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Physical Activity and Its Related Factors during the First COVID-19 Lockdown in Germany

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Abstract: Lockdown measures including the closure of physical activity facilities were installed against the spread of the novel coronavirus in March 2020. The aim of the current online survey was to assess the lockdown effects on physical activity in German adults. We assessed physical activity using the European Health Interview Survey (EHIS) questionnaire. Pre-lockdown vs. lockdown differences were tested with the X^2 test and the Student's *t*-test for paired data. Predictor variables to explain compliance with physical activity recommendations were identified using a fixed effects binary logistic regression analysis. Data of 979 respondents were analyzed. Transport related and leisure time physical activity decreased ($p < 0.001$, d = 0.16; $p < 0.001$, d = 0.22, respectively). Compliance with physical activity recommendations decreased from 38.1% to 30.4% (chi^2 [1, 1958] = 12.754, $p < 0.001$, V = 0.08). In the regression analysis, BMI (OR 0.944, 95% CI 0.909–0.981; $p = 0.003$), education (OR 1.111, 95% CI 1.021–1.208; $p = 0.015$), transport related (OR 1.000, 95% CI 1.000–1.000; $p = 0.008$) and leisure time physical activity (OR 1.004, 95% CI 1.003–1.004; $p < 0.001$), muscle strengthening (OR 5.206, 95% CI 4.433–6.114; $p < 0.001$), as well as the 'lockdown vs. normal' categorical variable (OR 0.583, 95% CI 0.424–0.802; $p = 0.001$) showed a contribution, while sex ($p = 0.152$), age ($p = 0.266$), work related physical activity ($p = 0.133$), and remote working ($p = 0.684$) did not. Physical activity declined in German adults, and should also be promoted in light of the emerging evidence on its protective effects of against COVID-19. Special attention should be given to muscle strengthening activities and groups with lower educational attainment.

Keywords: confinement; corona; cycling; leisure time activity; walking

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1. Introduction

In early 2020, the novel coronavirus (SARS-CoV-2) reached the European continent and spread rapidly [1]. The lung disease the virus causes (COVID-19) grew into a pandemic by mid-March 2020 [2], with Italy as one of the European countries that was hardest hit [3]. The exponential spread of the virus and very high excess mortality in Italy was a warning sign for "latecomer" countries [1,3], Since neither preventive nor therapeutic pharmacological options were widely available during the first wave of the pandemic, traditional public health measures aiming at the massive reduction of contacts among people such as shelter-in-place orders, social distancing, and quarantine were deemed to be the only successful strategies to contain the spread of the virus and save lives [4].

A large number of countries in Europe followed the path of Italy, which was the first country to impose lockdown measures [1,5]. In Germany, the lockdown measures led to a closure of all non-essential businesses, sports clubs, fitness studios, activity trails, and playgrounds [6]. Employers were very strongly encouraged to allow remote working

whenever possible. However, leaving one's house was not limited. It was only permissible to see one person other than those living in the same household. The first wave of the COVID-19 pandemic in Germany lasted from week 10 (2 March 2020) until week 23 (7 June 2020) [7]. At present (spring 2021), many countries are in the third wave and have had to impose lockdowns again. According to mathematical modeling, social distancing might be intermittently necessary as late as into 2022 [8].

Shelter-in-place orders disrupt normal daily lives and have massive effects on various aspects of health related behaviors [9], including physical activity (PA). According to a recent scoping review, international data on weight change seem somewhat contradictory, with about half of respondents reporting weight gains, and about one fifth reporting weight losses [9]. Also, the consumption of a healthy diet was shown to increase in some studies and reduce in others [9].

A systematic review on the change of PA from before to during the COVID-19 pandemic lockdown documented an overall decline in PA in 64 of the 66 studies included [10]. The overall decline, however, does not mean that all people reduced their PA or that all types of activities were reduced [10]. Changes in PA were also influenced by the strictness of lockdown measures [10].

