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Brief Report

Associations of Voluntary Exercise and Screen Time during the First Wave of COVID-19 Restrictions in Japan with Subsequent Grip Strength among University Students: J-Fit$^+$ Study

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Abstract: This study aimed to examine the combined effect of voluntary exercise and screen time during the first wave of the coronavirus disease 2019 (COVID-19) restrictions on subsequent grip strength among health and sports science students in Japan. The participants performed grip strength tests and had their weight assessed on 21 October 2020. Furthermore, they completed an online survey between 21 October and 28 October 2020, which included participants' current age, height, voluntary exercise, and screen time during the first wave of the COVID-19 pandemic (April and May 2020). In total, 380 participants provided complete data (mean age ± standard deviation [SD]: 18.8 ± 0.6 years; 233 males). Our results revealed that 87.6% of male students and 84.4% of female students performed voluntary exercise >1 day/week during the first wave of the pandemic. Moreover, 21.5% of male students and 23.1% of female students had >8 h/day of screen time. A trend toward greater grip strength was observed for both male and female students with high voluntary exercise and low screen time. In particular, grip strength ($p < 0.05$) was significantly greater in male students with high voluntary exercise and low screen time than those with low voluntary exercise and high screen time. In conclusion, this study revealed that during the first wave of COVID-19 restrictions, a combination of high voluntary exercise and low screen time positively affected the subsequent grip strength of health and sports science students.

Keywords: voluntary exercise; screen time; physical fitness; university student; health behaviors; grip strength; COVID-19

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1. Introduction

It is well-known that grip strength is an important predictor of people's physical health. Therefore, recently, there has been increased interest in the relationship between COVID-19 infection and grip strength. Previous studies show that the grip strength of community-dwelling older adults before and after infection with COVID-19 decreased significantly [1]. Additionally, a recent study on the predictors of disease severity in hospitalized COVID-19 patients has shown that low grip strength independently increased COVID-19 severity [2]. At the same time, previous studies have also shown that in young and middle-aged individuals, grip strength is a powerful predictor of future coronary heart disease, cardiovascular disease, all-cause death, and premature death [3–5]. Therefore, it is important to understand how drastic changes in lifestyle caused by the COVID-19 pandemic affect the grip strength of young people.

Since the World Health Organization declared the COVID-19 a global pandemic on 11 March 2020, the Japanese government has declared more than one state of emergency in some regions or across the country [6–8] to effectively curb the spread of the virus, the first of which was from 7 April to 25 May 2020. Japan and various countries and regions worldwide have adopted various control measures, including restricting travel and social contact. This has led to far-reaching changes in people's lifestyles, affecting every aspect of global life.

Previous data indicated a significant decrease in step counts [9] and physical activities [10–14] during COVID-19 confinement. In particular, prolonged control measures and restrictions, especially closure of schools, gymnasiums, and exercise facilities, obviously reduced the opportunities for students to participate in exercise and lead an active lifestyle. One study investigated physical activity changes in Spanish university students before and during the COVID-19 confinement and showed that moderate physical activity decreased by 29.5% and vigorous physical activity decreased by 18.3% [15]. A study using data from Italian undergraduate students also showed that all physical activities significantly reduced during the lockdown [16]. Another Australian study showed that the number of university students who achieved sufficient activity levels during the COVID-19 pandemic decreased by approximately 30% [17]. The decrease in physical activities caused by the long-term stay at home orders has led to the emergence of physical health issues [18]. Therefore, experts recommend voluntary exercise at home during the COVID-19 pandemic to offset the threat to health caused by the decrease in physical activity [19,20]. On the other hand, screen time significantly increased [11,14,21,22], especially among young people [23], during the COVID-19 pandemic. Recent studies have shown the negative effect of screen time on mental health during the COVID-19 restrictions [23,24]. Furthermore, a negative correlation has been found between smartphone usage duration and grip strength among young people [25]. Therefore, the grip strength of young people may be affected by the decrease in physical activity and the increase in screen time caused by COVID-19 confinement.

