



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

**Summary**

Background: Physical activity (PA) has been shown to be advantageous to one's health. Coronavirus disease 2019 (COVID-19) lockdown measures have reportedly led to substantial decrease of PA and to drastic reduction of well-being (WB). In light of this, the purpose of this review was to assess the impact of PA on WB during the COVID-19 pandemic.

Material and Methods: In May 2021, literature search was conducted in Pubmed/Medline. The eligible publication period was one year from the search date.

Results: Synthesis of results from eight publications reporting on data from around 100 countries showed that PA positively influences diverse dimensions of the multivariate construct of WB, all of them relating to mental health. Young adults and women showed lowest PA concomitant with lowest self-reported WB.

Conclusions: Reduced PA levels resulted in lower WB levels, which might have a negative impact on mental health. Forthcoming, initiatives will be needed to facilitate PA – ideally whilst promoting joy of moving – in consideration of pandemic circumstances. By this means it will be possible to effectively promote WB and to prevent arising mental health issues. The current findings are fundamental to develop suitable approaches to improve PA in pandemic situations.

Keywords

COVID-19– Exercise– Pandemic– Physical activity– Well-being

C. Symanzik et al.

Einfluss körperlicher Aktivität auf das Wohlbefinden zu Zeiten der COVID-19-Pandemie: eine Übersichtsarbeit

Zusammenfassung

Hintergrund: Körperliche Aktivität (PA) hat sich als gesundheitsfördernd

REVIEW

Influence of physical activity on well-being at times of the COVID-19 pandemic: a review

Cara Symanzik ^{a,b}, Clara Hagel^c, Thilo Hotfiel ^{d,e}, Martin Engelhardt^d, Swen Malte John ^{a,b}, Casper Grim^{d,f}

^aInstitute for Interdisciplinary Dermatological Prevention and Rehabilitation (iDerm) at Osnabrück University, Osnabrück, Germany

^bDepartment of Dermatology, Environmental Medicine and Health Theory, Institute for Health Research and Education (IGB), Faculty of Human Sciences, Osnabrück University, Osnabrück, Germany

^cDepartment of New Public Health, Institute for Health Research and Education (IGB), Faculty of Human Sciences, Osnabrück University, Osnabrück, Germany

^dCenter for Musculoskeletal Surgery Osnabrück (OZMC), Klinikum Osnabrück, Osnabrück, Germany

^eDepartment of Orthopedic Surgery, Friedrich-Alexander-Universität (FAU) Erlangen-Nürnberg, Erlangen, Germany

^fInstitute for Health Research and Education (IGB), Faculty of Human Sciences, Osnabrück University, Osnabrück, Germany

Introduction

It is scientific consensus that physical activity (PA) is generally beneficial to one's health. Those who engage in regular PA can improve their overall well-being (WB) as well as their physical, mental, and social health. As a practical matter, PA may be considered medicine since it protects the mind and body against physical and mental illnesses [\[13\]](#) According to the World Health Organization (WHO), PA is understood as any physical movement that is generated by the skeletal muscles and requires energy and describes all activity including movement in leisure, for transportation to and from locations, or as part of a person's occupation [\[26\]](#) PA is influenced by various determinants which comprise individual

(e.g., sociodemographic, biomedical, and skill-related descriptors), interpersonal (e.g., social surroundings and support), and environmental (e.g., living and working environment) factors [\[3,7,8,22\]](#)

To prevent transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causing coronavirus disease 2019 (COVID-19), far-reaching restrictions in daily life had to be undertaken involving so-called lockdown measures. Necessary social distancing comprised not only restraints of social contacts in the private life but also remote working scenarios as well as closings of local shops and facilities, such as sports venues. A substantial decrease of PA across diverse population groups throughout the COVID-19 pandemic has already been reported [\[13,17,24\]](#) Concomitantly, drastic reduction of

erwiesen. Die Eindämmungsmaßnahmen der Coronavirus-Krankheit-2019 (COVID-19) führten zu einem Rückgang der PA und zu einer Verringerung des Wohlbefindens (WB). Das Ziel dieser Arbeit war, Auswirkungen von PA auf WB während der COVID-19-Pandemie zu evaluieren.

