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Original Article

Factors Affecting Sensitivity to Tempo Changes in Rhythmic Sound Stimuli

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Abstract: [Participant(s) and Methods] Twelve young adults (11 males and one female) participated in this study. The task was to judge changes in the tempo of the auditory stimuli, set to three reference tempos: 60, 90, and 120 beats per minute. The sound consisted of 28 stimulus tones and the tempo changed from the 21st stimulus to $\pm 5\%$, $\pm 10\%$, and $\pm 15\%$. The participant listened to the sound stimulus with and without tapping and judged the tempo change after the stimulus ended. [Results] There was no difference in the percentage of correct responses with and without the tapping task. The average detection thresholds for tempo change were lower in the direction of tempo acceleration for all no-tap conditions. Subliminal phase correction was found after the tempo change. [Conclusion] The sensitivity of tempo change depends on the reference tempo, and the threshold level depends on the direction of tempo change.

Keywords: Tempo sensitivity, Rhythmic auditory stimuli, Sensorimotor synchronization

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I. INTRODUCTION

Sensorimotor synchronization (SMS) refers to the synchronized movements that respond to predictable external stimuli. SMS is an ability exhibited by humans, but not by some primates¹⁾ and birds²⁾. A typical example of a laboratory task is finger tapping, which involves pressing a button in response to a series of sounds. Several researchers have used this paradigm in conducting SMS research^{3,4)}.

Repp⁵⁾ had subjects perform a tapping task synchronized with a rhythmic auditory stimulus (RAS) at 120 beats per minute (BPM) and subjected to various tempo variation (step change) perturbations to determine their perceived threshold. The results revealed an asymmetric feature; tempo deceleration had a lower threshold than acceleration.

We also conducted a similar experiment under the RAS at a different tempo (60 BPM) with an additional condition of comparison with and without the tapping task to determine the effect of the tapping task on the threshold of tempo change perception⁶⁾. The results showed no significant difference in the thresholds with and without the tapping task; however, asymmetry was observed in the direction of the tempo change, in contrast to Repp's findings.

An application of SMS in rehabilitation is gait practice for patients with Parkinson's disease, who have difficulty generating their beat while walking; however, walking in sync with RAS improves gait parameters⁷⁻⁹⁾. In these studies, the effects of RAS were primarily evaluated for gait parameters rather than for tempo perception. During music training, increased sensitivity to tempo perception leads to the development of

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automatic beats that produce themselves¹⁰⁾. Assessing the sensitivity of tempo perception is essential if the goal of gait practice is automatic walking without RAS. The cadence of walking for patients with Parkinson’s disease reported by Thaut et al.⁷⁾ was 90 steps/min, and the RAS tempo was lower than 120 steps/min for a typical healthy adult. Therefore, it is questionable whether the tempo perception features found at 120 BPM can be applied to different BPMs.

This study investigated whether various tempo perception features vary with the reference tempo and with or without tapping in healthy adult subjects.

II. PARTICIPANTS AND METHODS

1. Participants

Twelve young adults (11 males and one female; mean age = 19.9 years; standard deviation [SD] = 0.8) participated in this study. Three of the participants were left-handed. All the participants used their dominant hands to participate in the experiment. Participants with musculoskeletal or neurological problems were excluded. The Research Ethics Board of the International University of Health and Welfare approved this study (Approval No. 21-Ig-50). All the participants provided written informed consent before the experiments were conducted.

2. Methods

We used the same methods as those used in our previous study to conduct the tapping task and data collection⁶⁾. The auditory stimuli used in this experiment were click sounds generated by a computer. The task was to assess changes in the tempo of the auditory stimuli, which were set to three reference tempos: 60, 90, and 120 BPM. The sound sequences used in this experiment consisted of 28 stimulus tones. We prepared seven sound sequences: one with no tempo change, and six with tempo changes of $\pm 5\%$, $\pm 10\%$, and $\pm 15\%$ from the 21st stimulus (Fig.1). The experimental equipment consisted of a laptop computer (Panasonic CF-SV), psychology experiment software (Cedrus SuperLab5), reaction pad (Cedrus RB-740), and headphones (Audio-Technica ATH-AVC200) (Fig.2). The laptop computer and psychology experiment software controlled the start and end of the sound stimulation sequence and recorded data from the reaction pad at a sampling frequency of 1,000 Hz. We conducted the experiment in a quiet, private room without clocks or other devices that maintained a specific tempo. Each participant sat in front of a laptop computer, and the reaction pad was placed on a desk with headphones. The experimenter instructed participants to operate the reaction pad with their dominant index finger during the experiment.

