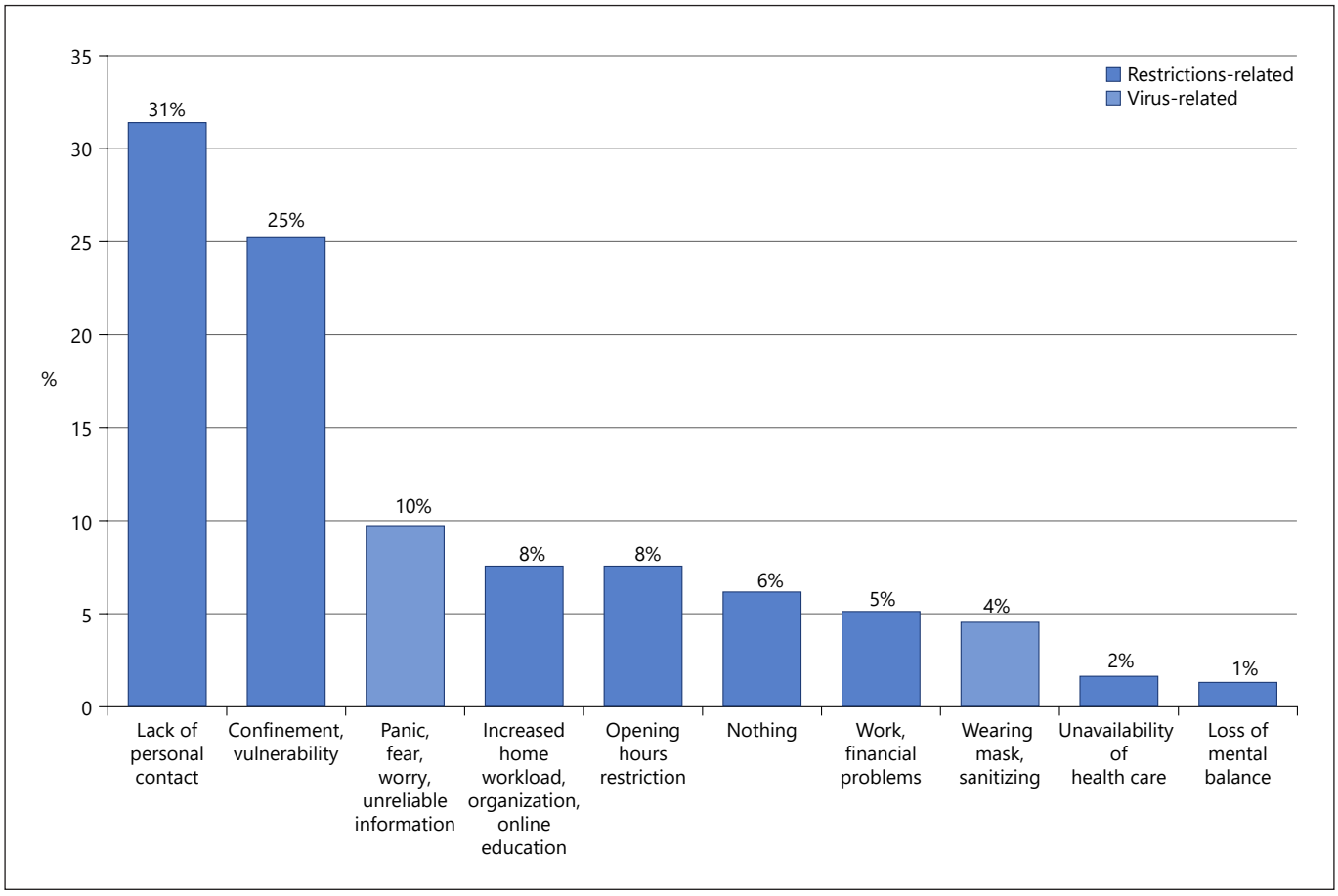

Fig. 1. Categories of participants' challenges and percentage distribution.

with stressor-related physical symptoms and impairment of social and occupational functioning as well as psychological well-being, was present in 128 people (29%). After adjusting for age, sex, and the number of chronic diseases, each additional life stress increased the likelihood of AO by 20% (OR 1.19; 95% CI 1.06–1.36, $p = 0.005$) and anxiety symptoms (on the KSQ) by 18% (OR 1.18; 95% CI 1.13–1.24, $p < 0.001$).

