【Original Article】

Relationship Between Physical Activity and Mental Health of Elementary School Children During COVID-19 Pandemic

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Abstract

We analyzed relationship between physical activity and mental health using physical activity level with Tri-axial accelerometers, salivary cortisol and mental health for elementary school children during COVID-19 pandemic.

The participants of this study were 32 students enrolled in an elementary school in Kyoto city, and the survey was conducted for three weeks including weekends. Physical activity [Step count (SC),Sedentary time (ST), which included sleep duration, Light-intensity physical activity (LPA), and Moderate-to-vigorous physical activity (MVPA)] was recorded for two weeks using a tri-axial accelerometers. Stress hormone (cortisol) obtained from saliva was analyzed to assess stress and collected by the participants themselves at home one hour before bedtime. At the same time as saliva collection, mental health was evaluated using the Mental Health Checklist for Children, which is comprised of four factors: Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness.

The results showed that the mental stress level was not so high during the study time period. However, significant and negative correlations were confirmed between ST and Irritability-Anger in the second and third weeks, as well as a tendency for a negative correlation between ST and Helplessness in the third. In addition, at the second and third weeks, a positive correlation was shown between light intensity physical activity (LPA) and the Irritability-Anger and Helplessness.

The results suggested that the temporary increase in ST may have functioned to control the Irritability-Anger and Helplessness feelings. This is specific to COVID-19, as the results of the children in this study differ from previous studies examining ST and mental health in adults.

Key words: COVID-19; Sedentary time; Light-intensity physical activity; Moderate-to-vigorous physical activity; Cortisol

要　旨

COVID-19パンデミック時の小学生を対象に，三軸加速度計による身体活動量，唾液中コルチゾール，メンタルヘルスを用い，身体活動とメンタルヘルスの関係を分析した．

調査対象者は，京都市内の小学校に在籍する児童32名で，調査は週末を含む3週間行った．身体活動量［歩数（SC），睡眠時間を含む在床時間（ST），軽強度の身体活動（LPA），中・高強度の身体活動（MVPA）］は3軸加速度計を用いて2週間記録した．ストレスを評価するために唾液から得られたストレスホルモン（コルチゾール）を分析し，就寝1時間前に自宅で被験者自身が採取した．唾液の採取と同時に，4つの要素からなる「子どものためのメンタルヘルスチェックリスト」を用いて心の健康状態を評価した．「身体症状」「抑うつ-不安」「イライラ-怒り」「無力感」の4つの要素で構成されていた．

調査期間中の精神的ストレス度はそれほど高くなかったが，2週目，3週目に示した身体活動量と精神的ストレス度の相関については，STとイライラ-怒りの因子が負の相関，STと無力感の因子が負の相関の傾向を示していることが判明した．また，2週目，3週目では，高強度身体活動（LPA）とイライラ-怒り，無力感の間に正の相関が示された．

この結果から，STの一時的な増加がイライラ-怒りと無力感の感情を制御するために機能したと考える．これらの子どもの結果は，従来の成人を対象とした研究結果と異なりCOVID-19に特有のものであった．

Ⅰ Background

Along with the spread of COVID-19 in Japan, a serious problem has arisen as a secondary wave of this threat to health in the daily life of the citizens of the country. The National Center for Geriatrics and Gerontology (Yamada, 2020) conducted a study on the actual physical activity time spent per day using 1,600 elderly participants aged from 65 to 84 years-old (average age 74 years-old) living in the Tokyo metropolitan areas well as in various prefectures, including Kanagawa, Chiba, Saitama, Aichi, Osaka, Hyogo, and Fukuoka. The results of that study showed that, compared with January of 2020 (before the spread of COVID-19), the physical activity time spent per week during April of 2020 (during the spread of COVID-19) was decreased by 60 minutes (about 30%). In addition, another study on this subject was conducted by the University of Tsukuba (Tanaka, 2020), using 100 participants (with an average age of 48 years-old) working at a Tokyo office of the Tanita Corporation, a company based in Kyushu producing health-care equipment. The results of this study showed that workers who had changed over to telecommuting (working at home) showed a 29% percent reduction in the average daily step count, clarifying that the length of sedentary behavior had increased.