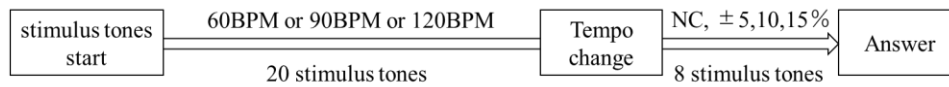


Figure. 1. Measurement flow. NC: No change.

After listening to all the stimulus tones (28 tones), participants answered whether the stimulus tones was an acceleration, deceleration or no change in the middle of stimulus tones (21st tone).

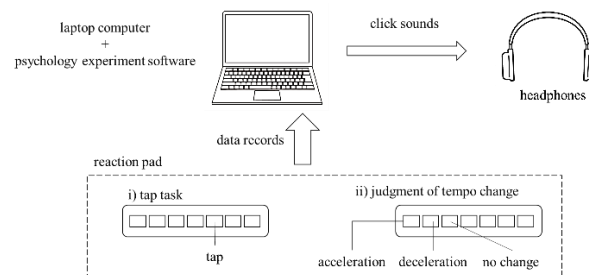


Figure. 2. Experimental equipment.

We used psychological experiment software to program the progression of our experiment. Participants listen to the click sound generated by the laptop computer through headphones. The information that participants tap on the reaction pad and their responses are recorded on the laptop computer.

The participants listened to the sound stimulus sequence under the following conditions and performed a task to judge whether the tempo had changed.

1) Tap: The participant performs the task while tapping the third button from the right of the reaction pad in synchronization with the sound stimulus.

2) No tap: The participant places both hands on their laps and performs the task without moving their body.

After listening to the sound stimulus sequence, the participant responded by pressing the "acceleration," "no change," and "deceleration" buttons assigned to the response pad to answer according to the tempo change. The participants completed 42 trials, encompassing two tapping conditions, three reference tempos, and seven tempo changes (Fig.3). The order of the 42 conditions was randomized for each participant.

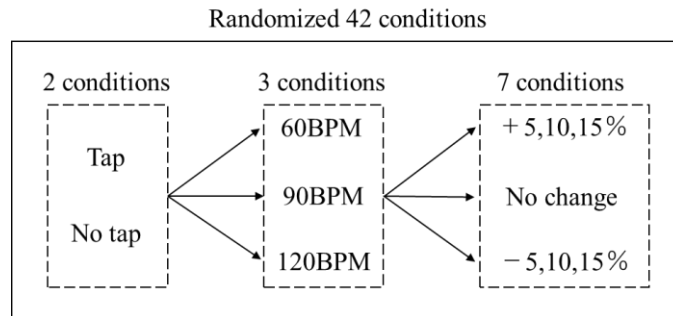


Figure. 3. Experimental conditions.

The task execution order of the 42 conditions (two tapping conditions × three reference tempos × seven sound stimulus sequences) was randomized.

After completing all the tasks, we determined the correctness of each participant's tempo–change assessment for each experimental condition. We calculated the correct answer rate for tempo change assessments for each experimental condition. Finally, we performed a three–way analysis of variance (ANOVA) (2 × 3 × 7) using the inverse sine method to determine the correct answer rate for tempo–change assessments. The factors were the task condition (Tap vs. No tap), reference tempo (60, 90, and 120 BPM), and tempo changes (0%, ±5%, ±10%, and ±15%). Multiple comparisons were performed using Ryan's method. The average detection threshold was used to compare acceleration and deceleration thresholds. For the average detection threshold, a linear function was calculated from two points that were before and after 50% of the correct response rate of the four change rates (no change, ±5%, ±10%, and ±15%). The tempo change rate at which the correct response rate reached 50% was determined according to the calculated linear function and used as the average detection threshold. The average detection threshold was obtained from a previous study⁵.