However, the focus of previous studies was during COVID-19 confinement. Whether physical activity is significantly reduced and screen time significantly increased, the impact of changes in exercise habits and lifestyles on physical fitness during COVID-19 has been largely unnoticed. Furthermore, most tests of physical fitness were performed with minimal physical contact between the measurer and the participant. The COVID-19 pandemic has focused attention on how best to minimize infection risk during the performance of physical function tests [26]. Therefore, after the COVID-19 pandemic, there have been almost no reports on physical fitness, except for those focusing on COVID-19 patients who survived hospitalization [27]. When we understand the physical fitness level of young people during COVID-19, and identify the effect of exercise habits and lifestyles on their physical fitness, stakeholders in public health can utilize the findings for policymaking and prevention of health problems during and after COVID-19. Our study group has implemented a physical fitness and lifestyle survey every October among university students who belong to a department of health and sports science in Japan [28]. This provides us the opportunity to explore the effects of reduced physical activity and increased screen time on grip strength during the first wave of the COVID-19 restrictions.

Therefore, we aimed to evaluate the combined effects of voluntary exercise and screen time during the first wave of the COVID-19 restrictions on subsequent grip strength in young people. Specifically, we investigated the voluntary exercise (i.e., number of times per week) and screen time (i.e., average screen time per day) of young people during the first wave of the COVID-19 restrictions. Additionally, we examined the combined effects of voluntary exercise and screen time on grip strength. We hypothesized that good lifestyle habits during the COVID-19 pandemic, including voluntary exercise at home and less screen time may have beneficial effects on grip strength.

2. Materials and Methods

2.1. Design and Procedure

Our study group has implemented annual physical fitness and lifestyle surveys since 1969 for all students who belong to a faculty of physical education/health and sports science in Juntendo University, Japan. We accumulated physical fitness data of approximately 10,000 university students up until 2020. This study was officially launched by Professor Toshiro Azuma, the Dean of the faculty in 1969, after some preliminary studies from 1958 to 1968 [29]. According to his report [29], the study was designed to understand the status of physical fitness, the secular trends of physical fitness, and the health benefits of physical activity and fitness through long-term tracking. In 2016, we newly named this study "J-Fit^{+} Study" (https://www.juntendo.ac.jp/jfit/en/, accessed on 3 December 2021) and conducted an alumni health survey in 2017 and 2018. The results of the historical cohort study are already published in some scientific journals [30–34].

In 2020, to prevent the spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, the physical fitness testing targets of the J-Fit^{+} Study only included the first-year students, and infection preventive measures were taken [28]. To limit the exposure time between the measurer and participant, the number of people entering the gymnasium, and the time taken to enter the gymnasium, the tests were incompletely performed. Compared to previous years, only a small number of physical fitness tests were conducted on 21 October 2020, at the university gymnasium, such as weight and grip strength.

2.2. Study Population

The sample of this study included all 419 (166 female students, 39.6%) first-year Japanese university students in the Department of Health and Sports Science of our university. They voluntarily chose to participate in the physical fitness tests and provided informed consent. Individuals who did not participate in the physical fitness and motor ability tests (n = 29) and who did not provide informed consent (n = 10) were excluded. Finally, 380 individuals (147 female students) were eligible for the analysis.

2.3. Grip Strength

Participants underwent a grip strength test as per methods previously described [33,35]. The specific test method is as follows: The grip strength of both hands was measured using a well-adjusted and correct grip dynamometer (T.K.K. 5401, Takei Scientific Instruments Co., Ltd. Niigata, Japan) with the participant in the standing position, and their feet slightly apart. Participants were told to keep the grip dynamometer away from any part of their body and encouraged to exert maximal grip effort. The better result of two trials for each hand was recorded, and the better records on the left and right hand were averaged.

2.4. Survey Questionnaires

We invited all undergraduate students from the Department of Health and Sports Science at our university to participate in an online questionnaire survey from 21 October to 28 October 2020. The content of the online questionnaire included age, height, voluntary exercise, and screen time. Only first-year students underwent the physical fitness tests, so only their response data were used in this study.

Questions on voluntary exercise, similar to previous research [36], was assessed using the following question: "What is the mean frequency of your voluntary exercise (day/week) during the COVID-19 emergency (April and May)?" Voluntary exercise in the present study was defined as any exercise/sports other than organized sports at school or in sports clubs. In addition, all organized sports were halted due to the closure of schools, gymnasiums, and exercise facilities required during the COVID-19 emergency (April and May) in Japan. We divided the participants into high and low voluntary exercise groups based on the median of their responses.