Furthermore, we have seen some evidence showing that since April of 2020, there has been a reduction in the physical activity level associated with students, ranging from elementary schools through universities. In another study using a total of 3,513 participants, including 441 lower-grade elementary school students, 397 mid-grade elementary school students, 360 higher-grade elementary school students, 436 junior high school students, 270 high school students, as well as 1,609 university and graduate students, Ogawa & Yoshida (2020), reported that 81.7% of the participants showed a reduction in the physical activity level, and that 73.2% felt that exercise had been reduced. That report continued to say that, in fact, due to the pandemic, 77.4% of the associated school clubs had discontinued their activities, and exercise activity conducted both outside, and in the gymnasium, had seen a sudden decrease, resulting in a reduction in the physical activity level. The results of one study showed that the elementary school children under a declared state of emergency, the number of steps taken was 9,912 (Mitsuishi, Maeda, Matsuki, Murakami & Aoki, 2020). This was approximately 3,000 steps less than the target of 12,500 to 13,000 steps in the previous study (Hanawa & Noi, 2018). Accordingly, it can be considered that, similar to adults, there has also been a large decrease in the physical activity level

of children. In this regard, it can be said that the spread of COVID-19 has caused a large decrease in the physical activity level, regardless of the age-range studied.

Going beyond the effect on the physical activity level, COVID-19 has also been responsible for a negative effect on mental health. The Ministry of Health, Labour and Welfare (2020) has posted a notice titled "About the performance of mental health-care related to infections of COVID-19," and along with that information, the Ministry has stressed the importance of mental health-care for both adults and children. Especially, mental stress related to COVID-19, such as anxiety, tension, and self-quarantine in daily life, has caused many cases of fatigue and exhaustion, and even children are not exceptions. Juntendo University (Naito & Suzuki, 2020) and Kao Corporation conducted a questionnaire study targeting parents, and the results showed that many parents felt that COVID-19 has caused stress in their children due to the self quarantine required by government during the spread of the virus. The results of that study clearly showed that about 50% of the participants felt that their children had suffered a reduction in the physical activity level, and that their children felt anxiety and a breakdown in the rhythm of daily life. As shown above, the physical activity level is a very important factor in the mental health of children, and along with the advent of COVID-19, no doubt improving children's physical activity levels during and after COVID-19 will become even more essential.

We analyzed relationship between physical activity and mental health using physical activity level with Tri-axial accelerometers, salivary cortisol and mental health (questionnaire survey) for elementary school children during the COVID-19 pandemic. The present study was conducted to overcome the lack of important information on the actual physical activity level of students and the effect on their mental health given the lack of evidence after the advent and spread of COVID-19, a time period in which many children had to spend much more time at home than usual, with an accompanying loss of play space and exercise opportunities.

II Method

1. Participants and the measurement time period

The participants of this study were sixth grade students (77 students: age 11.24±0.43) enrolled in T Elementary School in Kyoto City, and the survey was conducted for three weeks including weekends. Parents (or legal guardians) were asked to cooperate in the study, and the methods employed for the study were explained using handouts and videos. Among the children who participated in the survey, analysis indicators (physical activity level, salivary cortisol and mental health) were available for 32 students (18 boys and 14 girls) and these participants were included in the analysis.

This study was conducted for three weeks (June 8th to June 26th, 2020). All students attended school on June 12, during the period from June 8th to June 11th, divided into two groups within a class: those attending on June 8th and 10th, and those on June 9th and 11th. From the 22nd to the 26th, three days (22nd, 25th, 26th) were six-hour classes, and two days (23rd, 24th) were seven-hour classes. Physical education classes were held on June 16th and 25th (Table 1).

