Original Article

COVID-19: Effects of Pandemic Related Restrictions on Physical Activity, Screen Time, and Mental Well-being in German adolescents

Matthias Marckhoff[1], Milena Siebald[2], Nina Timmesfeld[3], Marius Janßen[2], Georg Romer[2], and Manuel Föcker[2]

[1] Helen Keller Hospital School, University Hospital Münster, Germany
[2] Department of Child and Adolescent Psychiatry, University Hospital Münster, Germany
[3] Department of Medical Informatics, Biometry, and Epidemiology, Ruhr University Bochum, Germany

Abstract: *Objective:* To describe the impact of the COVID-19 pandemic-related restrictions (PR) in April and May 2020 on physical activity (PA), sedentary screen time (SST), and mental well-being (MWB) in German adolescents, and to analyze associations between these variables. *Methods:* The Münster District Government invited all secondary school students (aged 11–17) in the region to take part in the online survey that assessed PA, SST, and MWB. For data analysis, we calculated descriptive statistics and ran linear regression analysis. *Results:* 1,038 students (627 [60.4%] female; 14.18 [± 1.97] years) were included in the analysis. During the PR, a marked decline in overall PA ($p < .001$) and a significant increase ($p < .001$) in SST were observed. One-third of the students reported worrying more and being less satisfied with their lives since PR. A decrease in life satisfaction (ß = −.524, $p < .001$) as well as an increase in general worrying (ß = −.336, $p = .015$) were associated with a decrease in PA during PR. *Conclusion:* The results show that the restrictions led to a decrease in physical activity, which may have detrimental effects on the students' mental and physical health.

Keywords: physical activity, screen time, mental well-being, COVID-19, pandemic restrictions

COVID-19: Auswirkungen der pandemiebedingten Kontaktbeschränkungen auf körperliche Aktivität, Bildschirmzeit und das psychische Wohlbefinden bei deutschen Jugendlichen

Fragestellung: Die Studie soll die Auswirkungen der pandemiebedingten Kontaktbeschränkungen im April und Mai 2020 auf die körperliche Aktivität, die sitzend verbrachte Bildschirmzeit und das psychische Wohlbefinden bei deutschen Jugendlichen beschreiben und mögliche Zusammenhänge analysieren. Methodik: Die Bezirksregierung Münster lud alle Schüler_innen der weiterführenden Schulen (11–17 Jahre) im Regierungsbezirk ein, an einem Online-Survey teilzunehmen, der die körperliche Aktivität, die Bildschirmzeit und Aspekte des psychischen Wohlbefindens erhob. Die Datenanalyse erfolgte im Rahmen deskriptiver Statistik und linearer Regressionsanalyse. Ergebnisse: 1038 Jugendliche (627 [60.4%] weiblich; 14,18 [± 1.97] Jahre) wurden in die Analyse einbezogen. Während der Kontaktbeschränkungen nahm die körperliche Aktivität deutlich ab ($p < .001$), wohingegen die Bildschirmzeit signifikant zunahm ($p < .001$). Ein Drittel der Schüler*innen gibt an, sich mehr Sorgen zu machen und weniger zufrieden mit ihrem Leben zu sein. Die Abnahme der Lebenszufriedenheit (ß = −.524; $p < .001$) als auch die Zunahme von Sorgen (ß = −.336; $p = .015$) waren mit einer Abnahme der körperlichen Aktivität assoziiert. Schlussfolgerungen: Die Ergebnisse deuten darauf hin, dass die Kontaktbeschränkungen zu einer Abnahme der körperlichen Aktivität geführt haben, was sich ungünstig auf die psychische und somatische Gesundheit der Jugendlichen auswirken kann.

Schlüsselwörter: körperliche Aktivität, Bildschirmzeit, psychisches Wohlbefinden, Kontaktbeschränkungen

Introduction

Physical inactivity and sedentary behavior are major risk factors for physical and mental ill-health as well as for a decrease in physical and mental well-being (Kohl et al., 2012; Poitras et al., 2016; Saunders et al., 2016; WHO, 2020).

On 16 March 2020, the German federal state governments took strict measures to contain the SARS-CoV-2 pandemic. These included closing schools, sports clubs, gyms, playgrounds, and parks, resulting in a shutdown of most areas of organized physical activity (PA). It was to be expected that such measures would have a strong impact on everyday activity and exercise patterns (Guan et al., 2020; Martinez-Ferran et al., 2020).

While emerging studies on adults have already provided a preliminary overview of collateral COVID-19 effects on PA, sedentary behavior, and mental health (Ammar et al., 2020; Bezerra et al., 2020; Constandt et al., 2020; Lesser & Nienhuis, 2020; Mazza et al., 2020; Qiu et al., 2020; Stanton et al., 2020; Talevi et al., 2020; Wang et al., 2020; Zhang et al., 2020), our current understanding of the COVID-19 influence on health-related lifestyle factors and mental well-being (MWB) of children and adolescents is still quite limited.

Studies from Canada, China, Poland, Czechia, and Austria on children and youth provide evidence of an adverse impact of the COVID-19 restrictions on movement and play behaviors (Greier et al., 2021; Luszczki et al., 2021; Moore et al., 2020; Stverakova et al., 2021; Xiang et al., 2020). From earlier studies on PA behavior in children and adolescents, we know that school-related activities, sports participation, and active transport make up a major part of their daily PA routines (Guan et al., 2020; Hoffmann et al., 2019; Parker et al., 2019). Consequently, negative changes in students' activity and exercise behavior had been observed even during national holidays (Aphamis et al., 2017; Weaver et al., 2019). For this reason, it was expected that the impact of the COVID-19 restrictions on PA would be particularly pronounced in this group.

As emerging studies show, a further symptom of the social distancing measures is also a serious increase in sedentary screen time (SST) (Greier et al., 2021; Moore et al., 2020; Pietrobelli et al., 2020; Xiang et al., 2020). For example, a considerable increase in gaming was observed and game download reached a record high during the corona pandemic in the United States (King et al., 2020; Ko & Yen, 2020).

Several studies revealed significant associations between PA, SST, MWB, and mental health, including in children and adolescents (Munasinghe et al., 2020; Wunsch et al., 2021; Zhang et al., 2020; Zhou et al., 2020). Whereas a positive impact of PA on the mood states of children and adolescents was found (Zhang et al., 2020), a highly significant negative association between depression and physical exercise was shown in female adolescents (Zhou et al., 2020). In a recent longitudinal study that included adolescents between 13 and 19 years of age, physical distancing and social restrictions were associated with a decrease in PA, an increase in SST, and decreases in well-being (Munasinghe et al., 2020). PA was determined as an important coping strategy associated with well-being during pandemic times (Pigaiani et al., 2020). On the other hand, however, an increase in overall PA during pandemic restrictions (PR) was found in a representative German sample of children and adolescents (Schmidt, Anedda, Burchartz, Eichsteller et al., 2020; Wunsch et al., 2021).

To contribute to a more comprehensive picture of the collateral effects of pandemic restrictive measures on adolescents' health-related lifestyle in Germany, the PAW Survey (1) describes the impact of the COVID-19 contact restrictions in Germany on PA, SST, and indicators of MWB in adolescents and (2) identifies factors associated with PA during PR. Against the background of the already existing body of evidence, we hypothesize that the social-distancing measures employed in Germany in April 2020 led to a decrease in PA, an increase in SST, and a deterioration of MWB in secondary school students.