To evaluate the tapping accuracy of the sound stimulus after a tempo change, we used a one–sample t–test for the mean of the 5–8 tapping intervals after the tempo change. Statistical analyses were performed using the statistical computing environment in R (version 4.1.2). The significance level was set at $p < 0.05$.

III. RESULTS

Table 1 lists the percentage of correct responses for each tap and no–tap condition for the three reference tempos by the 12 subjects. Although many of the tempo changes resulted in a 90% or higher response rate, the response rates for the ±5% tempo change at 60, 90, and 120 BPM tended to be lower than those for the other tempo changes. Three–way ANOVA using the inverse sine transform method revealed that the main effects of the reference tempo factor and tempo change rate factor were significant (reference tempo: $\chi^2(2) = 9.94$, $p < 0.05$, tempo change rate: $\chi^2(6) = 177.2$, $p < 0.05$). No main effects or interactions were observed regarding the tap conditions. The results of multiple comparisons among the three tempos showed a significantly higher percentage of correct responses at 120 BPM than at 60 or 90 BPM ($p < 0.05$). The results of multiple comparisons of tempo change rates showed no significant

differences in any of the combinations between -15%, no change, +10%, and +15% tempo change rates. No significant differences were observed between +5% and -5% tempo change rates. However, the -5% and +5% tempo change rates had significantly lower percentages of correct responses than the others ($p < 0.05$).

Table 1. Percentage of correct answers for each experimental condition.

Tempo change condition	Tap			No-tap		
	60BPM	90BPM	120BPM	60BPM	90BPM	120BPM
-15%	91.7	100.0	91.7	91.7	83.3	100.0
-10%	66.7	75.0	91.7	83.3	50.0	83.3
-5%	58.3	25.0	58.3	16.7	8.3	33.3
NC	100.0	75.0	100.0	91.7	91.7	91.7
+5%	25.0	33.3	41.7	33.3	58.3	83.3
+10%	91.7	91.7	100.0	83.3	100.0	100.0
+15%	100.0	100.0	100.0	100.0	100.0	100.0

(%)

NC: no tempo change The percentage notation of the tempo change condition (-15% to + 15%) indicates an increase or decrease in the change from the core tempo.

Table 2 lists the average detection thresholds for each condition. The average detection threshold was independent of the reference tempo, and the average detection threshold tended to be lower in the acceleration direction than in the deceleration direction under the no-tap condition.

A one-sample t-test between the tapping interval and sound stimulus interval after the tempo change revealed that the tapping interval (758.5 ms) was significantly shorter than the sound stimulus interval (766.7 ms) only under the -15% change condition at 90 BPM ($p < 0.05$).

Table 2. 50% crossover point for each experimental condition.

	Tap			No-tap		
	60BPM	90BPM	120BPM	60BPM	90BPM	120BPM
Acceleration	931ms (6.9%)	624ms (6.4%)	471ms (5.7%)	933ms (6.7%)	644ms (3.4%)	485ms (3.0%)
Deceleration	1,043ms (4.3%)	717ms (7.5%)	521ms (4.3%)	1,075ms (7.5%)	733ms (10.0%)	533ms (6.7%)

For each value in a cell, the real value represents the sound stimulus interval at the 50% crossover point, and the relative value is the deviation from the reference tempo expressed as a percentage.

IV. DISCUSSION

The task condition (tap vs. no tap) in this study was used to examine whether the activation of the motor system affects the sensitivity of tempo perception. In Ross’s review of the activation of the motor system during passive listening, the author states that, “The evidence reviewed above can be organized into two perspectives: motor system activation while listening to rhythms is 1) only shadowing or 2) it also has a predictive, causal role in beat perception”¹¹⁾. In this study, no difference was observed in the percentage of correct responses among the task conditions. This result differed from those of previous studies^{12–14)}, in which tapping improved tempo perception. The effect of tapping as a dual task on the attentional demand may be related to these differences. In addition, a study¹⁵⁾ has shown that physical movement helps tempo perception in nonmusicians compared with musicians, and differences in musical training might have influenced the variability in correct response rates.