2. Physical Activity Level

Physical activity was recorded for three weeks using Tri-axial accelerometers (made by Panasonic), which have been validated for measuring the daily physical activity of elementary school children (Yamada, Yokoyama, Noriyasu, Osaki, Adachi, Itoi, & Naito, 2009; Yamada, Yamagata, Yokoyama, Okayama, & Kimura, 2012). The use of activity meters with built-in accelerometers (hereafter referred to as accelerometers) is less costly and less burdensome for subjects than the doubly labeled water (DLW) method. Furthermore, it is easier to introduce into human participants studies than pedometer or questionnaire methods because of its higher validity and reliability (Sasai, Hikihara, Okazaki, Nakata & Ohkawara, 2015). In addition, the use of Tri-axial accelerometers makes it possible to identify children's activity patterns as daily activities, walking, and running, and to validate their daily physical activity levels (Oshima, Nakae, Yamada, Kimura, Ozawa, Suzuki, Hirakawa & Ishii, 2013). The Tri-axial accelerometers was worn in a small

Table 1. Class hours and number of children who attended each class

Date	Class hours	A		B		C	
		A-1	A-2	B-1	B-2	C-1	C-2
2020/6/8 (Mon)	six-hour classes	13		14		13	
2020/6/9 (Tue)	six-hour classes		14		13		13
2020/6/10 (Wed)	six-hour classes	13		14		13	
2020/6/11 (Thu)	six-hour classes		14		13		13
2020/6/12 (Fri) 2020/6/15 (Mon)	six-hour classes	27		27		26	
2020/6/16 (Tue)	One hour of the six-hour class is physical education.	27		27		26	
2020/6/17 (Wed) 2020/6/18 (Thu) 2020/6/19 (Fri) 2020/6/22 (Mon)	six-hour classes	27		27		26	
2020/6/23 (Tue) 2020/6/24 (Wed)	seven-hour classes	27		27		26	
2020/6/25 (Tur)	One hour of the six-hour class is physical education.	27		27		26	
2020/6/26 (Fri)	six-hour classes	27		27		26	

pouch with a belt, because it was likely to come off easily when secured with a clip or strap. The details of the fitting method were explained in printed materials and shown concretely using actual objects in on-demand briefings. We also asked the homeroom teachers to confirm the wearing status at school during the study period.

The Tri-axial accelerometers was worn around the waist at all times except for sleeping hours and unavoidable occasions such as swimming and bathing. If the Tri-axial accelerometers was not worn, the participant or the parent (or legal guardian) was asked to record the time on the form. The data recorded by the Tri-axial accelerometers were extracted after collection of the device.

In addition, the scales employed for the Physical Activity Level used in this study were Step count (SC), Sedentary time (ST), which included sleep duration, Light-intensity physical activity (LPA), and Moderate-to-vigorous physical activity (MVPA).

3. Salivary Cortisol

Stress hormone (cortisol) obtained from saliva was analyzed to assess stress. Saliva samples were collected using Oral Swab® (manufactured by Assist) by the participants themselves and their parents at home one hour before bedtime on June 8th, 18th, and 25th. For saliva collection, we asked the participants to refrain from eating or drinking (except caffeine-free beverages) and brushing their teeth within one hour of collection, and to rinse their mouth with water immediately before collection. In order to collect saliva, the cotton of an Oral Swab® (unflavored, unscented) was held in the mouth for one minute to allow the secreted saliva to be absorbed, and the participants and their parents were instructed to store the swabs in a refrigerator after collection.

The participants put each Oral Swab® in a zippered bag for collection and sent it by courier service to the research office by a cool delivery carrier. The experimenter received the Oral Swab® controlled by ID number and requested Yanaihara Research Institute, Inc. to analyze it. The salivary cortisol concentration was detected using the ELISA method.