Materials and Methods

Sample Recruitment

The study sample included students aged 11 to 17 attending secondary schools in northwestern Germany. The students were recruited from 22 April till 19 May 2020 in two ways:

1. Via e-mail, the Münster District Government invited 138 secondary schools (about 110,000 students) in the region to take part in the online survey. Of these, about 72,000 students attend a Gymnasium and 38,000 attend other secondary schools.
2. Using social media channels and local newspapers, the University Hospital Münster Communication Department reached out to further students and their families in the district.

Via an online link, the students could reach a LimeSurvey website on a Münster University server. On the website, the participants were automatically guided through the 38 items of the survey, which took about 20 minutes. Only fully completed surveys could be submitted. All questionnaires were submitted between 22 April 22 and 19 May, when the survey website went offline.

The study was performed in accordance with the declaration of Helsinki and approved by the Ethics Committee of the Medical Association of Westphalia-Lippe and the University of Münster (2020-259-f-S). All subjects gave written informed consent before the study.

Measures

Anthropometry

In the online survey, students were asked to specify their body height in cm and body weight in kg. Their BMI was subsequently calculated by dividing body weight by the square of body height (kg/m²). Individual BMI values were transformed into the Standard Deviation Score [SDS; (BMI-SDS)], using the LMS-Method (Cole & Green, 1992) based on German reference data for children and adolescents (Rosario et al., 2010).

Social, Environmental and Health Factors

To further characterize the study sample, we used self-developed questions related to (1) country of birth, (2) place of residence, (3) housing situation, (4) type of school, (5) Covid-19 status, (6) chronic diseases, (7) medication, (8) drug use, (9) alcohol use, and (10) smoking.

Physical Activity

Self-reported PA was measured based on an item of the German *Motoric Modul Physical Activity Questionnaire* (MoMo-PAQ). This questionnaire is part of the representative German KiGGS study (German Health Interview and Examination Survey for Children and Adolescents) and refers to the WHO recommendations on PA in children and adolescents (Schmidt et al., 2015):

"On how many days of a normal week have you been active for at least 60 minutes a day?"

To make sure every participant understood what is meant by "physical activity," we included the following explanation:

"Physical activity includes all activities in which your heart beats faster and your breathing is deeper and faster as well. Physical activities can be sports and exercise, playing with friends, or walking to school. Some examples are running, walking, inline skating, cycling, dancing, skateboarding, swimming, playing basketball, or soccer, or going surfing."

To enable a prepandemic and during-pandemic comparison, the participants were asked to self-report their PA by answering the following, slightly altered questions:

1. "Before the corona-restrictions (during the past 6 months): On how many days of a normal week have you been active for at least 60 minutes a day?"
2. "During the corona restrictions: On how many days of a 'normal' Corona week have you been active for at least 60 minutes a day?"

As a variable describing the pre-PR vs. during-PR differences, we calculated "delta PA" (PA during-PR – PA pre-PR). Positive delta PA values indicate an increase, whereas negative values indicate a decrease.

Notwithstanding the item alterations for this survey, data obtained with the MoMo-PAQ have been shown to be sufficiently reliable (test-retest reliability: *ICC* = 0.68). Correlation coefficients with accelerometry data are rather low (r = 0.29) (Jekauc et al., 2013).

Screen Time

To measure SST, the participants were asked to estimate the time spent on watching television, using a game console, a computer, and a smartphone on a 5-point scale (Lange et al., 2017) before and during PR: (1) not at all; (2) about 30 minutes; (3) about 1–2 hours; (4) about 3–4 hours; (5) more than 4 hours.

In order to obtain a *total SST* variable, we aggregated and totaled the time spent on each medium as performed in the German KiGGS health survey (Lange et al., 2017): not at all = 0 hours, about 30 minutes = 0.5 hours, about 1–2 hours = 1.5 hours, about 3–4 hours = 3.5 hours, more than 4 hours = 5 hours. Total SST was then recategorized into (1) 0 to <4 hours/day, (2) 4 to <8 hours/day, and (3) ≥ 8 hours/day.

As a variable describing the pre-PR vs. during-PR differences, we calculated "delta SST" (SST during-PR – SST pre-PR). Positive delta SST values indicate an increase, whereas negative values indicate a decrease.

Mental Health and Mental Well-Being

Mental health problems before PR were assessed using the Strengths and Difficulties Questionnaire (SDQ). The students were asked to estimate how the SDQ statements apply to them considering the 6 months before PR. The SDQ (Goodman, 1997) includes five subscales (emotional problems, hyperactivity/inattention, conduct problems, peer relationship problems, and prosocial behavior). The scores of the five subscales are summed up to a total difficulties score.

To obtain an indicator of MWB during PR, we used two self-developed items. On a 3-point scale, coded "1", "2", and "3", the students had to evaluate the changes regarding worrying and life satisfaction:

"Since the corona-restrictions, I worry ... rather less = 1, ... the same = 2, ... rather more = 3".

"Since the corona-restrictions, I am ... rather more satisfied with my life = 1, ... similarly satisfied with my life = 2, ... rather less satisfied with my life = 3."

For further analysis, we aggregated points 1 and 2 (not more worried/not less satisfied) to achieve a binary pattern, juxtaposing those who experienced a deterioration of well-being with those who experienced no change or even an improvement of well-being.

Statistical Analysis

For descriptive statistics, we calculated frequencies (absolute frequencies and percentages), means, and the respective standard deviations. Paired two-sample *t*-tests were performed to detect prepandemic and pandemic differences related to the variables PA and SST. Additionally, differences between male and female students were analyzed using unpaired *t*-tests.

A linear regression model was performed to examine the association between the independent variables: age, sex, BMI-SDS, PA before PR, Δ total SST (during PR minus before PR), SDQ total score, SDQ subscores, worrying since PR, life satisfaction since PR, and the outcome variable: ΔPA (during PR minus before PR).

Because our data indicate a homogeneous socioeconomic status (SES) (e.g., > 90 % attendance of Realschule/Gymnasium, 89 % reported to have a garden) we did not include this parameter as covariate. We calculated a sensitivity analysis including the dichotomous variable school type (1 = Gymnasium, 0 = other secondary schools). All analyses were explorative. They were performed with IBM© SPSS© Statistics (Version 24). *p*-values < .05 were considered significant.

Results

Sample Characteristics

1,060 students completed the online questionnaire, of which 22 had to be excluded because they were either too young (< 11) or too old (> 17). Table 1 shows the characteristics of the study group (total *N* = 1,038). 60 % were females, mean age was 14.18 (± 1.97) years. Mean BMI parameters were in the normal range. No student had been in hospital for COVID-19 treatment. Only two students (0.2 %) were tested positive for COVID-19. Nevertheless, 2.7 % of the students had already been in quarantine and 1.9 % were in quarantine when completing the questionnaire.