Material und Methoden: Eine Literatursuche in Pubmed/Medline wurde im Mai 2021 durchgeführt. Der eingeschlossene Publikationszeitraum betrug ein Jahr ab Recherchedatum.

Ergebnisse: Die Synthese der Ergebnisse aus acht Publikationen, die über Daten aus rund 100 Ländern berichteten, zeigte, dass PA verschiedene Dimensionen des multivariaten Konstrukts von WB positiv beeinflusst; alle mit Bezug zur psychischen Gesundheit. Junge Erwachsene und Frauen zeigten die niedrigste PA, die mit dem niedrigsten selbstberichteten WB einherging.

Schlussfolgerungen: Reduzierte PA führte zu niedrigerem WB, was sich generell negativ auf die psychische Gesundheit auswirken könnte. In der Zukunft werden Initiativen benötigt, um PA – idealerweise mit gleichzeitiger Förderung der Bewegungsfreude – unter Berücksichtigung der pandemiebedingten Umstände zu erleichtern. Nur auf diese Weise wird es möglich sein, WB effektiv zu fördern und aufkommenden psychischen Problemen vorzubeugen. Die aktuellen Erkenntnisse sind grundlegend, um geeignete Ansätze zur Verbesserung der PA in Pandemiesituationen zu entwickeln.

Schlüsselwörter

COVID-19– Körperliche Aktivität– Pandemie– Sport– Wohlbefinden

WB has been observed at a global scale under aforementioned pandemic conditions .[23]

Against this backdrop, this review aims at evaluating the influence of PA on WB at times of the COVID-19 pandemic. Important parameters which should be addressed in the future for facilitating PA in consideration of pandemic circumstances as well as particularly affected populations shall be identified. Perspective, this review seeks to contribute to the development of appropriate approaches to generally improve PA in pandemic situations.

Methods

Literature searches were performed in May 2021. A time period of 1 year retrospective to the search date was taken as eligible publication period. We systematically searched for *covid-19 AND (exercise* [TI] OR physical activity* [TI]) AND (well-being [MeSH] OR wellbeing [TI] OR well-being [TI])* in Pubmed/Medline. Eligibility criteria following the PICO (population, intervention, control, and outcomes) scheme are listed in Table 1. Only studies reporting on participants in early or mid-adulthood (18 to 59 years) written in English or German were considered. In general, all studies not meeting the inclusion criteria were excluded. Further, studies not reporting on relevant aspects about

the influence of PA on WB (e.g., assessment of another factor influencing the evaluated parameter of PA and WB) as well as studies not reporting on the impact of the COVID-19 pandemic at societal level (e.g., only patients with acute SARS-CoV-2 infection) were excluded.

Results

Study selection

A PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) 2020 flow diagram [19] of the literature search is presented in Figure 1. Initial searches yielded 25 separate study records, which were then evaluated. There were no new references found after manually searching references (forward and backward snowballing). After excluding publications that were irrelevant because they did not provide data on the influence of PA on WB at times of the COVID-19 pandemic, we obtained a final number of 8 papers for this review.

Characteristics of included studies

All included papers (n = 8) report on cross-sectional studies using online surveys/questionnaires to collect data. 1 study exclusively evaluated data from France, 1 study exclusively looked at data from New Zealand, and 1 study exclusively explored

Table 1. Eligibility criteria following the PICO (population, intervention, control, and outcomes) scheme.

Criterion	Inclusion
Population ^a	COVID-19
Intervention	exercise* OR physical activity*
Control	n/a
Outcomes	wellbeing OR well-being

^aIn this review, population has to be understood rather as ‘problem’; n/a, not applicable.