4. Mental Health

Mental Health was evaluated using the Mental Health Checklist for Children (Okayasu, Yuji, & Takayama, 1998), which is comprised of four factors: Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness. Each factor was subsequently comprised of four items, making a total of 16 items. In the present study, the participants rated each item on a four-point scale from one (not at all) to four (extremely) at the same time as saliva collection.

5. Ethical Considerations

This study was carried out with the approval of the Ethics Committee of Kyoto University of Advanced Science (20-4). The participants were informed of the purpose and content of this study, how to use the information obtained from the survey, and how they would receive feedback. For requests to the elementary schools and explanations to the homeroom teachers, we went directly to the related elementary schools and provided written and oral explanations. In addition, a briefing session for parents was delivered on-demand, and details of the study were explained by PowerPoint presentations and orally. Parents (substitutes or legal guardians) were given time to consider whether or not to allow their children to cooperate in this study, and were encouraged to give their informed consent. Finally, the survey was conducted employing elementary school students who had provided their parents' or guardians' names, substitute names, and addresses on the consent forms.

6. Statistical Analysis

Averages and SD were calculated for physical activity level (SC, ST, LPA, MVPA), the salivary cortisol level, the points on the Mental Health Checklist for Children (Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness) at each week point (first week / second week / third week).

We conducted a one-way analysis of variance (ANOVA) with these average levels as the dependent variable [within-subjects design: analysis method (first week / second week / third week)], with a Tukey test for multiple comparisons. Correlations were also calculated based on the physical activity (SC, ST, LPA, and MVPA), mental health (Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness), and the salivary cortisol measurements obtained at each week point.

III Result

1. Physical Activity Level

The results of physical activity level are shown in Table 2. The result of one-way ANOVA showed a significant main effect for the time point in SC [$F(2,62) = 50.614$, $p < .01$], ST [$F(2,62) = 50.614$, $p < .01$], and MVPA [$F(2,62) = 27.783$, $p < .01$]. Multiple comparisons showed that SC ($p < .01$) and the MVPA ($p < .05$) values for the third week were significantly longer than the first week and ST was significantly shorter than it was at the third week ($p < .05$).

2. Salivary Cortisol and Mental Health

Table 3 and Table 4 is the results of salivary cortisol levels and mental health point values at each week point. In the salivary cortisol levels, the one-way ANOVA showed no significant main effect related to time [$F(2,62) = 0.156$, *n.s*]. In the mental health point values, the one-way ANOVA showed no

Table 2. Mean physical activity level values at each week point

	Time	Mean (SD)		F value (sf, error)
SC (steps)	first week	9312.9	(1969.1)	$F(2,62)=50.614$, $p<.01$
	second week	11565.4	(2618.8)	
	third week*	12734.0	(3229.7)	
ST (min)	first week	1021.0	(76.1)	$F(2,62)=4.106$, $p<.05$
	second week	998.1	(84.6)	
	third week*	989.0	(102.9)	
LPA (min)	first week	340.1	(65.7)	$F(2,62)=0.058$, *n.s.*
	second week	349.2	(76.4)	
	third week	349.8	(88.7)	
MVPA (min)	first week	78.9	(21.4)	$F(2,62)=27.783$, $p<.01$
	second week	92.7	(25.3)	
	third week*	101.2	(29.9)	

*$p<.01$: first week vs third week

Table 3. Mean salivary cortisol levels at each week point

	Time	Mean (SD)	F value (sf, error)
salivary cortisol level	first week	0.066 (0.033)	
	second week	0.070 (0.044)	$F(2,62)=0.156$, *n.s.*
	third week	0.071 (0.049)	

*$p<.01$: first week vs third week

Table 4. Mean mental health point values at each week point

	Time	Mean (SD)	F (sf, error)
Physical Symptoms	first week	4.5 (1.9)	
	second week	4.5 (1.9)	$F(2,62)=0.315$, *n.s.*
	third week	4.3 (1.4)	
Depression-Anxiety	first week	4.0 (1.4)	
	second week	4.2 (1.7)	$F(2,62)=1.578$, *n.s.*
	third week	3.6 (1.3)	
Irritability-Anger	first week	4.5 (2.1)	
	second week	4.8 (2.3)	$F(2,62)=1.348$, *n.s.*
	third week	4.2 (1.9)	
Helplessness	first week	4.2 (1.8)	
	second week	3.9 (1.3)	$F(2,62)=1.142$, *n.s.*
	third week	3.8 (1.2)	

significant main effect related to time for any of the factors employed.