Information on screen time, similar to that of another study [37], was assessed by asking the following question: "What was your screen time (television, smartphones, computers, games, and so on) (hours/day) during the COVID-19 emergency before university classes started (1 April to 11 May)?" The answer was set to one decimal place. The first wave of COVID-19 restrictions was lifted on 22 May, but the survey period was from 1 April to 11 May to exclude the effects of university online classes that started on 11 May. Additionally, we divided the participants into high and low screen time groups based on the median of responses.

According to the grouping of voluntary exercise and screen time, participants were divided into the following four groups [38]: (1) High voluntary exercise/Low screen time; (2) High voluntary exercise/High screen time; (3) Low voluntary exercise/Low screen time; (4) Low voluntary exercise/High screen time (the reference group).

2.5. Statistical Analysis

First, we used descriptive statistics and calculated the frequencies and percentages for categorical variables; means ± standard deviation [SD] were calculated for continuous variables (Table 1). Next, one-way analysis of covariance (ANCOVA) adjusted for height and weight was used to test whether combinations of voluntary exercise and screen time during the first wave of COVID-19 restrictions were associated with subsequent grip strength by sex. If a significant difference was found in the ANCOVA, Bonferroni's correction was performed as a post hoc test. Although the primary purpose of this study was to examine the associations between combinations of voluntary exercise and screen time during the first wave of COVID-19 restrictions with subsequent grip strength, we also used Student's *t* test (*t*-test) and ANCOVA adjusted for height and weight to examine the relationship between voluntary exercise (high and low) and grip strength (Table S1), as well as between screen time (high and low) and grip strength (Table S2). Finally, SPSS v21.0 (IBM Corp, New York, NY, USA) was used for all statistical analyses, with the statistical significance level set at $p < 0.05$.

Table 1. Descriptive characteristics of the participants.

	All (n = 380)			Male (n = 233)			Female (n = 147)		
Age (years)	18.8	±	0.6	18.8	±	0.7	18.6	±	0.5
Height (cm)	168.3	±	8.8	173.3	±	5.9	160.4	±	6.7
Weight (kg)	62.8	±	12	68.3	±	11.4	54.1	±	6.4
BMI (kg/m^2)	22.1	±	3	22.7	±	3.3	21	±	2.1
Grip strength (kg)	38.2	±	10.1	44.6	±	6.8	28.1	±	4.9
Voluntary exercise (n, %)									
0 days	52	(13.7)		29	(12.4)		23	(15.6)	
1–2 days	75	(19.7)		34	(14.6)		41	(27.9)	
3–4 days	106	(27.9)		66	(28.3)		40	(27.2)	
≥5 days	147	(38.7)		104	(44.6)		43	(29.3)	
Screen time (n, %)									
<2.0 h	15	(3.9)		13	(5.6)		2	(1.4)	
2.0–3.9 h	94	(24.7)		66	(28.3)		28	(19.0)	
4.0–5.9 h	118	(31.1)		65	(27.9)		53	(36.1)	
6.0–7.9 h	69	(18.2)		39	(16.7)		30	(20.4)	
≥8.0 h	84	(22.1)		50	(21.5)		34	(23.1)	

Data were described as mean ± standard deviation or n (%); BMI: body mass index.

3. Results

3.1. Descriptive Data of Participants

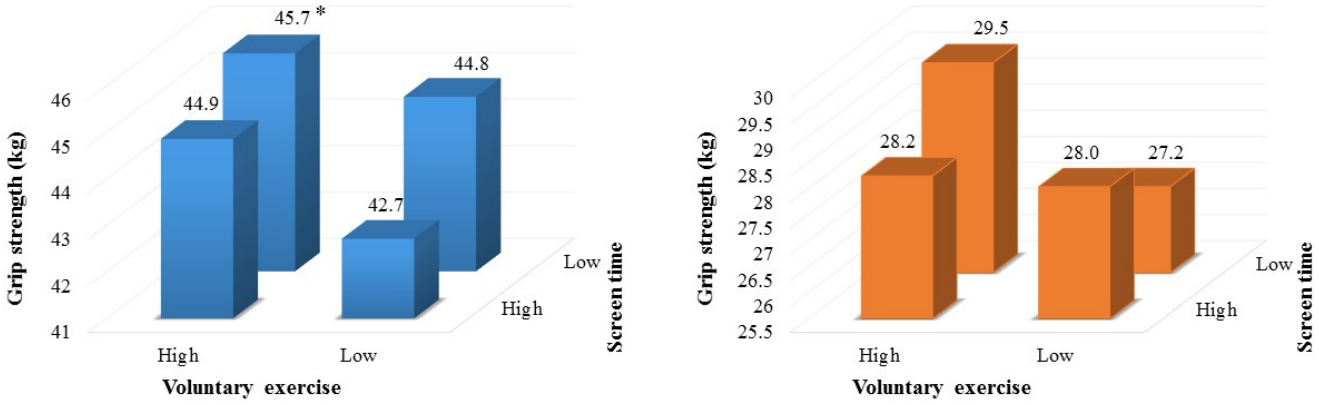
The study participants' voluntary exercise and screen time characteristics are presented in Table 1. In total, 380 individuals (mean age 18.8 ± 0.6 years, 147 female students) participated in and completed the tests. Among the male students, during the first wave of the COVID-19 emergency in Japan, the prevalence of voluntary exercise of >1 day and screen time of >8.0 h was 204 (87.6%) and 50 (21.5%), respectively. Among the female students, during the first wave of the COVID-19 emergency in Japan, the prevalence of