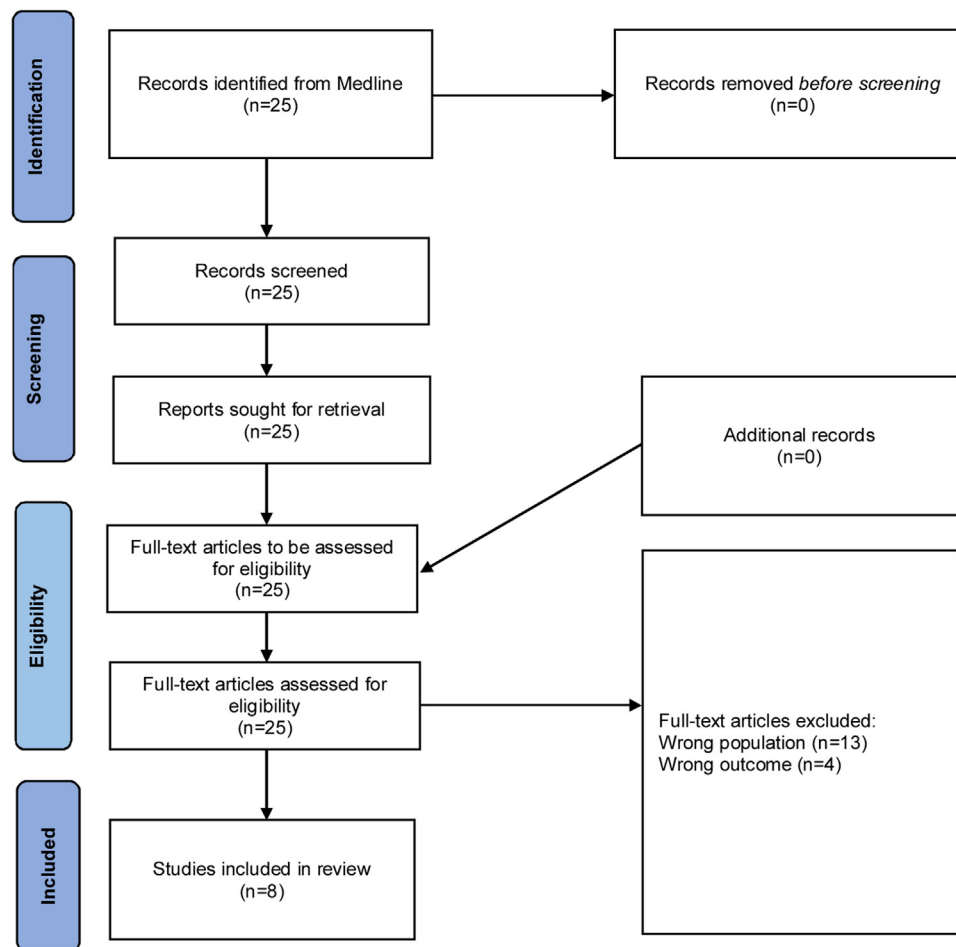


Figure 1
PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) 2020 flow diagram.

data from Canada. 2 studies examined data exclusively from the United Kingdom (UK). 1 study looked at data collected in 99 countries, among them Austria, Brazil, China, Finland, Germany, Greece, Iceland, Iran, Chile, Malaysia, Philippines, Russia, Spain, Switzerland, Taiwan, Turkey, the UK, and the United States of America (USA). 1 study examined data collected in Australia, Ireland, New Zealand, and the UK. In 7 of 8 (87.5%) studies reporting on gender, the proportion of women amongst the study population was 79.3% (n = 1), 59.5% (n = 1), 79.3% (n = 1), 68.8% (n = 1),

73.0% (n = 1), 75.2% (n = 1), and 70.7% (n = 1). Within 8 of 8 (100%) studies giving detailed information about the age of the participants, the age ranged from 18 to 59 years (n = 1) and averaged 42 ± 15 years (n = 2), 34.1 ± 14.4 years (n = 1), 34.1 ± 14.2 years (n = 1), 43 ± 13 years (n = 1), 40.2 ± 13.5 years (n = 1), and 44.5 ± 14.8 years (n = 1).

Synthesis of results

Influence of physical activity on well-being

Different levels (high, moderate, and low) of PA and their correlation

with varying dimensions of WB are summarized in Table 2. People with low PA show higher Depression Anxiety and Stress Scales (DASS)-9 scores and lower World Health Organization (WHO)-Five Well-Being Index scores compared to people with moderate or high PA . [6] Further, people with low PA present with worse scores for WB – with regard to depression, anxiety, and stress – compared to people with moderate or high PA .[25] People with high PA overall showed better scores in terms of mental health .[16,18] Especially people with high PA – who practiced PA daily – evinced the most positive

Table 2. Correlation between physical activity (PA) and well-being (WB). If not mentioned otherwise, data are displayed as mean ± standard deviation.