Regular PA is one of the most potent health resources [11]. It reduces the risk of chronic conditions with the greatest burden of disease, lowers the risk of premature death, improves quality of life, and contributes to maintaining independence in old age [11]. Physical inactivity causes approximately 6% of coronary heart disease cases, 7% of type 2 diabetes mellitus cases, and 10% each of breast and colon cancer cases worldwide [12]. In addition, physical inactivity can account for 9% of premature deaths [12].

Risks factors for the severity of the COVID-19 disease and increased risk of hospitalization and mortality are partially non-modifiable, such as age and male sex, and partially modifiable. Modifiable risk factors include obesity, diabetes, hypertension, and cardiovascular diseases, all of which are strongly influenced by lifestyle, including PA [13,14], Taken together, sustaining an active life style is paramount to maintaining good somatic and mental health, and might play an as of now underappreciated role in countering COVID-19.

Often cited barriers to regular PA include environmental factors, including facilities and time management [15]. Facilitators are social motivators such as being part of a group, peer encouragement, and PA as an opportunity to socialize [15]. During the lockdown in Germany, sports facilities were closed, no group exercise was possible, and the number of people who could meet was limited even outdoors. All of these factors could detrimentally impact PA behavior. At the same time, the economic crisis forced many people onto short-time work schemes, which could theoretically result in more discretionary time. This, in turn, might potentially be beneficial for leisure time PA. For employees who worked remotely during the lockdown, the loss of commutes might also result in time saving, but also in the loss of time spent on active travel. In Germany, leaving one's house was not limited during lockdowns.

The aim of the current study was to assess the potential changes in PA in Germany following the lockdown measures in the spring of 2020 and explore associations with facilitating and hindering factors. We hypothesized that similar to other reports, overall activity levels declined and the number of respondents who complied with current PA recommendations also reduced, but also that some of the respondents were able to maintain and even increase their PA.

2. Materials and Methods

2.1. Study Design

We conducted a cross-sectional online survey using the SoSci Survey tool (SoSci Survey GmbH, Munich, Germany, https://www.soscisurvey.de/ (accessed on 23 April–12 September 2020)) involving German adults. All participants provided informed consent. Prior

to launching the survey, ethical approval by Goethe University, Frankfurt was obtained (reference number 2020-18).

The link to the survey was distributed electronically via authors' professional and personal networks. Recipients of the mailings were invited to further distribute the link in their respective networks (snowball method) and publish it on their website and other communication channels (e.g., newsletters) as applicable and appropriate.

The invitation included a short description of the study aims, information on data security, and the possibility to discontinue the study at any time. The identity of respondents was not traceable. The survey was open during 23 April–12 September 2020.

2.2. Questionnaire

The survey instrument covered two major thematic sections: one on habitual PA and one on the use of, and attitude towards, virtual PA offers. Here, we report on habitual PA only. Questions on anthropometric data (questions BM1–2), and on PA (questions PE1–PE8) were identical to the respective questions from the European Health Interview Survey (EHIS wave 2) [16], and wording was identical to the official German translation. EHIS PAQ has been validated with acceptable-to-good reliability and validity [17]. All questions on PA were posed twice, once relating to conditions prior to lockdown (prior to 2 March 2020) ("normal"), and once relating to lockdown (between 2 March and 7 June 2020) ("lockdown") conditions. Participants were asked to indicate their highest educational attainment according to the International Standard Classification of Education (ISCED 2011) [18]. ISCED 2011 provides uniform and internationally agreed definitions to facilitate comparisons of education systems across countries [18]. Further, participants were asked to indicate whether they were in a short-time work scheme and whether they were working remotely.

2.3. Data Processing and Statistical Analysis

PA data scoring followed the official EHIS scoring protocol [19]. In short, we calculated the following PA outcomes: (a) work related PA (WRPA), (b) transport related PA (transport related walking and cycling minutes per week; TRPA), (c) leisure time PA (total minutes of sports, fitness and recreational leisure time activities in at least 10 minute bouts per week; LTPA), (d) days of muscle strengthening activities per week (DMSA), (e) compliance with World Health Organization (WHO) PA recommendations [20] (aerobic activities > 150 min/week determined from LTPA and cycling from TRPA and $\geq$2 days muscle strengthening activities/week; active vs. inactive).