In this study, the reference tempo of 120 BPM had the highest percentage of correct responses. Classically, the most stably synchronized tapping tempo has an interstimulus interval (ISI) of 400–800 ms¹⁶⁾. The ISI for spontaneous motor tempo, the tempo at which the subject taps spontaneously, is 500–650 ms in adults

(18–66 years old)^{17, 18)}. The 120 BPM, which had the highest percentage of correct responses, was in both ranges. Stable and spontaneous tapping is likely to be responsible for the high sensitivity of tempo perception.

The correct response rates were divided into three groups based on the results of multiple comparisons of tempo change ranges. The highest correct response rates were $\pm 15\%$, $+10\%$, and 0% , the moderate group was -10% , and the lowest was $\pm 5\%$. The significant difference between $+10\%$ and -10% leads to the asymmetry of the average detection threshold for the direction of tempo change, discussed below.

Darabi et al.¹⁹⁾ proposed a dynamic system model of the SMS and found that the conscious perception of tempo change attributed to a step change was approximately 12% of the reference tempo. The 100% correct response rate for the $+15\%$ tempo change in our study under all conditions was in good agreement with the results of Darabi et al.

The average detection thresholds were lower in the tempo acceleration direction for all the no-tap conditions. This result indicated that the sensitivity of tempo perception was higher when the tempo changed in the direction of the reference tempo (120 BPM), which had a higher percentage of correct responses. However, for the tap condition at 60 BPM, the thresholds were higher in the acceleration direction, showing an asymmetry opposite to our previous finding⁶⁾. This discrepancy in the results is probably related to the fact that 60 BPM (ISI = 1000 ms) is the point at which the two control systems (automatic and cognitive timing) switch²⁰⁾.

The participants adapted to the phase correction after tempo changes, except for the -15% tempo change at 90 BPM. Thus, even though conscious auditory assessment of the tempo change was incorrect, the phase correction of the tapping was accurate. Moreover, this subliminal phase correction occurred not only at a single tempo, as in previous studies²¹⁾, but also over a wide range of reference tempos and tempo change rates. However, the factors that cause individual differences regarding whether this correction is subliminal under the same conditions remain to be determined.

In this study, the tapping task did not affect sensitivity to tempo perception. Several studies^{22, 23)} have reported different results on the relationship between tapping tasks and attention. In addition, a study²⁴⁾ has shown that temporal attention to tapping improves synchronization accuracy; future research designs should consider the effect of attention. However, the results of this study indicate that the sensitivity of the tempo change depends on the reference tempo and that the threshold level depends on the direction of the tempo change. These characteristics in healthy adults may provide clues for evaluating the efficacy of RAS treatment.

FUNDING AND CONFLICT OF INTEREST

There are no conflicts of interest to disclose in this study.

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Original Article

Do Students Feel that Flipped Classes Increase their Workload? Impact of the COVID–19 Pandemic

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Abstract: [Purpose] The aim of this study is to assess the workload and perceptions related to flipped classrooms as experienced by students before and during the COVID–19 pandemic. [Subjects and Methods] The research involved 331 undergraduate physical therapy students who were part of flipped classrooms between 2017 and 2020 for four years. To assess the student workload, a survey was conducted using a 10–point Likert scale. Furthermore, we compared the experiences of students in flipped and traditional classes in terms of their ease of learning and understanding of course content. [Results] A significant increase in student workload was found in 2020. Moreover, the respondents of the 2020 survey exhibited a preference for traditional teaching methods, which they found easier to comprehend and learn the course content. [Conclusion] The study concludes that the increased workload in flipped classrooms during the COVID–19 pandemic can be attributed to the changed learning environment for students.

Keywords: Flipped classroom, Workload, COVID–19

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I. INTRODUCTION

In April 2020, the declaration of a state of emergency in Japan prompted the Ministry of Education, Culture, Sports, Science and Technology to require universities to cancel in–person classes as a measure to mitigate the spread of the COVID–19 virus ¹⁾. Afterward, almost 90% of universities in Japan adopted remote learning methods ²⁾. A survey conducted during the second semester of the 2020 academic year revealed that 60% of students received a blend of in–person and remote classes ²⁾.