Study	WB	Increased PA / high PA	Consistent PA / moderate PA	Reduced PA / low PA
Lesser and Nienhuis 2020 [16]	MHC score	49.34 ± 12.30 (IA); 48.92 ± 12.50 (A)	50.54 ± 11.51 (IA); 50.56 ± 10.53 (A)	44.42 ± 13.07 (IA); 48.13 ± 12.35 (A)
Lesser and Nienhuis 2020 [16]	Social	15.83 ± 5.59 (IA); 14.96 ± 5.88 (A)	15.75 ± 5.38 (IA); 15.63 ± 5.06 (A)	13.50 ± 5.89 (IA); 14.93 ± 5.36 (A)
Lesser and Nienhuis 2020 [16]	Emotional	11.66 ± 2.61 (IA); 11.88 ± 2.60 (A)	12.23 ± 2.47 (IA); 11.97 ± 2.43 (A)	10.62 ± 3.05 (IA); 11.47 ± 2.82 (A)
Lesser and Nienhuis 2020 [16]	Psychological	21.88 ± 5.58 (IA); 22.05 ± 5.70 (A)	22.51 ± 5.59 (IA); 22.97 ± 4.70 (A)	20.22 ± 6.02 (IA); 21.39 ± 5.97 (A)
Lesser and Nienhuis 2020 [16]	GAD-7	9.87 ± 4.26 (IA); 9.65 ± 4.74 (A)	8.83 ± 4.71 (IA); 9.62 ± 4.76 (A)	11.24 ± 4.66 (IA); 10.98 ± 4.46 (A)
Brand <i>et al.</i> 2020 [1] ^a	POMS	During exercise: 4-2 → 0.121	During exercise: 3-2 → 0.020	During exercise: 1-2 → -0.241 0-2 → -0.0248
Faulkner <i>et al.</i> 2021 [6]	WHO-5 score	55.53 ± 19.54	58.48 ± 20.45	40.52 ± 19.97
Faulkner <i>et al.</i> 2021 [6]	DASS-9	2.22 ± 1.94	2.09 ± 1.89	3.65 ± 2.39
Faulkner <i>et al.</i> 2021 [6]	Anxiety	0.84 ± 1.44	0.65 ± 1.30	1.24 ± 1.85
Faulkner <i>et al.</i> 2021 [6]	Stress	2.26 ± 1.92	2.13 ± 1.85	3.03 ± 2.21
Nienhuis and Lesser 2020 [18]	MHC score	49.63 ± 12.18	50.70 ± 10.99	45.36 ± 13.37
Nienhuis and Lesser 2020 [18]	Social	15.75 ± 5.60	15.81 ± 5.13	13.90 ± 5.89
Nienhuis and Lesser 2020 [18]	Emotional	11.77 ± 2.52	12.07 ± 2.31	10.75 ± 3.09
Nienhuis and Lesser 2020 [18]	Psychological	22.14 ± 5.58	22.79 ± 5.32	20.55 ± 6.16
Nienhuis and Lesser 2020 [18]	GAD-7	9.96 ± 4.41	10.00 ± 4.60	11.20 ± 4.78
Wood <i>et al.</i> 2021 [25]	SWEMWBS	21.9 ± 3.4	21.7 ± 3.0	19.9 ± 4.5
Wood <i>et al.</i> 2021 [25]	Depression	8.7 ± 7.1	9.5 ± 6.9	14.8 ± 11.1
Wood <i>et al.</i> 2021 [25]	Anxiety	4.2 ± 5.3	4.8 ± 5.5	8.8 ± 9.0
Wood <i>et al.</i> 2021 [25]	Stress	11.7 ± 6.8	13.0 ± 8.1	16.4 ± 10.2

^aData are displayed as estimates; A, active people; DASS, Depression Anxiety and Stress Scales; GAD-7, Generalized Anxiety Disorder Scale-7; IA, inactive people; MHC, Mental Health Continuum; PA, physical activity; POMS, Profile of Mood Scale; SWEMWBS, short version of the Warwick–Edinburgh Mental Wellbeing Scale; WB, well-being; WHO-5, World Health Organization (WHO)-Five Well-Being Index.