Body mass index (BMI) was calculated using self-reported body weight and height, and BMI values were used and computed in the analyses as a scaled variable in its original values.

We present data here as frequencies (categorical variables), and as mean and standard deviation (SD) (scaled parameters). Differences between conditions were tested Chi^2-based (X^2 test) for categorical variables with Cramer's V as a measure for the effect size in the case of significant differences, with small (V = 0.1), moderate (V = 0.3), or large effect sizes (V = 0.5), respectively. For scaled data sets, mean differences between conditions were analyzed using the Student's *t*-test for paired data including the respective confidence interval for difference of means (95% CI) and effect size (Cohen's d), with small ($|d| = 0.2$), moderate ($|d| = 0.5$), or large ($|d| = 0.8$) effect sizes, respectively. A two-way rANOVA was conducted to identify potential interaction effects with COVID-19-related working condition changes such as working remotely vs. not working remotely. Frequencies (counts and % values) were described for changes in PA subdivided into increases, no changes or decreases from the normal to the lockdown condition separately for participants complying and not complying with WHO PA recommendations prior to the lockdown.

In order to identify relevant predictor variables to explain the compliance with WHO recommendations (0 = inactive/1 = active), a fixed effects binary logistic regression analysis was conducted using the following measures: WRPA (work effort: 0 = no task [new

encoded], 1 = sitting/standing, 2 = moderate, 3 = demanding interpreted as scaled variable), TRPA, LTPA and DMSA interpreted as scaled variable, and demographic data including sex (0 = male, 1 = female), education level (1 = secondary I [middle school/junior high school], 2 = secondary II [senior high school], 3 = post-secondary [college foundation course], 4 = Short-cycle tertiary education, 5 = Bachelor's degree, 6 = Master's degree, 7 = doctoral degree) interpreted as scaled variables, including age and BMI. Additionally, remote working conditions forced by lockdown rules (encoded as 0 = remote working, 1 = normal) and the 'normal' and 'lockdown' condition (encoded as 0 = lockdown, 1 = normal) were entered as categorical variables.

All statistical analyses were computed using IBM SPSS software, V.22, IBM Armonk, VA, USA). Significance was accepted for p-values ≤ 0.05.

3. Results

3.1. Descriptive Statistics

After removing 25 datasets because of missing data necessary for the binary logistic regression (sex, age, BMI), data of 979 respondents (n = 703; 71.8% females) were included into the detailed analysis. Participants were 44.0 ± 14.7 years old and had a BMI of 24.6 ± 5.4. Educational attainment was as follows: lower secondary education n = 106 (10.8%), higher secondary education n = 134 (13.7%), post-secondary non-tertiary education n = 55 (5.6%), short-cycle tertiary education n = 16 (1.6%), Bachelor's degree or equivalent n = 161 (16.4%), Master's degree or equivalent n = 396 (40.4%), doctoral or equivalent level n = 110 (11.2%). For detailed sample characteristics, please see Table 1.

Table 1. Sample characteristics (n = 979).

Characteristics		*n*	Mean ± SD
Age (y)	females	703	42.9 ± 14.0
	males	276	46.7 ± 16.0
Weight (kg)	females	703	68.2 ± 15.0
	males	276	84.6 ± 19.2
Height (m)	females	703	1.68 ± 0.06
	males	276	1.80 ± 0.07
BMI (kg/m^2)	females	703	24.1 ± 5.2
	males	276	25.9 ± 5.4

Abbreviation: BMI = Body mass index.

A total of 115 (11.7%) respondents were affected and 675 (68.9%) were not affected by a short-time work scheme, respectively, while 189 respondents (19.3%) were pensioners, students or pupils. Additionally, 428 (43.7%) respondents worked remotely and 369 (37.7%) did not, while 182 respondents (18.6%) mentioned that they were pensioners, students, or pupils.