PE and Physical and Mental Health during the First Wave of the Pandemic

Median number of years practicing PE 3–5 times weekly or regularly every day (i.e., frequent PE [fPE]) was 5 years in our sample (IQR 2.5–7 and 3–6.5, respectively; Table 1). AO was less prevalent in the fPE group compared to controls ($\chi^2[1] = 5.6$; $p = 0.018$). fPE was also associated with significantly fewer depressive, stress, and anxiety symptoms (KSQ; Table 1). Although somatization symptoms proved to be nonsignificant on the subscale between the exercise groups and the controls, well-being was markedly higher in those who were exercising, so that the final somatization scale was better in the fPE group (Table 1). Total well-being reached higher scores in the exercising groups, and the same good results were shown for both mental and physical aspects (Table 1). After controlling for the effect of age, sex, and chronic diseases, we found a significant effect of exercise on well-being ($F[2, 435] = 225.0$, $p < 0.001$). Planned contrasts revealed that both fPE ($p < 0.001$, 95% CI 1.4–3.9) and PE ($p = 0.043$, 95% CI 0.04–2.83) was associated with significantly higher well-being than in the controls.

Discussion

We found that AO was less prevalent in those exercising frequently than those who lived a sedentary life during the first wave of COVID-19 pandemic. Moreover, fPE

Table 1. Health-related characteristics of an adult community sample (n = 442) who practiced 312 meridian exercise frequently (fPE) or less frequently (PE) and controls

	fPE (n = 217)	PE (n = 120)	Controls (n = 105)	p value	p (adjusted)
Sociodemographic and health-related characteristics					
Female sex	196 (90)	116 (97)	94 (90)	ns	
Age, years	65 (9.1)	64 (9.8)	57 (12.5)	<0.001	
Need of healthcare system (n = 99)	45 (21)	26 (22)	28 (27)	ns	
Chronic diseases, n (0/1–2/3–4/>5)	109/87/16/5	52/58/4/6	52/39/11/3	ns	
Acute diseases, n (0/1/2/>2)	195/19/3/0	108/10/1/1	87/16/2/0	ns	
ICD-10 diagnosed psychiatric disease	9 (4.2)	5 (4.3)	6 (5.7)	ns	
Years practicing 312 meridian exercise	5 (3–7)	3 (1.8–5)	1 (0–4)	–	
Stress-related parameters					
AO/A2	62 (29)	39 (32)	47 (45)	0.015	
AO	53 (24)	36 (30)	39 (37)	0.059	0.018*
PSI_stress_total	1 (0–3)	2 (1–4)	2 (1–4)	0.001	0.001*
PSI_psychological_distress	4 (1–9)	6 (2–11)	8 (3–14)	0.002	0.002*
Mental health characteristics					
DASS_depression	2 (0–4)	3 (1–6)	2 (0–7.25)	0.02	0.017§
DASS_anxiety	1 (0–2)	1 (0–3)	1 (0–5)	ns	
DASS_stress	2 (0–5)	3.5 (1–6.25)	4 (1–7)	0.006	0.012*
Kellner_anxiety	1 (0–5.5)	3 (1–6)	3 (1–8.5)	0.001	<0.001*
Kellner_depression	1 (0–4)	2 (0–4)	3 (1–6.5)	<0.001	<0.001*
Kellner_somatic symptoms	1 (0–4)	2 (0–4)	3 (0–6)	ns	
Kellner_hostility	0 (0–4)	2 (0–4)	2 (0–8)	<0.001	<0.001*; 0.041§
Kellner_anxiety	2 (0–8)	4 (1–9)	5 (2–11.5)	<0.001	<0.001*; 0.022§
Kellner_depression	3 (1–6)	4 (2–7)	5 (2–9.5)	<0.001	<0.001*
Kellner_somatization	4 (2–9)	5 (2–8)	6 (3–10)	0.008	0.006*
Kellner_hostility	1 (0–5)	3 (1–5)	3 (1–9)	<0.001	<0.001*; 0.032§
Kellner_psychological_distress	11 (4.5–25)	17 (8–28.75)	21 (11–39)	<0.001	<0.001*
Whiteley-7	3 (1–8)	5 (2–9.25)	6 (3–11)	0.002	0.002*
Well-being characteristics					
PHS_mental well-being	4.4 (3.8–4.8)	4.1 (3.6–4.6)	4.2 (3.6–4.6)	0.004	0.006§
PHS_social well-being	4.5 (4–5)	4 (3.5–5)	4 (3.5–5)	ns	
PHS_physical well-being	4.3 (3.3–4.7)	4 (3.3–4.7)	4 (3–4.3)	0.003	0.006*; 0.042§
PHS_well-being_total	4.3 (3.7–4.7)	4.0 (3.4–4.5)	4.1 (3.5–4.4)	0.004	0.033*; 0.011§
Kellner_relaxation	6 (4–6)	5 (3–6)	5 (2.5–6)	<0.001	0.001*; 0.014§
Kellner_contentment	5 (3–6)	4 (2.25–5)	4 (2–5)	0.039	0.059*
Kellner_physical well-being	4 (2–5)	3 (2–5)	2 (1–4)	<0.001	<0.001*
Kellner_friendliness	6 (5–6)	5 (5–6)	5 (4–6)	ns	
Kellner_well-being	19 (15–22)	17 (13–20)	17 (11–20)	<0.001	<0.001*; 0.024§