Table 1. Sample characteristics

Participant characteristics	Male *N* (%) 411 (39.6)	Female *N* (%) 627 (60.4)	Total *N* (%) 1,038 (100)
Age (mean, (*SD*))	13.95 (±2.0)	14.33 (±1.9)	14.18 (±2.0)
Weight (mean, (*SD*))	58.59 (±16.5)	55.77 (±11.9)	57.03 (±13.9)
Height (mean, (*SD*))	169.82 (±14.3)	164.99 (±8.7)	166.93 (±11.5)
BMI (mean, (*SD*))	20 (±3.6)	20.4 (±3.3)	20.2 (±3.5)
BMI SDS	−0.2(±0.9)	−0,2(±0.9)	−0.2(±0.9)
BMI percentile	45.1(±27.4)	45.6(±26.9)	45.4(±27.1)
Who fills out the questionnaire?			
Student	303 (73.7)	508 (81.0)	811 (78.1)
Student with help of an adult	108 (26.3)	119 (19.0)	227 (21.9)
Country of birth			
Germany	401 (97.6)	616 (98.2)	1017 (98.0)
Other	10 (2.4)	11 (1.8)	21 (2.0)
Place of residence			
Major city (> 100,000 inhabitants)	85 (20.7)	130 (20.7)	215 (20.7)
Medium-sized town (20,000–99,999 inhabitants)	164 (39.9)	237 (37.8)	401 (38.6)
Small town (5,000–19,999 inhabitants)	113 (27.6)	179 (28.5)	292 (28.1)
Village (< 5,000 inhabitants)	49 (11.9)	81 (12.9)	130 (12.5)

Table 1. Continued

Participant characteristics	Male *N* (%) 411 (39.6)	Female *N* (%) 627 (60.4)	Total *N* (%) 1,038 (100)
Housing situation			
With garden	366 (89.1)	558 (89.0)	924 (89.0)
With balcony/terrace	40 (9.7)	62 (9.9)	102 (9.8)
No garden, balcony, or terrace	5 (1.2)	7 (1.1)	12 (1.1)
Type of school			
Hauptschule[1]	2 (0.5)	5 (0.8)	7 (0.8)
Realschule[2]	62 (15.1)	101 (16.1)	163 (15.7)
Comprehensive school	23 (5.6)	45 (7.2)	68 (6.6)
Gymnasium[3]	320 (77.9)	471 (75.1)	791 (76.2)
Sekundarschule[4]	3 (0.7)	3 (0.5)	6 (0.6)
Vocational school	1 (0.2)	0 (0)	1 (0.1)
Oberstufenkolleg[5]	0 (0)	2 (0.3)	2 (0.2)
COVID-19 status			
Positive test result	1 (0.2)	1 (0.2)	2 (0.2)
Negative test result	7 (1.7)	6 (1.0)	13 (1.3)
Not tested hospitalized for COVID-19 treatment	360 (87.6) 0	553 (88.2) 0	913 (88.0) 0
in quarantine (past)	10 (2.4)	18 (2.9)	28 (2.7)
in quarantine (now)	13 (3.2)	7 (1.1)	20 (1.9)
A relative was/is infected	8 (1.9)	15 (2.4)	23 (2.2)
None of the above	53 (12.9)	82 (13.1)	135 (13.0)
Chronic diseases			
Pulmonary diseases	27 (6.6)	41 (6.5)	68 (6.6)
Allergies	83 (20.2)	106 (16.9)	189 (18.2)
Cardiovascular diseases	4 (1.0)	4 (0.6)	8 (0.8)
Cancer	1 (0.2)	0 (0)	1 (0.1)
Orthopedic diseases	15 (3.6)	39 (6.2)	54 (5.2)
Autoimmune diseases	2 (0.5)	14 (2.2)	16 (1.5)
Mental illness	13 (3.2)	39 (6.2)	52 (5.0)
No diseases	279 (67.9)	422 (67.3)	701 (67.5)
Medication			
Regular medication intake No medication intake	45 (10.9) 366 (89.1)	73 (11.6) 554 (88.4)	118 (11.4) 920 (88.6)
Drug use			
None	396 (96.4)	618 (98.6)	1014 (97.7)
Daily	1 (0.2)	1 (0.2)	2 (0.2)

Table 1. Continued

Participant characteristics	Male *N* (%) 411 (39.6)	Female *N* (%) 627 (60.4)	Total *N* (%) 1,038 (100)
Once a week	3 (0.7)	0 (0)	3 (0.3)
2–3 times a month	1 (0.2)	2 (0.3)	3 (0.3)
Once a month	1 (0.2)	1 (0.2)	2 (0.2)
Less than that	9 (2.2)	5 (0.8)	14 (1.3)
Alcohol use			
None	309 (75.2)	461 (73.5)	770 (74.2)
Daily	2 (0.5)	1 (0.2)	3 (0.3)
Once a week	22 (5.4)	19 (3.0)	41 (3.9)
Several times a week	10 (2.4)	14 (2.2)	24 (2.3)
2–3 times a month	24 (5.8)	37 (5.9)	61 (5.9)
Once a month	15 (3.6)	32 (5.1)	47 (4.5)
Less than that	29 (7.1)	63 (10)	92 (8.9)
Smoking			
None	390 (94.9)	603 (96.2)	993 (95.7)
Daily	2 (0.2)	4 (0.6)	6 (0.6)
Once a week	4 (1.0)	4 (0.6)	8 (0.8)
Several times a week	3 (0.7)	4 (0.6)	7 (0.7)
Less than that	12 (2.9)	12 (1.9)	24 (2.3)

Note. SD = standard deviation; SDS = standard deviation score. A "Hauptschule" is a secondary school in Germany and Austria, starting after 4 years of elementary schooling, offering lower secondary education (Level 2) according to the International Standard Classification of Education (source: en.wikipedia.org). [2]The "Realschule" is a type of secondary school in Germany, Switzerland, Liechtenstein, and Estonia (source: en.wikipedia.org). [3]A "Gymnasium" is a type of school with a strong emphasis on academic learning which provides advanced secondary education in some parts of Europe and the CIS, comparable to British grammar schools, sixth form colleges, and U.S. preparatory high schools (source: en.wikipedia.org). [4]A "Sekundarschule" is a comprehensive secondary school in North Rhine-Westphalia leading to an intermediate school-leaving qualification. [5]An "Oberstufenkolleg" is a German school for sixth-form students.

Physical Activity

On average, under prepandemic conditions, the participants reported meeting the WHO recommendation of at least 60 minutes of moderate to vigorous intensity PA on 4.48 (± 1.81) days of the week. During the contact restrictions, the number of days dropped significantly ($p < .001$) to 3.33 (± 2.31) days (Table 2).

The decrease of PA was significantly ($p = .001$) more pronounced among males. In this group, we observed a mean loss of 1.44 (± 2.31) days per week compared to 0.96 (± 2.20) days among females.

While under prepandemic conditions 17.7 % of the students (male: 20.0 % and female: 16.3 %) met the WHO recommendations of daily PA (WHO, 2010), this number dropped slightly under COVID-19 conditions to 15.6 % (male and female: each 15.6%).

In total, during the pandemic, there was an inactive group of 25.9 % of the students who met the recommendation on only 1 day or not at all, compared to 5.3 % under pre-COVID-19 conditions.

Screen Time

Compared to prepandemic conditions, there was a significant ($p < .001$) increase in total SST during the pandemic restrictions (Table 3). The number of students reporting a daily SST of 8 hours and more rose from 19.4 % before the pandemic to 45.4 % during the shutdown (Table 3). Regar-

Table 2. Physical activity according to WHO recommendations: "On how many days of a normal week have you been active for at least 60 minutes a day?"

	Male N (%) 411 (39.6)		Female N (%) 627 (60.4)		Total N (%) 1,038 (100)	
	Prepandemic	Pandemic	Prepandemic	Pandemic	Prepandemic	Pandemic
not at all	7 (1.7)	59 (14.4)	13 (2.1)	73 (11.6)	20 (1.9)	132 (12.7)
1	15 (3.6)	55 (13.4)	20 (3.2)	82 (13.1)	35 (3.4)	137 (13.2)
2	30 (7.3)	68 (16.5)	70 (11.2)	94 (15)	100 (9.6)	162 (15.6)
3	59 (14.4)	59 (14.4)	99 (15.8)	96 (15.3)	158 (15.2)	155 (14.9)
4	73 (17.8)	48 (11.7)	121 (19.3)	79 (12.6)	194 (18.7)	127 (12.2)
5	75 (18.2)	34 (8.3)	125 (19.9)	51 (8.1)	200 (19.3)	85 (8.2)
6	70 (17)	24 (5.8)	77 (12.3)	54 (8.6)	147 (14.2)	78 (7.5)
7	82 (20)	64(15.6)	102 (16.3)	98 (15.6)	184 (17.7)	162 (15.6)
Mean (*SD*)	4.65** (1.81)	3.22** (2.33)	4.37** (1.80)	3.41** (2.30)	4.48** (1.81)	3.33** (2.31)
Delta PA (*SD*)	−1.44** (2.31)		− 0.96** (2.20)		−1.15 (2.25)	

Note. *SD* = standard deviation, PA = physical activity, **$p < .001$ (significant difference between before PR and during PR).

ding total SST, there is no significant difference between the sexes, before as well as during pandemic restrictions (Table 3). There is a significant increase ($p < .001$) for all four analyzed types of media, both in males and females.