3.2. Inferential Statistics

3.2.1. Transport Related PA (TRPA)

Transport related walking and cycling (both in minutes per week and MET-minutes per week) decreased significantly with a trivial effect size ($p < 0.001$, d = 0.13 and $p < 0.001$, d = 0.12, respectively). Also, the composite measure TRPA (walking and cycling) decreased significantly with a trivial effect size ($p < 0.001$, d = 0.16), as can be seen in Table 2.

Table 2. Transport related physical activity during normal and lockdown conditions (n = 979).

Activity	Condition	Mean	SD	Mean Diff	*t*-Value	*p*-Value	95% CI Lower	95% CI Upper
Walking (min/week)	normal lockdown	218.4 195.4	232.0 242.6	23.1	4.024	<0.001	11.8	34.3
Walking (METmin/week)	normal lockdown	720.8 644.7	765.5 800.7	76.1	4.024	<0.001	39.0	113.2
Cycling (min/week)	normal lockdown	78.1 63.8	137.5 134.9	14.3	3.644	<0.001	6.6	22.0
Cycling (METmin/week)	normal lockdown	468.5 382.6	824.9 809.3	85.9	3.644	<0.001	39.7	132.2
TRPA (METmin/week)	normal lockdown	1189.4 1027.3	1184.8 1226.6	162.0	4.896	<0.001	97.1	227.0

Abbreviations: METmin/week = metabolic equivalent of task-minutes per week; TRPA = transport related physical activity.

3.2.2. Leisure Time Activity and Muscle Strengthening Activities

Time spent in LTPA decreased significantly ($p < 0.001$) with a small effect size (d = 0.22). The number of days of muscle strengthening activities decreased slightly but significantly with an average of 0.1 days ($p = 0.020$), and with a trivial effect size (d = 0.07), as can be seen in Table 3.

Table 3. Leisure time activity muscle strengthening activities during normal and lockdown conditions (n = 979).

		Mean	SD	Mean Diff	*t*-Value	*p*-Value	95% CI Lower	95% CI Upper
LTPA (min/week)	normal lockdown	225.7 189.7	218.1 224.5	36.0	6.932	<0.001	25.8	46.2
DMSA	normal	1.6	1.7	0.1	2.325	0.020	0.0	0.2
	lockdown	1.5	1.9					

Abbreviation: LTPA = leisure time physical activity; DMSA = days of muscle strengthening activities per week.

3.2.3. Effects of Short-Time Work or Remote Work on PA

In a two-factorial model with normal vs. lockdown and remote working [n = 423] vs. no remote working [n = 551], and short-time work [n = 115] vs. no short-time work [n = 864], respectively, we found a significant interaction such that the decline in LTPA in the subsample working remotely was lower compared to for those not working remotely ($F[1, 977] = 4.190$, $p = 0.041$, $eta^2p = 0.004$), (Figures 1 and 2). No further interactions (remote work on TRPA ($F[1, 977] = 1.363$, $p = 0.243$, $eta^2p = 0.001$), short-time work on LTPA ($F[1, 977] = 0.113$, $p = 0.737$, $eta^2p < 0.001$), or short-time work on TRPA ($F[1, 977] = 0.008$, $p = 0.929$, $eta^2p < 0.001$) were observed.

3.2.4. Compliance with WHO PA Recommendations

In the normal condition, 373 individuals (38.1%) fulfilled the combined WHO PA recommendation (active), and 606 individuals (61.9%) did not (inactive). Compliance with overall WHO recommendations decreased significantly from 373 cases (38.1%) to 298 cases (30.4%) (chi^2 [1, 1958] = 12.754, $p < 0.001$, V = 0.08), with similar declines in the two major parts of the recommendations (aerobic activity from 68.3% to 56.3% (chi^2 [1, 1958] = 30.280, $p < 0.001$, V = 0.12) and muscle strengthening activity from 44.2% to 37.7% (chi^2 [1, 1958] = 8.650, $p = 0.003$, V = 0.07) in the lockdown condition.