voluntary exercise of >1 day and screen time of >8.0 h was 124 (84.4%) and 34 (23.1%), respectively.

3.2. Association of Combinations of Voluntary Exercise and Screen Time during the First Wave of COVID-19 Restrictions with Subsequent Grip Strength

As shown in Figure 1, male and female students with High voluntary exercise/Low screen time tended to have greater grip strength than those in other groups; however, only male students with High voluntary exercise/Low screen time had significantly greater grip strength than those with Low voluntary exercise/High screen time (Figure 1 and Supplementary Materials, Table S3).

The analysis results of voluntary exercise and screen time as separate variables are presented in Supplementary Materials (Tables S1 and S2). No difference was found between different voluntary exercise (High/Low) and grip strength in female students; however, male students with voluntary exercise of ≥5 days/week had significantly greater grip strength than those with voluntary exercise of ≤4 days/week (Table S1). No significant differences were observed in different screen time (High/Low) for grip strength between male and female students (Table S2).



Male students Female students

Figure 1. Difference in grip strength according to combined categories of voluntary exercise (High or Low) and screen time (High or Low). Data were described as mean. One-way ANCOVA adjusted for height and weight was performed to examine the differences among the groups. * Significant differences between High voluntary exercise/Low screen time group and Low voluntary exercise/High screen time group ($p < 0.05$) in male students; there are no post hoc differences in female students.

4. Discussion

The present study examined the combined effects of voluntary exercise and screen time during the first wave of COVID-19 restrictions on subsequent grip strength among university students from the Department of Health and Sports Science in Japan. The major finding of this study is that the combination of high voluntary exercise and low screen time was consistently associated with greater grip strength, especially in male students. These findings show that university students' grip strength after the first wave of COVID-19 restrictions may have been influenced by voluntary exercise and screen time during the first wave of COVID-19 restrictions. These findings supported our hypothesis that maintaining good lifestyle habits (higher voluntary exercise at home and less screen time) during the COVID-19 pandemic may bring benefits to grip strength. Additionally, we found that 328 (86.3%) participants performed voluntary exercise for >1 day/week and 84 (22.1%) participants had screen time of >8 h/day during the first wave of COVID-19 restrictions among the university students.

Our data showing that 328 (86.3%) participants who performed voluntary exercise of >1 day/week during the first wave of COVID-19 restrictions are comparable to the findings of previous research. Previous studies demonstrated that respondents reported increased

frequency of and time spent in non-organized physical activities during the COVID-19 pandemic [14,39]. These findings demonstrate that despite the closure of schools and sports clubs preventing organized physical activity, non-organized voluntary physical activities increased. At the same time, previous studies from various countries and regions showed that screen time significantly increased during the COVID-19 pandemic [11,14,21,22]. Further, in younger people aged 18–34 years, the screen time per day was 8.8 ± 3.7 h in the UK during the COVID-19 social distancing measures [23]. The results of our study were consistent with those of previous studies.