The abrupt transition to remote learning has made it necessary to enhance educational systems and the learning environment for students, which is now becoming more conducive to online education ³⁾. Flipped classrooms, a type of blended learning where students watch pre–recorded video lectures online before class and participate in collaborative learning activities in person, have been employed in medical education to encourage student engagement and motivation ⁴⁾. Balakrishnan et al.'s research has shown not just changes in learning motivation but also changes in learning strategies when comparing flipped classrooms to e–learning ⁵⁾.

Several studies have reported that teachers face excessive demands in flipped classrooms, such as preparing videos and maintaining a suitable delivery environment for both videos and assignments. Students also experience additional workload, including increased assignments and a more demanding internet environment for class participation, according to sources ^{6–8)}. Although the pandemic has led to improvements in IT literacy and internet environment for teachers and students, no investigation has been conducted to determine whether COVID–19 has affected student workload in flipped classrooms.

This study conducted a survey among students to investigate their perceived workload of flipped classes before and after the COVID–19 pandemic outbreak.

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II. PARTICIPANTS AND METHODS

1. Participants

The study comprised 331 participants who were enrolled in a physical therapist training program and underwent the same reversal course from 2017 to 2020. The analysis comprised 306 individuals (148 of whom were women) with a mean age of 19.6 ± 0.8 years, excluding missing data. For each year, the data were analyzed and divided into two separate periods: before the COVID–19 pandemic (2017–2019) and during the pandemic (2020) (Fig. 1).

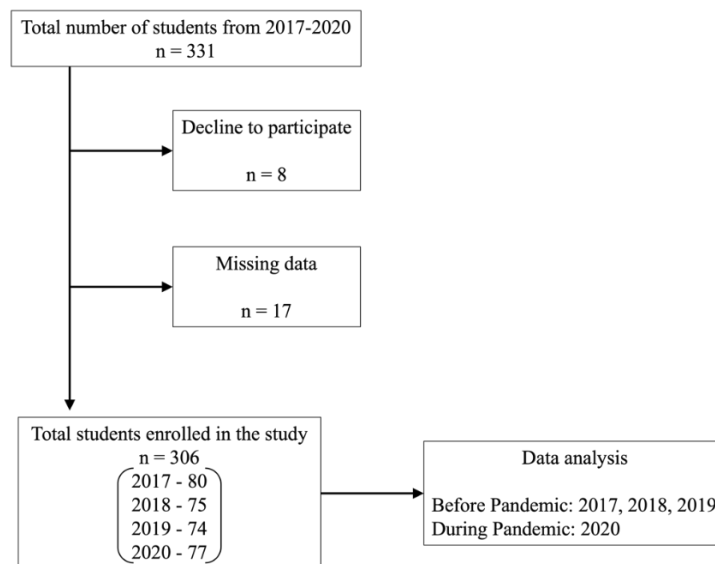


Figure 1. Flow diagram for study participants

2. Methods

Course Overview

In this study, "Developmental Humanics," a course offered in the second semester of the second year of the physical therapist education program, was selected as the subject of investigation. The course covers human physical functions, cognitive and social abilities from birth to death, and consists of 15 lectures. Except for the initial orientation and the 8th mid–term exam, 13 lectures were delivered through a flipped classroom model. The flipped classroom model involved students watching the lecture video online before class to learn about the topic, and then working in groups and individually during the actual lecture. The instructor provided a comprehensive explanation of the purpose, structure, and implementation of the flipped classroom during the course orientation. Additionally, how to use a learning management system to view the video lectures was demonstrated. Although watching the video lectures was not obligatory, students were advised to do so and test their rudimentary knowledge by taking mini–quizzes. The classroom tasks, such as lectures and group or individual work, were in line with the content discussed in the videos watched before the class.

Lecture Video

The lecture videos were recorded using Camtasia (TechSmith Co. Ltd.) and included the lecture slides and the instructors' voices. The videos were edited to be 10–15 minutes long per lecture and were optimized for smartphone viewing purposes. To confirm the video viewing, a Google form was used. The videos were shared on Google Classroom. To demonstrate their viewing status, students had to submit the form for confirming the video viewing.