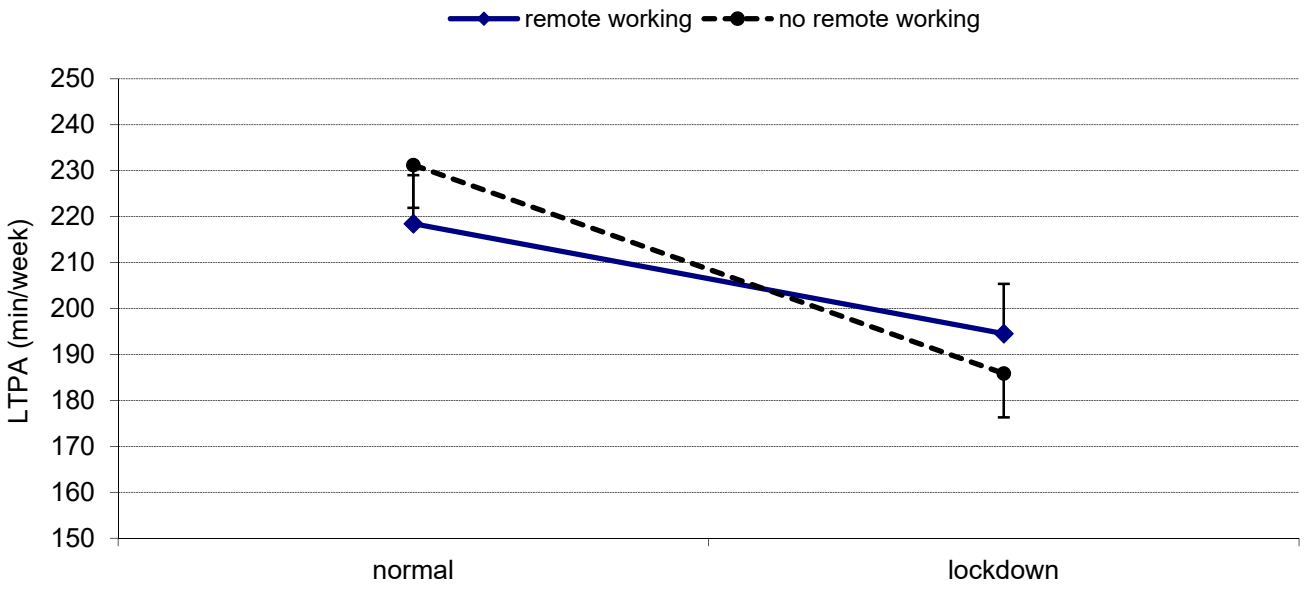

Figure 1. Changes in leisure time physical activity (min/week) from normal to lockdown conditions according to remote working status (mean ± SEM).

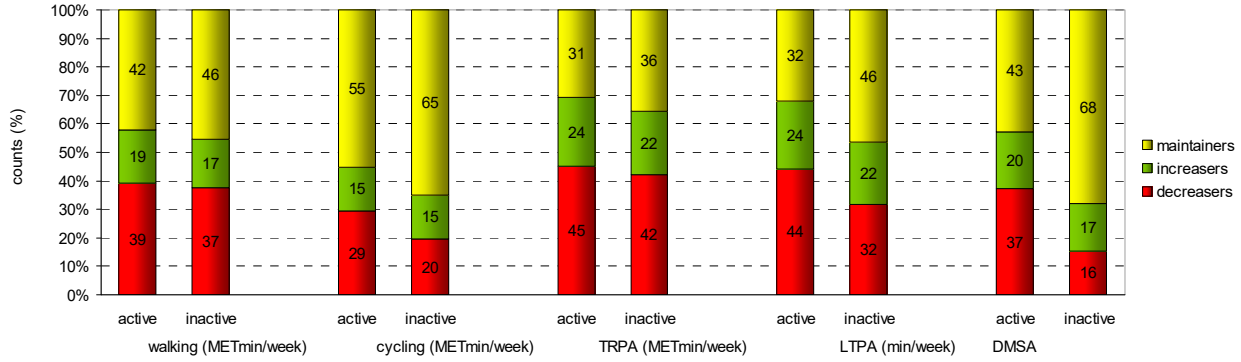

Figure 2. Counts (%) changes from normal to lockdown in the active and the inactive subsample.