3. Correlation coefficients between the salivary cortisol levels and mental health

Pearson's correlation was calculated between the salivary cortisol levels and mental health factors (Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness) at each week point (Table 5). No significant correlations were demonstrated.

4. Correlation coefficients between the salivary cortisol levels and physical activity

Pearson's correlation was calculated between the salivary cortisol levels and physical activity (SC, ST, LPA, and MVPA) at each week point (Table 6). No significant correlations were demonstrated.

5. Correlation coefficients between physical activity levels and mental health

Pearson's correlation was calculated between the physical activity levels (SC, ST, LPA, and MVPA) and mental health (Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness) at each week point (Table 7). As a result, there was a significant negative correlation demonstrated between ST and Irritability-Anger (r = - .394, p < .05), and a significant positive correlation between LPA and Irritability-Anger (r = .355, p < .05) at the second week.

In the third week, a slight tendency towards negative correlation coefficients were confirmed between ST and Irritability-Anger (r = -.308, p < .10), and Helplessness (r = -.329, p < .10). Furthermore,

Table 5. Correlation coefficients between the salivary cortisol levels and mental health

	Salivary Cortisol Level (First week)	Salivary Cortisol Level (Second week)	Salivary Cortisol Level (Third week)
Physical Symptoms	-.275	-.171	-.243
Depression-Anxiety	-.292	-.110	.017
Irritability-Anger	-.277	.076	-.185
Helplessness	-.243	-.011	-.149

Table 6. Correlation coefficients between the salivary cortisol levels and physical activity

	Salivary Cortisol Level (First week)	Salivary Cortisol Level (Second week)	Salivary Cortisol Level (Third week)
Step Counts	-.198	-.049	-.104
ST	.103	-.011	.167
LPA	-.068	-.056	-.159
MVPA	-.156	-.134	-.102

Table 7. Correlation coefficients between physical activity and mental health at each week point

First week:	Physical Symptoms	Depression-Anxiety	Irritability-Anger	Helplessness
SC	-.082	.123	-.069	-.097
ST	-.056	-.086	-.145	-.108
LPA	.031	.030	.086	.088
MVPA	.104	.215	.250	.114
Second week:				
SC	.099	.039	-.035	-.126
ST	-.158	-.296	-.394*	-.105
LPA	.122	.294	.355*	.144
MVPA	.161	.100	.244	-.083
Third week:				
SC	.080	.071	.050	-.158
ST	-.220	-.096	-.308†	-.329†
LPA	.248	.093	.300†	.402*
MVPA	.022	.054	.173	-.059

*p<.05, †p<.10

there was a significant positive correlation between LPA and Helplessness (r = .402, p < .05), and Irritability-Anger (r = .300, p < .10).

IV Discussion

Due to the occurrence and spread of COVID-19, it can be inferred that there has been an increase in the time spent at home by elementary school students, as well as an accompanying decrease in play space and a loss of opportunities for exercise. In spite of these developments, there have also been few opportunities to measure the physical activity levels of these students and grasp the actual situation. Accordingly, this study was conducted in order to measure the physical activity levels and determine if there was any correlation with the emotional or mental stress of elementary school students (using salivary cortisol concentration and questionnaires). The results showed that the mental stress level was not so high during the study time period. However, significant and negative correlations were confirmed between ST and Irritability-Anger in the second and third weeks, as well as a tendency for a negative correlation between ST and Helplessness in the third. In the following section, we considered these results regarding the relationship between the physical activity level and mental stress.