Evaluation

Upon completing 15 classes, students were requested to evaluate their workload during the flipped class on a 10–point Likert scale, ranging from 1, indicating 'no workload,' to 10, indicating 'extremely high workload.' The evaluation was subjective in nature. Furthermore, students were surveyed on their perception of learning in the course, rating on a 5–point scale ranging from 1 (conventional class) to 5 (flipped class) in terms of 'ease of learning' and 'understandability.' The 5–point scale included the intermediate options of 'somewhat flipped class,' 'neither,' and 'somewhat conventional class.'

Statistical Analysis

The results of the questionnaire were analyzed by counting the frequency of each response and calculating the median as a representative value of the student's workload. The items rated on the five–point scale were aggregated into three categories: "flipped class," "neutral," and "conventional class." The Shapiro–Wilk test was used to assess the normality of the data, but no normality was found. As a result, the Kruskal–Wallis test was used to compare between years, and the Steel–Dwass method was used for multiple comparisons. Cross–tabulation was used to analyze the responses regarding "ease of learning" and "understandability" of the course, and the chi–squared test was used to determine the percentage of responses. Residual analysis was used when significant bias was detected. Statistical analysis was performed using R3.6.3, and the significance level was set at 5%.

Ethical Considerations

This study was approved by the International University of Health and Welfare Ethics Committee (approval number: 16–IO–143), and in accordance with the Declaration of Helsinki, participants were provided with an information sheet and gave written informed consent.

III. RESULTS

The median (interquartile range) student workload was 3(3) in 2017, 3(4) in 2018, 3(3) in 2019, and 5(3) in 2020. The distribution of student workload for each year is shown in Figure 2. Comparisons between years showed significantly more student workload in 2020; there was no significant difference between 2017 and 2019.

A significant difference was found between the conventional class and the ease of learning and understandability (ease of learning: $\chi^2(6) = 76.10, p < 0.01, V = 0.35$; understandability: $\chi^2(6) = 77.73, p < 0.01, V = 0.36$). Residual analysis showed a significant increase in the number of responses for the conventional class and the neutral category, and a corresponding decrease in the number of responses for the flipped class, for the ease of learning and understandability items in 2020 ($p < 0.01$) (Table 1).

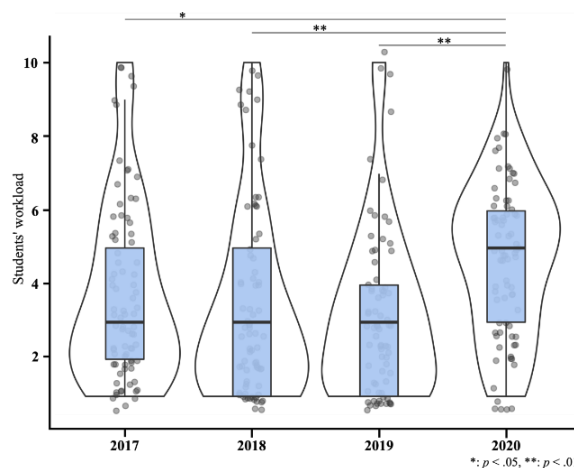


Figure 2. The distribution of student workloads for each year.

Table 1. Comparison of flipped and conventional classes in terms of ease of learning and understandability.

		Ease of learning			Understandability		
		Conventional	Neutral	Flipped	Conventional	Neutral	Flipped
2017	Frequency (%)	8 (10.0)	8 (10.0)	64 (80.0)	8 (10.0)	9 (11.3)	63 (78.7)
	Adjusted residual	-1.21	-2.52*	3.01**	-1.33	-1.22	1.99*
2018	Frequency (%)	5 (6.7)	10 (13.3)	60 (80.0)	6 (8.0)	4 (5.3)	65 (86.7)
	Adjusted residual	-2.12	-1.58	2.88**	-1.33	-1.22	1.99*
2019	Frequency (%)	5 (6.8)	10 (13.5)	59 (79.7)	6 (8.1)	5 (6.8)	63 (85.1)
	Adjusted residual	-2.07	-1.52	2.80**	-1.75	-2.35*	3.20**
2020	Frequency (%)	25 (32.5)	32 (41.6)	20 (25.9)	24 (31.2)	29 (37.7)	24 (31.1)
	Adjusted residual	5.37**	5.61**	-8.66**	4.87**	6.29**	-8.70**

Data are presented as median (interquartile range). *: $p < .05$, **: $p < .01$

IV. DISCUSSION

In this study, we found that the flipped classroom workload of university students enrolled in a physical therapy education program increased significantly after the COVID-19 pandemic. Our previous research has shown that flipped classroom workload decreases with increased exposure to this instructional format⁹). Thus, our hypothesis for this study was that students in the class of 2020 who had experience with online classes in their first semester would show a decrease in workload compared to previous years. However, the results of this study contradict this hypothesis and show a significant increase in student workload.