3.2.5. PA Decreases and Increases from Normal to Lockdown Depending on Prior WHO PA Compliance

While all PA measures decreased in the overall sample from the normal to the lockdown condition (Tables 2 and 3), a detailed analysis of case frequencies revealed distinct patters of decreasers, maintainers, and increasers in both active and inactive persons (Table 4 and Figure 2).

3.2.6. Binary Logistic Regression Analysis

To explain the compliance with WHO PA recommendations, binary logistic regressions were calculated using demographic data (sex: male vs. female, age and BMI, education, remote working yes vs. no), as well as PA measures (WRPA, TRPA, LTPA, and DMSA) and the categorical variable 'lockdown vs. normal' condition. The regression model explained 65.7% of the total variance of the compliance with the WHO recommendations (R^2Nagelkerke = 0.733) with a correct estimation of 90.1%. The predictors BMI ($p = 0.003$), education level ($p = 0.015$), TRPA ($p = 0.008$), LTPA, and DMSA ($p < 0.001$), as well as the 'lockdown vs. normal' categorical variable ($p = 0.001$) showed a significant contribution, while sex ($p = 0.152$), age ($p = 0.266$), WRPA ($p = 0.133$), and remote working ($p = 0.684$) did not.

Table 4. Counts (%) changes from normal to lockdown in the total, the active, and the inactive subsample.

		Total (*n* = 979)		**Active (*n* = 373)**		**Inactive (*n* = 606)**	
		counts	(%)	counts	(%)	counts	(%)
walking (METmin/week)	decreasers	373	38.1	146	39.1	227	37.5
	increasers	173	17.7	70	18.8	103	17.0
	maintainers	433	44.2	157	42.1	276	45.5
cycling (METmin/week)	decreasers	229	23.4	110	29.5	119	19.6
	increasers	149	15.2	57	15.3	92	15.2
	maintainers	601	61.4	206	55.2	395	65.2
TRPA (METmin/week)	decreasers	423	43.2	168	45.0	255	42.1
	increasers	225	23.0	90	24.1	135	22.3
	maintainers	331	33.8	115	30.8	216	35.6
LTPA (min/week)	decreasers	356	36.4	164	44.0	192	31.7
	increasers	223	22.8	90	24.1	133	21.9
	maintainers	400	40.9	119	31.9	281	46.4
DMSA	decreasers	233	23.8	139	37.3	94	15.5
	increasers	174	17.8	74	19.8	100	16.5
	maintainers	572	58.4	160	42.9	412	68.0

Odds ratios were small for TRPA and LTPA, but highly relevant for DMSA and the lockdown condition (Table 5). Analysis showed a strongly reduced chance (−41.7%) (OR 0.583, 95% CI 0.424–0.802) to comply with WHO PA recommendations under the lockdown condition (p = 0.001). Men were found to have an increased chance (+30.4%) to comply with WHO PA recommendations under the lockdown condition, although this did not reach statistical significance (p = 0.152). A higher education level also showed an increased chance (+11.1%) (OR 1.111 95% CI 1.021–1.208) to comply with WHO PA recommendations, and the variable DMSA demonstrated a highly increased chance (+520.6%) regarding compliance with WHO PA recommendations.

Table 5. Binary logistic regression model with Odds Ratios (95% CI) for the explanation of compliance with WHO PA recommendations including sex, age, BMI, education, remote working, WRPA, TRPA, LTPA, and DMSA and the categorical variable 'lockdown vs. normal' condition.