In this study we employed a questionnaire to obtain subjective indices regarding emotional stress in order to assess the major mental health factors (Physical Symptoms, Depression-Anxiety, Irritability-Anger, and Helplessness) using an objective index obtained by analysing the salivary cortisol concentration in oral swabs. Using both indices, the results showed no significant changes from the first week to either the second or the third week. In more concrete terms, using the subjective values representing mental health on the mental health checklist for children, where it was previously determined that an average score of 7 or higher (80% or higher) was the number that required attention (Public Research Center, 2004), most of the values we obtained were lower than five or four (60% or lower). Furthermore, the average salivary cortisol concentration values were very similar to the range from 0.066μg/dL to 0.071μg/dL that is considered the lowest range of variation (Gröschl, Rauh, & Dörr, 2003) normally seen during a day. Thus, judging by these subjective and objective indices, the results we obtained suggested that the participants we studied were in a situation with a comparatively low emotional stress factor during the study time period.

The result of the physical activity level in this study showed that the sedentary time (ST) is abnormally long. Even looking at the model studies that investigated the time spent watching TV, playing games, or being engaged in net activities, there are no studies in which the ST was more than 400 minutes (about 6.66 hours). Even considering our results that showed a significant decrease in ST at the third week, compared with the first week, the measures (stay at home and avoid contact with other people) were conducted in order to prevent the spread of COVID-19 infections, it is clear that the time allowed for children to be engaged in physical activity was been extremely limited. The effect of the spread of COVID-19 also severely limited the time spent in light-intensity physical activity (LPA) in this study. Although our data showed no changes in the LPA from the first week to the third week, the average LPA values for each week were constantly high, compared with the values seen in previous study (Tanaka, Reilly, Tanaka, & Tanaka, 2016).

It has been said that, in general, high MVPA values are related to the maintenance and improvement mental health in children. However, in our results, no significant correlation was demonstrated between mental health and the MVPA values. This may be because the mental health values (all factors) were generally low concerning the MVPA values. However, At the second and third weeks, a negative correlation was shown between ST and the Irritability-Anger factor, and there was a tendency shown for a negative correlation between ST and Helplessness. This may be due to the temporary closure of the elementary schools and the related "stay at home" lifestyle imposed from April 10th until May 31st, 2020 due to the spread of COVID-19. The elementary schools were reopened on June 1st, and the students were divided into two groups, attending school on alternate days only in the mornings for a total of four hours per week. From June 8th, class time was increased to six hours, with the students divided into two groups attending school on alternate days. From the 15th until the 19th, all of the students attended six hours of classes. From

the 22nd through the 26th, classes were held for seven hours on three days (six hours on the other two days). Because of this, although the duration of sitting time was the same, the duration of class time became longer, while the duration of rest time became shorter, which may have increased the Irritability-Anger and Helplessness. It may be considered that the temporary increase in ST may have functioned to control the Irritability-Anger and Helplessness feelings. This may indicate to have something to do with the length of the rest during a survey period.

Furthermore, there was a positive correlation seen in the second and third weeks between LPA and Irritability-Anger and Helplessness. This may be due to the fact that from the time elementary school resumed until the end of the third week, the number of classes increased with each passing week, while the LPA fluctuated little. However, even compared with previous intervention study (Morimura, Kiyonaga, Shindo, & Tanaka, 2015), where LPA was employed to promote physical activity, the LPA values seen in this study were exceptionally high. The LPA seen in this study was about 1.5 METs to almost 3 METs, which indicated a level of activity similar to either sitting (sedentary behavior), standing conversation, reading, or walking around the house, that is, normal daily behavior. Previous studies have reported that physical activity levels below 1.5 METs worsen mental health and above 3 METs improve (Matsunaga, 2015). And yet, to our knowledge, no study has examined whether the effects of 1.5 to 3 METs physical activity level on mental health (Irritability-Anger or Helplessness). However, the results of this study suggest that being active in the behavioral restrictions associated with COVID-19 may have affected Irritability-Anger or Helplessness.