Several studies^{4, 10, 11}) have reported that students generally prefer flipped classrooms to conventional classrooms. Our survey found that prior to the COVID-19 pandemic, many students preferred flipped classrooms, citing greater ease of learning and better comprehension. In 2020, however, the trend reversed, with more students opting for traditional classroom instruction.

Although many studies have examined the advantages and disadvantages of teaching formats using online content, including flipped classrooms, online classes offer the convenience and flexible pace of home lectures, but require prolonged use of ICT devices, which can cause musculoskeletal symptoms such as neck and shoulder stiffness, anxiety, and psychological disturbances such as loneliness and insomnia, which may interfere with academic performance¹²⁻¹⁴). In addition, in terms of mental health effects, it has been reported that working in an excessive Internet environment can cause stress and be detrimental to mental health^{15, 16}) and that the flipped classroom format requires students to watch lecture videos in advance, which increases the workload^{6, 8, 17}).

An important clue in deciphering the change in students' attitudes toward flipped classrooms before and after the COVID-19 pandemic is the prevalence of online classes instead of face-to-face classes due to the behavioral restrictions imposed by COVID-19, which is expected to increase class assignments^{15,16}) and psychological stress among students in 2020. In addition, because a mixed format of face-to-face and online classes was used, students had to adapt to a variety of teaching styles, which may have increased psychological stress among students¹⁸). Furthermore, direct interaction with others, such as discussions in flipped classrooms, may have been perceived by students as a behavior that increases the risk of COVID-19 infection, leading to a negative view of this teaching format.

Limitations of this study include the use of a simplified 10-point Likert scale to assess student workload in flipped classrooms and no professional assessment to determine workload. In addition, the students included in the analysis were from different years of enrollment and cannot be interpreted as changes in the same population. In addition, because the target population was only physical therapy students, who may be influenced by the university curriculum and course progression, the results may not reflect trends for all college students.

FUNDING AND CONFLICT OF INTEREST

No funding was provided for this study. The author declares no conflict of interest.

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Original Article

Associations of Physical Activity with Mental Health and Health Literacy among Medical University Students during The Coronavirus Disease 2019 Pandemic

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Abstract: [Purpose] This cross-sectional study aimed to investigate and verify the association of physical activity with anxiety, fear of coronavirus disease 2019, and health literacy among medical university students during the pandemic. [Participants and Methods] A total of 107 medical university students were interviewed regarding their physical activity, basic attributes, fear of coronavirus disease 2019, psychological anxiety, depression, stress, and comprehensive health literacy. The relationship between physical activity and each item was examined. [Results] Physical activity was 1220.0 ± 1689.8 MET/min/week. Depression, stress, fear of coronavirus disease 2019, place of residence, the health literacy healthcare domain score, and sedentary activity time were associated with physical activity ($R = 0.74$, $R^2 = 0.55$). [Conclusion] The health literacy healthcare domain scores were associated with mental health problems related to reduced physical activity during the coronavirus disease 2019 pandemic. Implementing a mental health program that includes information provision and understanding of secondary medical problems associated with infection control and countermeasures may be effective for university students with reduced physical activity during the coronavirus disease 2019 pandemic.