status of WB with a proven correlation between training frequency and WB [1,16,18]. Moderate to high PA positively correlated with self-reported psychological detachment, relaxation, self-mastery, control over leisure time, satisfaction of needs, and subjective vitality [9]. A positive relation between PA and WB has been shown regardless of severely limited mobility associated with the pandemic conditions [15]. Data on differences between inactive and active people show that generally people who overall practiced less PA – regardless of being in the group of inactive or active people – reported on less value,

joy, self-confidence, support, and possibilities of being active [16]. Compared to active people, inactive people had an overall worse state of mental health [16]. Moreover, better scores on mental health were reported for people practicing PE within a group of people and not alone [16].

Age-related and sex-related differences

In general, young adults practiced less PA than all other age groups [6] and were shown to have worse scores on WB compared to older adults [9]. Overall, women practiced less PA

compared to men and simultaneously showed more generalized anxiety than men – Generalized Anxiety Disorder Scale (GAD)-7 scores averaged to 10.40 ± 4.63 for women and to 8.74 ± 4.63 for men [6]. Collectively, women also reported on less WB compared to men [9]. Women who conducted PA had higher Mental Health Continuum (MHC) scores (average of 49.60 ± 11.66) by contrast with women who did not practice PA (average of 47.82 ± 12.89) [18]. Low PA in women has reportedly mainly resulted from self-perceived barriers as well as little facilitations

for conducting PA .[18] However, when PA was practiced more positive changes related to movement behavior were reported for women than for men .[6]

Physical activity – motivation, importance, and places

Women who were able to maintain their levels of PA during the COVID-19 pandemic were shown to have greater autonomous motivation for practicing PA .[18] Low self-effectiveness regarding PA was associated with depressive symptoms and no joy of moving .[18] WB was highest in people practicing PA out of joy of moving .[15] Regarding self-assessed importance of PA, 54.3% of 171 people reported to think that PA has become more important during lockdown periods than before .[25] People who reportedly had low PA showed worse scores for all measures of WB (overall well-being, depression, anxiety, and stress) than people practicing moderate or high PA .[25] Increased expenditure of time for PA was associated with enhancement of psychological well-being, reduction of depression and anxiety, and improved life satisfaction .[25] The share of people (n = 171) practicing PA at home rose by 34.3% for activities indoors as well as by 25.4% for activities outdoors .[25]

Discussion

In this review we were able to show that there is an influence of PA on WB at times of the COVID-19 pandemic. Self-reported WB is highest in people practicing PA to moderate or high extent whereby PA yields influence on diverse dimensions of WB, which all are associated with mental health; the lowest self-reported WB is found in people with low PA .[1,2,6,9,15,16,18,25] These

findings are similar to earlier research that found a significant decrease in WB during the COVID-19 pandemic, for a variety of causes .[11] Interestingly, it was shown that a further decrease in PA leads to lower self-reported WB regardless of someone generally being rather active or inactive in terms of practicing PA .[16] Furthermore, it was shown that negative changes in terms of movement behavior – characterized by reduced PA – are connected to a worse state of WB .[6] As the studies included in this review were conducted in various countries from many regions of the world – one study even examining data from 99 countries [1] – it can be assumed that the regulations influencing PA in various territories all exert similar effects on WB. Further, the findings of this review seem to be relevant on a global scale. Whereas the general negative impact of the pandemic on mental health has been addressed in previously conducted studies ,[10] our review is – to the best of our knowledge – the first to reflect upon the influence of PA on WB during the COVID-19 pandemic.

Actions associated with containment of the COVID-19 pandemic – such as lockdown measures, social distancing, and remote working – generally entail far-reaching implications on daily life. Aforementioned sanctions and especially remote working led, inter alia, to long periods of sitting associated with a worse state of WB [6,9] – and further genesis of cardiovascular diseases and metabolic diseases such as diabetes [4,12] – which is especially relevant for a high share of white-collar workers working from so-called home offices for reasons of social distancing. Adverse effects of sitting can easily be ameliorated by PA ;[5] preventative strategies in

this field – which are tailored to the needs of workers under pandemic circumstances – could be conceptualized and explored in future studies. It was also shown that young adults practiced PA to a lesser extent compared to all other age groups, resulting in reduced self-reported WB .[6,9] Women were reported to practice less PA compared to men and consequently to have lower self-reported WB than men .[6,9] One explanation of age-related and sex-related differences mentioned in literature is that in general affective disposition and processes of mood regulation differentiate depending on factors such as age and sex .[9] Important obstacles for women with regard to practicing PA were found to be self-perceived barriers as well as little facilitations for conducting PA, in which context a lapse of childcare due to social distancing should be named .[14,18] Future strategies for promoting PA in women might focus on those identified hindrances.