In a study using 1,095 normal Japanese workers as the participants, Kitano, Kai, Jindo, Tsunoda, & Arao (2020) showed that it was possible to expect an increase in mental health by reducing the length of time spent working in a sitting position (sedentary behavior) and increasing the length of time spent sleeping. In concrete terms, the results of that study suggested a relationship between the findings that, 1) when the length of time spent in a sitting position (sedentary behavior) in a normal day is long, 2) the mental stress increases, and 3) when LPA continues for a long time, the mental stress also increases. However, no correlation between MVPA and mental health was observed in this study. As a result of using the data produced in that study to provide a statistical prediction, the results of the prediction showed that if 60 minutes of the sitting behavior (sedentary behavior) could be used for sleeping, the chance of mental stress could be reduced by 20.2%. Furthermore, Kitano et al. reported that if 60 minutes of the LPA time could be used for sleeping, the chance of mental stress could be reduced by 26.6%.

While the results of the present study and the study conducted by Kitano et al. in 2020 were similar in regard to the relationships between LPA, MVPA and mental health, the participants of these studies, children and working people, were quite different, so the results for the correlation between ST and mental health were directly contrary to each other. In order to impede the spread of COVID-19 infections, the authorities issued strong demands for self-restraint in conduct (stay at home requests), and during that time period, and it is quite likely that there was a characteristic effect due to these circumstances. In the present study, the sleeping time of the participants was included in the ST. Accordingly, the inclusion of the sleeping time may have been at least partly responsible for the negative correlation we found between ST and mental health. Thus, one of the limitations we encountered in this study was the fact that we could not clearly separate the ST into sleeping time and sitting time (sedentary behavior). At present, the third wave of COVID-19 infection surge is rampant, and playing havoc with the daily life and economy of the country. While the vaccination program has just gotten underway, it has been predicted that another similar wave can be expected.

It is known that ensuring a sufficient amount of rest and sleeping time has a good effect on mental health for children in the 6th year of elementary school. However, even given COVID-19 pandemic, it can be expected that any increase in the time spent watching TV or playing games, or a simple increase sedentary time, over a long period, will have a detrimental effect on mental health. In the near future it will be necessary to conduct studies designed to

measure the actual sleeping time of children, conduct an analysis with the sedentary time (sedentary behavior) separated from the sleeping time, in order to provide more concrete information on the relationship between ST and mental health. This new information must then be studied along with the current basic knowledge in regard to its significance related to the effect of physical activity on mental health in the midst of COVID-19 pandemic. Finally, we must mention that the results of the study employing working people as the participants showing a correlation between an increase in LPA over a long period and mental health are quite rare (Kitano et al., 2020; Hamer, Coombs, & Stamatakis, 2014). In addition, by changing the methods employed in this type of study, it should be possible to eliminate findings showing any erroneous relationship between mental health (McGregor, Carson, Palarea-Albaladejo, Dall, Tremblay, & Chastin, 2018) and depression, but we could not ensure such stable results in this study. Accordingly, we consider it necessary to develop new concepts and study methods encompassing the new lifestyle imposed by the spread of COVID-19, methods that will promote improved studies on the correlation between the physical activity of children and mental health.

V Conclusion

We analyzed relationship between physical activity and mental health using physical activity level with Tri-axial accelerometers, salivary cortisol and mental health (questionnaire survey) for elementary school children during COVID-19 pandemic. In regard to the correlation between the physical activity levels shown at the second and third weeks and the mental stress levels, we found a negative correlation between ST and the Irritability-Anger factor, as well as a tendency for a negative correlation between ST and the Helplessness factor. In addition, at the second and third weeks, a positive correlation was shown between light intensity physical activity (LPA) and the Irritability-Anger and Helplessness. We believe that the results were specific to COVID-19, as the results of the children in this study differed from the previous studies examining ST and mental health in adults.

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