The present study also showed that during the first wave of COVID-19 restrictions in Japan, a good lifestyle that combines higher voluntary exercise at home and less screen time is important for grip strength. However, due to potential confounding factors, such as the intensity and type of voluntary exercise, we need to interpret these results cautiously. Romero-Blanco et al. [40] recently observed that the lockdown caused an increase in both the number of days on which students engaged in physical activity and the total number of minutes of physical activity per week among health science students, probably because their habit of exercising regularly influenced their decision to exercise at home, which is supported by the present results. In addition, an international online survey of 18 countries and regions showed that endurance, muscular strength, and multimodal exercise were the most popular types of exercise during the initial COVID-19 restrictions [41]. Rodríguez-Larrad et al. [15] also reported that during the COVID-19 confinement, time spent by university students on moderate and vigorous physical activity reduced; however, time spent on high intensity interval training (HIIT) increased. Although we did not investigate the voluntary exercise type and intensity of the participants in this study, we believe that the results may be the same for our participants. Molina-Hidalgo et al. [42] reported grip strength clinical improvements after 10 weeks of HIIT intervention among young healthy people. On the other hand, Osailan et al. [25] examined the relationship between smartphone use duration and grip strength and pinch-grip strength among young people and found that prolonged use of smartphones (screen time) was associated with weaker grip strength; conversely, shorter smartphone use (screen time) was associated with greater grip strength. However, this relationship is weak, and we believe it may be due to the failure to consider physical activity as a confounding factor. Thus, our study results support the possibility that during the COVID-19 pandemic, maintaining good lifestyle habits (higher voluntary exercise at home and less screen time) are important for grip strength and that increased voluntary exercise at home with reduced screen time is necessary to maintain good health.

In the current study, we did not observe that screen time during the first wave of COVID-19 restrictions affected grip strength after this period in young people. However, a previous study suggested that prolonged use of smartphones was associated with weaker grip strength among young people [25] and that screen time may be a factor associated with weaker grip strength. There are differences between our study and the previous study findings. This difference may be due to the significant increase in screen time of young people due to the COVID-19 restrictions. Our data also supports this hypothesis. Governments and related organizations recommend a screen time of no more than 2 h/day [43,44]. It is noteworthy that in our research participants, 94.4% of male students and 98.6% of female students exceeded this standard requirement.

Although we found that during the first wave of COVID-19 restrictions, the combination of high voluntary exercise and low screen time tended to have better grip strength compared with other groups, and among female students, this effect was smaller. In addition, we also found that high voluntary exercise did not bring additional grip strength benefits to female students. First, the reason for this result may be that the sample size of female students was smaller than that of male students. Further, a previous study reported that younger women's menstrual cycles are related to grip strength, which will decrease in the early follicular period [45]. Female students must have been at different phases of the

menstrual cycle when participating in the grip strength test, which may have caused the grip strength value to be affected. This may also be a confounding factor for our results.

Strengths and Limitations

The main strength of this study is its novelty; this study is the first to examine the combined effect of voluntary exercise and screen time during the first wave of COVID-19 restrictions on grip strength. The data of health and sports science students were collected during the pandemic. However, some limitations should also be considered. First, it is not possible to hold a large event during the COVID-19 pandemic; thus, the grip strength (physical fitness tests) and surveys were conducted 5 months after the cancellation of the first wave of COVID-19 restrictions in Japan (25 May 2020); thus, we could not rule out this time gap's influence on the results. Additionally, a self-administered questionnaire was used to evaluate voluntary exercise and screen time, which may have recall bias. Therefore, future studies based on objective assessment of voluntary exercise and screen time data are required to clarify this relationship. Second, regarding voluntary exercise, we did not investigate the detailed exercise content, intensity, or time. Moreover, since the sample size of the survey respondents was small, we did not examine whether voluntary exercise can reduce the adverse effects of screen time. However, this should be considered in future studies. Third, participants in this study are health and sports science students; thus, whether the results can be generalized to other populations needs to be confirmed.

5. Conclusions

The combination of high voluntary exercise and low screen time during the first wave of COVID-19 restrictions seems to be positively associated with subsequent grip strength. In particular, individuals with high voluntary exercise and low screen time tended to have greater grip strength than those with low voluntary exercise and high screen time in male students. These results indicate that increasing the number of home voluntary exercises and reducing screen time during restrictions may effectively maintain grip strength. Governments, schools, and families need to take necessary interventions to manage the positive effects of voluntary exercise and negative effects of screen time during the COVID-19 pandemic on university students. For example, targeted encouragement of university students to actively exercise at home and reduce screen time and to maintain a healthy lifestyle during the restrictions must be undertaken.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su132413648/s1, Table S1: Difference in grip strength according to the voluntary exercise, Table S2: Difference in grip strength according to the screen time, Table S3: Difference in grip strength according to combination of voluntary exercise and screen time.

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Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Data Availability Statement: The data used in the current study are available from the corresponding authors.

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