However, focusing on the four different types of media individually, we found significant differences in the media consumption patterns between males and females.

Table 3. Total screen time and aggregated screen time: differences between prepandemic vs. pandemic and male vs. female

Total screen time	Male N (%) 411 (39.6)		Female N (%) 627 (60.4)		Total N (%) 1038 (100)	
	Prepandemic	Pandemic	Prepandemic	Pandemic	Prepandemic	Pandemic
< 4 hours/day	172 (41.8)	60 (14.6)	285 (45.5)	94 (15.0)	457 (44.0)	154 (14.8)
4 to < 8 hours/day	150 (36.5)	161 (39.2)	230 (36.6)	252 (40.2)	380 (36.6)	413 (39.8)
≥ 8 hours/day	89 (21.7)	190 (46.2)	112 (17.9)	281 (44.8)	201 (19.4)	471 (45.4)
Aggregated screen time						
	Prepandemic	Pandemic	Prepandemic	Pandemic	Prepandemic	Pandemic
Total screen time (aggregated)	5.41(±3.53)**	8.04(±4.18)**	5.08(±3.37)**	7.68(±3.76)**	5.21(±3.43)**	7.82(±3.93)**
Television	1.12(±1.08)**	1.74(±1.50)**#	1.19(±1.07)**	1.98(±1.50)**#	1.16(±1.10)**	1.88(±1.50)**
Game console	0.90(±1.12)**##	1.44(±1.61)**##	0.15(±0.56)**##	0.34(±0.90)**##	0.45(±0.91)**	0.77(±1.34)**
Computer	1.36(±1.50)**	2.14(±1.79)**	1.24(±1.30)**	2.03(±1.69)**	1.29(±1.44)**	2.07(±1.73)**
Smartphone	2.04(±1.51)**##	2.72(±1.68)**##	2.50(±1.57)**##	0.34(±0.90)**##	2.32(±1.56)**	3.09(1.68)**

Note. Significant differences before and during PR *$p < .05$, **$p < .001$. Significant differences between males and females #$p < .05$, ##$p < .001$. Aggregated screen time according to Lange et al. 2017: not at all = 0 hours; about 30 min = 0.5 hours; about 1–2 hours = 1.5 hours; about 3–4 hours = 3.5 hours; more than 4 hours = 5 hours.

During PR the females reported watching significantly more TV ($p = .011$) than the males. The use of game consoles was significantly higher in males than in females, both before and during PR ($p < .001$). The female participants used smartphones for significantly ($p \leq .001$) longer periods of time each day, both before and during PR. No significant difference was found for computer use between males and females.

Mental Health and Well-Being

Regarding the 6-month period before the pandemic, the mean total difficulties score of the respondents is 10.79 (Table 4). This value is well in the range considered normal (0–15) (www.sdqinfo.org) (Goodman et al., 1998). The mean values of the five subscales are also within the normal range. However, while 82.9 % have normal total SDQ-scores, 10.4 % (108 students) have an increased total score, and 6.7 % (70 students) have an abnormal SDQ-score.

More than one-third of the respondents (37.1 %) report worrying rather more since the contact restrictions. Again, this value is higher among the females (41.9 %) compared to the males (29.7 %). Nevertheless, there is also a group of 12.8 % of the students who worry rather less since the pandemic (Table 4).

Regarding life satisfaction, 37.1 % of the students report being rather less satisfied with their lives since the contact restrictions. With 41.9 % compared to 29.7 %, this value is higher among the females than among the males. However, a considerable group of students (10.1 %) also report being rather more satisfied with their lives during the pandemic.

Table 4. Mental Health and Well-Being

SDQ (Strength and Difficulties Questionnaire) N = 1,038	Mean (*SD*) male	Mean (*SD*) female	Mean (*SD*) total	Reference values normal range	Reference values raised range	Reference values abnormal range
total difficulties	9.74** (4.92)	11.47** (5.22)	10.79 (5.17)	0–15	16–19	20–40
emotional symptoms	2.11** (1.91)	3.52** (2.37)	2.96 (2.31)	0–5	6	7–10
conduct problems	1.80 (1.45)	1.73 (1.46)	1.77 (1.45)	0–3	4	5–10
hyperactivity/inattention	3.59 (2.40)	3.76 (2.21)	3.69 (2.29)	0–5	6	7–10
peer relationship problems	2.24* (1.77)	2.48* (1.66)	2.38 (1.71)	0–3	4–5	6–10
prosocial behaviour	7.48** (1.78)	8.22** (1.62)	7.93 (1.72)	6–10	5	0–4

Since the contact-restrictions I worry ...	Male *N* (%) 411 (39.6)	Female *N* (%) 627 (60.4)	Total *N* (%) 1,038 (100)
... rather more	122 (29.7)	263 (41.9)	385 (37.1)
... the same	232 (56.4)	288 (45.9)	520 (50.1)
... rather less	57 (13.9)	76 (12.1)	133 (12.8)
Since the contact-restrictions I am ...			
... rather more satisfied with my life	44 (10.7)	61 (9.7)	105 (10.1)
... similarly satisfied with my life	245 (59.6)	303 (48.3)	548 (52.8)
... rather less satisfied with my life	122 (29.7)	263 (41.9)	385 (37.1)

Note. **$p < .001$ (significant differences between males and females), *SD* = standard deviation.

Associations Between Physical Activity, Sedentary Screen Time, and Mental Well-Being

The regression model explained 24% of the variance of ΔPA. All SDQ variables were not significantly associated with the outcome variables (Table 5). Concerns and life dissatisfaction since PR were negatively associated with ΔPA (β = –.336, p = .015 and ß = –.524, p < .001, respectively). In addition, the covariates sex (β = .368, p = .007), PA before PR (β = –.431, p < .001), and Δ total SST (β = –.190, p < .001) had a significant impact on ΔPA. After performing the sensitivity analysis including school type as covariate, we found β coefficients of the other covariates had changed only marginally. School type was not significantly associated with ΔPA (β = –.126, p = .395).

Discussion

As hypothesized, we found a strong decrease in reported daily PA, a notable increase in daily SST, and indicators pointing toward a deterioration of the students' MWB. Most students attend a Gymnasium or Realschule, had access to a garden, and were physically and psychologically healthy.