A pleasing trend was seen regarding substitution of sports venues which were closed within lockdown measures .[20,25] It was shown that many people practiced PA at home (indoors and/or outdoors) which can be positively emphasized .[25] At this juncture, it should be mentioned that self-reported WB was higher in people practicing PE within a group .[16] In connection with increasing numbers of people practicing PA outdoors at home, PA in groups conducted outdoors could prospectively contribute to better WB and still conform to necessary COVID-19 measures. It seems reasonable to scrutinize current physical activity recommendations against the backdrop of changes in daily life. It could be assumed that the WHO recommendation of at least 150 to 300 minutes of moderate-intensity aerobic physical activity

or at least 75 to 150 minutes of vigorous-intensity aerobic physical activity for adults aged 18 to 64 years [26] might not be sufficient to account for ceased daily movement due to restrictions associated with the pandemic (i.e., remote working etc.). Moreover, the necessary amount of PA for WB might be higher under the specific pandemic situation than under normal circumstances, e.g., in terms of an expedient coping strategy for experienced stress.

A limitation of this review is that all analyzed articles solely referred to self-reported survey data. It should be mentioned that self-reported data is inherently of subjective nature and might be influenced by under-estimations or over-estimations of individuals. However, the utilization of validated questionnaires in the included studies can be emphasized positively.

Decreasing levels of PA have justifiably been proclaimed another pandemic within the COVID-19 pandemic [24]. The results of this review overall indicate that in the future strategies are needed for facilitating a consistent or even increased level of PA whilst decreasing levels of PA should urgently be circumvented in order to make use of the beneficial effects of PA on WB. Strategies should focus on young adults and women as they might profit particularly of improved PA routines. Acute cogitable approaches might be creating easy opportunities for practicing PA as well as supporting coping strategies for dealing with individually perceived barriers for not practicing PA. In this, increasing daily activity could be focused as a key role as even daily activities such as stair-climbing have been shown to lead to an enhancement of WB [21]. Against the background that adherence to COVID-19-associated measures

might stay necessary for a while, longstanding strategies are needed to promote PA in the general population in order to contribute to better WB. In future research, the elderly as well as children and adolescents might be a focus group worth paying particular attention to.

Conclusion

The findings of this study indicate that PA has a beneficial effect on various dimensions of WB at times of the COVID-19 pandemic. Decreasing levels of PA led to decreasing levels of WB and might consequently exert an adverse influence on mental health. In the future, strategies are needed to facilitate practicing PA – at best whilst promoting joy of moving – in consideration of the pandemic circumstances. Only this way will it be possible to effectively promote WB and to prevent possibly arising mental health problems.

Conflict of interest statement

The authors declare that no conflicts of interest exist.