Values express n (%) or median (IQR), unless otherwise indicated. The fPE group practiced 312 meridian exercise at least 3–5 times weekly, the PE group practiced 312 meridian exercise 1–2 times weekly, and the controls did not practice 312 meridian exercise at all or irregularly. Kellner capital letter scales indicate the total score (clinical symptoms added up with the inverse of related well-being scores; see OSM); χ^2 tests were applied in case of categorical variables and Kruskal-Wallis tests with Dunn's pairwise tests with Bonferroni corrections. AO/A2, stressor exceeded coping resources of participants; AO, allostatic overload.

* Significance between fPE and controls; § significance between fPE and PE.

was associated with lower depressive, anxiety, and stress symptoms and greater mental and physical well-being. Interestingly, the beneficial effects of increased physical well-being compensated for somatization, resulting in significantly fewer symptoms when measured with the KSQ.

According to the clinimetric definition, AO serves as a global distress index of the interaction between chron-

ic life-stresses and life events [2, 8, 11, 12, 44, 45]. Its prevalence in healthy populations ranges between 15.8 and 43% [46–48], and it is associated with increased symptoms of depression, anxiety [47], somatization, and hostility [46] as well as with impaired well-being [47]. We found that pandemic-related acute stress was more likely to cause AO when combined with chronic life-stresses, and its prevalence was significantly lower in those who exercised regularly. The beneficial effects of regular exercise on inflammation and stress-related diseases are widely known [5, 49–51], and mental health and well-being indices can also be improved [24, 28]. Regular exercise has proved to be beneficial during the pandemic in increasing resilience [52], improving mental well-being [53, 54], and easing symptoms of depression [52, 54] and anxiety [54]. Our research adds to this knowledge by exploring the beneficial effects of exercise on the physical health domain of well-being as well. Somatizing patients burden the health care system with excessive utilization of medical care [55]. According to our results, fPE is associated with increased physical well-being, resulting in improved subjective physical health and significantly decreased somatization. Thus, PE may indirectly contribute to unencumbering the health care system.

Our study had several limitations. Although exposure to fPE preceded the pandemic, the cross-sectional nature of the study hindered drawing causal relationships. The significantly higher proportion of females made our sample nonrepresentative.

Acknowledgment

We thank K. Szamosi and E. Haide for their effort in recruiting participants.

Statements of Ethics

Online consent was secured by all participants. The study was conducted according to the Declaration of Helsinki and approved by the review board of the Medical Research Council (IV/5657–2/2020/EKU).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Funding Sources

There was no funding.

Author Contributions

Ajandek Eöry, Ajandok Eöry, and D. Békési designed and planned the study. D. Békési collected the data. Ajandek Eöry and S. Rózsa analyzed the data and interpreted the results. All authors drafted and revised the intellectual content of the manuscript. We sadly report that Ajandok Eöry, who established 312 meridian exercise in Hungary and played a fundamental role in the scientific and practical aspects of our research, died during the data collection period.

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