Physical Activity

In our survey, the number of days on which the students met the WHO recommendation of at least 60 minutes of moderate to vigorous PA per day decreased significantly. Despite certain methodological differences, this finding is supported by the results of a survey on Canadian children and adolescents, in which the participants met the WHO recommendation on 3.55 (children aged 5–13) and 2.59 (adolescents aged 14–17) days per week during a social distancing period in April 2020 (Moore et al., 2020). However, the observed decrease in daily PA is not in line with the findings of a recent German study from Karlsruhe, in which an overall increase of PA was found for a representative sample of children and adolescents during the shutdown period in April 2020 (Schmidt, Will et al., 2020). Although Schmidt and colleagues observed a decline in sports and exercise activities, a marked increase in habitual physical activities overcompensated for the losses in

Table 5. Associations between biometric variables, activity behavior variables, psychological variables, and ΔPA (according to WHO recommendations)

Model	R .490	R-squared .240	Corrected R-squared .231	Standard error of the estimator 1.977
		Outcome: ΔPA (PA during PR – PA before PR)		
		β	95% CI	p-value
Constant		.637	–.614; 1.887	.318
Age (years)		–.003	–.068; .061	.920
Sex (male = 1; female = 2)		.369	.102; .635	.007
BMI-SDS		.067	–.065; .198	.319
Physical activity before PR		–.431	–.501; –.361	<.001
Δtotal screen time (during PR – before PR)		–.190	–.234; –.146	<.001
SDQ: emotional symptoms		.038	–.024; .101	.231
SDQ: conduct problems		–.007	–.103; .090	,893
SDQ: hyperactivity/inattention		–.029	–.088; .031	.341
SDQ: peer problems		–.042	–.122; .038	.307
SDQ: prosocial behavior		.067	–.011; .145	.091
More concerns since PR		–.336	–.608; –.065	.015
Less life-satisfaction since PR		–.524	–.798; –.250	<.001

Note. PA = physical activity, PR = pandemic restrictions, SDQ = Strengths and Difficulties Questionnaire, SDS = standard deviation score.

sports and exercise. In Schmidt et al., activities like helping with housework and gardening were explicitly defined as part of PA, which was not the case in our study. We assume that the differences between the two studies in terms of overall PA and adherence to the WHO guidelines might partly be explained by a slightly different understanding of PA on the part of the participants. A further aspect, possibly explaining the different findings, might be the SES of the participants. As Schmidt et al. discuss in their study, children and adolescents from lower SES backgrounds do not seem to rely as strongly on organized sports and exercise activities as those from higher SES backgrounds (Schmidt, Anedda, Burchartz, Oriwol et al., 2020). Although we did not explicitly measure SES, attending a Gymnasium, which most students in our study do, can still be regarded as an indicator of a higher SES (Büchler, 2016). There is an ongoing discussion on the relationship between SES and PA with studies hinting at a certain social gradient (Heradstveit et al., 2020). Higher SES, for its part, is associated with better health and health-related behavior in general (Waldhauer et al., 2018) and a higher total physical activity level and less screen time (Auhuber et al., 2019; Poulain et al., 2018) in particular. Together with the privileged housing situation, it must be acknowledged that the investigated group of students was probably better positioned for a long period of social distancing than the average student in Germany. In the present study, school type as covariate was not significantly associated with ΔPA, which may be due to the fact that the study sample is very homogeneous in terms of school type (> 90 % Gymnasium and Realschule).

The already existing gap between the most active and the least active students seems to have widened during the lockdown. According to Manz et al. (2014), all those students are considered "inactive" who meet the WHO recommendations on less than 2 days per week. Considering the negative short- and long-term impact of inactivity on somatic (de Rezende et al., 2014; Kumar et al., 2015; Wu et al., 2017) and mental health (Hoare et al., 2016; Lachytova et al., 2017; Suchert et al., 2015), this finding is alarming.

In contrast to the Canadian findings (Moore et al., 2020), in our study, the decline in PA was significantly larger in males compared to females, and male sex was identified as a risk factor for a decrease in PA during PR (ΔPA). Under "normal" (prepandemic) conditions, male adolescents are usually found to have been more physically active than female adolescents (Butt et al., 2011; Krist et al., 2020; Manz et al., 2014). However, the effect might be explained by gender-specific differences in physical exercise motivation (Navarro et al., 2020) and their effects on the students' exercise behavior during a period of contact restrictions.

Against the background of trajectory studies showing that PA behavior at a young age mostly persists over time (Hayes et al., 2019; Mikalsen et al., 2020), a positive association between PA before PR and during PR was to be expected. Thus, students on an active trajectory seem to keep up a rather active lifestyle even under unfavorable conditions, whereas less active students stay less active during the pandemic. On the other hand, the decrease of PA during the pandemic might be stronger among active students than among less active students due to their higher baseline levels of PA (Auhuber et al., 2019).

Screen Time

We found a significant increase in total SST during PR. Regarding the total SST score, it must be considered that the accumulation of the single SST items also leads to an accumulation of the errors in these items.

In the face of a large Chinese study (Xiang et al., 2020), a strong increase of SST had to be expected in Germany as well. In our study, under PR conditions, 85.2 % of the students reported a daily total SST of more than 4 hours. This result is also supported by Schmidt and colleagues who found mean recreational SST values of 251.6 minutes/day (11–13-year-olds) and 290.2 minutes/day (14–17-year-olds) during the first shutdown period in Germany (Schmidt et al., 2020a).

Regarding total SST, no significant difference was found between males and females, neither during nor before pandemic restrictions. Nevertheless, media-use patterns seem to be gender-specific. Males used game consoles more extensively, both in prepandemic and pandemic times. Female participants used smartphones for significantly longer times each day, independent of pandemic restrictions. These results support an extensive body of evidence on the leisure time behavior of male and female adolescents (Auhuber et al., 2019; Fischer-Grote et al., 2019).

Considering possible associations of SST and PA, we found that an increase in SST was associated with a decrease in PA. Despite the small effect size, this finding is in line with Xiang et al., who also found a significant correlation between both variables (Xiang et al., 2020).

Mental Health and Well-Being

The SDQ results show that most students in our cohort can probably be considered mentally healthy. Regarding MWB, 37.1 % of the participants reported to worry more and to be less satisfied with their lives since PR. For both variables, worrying and life-satisfaction, females seem to

experience more negative changes due to PR than males. This is in accordance with a current review by Marques de Miranda et al. (2020), in which the authors identified female sex as a risk factor for several mental distress measures.

With social isolation being an important risk factor for poor mental health and well-being (Fegert et al., 2020; Hall-Lande et al., 2007), a marked change in MWB had to be expected. However, our regression model revealed significant associations between these two variables (worrying/life-satisfaction) and the changes in PA during PR. According to our model, life-satisfaction during PR is the strongest predictor variable for a decrease of PA during PR. This finding is in line with several studies showing associations between PA, MWB, and mental health (Lubans et al., 2016). For those experiencing psychological distress, PA and exercise being easily accessible could be of paramount importance to overcome motivational barriers (Firth et al., 2016) and to prevent the vicious cycle of a primary reduction in PA, in combination with an increase in SST, which leads to a deterioration of physical and mental health, which, in turn, leads to an even further reduction of PA and an even further increase in SST (Xiang et al., 2020).

Strengths and Limitations

The study included a high number of students and analyzed PA, SST, and certain aspects of MWB in a combined approach in German. The cohort is not representative of the whole adolescent population. 76.2% of the students in our cohort attended a Gymnasium compared to a North-Rhine Westphalian average of 42.8% (Ministry for School and Education of the State of North Rhine-Westphalia, 2021). Due to limitations of the online questionnaire, some confounding variables could not be included in the analysis (exercise motivation, individual stressors, socioeconomic status, and quality-of-life variables). Furthermore, it must be acknowledged that the findings of a self-report online survey do not always reflect everyday reality and might be confounded by a social desirability bias. Additionally, the correlation coefficient of the physical activity questionnaire with accelerometry is very low (Jekauc et al., 2013). Regarding the total SST score, it must be considered that the accumulation of the single SST items also leads to an accumulation of the errors in these items, and that the given time categories did not exceed ≥ 8 hours per day. The latter might lead to an underestimation of the actual amount of media consumption.