References

- [1] R. Brand, S. Timme, S. Nosrat, When Pandemic Hits: Exercise Frequency and Subjective Well-Being During COVID-19 Pandemic, *Front Psychol* 11 (2020), 570567–570567.
- [2] C. Coyle, H. Ghazi, I. Georgiou, The mental health and well-being benefits of exercise during the COVID-19 pandemic: a cross-sectional study of medical students and newly qualified doctors in the UK, *Ir J Med Sci* 190 (2021) 925–926.
- [3] R.K. Dishman, J.F. Sallis, D.R. Orenstein, The determinants of physical activity and exercise, *Public Health Rep* 100 (1985) 158–171.
- [4] D.W. Dunstan, N. Owen, Less Sitting for Preventing Type 2 Diabetes, *Diabetes Care*, online ahead of print (2021), <http://dx.doi.org/10.2337/dci2321-0028>.
- [5] U. Ekellund, J. Tarp, M.W. Fagerland, J. S. Johannessen, B.H. Hansen, B.J. Jefferis, P.H. Whincup, K.M. Diaz, S. Hooker, V.J. Howard, A. Chernofsky, M. G. Larson, N. Spartano, R.S. Vasani, I.-M. Dohrn, M. Hagströmer, C. Edwardson, T. Yates, E.J. Shiroma, P. Dempsey, K. Wijndaele, S.A. Anderssen, I.-M. Lee, Joint associations of accelerometer-measured physical activity and sedentary time with all-cause mortality: a harmonised meta-analysis in more than 44 000 middle-aged and older individuals, *Br J Sports Med* 54 (2020) 1499–1506.
- [6] J. Faulkner, W.J. O'Brien, B. McGrane, D. Wadsworth, J. Batten, C.D. Askew, C. Badenhorst, E. Byrd, M. Coulter, N. Draper, C. Elliot, S. Fryer, M.J. Hamlin, J. Jakeman, K.A. Mackintosh, M.A. McNarry, A. Mitchelmore, J. Murphy, H. Ryan-Stewart, Z. Saynor, M. Schaumberg, K. Stone, L. Stoner, B. Stuart, D. Lambrick, Physical activity, mental health and well-being of adults during initial COVID-19 containment strategies: A multi-country cross-sectional analysis, *J Sci Med Sport* 24 (2021) 320–326.
- [7] I. Ferreira, K. van der Horst, W. Wendel-Vos, S. Kremers, F.J. van Lenthe, J. Brug, Environmental correlates of physical activity in youth - a review and update, *Obes Rev* 8 (2007) 129–154.
- [8] C.E. Garber, J.E. Allsworth, B.H. Marcus, J. Hesser, K.L. Lapane, Correlates of the stages of change for physical activity in a population survey, *Am J Public Health* 98 (2008) 897–904.
- [9] C. Ginoux, S. Isoard-Gautheur, C. Teran-Escobar, C. Forestier, A. Chalabaev, A. Clavel, P. Sarrazin, Being Active during the Lockdown: The Recovery Potential of Physical Activity for Well-Being, *Int J Environ Res Public Health* 18 (2021) 1–13.
- [10] A. Gupta, J.H. Puyat, H. Ranote, F. Vila-Rodriguez, A. Kazanjian, A cross-sectional survey of activities to support mental wellness during the COVID-19 pandemic, *J Affect Disord Rep* 5 (2021) 100167.
- [11] R. Hansmann, L. Fritz, A. Pagani, G. Clément, C.R. Binder, Activities, Housing Situation and Other Factors Influencing Psychological Strain Experienced During the First COVID-19 Lockdown in Switzerland, *Front Psychol* 12 (2021) 735293.