	OR	**95% CI EXP(B)**		**Sig.**
		Lower	**Upper**	
Lockdown	0.583	0.424	0.802	0.001
Sex	1.304	0.907	1.874	0.152
Age	0.994	0.982	1.005	0.266
BMI	0.944	0.909	0.981	0.003
Education	1.111	1.021	1.208	0.015
Remote working	0.935	0.674	1.295	0.684
WRPA	1.262	0.932	1.710	0.133
TRPA	1.000	1.000	1.000	0.008
LTPA	1.004	1.003	1.004	0.000
DMSA	5.206	4.433	6.114	0.000
constant	0.029			0.000

4. Discussion

The aim of our study was to assess the change in PA following the first lockdown installed to contain the spread of the Coronavirus in German adults in the spring of 2020 and explore factors that might be associated with these changes. We found a significant decline in all PA measures. Compliance with the aerobic and muscle-strengthening parts of the PA recommendations showed a decrease from 68.3% to 56.3% and 44.2% to 37.7%, respectively, and the overall compliance sunk from 38.1% to 30.4%. Walking MET minutes

and cycling MET minutes declined by 10.6% and 18.3%, respectively. Within both the inactive and active subsample, three distinct behavioral patterns were observed: decreasers, maintainers, and increasers. Interestingly, the rate of increasers in both subsamples was quite similar in all PA measures. It is remarkable that depending on the PA domain 15–22% of previously inactive respondents increased their PA (cf. Figure 2) during lockdown, in a period when circumstances for PA were less than optimal. This is of high individual and public health relevance, since the most pronounced relative health benefits take place when previously entirely inactive individuals become at least somewhat active, even if their activity remains well below the currently recommended amounts [21]. On the other hand, it is alarming that about 30% of inactive respondents reported further reducing their PA levels that were low to begin with.

We found that respondents with a higher BMI and lower educational attainment had lower chances of complying with PA recommendations during lockdown. Representative data of the German National Health Survey also confirm that a higher level of education is associated with higher frequency of engaging in PA according to current recommendations [22]. Higher BMI has been shown to be associated with lower levels of PA [23,24], Our data imply that overweight people might be especially at risk due to reductions in PA during lockdown.

Our findings are on the whole in agreement with previous investigations worldwide [10] and in Germany [25–27], Direct comparison, however, is impeded because of large methodological differences, such as different study populations, tools, and methods to assess PA, definitions of active vs. inactive respondents and change in activity, as well as data processing and statistical analyses applied.

Mutz and Gerke found in a representative survey using non-validated questions that "leisure time sport and exercise activities" significantly declined at the population level in Germany, with inactivity increasing from 39.4% before the lockdown to 59.5% during the lockdown [25]. The inactivity rate during lockdown in our sample (69.6%) compares very well with the results of the COVID-19 Snapshot Monitoring Study (67.9%), which also used the EHIS PAQ and thus allows an easier comparison [28]. A smaller study using the validated Physical Activity Questionnaire 50+ questionnaire [29] among seniors in the Federal State of Bavaria also documented a decline in PA, with the most pronounced reductions in leisure time activities and exercise [26]. In a large, non-representative sample of university students, 19.3% and 23.3% reported increased vigorous and moderate PA, respectively [27], which is also in line with our findings.

In accordance with the German National Health Survey [22] and the COVID-19 Snapshot Monitoring Study [28] but in contrast to Mutz and Gerke [25], we found that a higher educational level was associated with an increased chance of complying with the WHO recommendations. In agreement with the COVID-19 Snapshot Monitoring Study [28], in our sample neither age nor sex was related to the chance of being active according to the PA guidelines.

The regression analysis highlights the importance of muscle strengthening activities. Strength training is critically relevant for health [30–32], which explains its explicit inclusion in health oriented PA recommendations [11,33]. The closure of fitness studios might have specifically hampered engaging in muscle strengthening activities. Alternatives, such as using one's own body weight or elastic bands, which have been shown to produce health benefits [34,35], should be explicitly promoted by health authorities.