On the other hand, the impact of the pandemic restrictions could be clearly highlighted, and our hypotheses could be tested. Because of residual confounding and reverse causation our study could detect only associations but not their direction. As our survey started in the first weeks of the pandemic restrictions in Germany, the confounding effect of the retrospectivity of the questions in the SDQ is assumed to be low.

Conclusions

The contact restrictions implemented in the initial period of the COVID 19 pandemic in Germany had a marked collateral impact on adolescents' PA behavior, SST, and MWB. All three factors were found to be associated and, thus, can be regarded as important prognostic factors for health trajectories in times of social isolation and pandemic-related contact restrictions.

For these reasons, schools, sports clubs, and other leisure and sports providers should develop sports and exercise programs, compatible with pandemic restrictions, to try to increase PA in children and adolescents during such times.

Child and adolescent psychiatrists should ensure continuity of care during all phases of the pandemic to prevent a deterioration of their patients' mental health status.

Literature

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., Bouaziz, B., Bentlage, E., How, D., Ahmed, M., Müller, P., Müller, N., Aloui, A., Hammouda, O., Paineiras-Domingos, L. L., Braakman-Jansen, A., Wrede, C., Bastoni, S., Pernambuco, C. S., … Hoekelmann, A. (2020). Effects of COVID-19 home confinement on eating behaviour and physical activity: Results of the ECLB-COVID19 International Online Survey. *Nutrients*, *12*(6). https://doi.org/10.3390/nu12061583

Aphamis, G., Ioannou, Y., & Giannaki, C. D. (2017). Physical fitness and obesity levels during an academic year followed by summer holidays: an issue of insufficient time for physical activity. *International Journal of Adolescent Medical Health, 31*(1). https://doi.org/10.1515/ijamh-2016-0137

Auhuber, L., Vogel, M., Grafe, N., Kiess, W., & Poulain, T. (2019). Leisure activities of healthy children and adolescents. *International Journal of Environmental Research on Public Health, 16*(12). https://doi.org/10.3390/ijerph16122078

Bezerra, A. C. V., Silva, C., Soares, F. R. G., & Silva, J. (2020). Factors associated with people's behavior in social isolation during the COVID-19 pandemic. *Cien Saude Colet, 25*(suppl 1), 2411–2421. https://doi.org/10.1590/1413-81232020256.1.10792020

Büchler, T. (2016). Schulstruktur und Bildungsungleichheit: [School structure and the education gap: the effect of federal state-specific differences in the transfer process into secondary education on academic success]. *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, *68*, 53–87. doi: 10.1007/s11577-015-0350-5

Butt, J., Weinberg, R. S., Breckon, J. D., & Claytor, R. P. (2011). Adolescent physical activity participation and motivational determi-

nants across gender, age, and race. *Journal of Physical Activity and Health, 8*(8), 1074–1083. https://doi.org/10.1123/jpah.8.8.1074

Cole, T.J., & Green, P.J. (1992). Smoothing reference centile curves: the LMS method and penalized likelihood. *Statistics in Medicine, 11*(10), 1305–1319. https://doi.org/10.1002/sim.4780111005

Constandt, B., Thibaut, E., De Bosscher, V., Scheerder, J., Ricour, M., & Willem, A. (2020). Exercising in times of lockdown: An analysis of the impact of COVID-19 on levels and patterns of exercise among adults in Belgium. *International Journal of Environmental Research on Public Health, 17*(11). https://doi.org/10.3390/ijerph17114144

de Rezende, L.F., Rodrigues Lopes, M., Rey-Lopez, J.P., Matsudo, V.K., & Luiz Odo, C. (2014). Sedentary behavior and health outcomes: An overview of systematic reviews. *PLoS One, 9*(8), e105620. https://doi.org/10.1371/journal.pone.0105620

Fegert, J.M., Vitiello, B., Plener, P.L., & Clemens, V. (2020). Challenges and burden of the Coronavirus 2019 (COVID-19) pandemic for child and adolescent mental health: A narrative review to highlight clinical and research needs in the acute phase and the long return to normality. *Child and Adolescent Psychiatry and Mental Health, 14*, 20. https://doi.org/10.1186/s13034-020-00329-3

Firth, J., Rosenbaum, S., Stubbs, B., Gorczynski, P., Yung, A.R., & Vancampfort, D. (2016). Motivating factors and barriers towards exercise in severe mental illness: A systematic review and meta-analysis. *Psychological Medicine, 46*(14), 2869–2881. https://doi.org/10.1017/S0033291716001732

Fischer-Grote, L., Kothgassner, O.D., & Felnhofer, A. (2019). Risk factors for problematic smartphone use in children and adolescents: A review of existing literature. *Neuropsychiatr, 33*(4), 179–190. https://doi.org/10.1007/s40211-019-00319-8

Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry, 38*(5), 581–586. https://doi.org/10.1111/j.1469-7610.1997.tb01545.x

Goodman, R., Meltzer, H., & Bailey, V. (1998). The Strengths and Difficulties Questionnaire: a pilot study on the validity of the self-report version. *European Child and Adolescent Psychiatry, 7*(3), 125–130. https://doi.org/10.1007/s007870050057

Greier, K., Drenowatz, C., Bischofer, T., Petrasch, G., Greier, C., Cocca, A., & Ruedl, G. (2021). Physical activity and sitting time prior to and during COVID-19 lockdown in Austrian high-school students. *AIMS Public Health, 8*(3), 531–540. https://doi.org/10.3934/publichealth.2021043

Guan, H., Okely, A.D., Aguilar-Farias, N., Del Pozo Cruz, B., Draper, C.E., El Hamdouchi, A., Florindo, A., Jáuregui, A., Katzmarzyk, P.T., Kontsevaya, A., Löf, M., Park, W., Reilly, J.J., Sharma, D., Tremblay, M.S., Veldman, S.L.C. (2020). Promoting healthy movement behaviours among children during the COVID-19 pandemic. *Lancet Child and Adolescent Health, 4*(6), 416–418. https://doi.org/10.1016/S2352-4642(20)30131-0

Hall-Lande, J.A., Eisenberg, M.E., Christenson, S.L., & Neumark-Sztainer, D. (2007). Social isolation, psychological health, and protective factors in adolescence. *Adolescence*, *42*(166), 265–286. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/17849936

Hayes, G., Dowd, K.P., MacDonncha, C., & Donnelly, A.E. (2019). Tracking of physical activity and sedentary behavior from adolescence to young adulthood: A systematic literature review. *Journal of Adolescent Health, 65*(4), 446–454. https://doi.org/10.1016/j.jadohealth.2019.03.013

Heradstveit, O., Haugland, S., Hysing, M., Stormark, K.M., Sivertsen, B., Bøe, T. (2020). Physical inactivity, non-participation in sports and socioeconomic status: a large population-based study among Norwegian adolescents. *BMC Public Health, 20*(1):1010. doi: 10.1186/s12889-020-09141-2.