- [12] G.N. Healy, E.A.H. Winkler, N. Owen, S. Anuradha, D.W. Dunstan, Replacing sitting time with standing or stepping: associations with cardio-metabolic risk biomarkers, *Eur Heart J* 36 (2015) 2643–2649.
- [13] C. Herbert, V. Gilg, M. Sander, S. Kobel, A. Jerg, J.M. Steinacker, Preventing Mental Health, Well-Being and Physical Activity during the Corona Pandemic?. Recommendations from Psychology and Sports Medicine, *Dtsch Z Sportmed*, Volume 71 (2020) 249–257.
- [14] M. Huebener, C. Spieß, N. Siegel, G. Wagner, Wohlbefinden von Familien in Zeiten von Corona: Eltern mit jungen Kindern am stärksten beeinträchtigt, *DIW Wochenber* 87 (2020) 527–537.
- [15] M. Jenkins, S. Houge Mackenzie, K. Hodge, E.A. Hargreaves, J.R. Calverley, C. Lee, Physical Activity and Psychological Well-Being During the COVID-19 Lockdown: Relationships With Motivational Quality and Nature Contexts, *Front Sports Act Living* 3 (2021), 637576–637576.
- [16] I.A. Lesser, C.P. Nienhuis, The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians, *Int J Environ Res Public Health* 17 (2020) 1–12.
- [17] X. Li, J. Li, P. Qing, W. Hu, COVID-19 and the Change in Lifestyle: Bodyweight, Time Allocation, and Food Choices, *Int J Environ Res Public Health* 18 (2021) 1–14.
- [18] C.P. Nienhuis, I.A. Lesser, The Impact of COVID-19 on Women's Physical Activity Behavior and Mental Well-Being, *Int J Environ Res Public Health* 17 (2020) 1–12.
- [19] M.J. Page, J.E. McKenzie, P.M. Bossuyt, I. Boutron, T.C. Hoffmann, C.D. Mulrow, L. Shamseer, J.M. Tetzlaff, E.A. Akl, S.E. Brennan, R. Chou, J. Glanville, J.M. Grimshaw, A. Hróbjartsson, M.M. Lalu, T. Li, E.W. Loder, E. Mayo-Wilson, S. McDonald, L.A. McGuinness, L.A. Stewart, J. Thomas, A.C. Tricco, V.A. Welch, P. Whiting, D. Moher, The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, *BMJ* 372 (2021) n71.
- [20] S. Pietsch, S. Linder, P. Jansen, Well-being and its relationship with sports and physical activity of students during the coronavirus pandemic, *Ger J Exerc Sport Res* (2021) 1–8.
- [21] M. Reichert, U. Braun, G. Gan, I. Reinhard, M. Giurgiu, R. Ma, Z. Zang, O. Hennig, E.D. Koch, L. Wieland, J. Schweiger, D. Inta, A. Hoell, C. Akdeniz, A. Zipf, U.W. Ebner-Priemer, H. Tost, A. Meyer-Lindenberg, A neural mechanism for affective well-being: Subgenual cingulate cortex mediates real-life effects of nonexercise activity on energy, *Sci Adv* 6 (2020), eaaz8934.
- [22] K. Van Der Horst, M.J. Paw, J.W. Twisk, W. Van Mechelen, A brief review on correlates of physical activity and sedentariness in youth, *Med Sci Sports Exerc* 39 (2007) 1241–1250.
- [23] J. Wilke, K. Hollander, L. Mohr, P. Edouard, C. Fossati, M. González-Gross, C. Sánchez Ramírez, F. Laiño, B. Tan, J.D. Pillay, F. Pigozzi, D. Jimenez-Pavon, M.C. Sattler, J. Jaunig, M. Zhang, M. van Poppel, C. Heidt, S. Willwacher, L. Vogt, E. Verhagen, L. Hespanhol, A.S. Tenforde, Drastic Reductions in Mental Well-Being Observed Globally During the COVID-19 Pandemic: Results From the ASAP Survey, *Front Med* 8 (2021) 578959.
- [24] J. Wilke, L. Mohr, A.S. Tenforde, P. Edouard, C. Fossati, M. González-Gross, C. Sánchez Ramírez, F. Laiño, B. Tan, J.D. Pillay, F. Pigozzi, D. Jimenez-Pavon, B. Novak, J. Jaunig, M. Zhang, M. van Poppel, C. Heidt, S. Willwacher, G. Yuki, D.E. Lieberman, L. Vogt, E. Verhagen, L. Hespanhol, K. Hollander, A Pandemic within the Pandemic?. Physical Activity Levels Substantially Decreased in Countries Affected by COVID-19, *Int J Environ Res Public Health* 18 (2021) 2235.
- [25] C.J. Wood, J. Barton, N. Smyth, A cross-sectional study of physical activity behaviour and associations with well-being during the UK coronavirus lockdown, *J Health Psychol*, online ahead of print (2021), <http://dx.doi.org/10.1177/1359105321999710>.
- [26] World Health Organization, Physical activity, 2020, URL: <https://www.who.int/news-room/fact-sheets/detail/physical-activity>. (last accessed 8 October 2021).

Corresponding author:

Dr. rer. nat. Cara Symanzik, B.Sc., M.Ed.,
 Institute for Interdisciplinary
 Dermatological Prevention and
 Rehabilitation (iDerm) and Department of
 Dermatology, Environmental Medicine and
 Health Theory at Osnabrück University, Am
 Finkenhügel 7a, D-49076 Osnabrück,
 Germany. Tel.: +49 541 969 7448, Fax:
 +49 541 969 2445.
 E-Mail: cara.symanzik@uni-osnabrueck.de

Available online at www.sciencedirect.com

ScienceDirect