Bearing in mind the methodological differences limiting comparisons with other studies, the degree of decrease in PA seems to be relatively modest in our sample. Indeed, our previous study conducted with the same methodology in Italy showed stronger declines in PA measures and higher effect sizes [36]. The compliance with PA recommendations was reduced by 10.3 and by 7.7 percentage points in Germany, respectively. Also, TRPA practically halved in Italy and declined in Germany by about 14%. The differential drop in PA might be explained by two contextual factors. Habitual PA volume is associated with seasonal effects, such that it is typically lower in winter and in periods with high levels of

precipitation [37,38]. The weather in Germany during the spring months 2020 was very pleasant; in fact, it was extremely sunny (about 150% of multi-annual average), unusually dry (about 50% rain of multi-annual average), and also warm; April 2020 was among the seven warmest Aprils since the beginning of weather recordings in 1881 [39]. Also, unlike in Spain and Italy, lockdown measures in Germany were comparatively mild, e.g., leaving one's house was never limited [40]. The combination of these two factors might have buffered the negative effects of the lockdown in Germany in the spring of 2020. It cannot be ruled out that fall and winter lockdowns might have had an even more detrimental impact on PA levels.

The potential health effects due to the decline in PA during lockdown might be best illustrated by detraining [41,42], and step reduction studies [43]. While such health effects may be influenced by many various aspects, including individuals' prior fitness and training levels, health status, and age, as well as by the duration and magnitude of training or PA reduction or cessation, these studies collectively suggest that discontinuation of regular exercise reverses beneficial training effects [41,42], and reduction of habitual ambulation activity induces detrimental cardiometabolic adaptations [43]. Reduction of PA does not seem to be paralleled by a lower energy intake, which can affect energy balance [44] and contribute to weight gain [45]. Taken together, even seemingly modest reductions in PA can induce detrimental health effects and should be avoided.

There is now growing appreciation for the protective role of PA [46], cardiorespiratory fitness [47], and muscular fitness [48] against the severity of COVID-19 disease, defined as hospitalization. In a community-based cohort study of 387,109 adults in the United Kingdom, PA physical inactivity was associated with an increased risk of COVID-19 hospitalization (relative risk 1.32, 95%CI: 1.10–1.58) after adjustment for age, sex, smoking history, alcohol consumption, and obesity [46]. Brawner et al. report an inverse association between maximal exercise capacity and COVID-19 hospitalization in a racially diverse cohort [47]. Each additional MET exercise capacity was independently associated with a 13% (adjusted OR, 0.87; 95%CI: 0.76–0.99) lower odds of hospitalization [47]. Muscle strength, defined as grip strength, was also associated with a lower risk of COVID-19 hospitalization in older adults after adjusting for established risk factors for severe COVID-19 (adjusted OR per increase of 1 standard deviation in grip strength = 0.64, 95%CI: 0.45–0.87, $p = 0.015$) [48].

While this is as of now preliminary observational evidence, various PA induced mechanisms such as improved immunological response, anti-inflammatory effects, and improved mitochondrial fitness [14,49], might indeed explain these effects. Higher cardiorespiratory and muscular fitness might be an expression of altogether more robust multiple organ systems, which in turn are better able to respond to the acute stress posed by the infection [47,48]. In light of these findings and the ongoing pandemic, the promotion of PA seems of paramount importance and might confer meaningful public health benefits at the population level.

Our study has several strengths. We used the validated EHIS PAQ, which allows a differential measurement of PA forms, such as walking, cycling, and leisure time activity, and explicitly assesses muscle strengthening activities and is thus able to provide information on compliance with current PA guidelines (both major parts). By asking the same questions twice, we could quantify the changes in PA. Our sample is reasonably large, even if not representative. Nonetheless, like all self-reported data, ours might be subject to reporting bias and the effects of social desirability. Also, less than one third of respondents were men and only about 30% of respondents had a non-tertiary education. We cannot rule out that more health and PA conscious people participated in the survey.

5. Conclusions

In agreement with previous reports in Germany and worldwide, we found significant reductions in different PA measures in a large sample of German adults during the first COVID-19-related lockdown in spring 2020. Our results also indicate that lockdown

differentially impacted PA in different subgroups. PA should be promoted, especially among societal groups with lower educational attainment and in people with overweight and obesity. Engagement in muscle-strengthening activities in particular should also be encouraged. Emerging evidence on the protective effects of PA and fitness against severe COVID-19 symptoms also provides further compelling reasons to promote an active lifestyle.

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