Hoare, E., Milton, K., Foster, C., & Allender, S. (2016). The associations between sedentary behaviour and mental health among adolescents: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 13*(1), 108. https://doi.org/10.1186/s12966-016-0432-4

Hoffmann, B., Kobel, S., Wartha, O., Kettner, S., Dreyhaupt, J., & Steinacker, J.M. (2019). High sedentary time in children is not only due to screen media use: A cross-sectional study. *BMC Pediatrics, 19*(1), 154. https://doi.org/10.1186/s12887-019-1521-8

Jekauc, D., Voelkle, M., Wagner, M.O., Mewes, N., & Woll, A. (2013). Reliability, validity, and measurement invariance of the German version of the physical activity enjoyment scale. *Journal of Pediatric Psychology, 38*(1), 104–115. https://doi.org/10.1093/jpepsy/jss088

King, D.L., Delfabbro, P.H., Billieux, J., & Potenza, M.N. (2020). Problematic online gaming and the COVID-19 pandemic. *Journal of Behavioral Addictions, 9*(2), 184–186. https://doi.org/10.1556/2006.2020.00016

Ko, C.H., & Yen, J.Y. (2020). Impact of COVID-19 on gaming disorder: Monitoring and prevention. *Journal of Behavioral Addictions, 9*(2), 187–189. https://doi.org/10.1556/2006.2020.00040

Kohl, H.W., 3rd, Craig, C.L., Lambert, e.V., Inoue, S., Alkandari, J.R., Leetongin, G., Kahlmeier, S., Lancet Physical Activity Series Working, G. (2012). The pandemic of physical inactivity: global action for public health. *Lancet, 380*(9838), 294–305. https://doi.org/10.1016/S0140-6736(12)60898-8

Krist, L., Roll, S., Stroebele-Benschop, N., Rieckmann, N., Muller-Nordhorn, J., Bürger, C., Willich, S.N., Müller-Riemenschneider, F. (2020). Determinants of physical activity and screen time trajectories in 7th to 9th grade adolescents: A longitudinal study. *International Journal of Environmental Research on Public Health*, *17*(4). https://doi.org/10.3390/ijerph17041401

Kumar, B., Robinson, R., & Till, S. (2015). Physical activity and health in adolescence. *Clinical Medicine (Lond), 15*(3), 267–272. https://doi.org/10.7861/clinmedicine.15-3-267

Lachytova, M., Katreniakova, Z., Mikula, P., Jendrichovsky, M., & Nagyova, I. (2017). Associations between self-rated health, mental health problems and physical inactivity among urban adolescents. *European Journal of Public Health, 27*(6), 984–989. https://doi.org/10.1093/eurpub/ckx051

Lange, K., Cohrs, S., Skarupke, C., Gorke, M., Szagun, B., & Schlack, R. (2017). Electronic media use and insomnia complaints in German adolescents: Gender differences in use patterns and sleep problems. *Journal of Neural Transmission(Vienna), 124*(Suppl 1), 79–87. https://doi.org/10.1007/s00702-015-1482-5

Lesser, I.A., & Nienhuis, C.P. (2020). The impact of COVID-19 on physical activity behavior and well-being of Canadians. *International Journal of Environmental Research on Public Health, 17*(11). https://doi.org/10.3390/ijerph17113899

Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., Kelly, P., Smith, J., Raine, L., Biddle, S. (2016). Physical activity for cognitive and mental health in youth: A systematic review of mechanisms. *Pediatrics, 138*(3). https://doi.org/10.1542/peds.2016-1642

Luszczki, E., Bartosiewicz, A., Pezdan-Sliz, I., Kuchciak, M., Jagielski, P., Oleksy, L., Stolarczyk, A., Dereń, K. (2021). Children's eating habits, physical activity, sleep, and media usage before and during COVID-19 pandemic in Poland. *Nutrients*, *13*(7). https://doi.org/10.3390/nu13072447

Manz, K., Schlack, R., Poethko-Muller, C., Mensink, G., Finger, J., Lampert, T., & Ki, G.G.S.S.G. (2014). Körperlich-sportliche Aktivität und Nutzung elektronischer Medien im Kindes- und Jugendalter: Ergebnisse der KiGGS-Studie – Erste Folgebefragung (KiGGS Welle 1). *Bundesgesundheitsblatt Gesundheits-*

forschung Gesundheitsschutz, 57(7), 840–848. https://doi.org/10.1007/s00103-014-1986-4

Marques de Miranda, D., da Silva Athanasio, B., Sena Oliveira, A.C., & Simoes, E.S.A.C. (2020). How is COVID-19 pandemic impacting mental health of children and adolescents? *International Journal of Disaster Risk Reduction, 51*, 101845. https://doi.org/10.1016/j.ijdrr.2020.101845

Martinez-Ferran, M., de la Guia-Galipienso, F., Sanchis-Gomar, F., & Pareja-Galeano, H. (2020). Metabolic impacts of confinement during the COVID-19 pandemic due to modified diet and physical activity habits. *Nutrients, 12*(6). https://doi.org/10.3390/nu12061549

Mazza, C., Ricci, E., Biondi, S., Colasanti, M., Ferracuti, S., Napoli, C., & Roma, P. (2020). A nationwide survey of psychological distress among Italian people during the COVID-19 pandemic: Immediate psychological responses and associated factors. *International Journal of Environmental Research on Public Health, 17*(9). https://doi.org/10.3390/ijerph17093165

Mikalsen, H.K., Bentzen, M., Safvenbom, R., & Lagestad, P.A. (2020). Trajectories of physical activity among adolescents in the transition from primary to secondary school. *Frontiers in Sports and Active Living, 2*, 85. https://doi.org/10.3389/fspor.2020.00085

Ministry for School and Education of the State of North Rhine-Westphalia (2021). Das Schulwesen in Nordrhein-Westfalen aus quantitativer Sicht 2020/21. Statistische Übersicht Nr. 413. Retrieved from https://www.schulministerium.nrw/system/files/media/document/file/quantita_2020.pdf

Moore, S.A., Faulkner, G., Rhodes, R.E., Brussoni, M., Chulak-Bozzer, T., Ferguson, L.J., ... Tremblay, M.S. (2020). Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: a national survey. *International Journal of Behavioral Nutrition and Physical Activity, 17*(1), 85. https://doi.org/10.1186/s12966-020-00987-8

Munasinghe, S., Sperandei, S., Freebairn, L., Conroy, E., Jani, H., Marjanovic, S., & Page, A. (2020). The impact of physical distancing policies during the COVID-19 pandemic on health and well-being among Australian adolescents. *Journal of Adolescent Health, 67*(5), 653–661. https://doi.org/10.1016/j.jadohealth.2020.08.008

Navarro, J., Escobar, P., Miragall, M., Cebolla, A., & Banos, R.M. (2020). Adolescent motivation toward physical exercise: The role of sex, age, enjoyment, and anxiety. *Psychological Reports*, 33294120922490. https://doi.org/10.1177/0033294120922490

Parker, K.E., Salmon, J., Costigan, S.A., Villanueva, K., Brown, H.L., & Timperio, A. (2019). Activity-related behavior typologies in youth: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 16*(1), 44. https://doi.org/10.1186/s12966-019-0804-7

Pietrobelli, A., Pecoraro, L., Ferruzzi, A., Heo, M., Faith, M., Zoller, T., Antoniazzi, F., Piacentini, G., Fearnbach, S.N., Heymsfield, S.B. (2020). Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: A longitudinal study. *Obesity (Silver Spring), 28*(8), 1382–1385. https://doi.org/10.1002/oby.22861

Pigaiani, Y., Zoccante, L., Zocca, A., Arzenton, A., Menegolli, M., Fadel, S., Ruggeri, M., Colizzi, M. (2020). Adolescent lifestyle behaviors, coping strategies and subjective wellbeing during the COVID-19 pandemic: An online student survey. *Healthcare (Basel), 8*(4). https://doi.org/10.3390/healthcare8040472

Poitras, V.J., Gray, C.E., Borghese, M.M., Carson, V., Chaput, J.P., Janssen, I., Katzmarzyk, P.T., Pate, R.R., Connor Gorber, S., Kho, M.E., Sampson, M., & Tremblay, M.S. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiologiy, Nutrition, and Metabolism, 41*(6 Suppl 3), S197–239. https://doi.org/10.1139/apnm-2015-0663

Poulain, T., Peschel, T., Vogel, M., Jurkutat, A., & Kiess, W. (2018). Cross-sectional and longitudinal associations of screen time and physical activity with school performance at different types of secondary school. *BMC Public Health, 18*(1), 563. https://doi.org/10.1186/s12889-018-5489-3

Qiu, J., Shen, B., Zhao, M., Wang, Z., Xie, B., & Xu, Y. (2020). A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: implications and policy recommendations. *Gen Psychiatr, 33*(2), e100213. https://doi.org/10.1136/gpsych-2020-100213

Rosario, A.S., Kurth, B.M., Stolzenberg, H., Ellert, U., & Neuhauser, H. (2010). Body mass index percentiles for children and adolescents in Germany based on a nationally representative sample (KiGGS 2003–2006). *European Journal of Clin Nutr, 64*(4), 341–349. https://doi.org/10.1038/ejcn.2010.8

Saunders, T.J., Gray, C.E., Poitras, V.J., Chaput, J.P., Janssen, I., Katzmarzyk, Olds T., Connor Gorber, S., Kho, M.E., Sampson, M., Tremblay, M.S., Carson, V. (2016). Combinations of physical activity, sedentary behaviour and sleep: relationships with health indicators in school-aged children and youth. *Applied Physiologiy, Nutrition, and Metabolism, 41*(6 Suppl 3), S283–293. https://doi.org/10.1139/apnm-2015-0626

Schmidt, S., Will, N., Henn, A., Reimers, A., & Woll, A. (2020). Der Motorik-Modul Aktivitätsfragebogen MoMo-AFB – Leitfaden zur Anwendung und Auswertung [translation please]. *KIT Scientific Working Papers*, *53*. Retrieved from https://publikationen.bibliothek.kit.edu/1000062199

Schmidt, S., Will, N., & Woll, A. (2015). [Physical activity of German children and adolescents in sports clubs and at school. The Motor Module Study (MoMo).]. *sportunterricht*, *65*, 233–238. ISSN: 0342-2402.

Schmidt, S.C.E., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., Niessner, C., Oriwol, D., Worth, A., Woll, A. (2020). Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Scientific Reports, 10*(1), 21780. https://doi.org/10.1038/s41598-020-78438-4

Schmidt, S.C.E., Anedda, B., Burchartz, A., Oriwol, D., Kolb, S., Wäsche, H., Niessner, C., Woll, A. (2020). The physical activity of children and adolescents in Germany 2003–2017: The MoMo-study. *PLoS One, 15*(7), e0236117. https://doi.org/10.1371/journal.pone.0236117

Stanton, R., To, Q.G., Khalesi, S., Williams, S.L., Alley, S.J., Thwaite, T.L., Fenning, A.S., Vandelanotte, C. (2020). Depression, anxiety and stress during COVID-19: Associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *International Journal of Environmental Research on Public Health*, *17*(11). https://doi.org/10.3390/ijerph17114065

Stverakova, T., Jacisko, J., Busch, A., Safarova, M., Kolar, P., & Kobesova, A. (2021). The impact of COVID-19 on physical activity of Czech children. *PLoS One, 16*(7), e0254244. https://doi.org/10.1371/journal.pone.0254244

Suchert, V., Hanewinkel, R., Isensee, B., & lauft Study, G. (2015). Sedentary behavior, depressed affect, and indicators of mental well-being in adolescence: Does the screen only matter for girls? *J Adolesc, 42*, 50–58. https://doi.org/10.1016/j.adolescence.2015.03.014

Talevi, D., Socci, V., Carai, M., Carnaghi, G., Faleri, S., Trebbi, E., ... Pacitti, F. di Bernardo, A., Capelli, F., Pacitti, F. (2020). Mental health outcomes of the CoViD-19 pandemic. *Rivista di Psichiatria, 55*(3), 137–144. https://doi.org/10.1708/3382.33569

Waldhauer, J., Kuntz, B., & Lampert, T. (2018). [Differences in subjective health, mental health, and health behavior among 11- to 17-year-olds at secondary schools in Germany: Results of the German Health Interview and Examination Survey for Children and Adolescents: First follow-up (KiGGS Wave 1)]. *Bundesge-*

sundheitsblatt Gesundheitsforschung Gesundheitsschutz, 61(4), 374–384. https://doi.org/10.1007/s00103-018-2704-4

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C.S., & Ho, R.C. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 Coronavirus disease (COVID-19) epidemic among the general population in China. *International Journal of Environmental Research on Public Health, 17*(5). https://doi.org/10.3390/ijerph17051729

Weaver, R.G., Beets, M.W., Perry, M., Hunt, E., Brazendale, K., Decker, L., Turner-McGrievy, G., Pate, R., Youngstedt, SD., Saelens, BE., Maydeu-Olivares, A. (2019). Changes in children's sleep and physical activity during a 1-week versus a 3-week break from school: a natural experiment. *Sleep*, *42*(1). https://doi.org/10.1093/sleep/zsy205

WHO. (2010). Global recommendations on physical activity for health. Author. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/44399/9789241599979_eng.pdf?sequence=1

WHO. (2020). Assessing national capacity for the prevention and control of noncommunicable diseases. Report of the 2019 Global Survey. Author. Retrieved from https://apps.who.int/iris/bitstream/handle/10665/331452/9789240002319-eng.pdf

Wu, X.Y., Han, L.H., Zhang, J.H., Luo, S., Hu, J.W., & Sun, K. (2017). The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: A systematic review. *PLoS One, 12*(11), e0187668. https://doi.org/10.1371/journal.pone.0187668

Wunsch, K., Nigg, C., Niessner, C., Schmidt, S.C.E., Oriwol, D., Hanssen-Doose, A., Burchartz, A., Eichsteller, A., Kolb, S., Worth, A., Woll, A. (2021). The impact of COVID-19 on the interrelation of physical activity, screen time and health-related quality of life in children and adolescents in Germany: Results of the Motorik-Modul Study. *Children (Basel)*, *8*(2). https://doi.org/10.3390/children8020098

Xiang, M., Zhang, Z., & Kuwahara, K. (2020). Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. *Progress in Cardiovascular Diseases, 63*(4), 531–532. https://doi.org/10.1016/j.pcad.2020.04.013

Zhang, X., Zhu, W., Kang, S., Qiu, L., Lu, Z., & Sun, Y. (2020). Association between physical activity and mood states of children and adolescents in social isolation during the COVID-19 epidemic. *International Journal of Environmental Research on Public Health, 17*(20). https://doi.org/10.3390/ijerph17207666

Zhou, J., Yuan, X., Qi, H., Liu, R., Li, Y., Huang, H., ... Wang, G. (2020). Prevalence of depression and its correlative factors among female adolescents in China during the coronavirus disease 2019 outbreak. *Global Health, 16*(1), 69. https://doi.org/10.1186/s12992-020-00601-3

History
Manuscript submitted: 24.08.2021
Accepted after revision: 28.01.2022
Published online: 28.03.2022

Conflicts of interests
No conflicts of interest exist.

Acknowledgments
We thank all participants for taking part in the survey.
We acknowledge the continuous support of Uwe Eisenberg and Thomas Michel (Münster District Government).

Funding
Open access publication enabled by the University of Münster.

ORCID
Manuel Föcker
0000-0002-4783-6265

PD Dr. Manuel Föcker
Department of Child and Adolescent Psychiatry
University Hospital Münster
Schmeddingstraße 50
48149 Münster
Germany

manuel.foecker@ukmuenster.de