Keywords: Coronavirus disease 2019, Health literacy, Physical activity

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I. INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has had a direct impact on the general public, creating unprecedented challenges for education and healthcare systems and causing a sense of fear. The Fukuoka prefecture in which the university is located is in a declared state of emergency, and the amount of human contact and physical activity has reduced, even among the university students. A previous study reported an association between medical students' health-related behaviours and fear of COVID-19 during the pandemic ¹⁾. An association of reduced physical activity with anxiety, depression, and mental health among university students during the pandemic has also been reported ^{2, 3)}. As public health strategies to control the spread of COVID-19, measures such as lockdowns and social distancing have been implemented outside Japan. In Japan, the declaration of a state of emergency mainly required efforts, such as implementing basic infection prevention, refraining from unnecessary outings and avoiding the 'closed spaces, crowded places, close-contact settings', to avoid infection to oneself and others ⁴⁾. Therefore, refraining from activities and limiting behaviour are related

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to individual health-related behaviour, morals, and health literacy (HL)⁵⁾, which is ‘the knowledge, motivation and ability to obtain, understand, evaluate and use health information’, can be considered to play an important role for the infection control. Additionally, the COVID-19 pandemic started in Japan since week 13 of 2020, when the delta strain of the coronavirus became prevalent⁶⁾. Furthermore, each media outlet was positioned to receive information, including that on the spread of the infection, difficulty in accepting patients and deaths. Therefore, we hypothesised that university students with high activity levels would adjust their anxiety, activity levels, activity range, and environment by obtaining, understanding, and utilising various information available on COVID-19.

This study aimed to investigate the relationship of physical activity with anxiety, fear of COVID-19, and HL during the pandemic among medical university students.

II. PARTICIPANTS AND METHODS

1. Research design

Questionnaire survey and observational cross-sectional study.

2. Participants

The participants were 107 university students (66 females, 41 males; average age 20.9 ± 0.9 years) enrolled in medical universities. We included medical university students from whom consent to participate in the study could be obtained verbally and in writing and who were at least 20 years of age at the time of consent. The exclusion criterion was physical activity limitation due to trauma or other causes.

3. Research period

Data were obtained between July and early September 2021 when the university was under a state of emergency following the COVID-19 pandemic. Additionally, because face-to-face lectures were conducted by the university, students were required to commute to the university during this period.

4. Evaluation items

1) Physical activity

The level of physical activity was assessed using the International Physical Activity Questionnaire short version. Participants were instructed to reflect on their physical activity over the past week and complete the form. The total physical activity and sedentary activity time were calculated based on previous studies⁷⁾.

2) Basic information

Basic information regarding age, gender, place of residence, method of commuting to university, and vaccination status was obtained. Residence was divided into the following categories: around the university, within a radius of 5–10 km, 10–20 km, 20–40 km and > 40 km from the university. Commuting methods were classified as train, bus, private car, motorcycle, bicycle, and walking. Students were also asked to provide multiple answers regarding how they relieved their stress.

3) Fear of COVID-19

The fear of COVID-19 was assessed using the Japanese version of the fear of COVID-19 scale, after obtaining permission. This scale has been tested for reliability and validity⁸⁾. The fear of COVID-19 was determined by providing the score for each question in the scale and calculating the total score for seven questions.

4) Anxiety, depression and stress

Mental health was assessed using the Japanese version of the Depression Anxiety Stress Scale (DASS-21)⁹⁾ modified by Antony et al.¹⁰⁾. The Japanese version of the DASS-21 is a 21-item self-administered questionnaire designed to measure depression, anxiety, and stress levels in the general population over the past week. Its validity and reliability has been validated¹⁰⁾. It comprises three subscales: DASS-21 Depression (DASS-D), DASS-21 Anxiety (DASS-A) and DASS-21 Stress (DASS-S). Each subscale score is calculated by doubling the total score of the corresponding seven items. A DASS-D score ≥ 9 , DASS-A score ≥ 7 , and DASS-S score ≥ 14 were considered to indicate the presence of depression, anxiety, and stress, respectively.

5) HL

HL is the ability to obtain and use information regarding health. The Japanese version of the European Health Literacy Survey Questionnaire (HLS-EUQ47) was used as a comprehensive HL assessment instrument ¹¹⁾. This subscale consists of three domains: healthcare, disease prevention, and health promotion. Questions in the healthcare domain relate to medical issues, such as symptoms and coping with illness. Questions in the disease prevention domain relate to risk factors for illness and health, whereas questions in the health promotion domain relate to determinants of health in social and physical environments. For each question, respondents were asked to choose an answer from the options 'very easy' (4 points), 'somewhat easy' (3 points), 'somewhat difficult' (2 points), 'very difficult' (1 point), and 'don't know' or 'not applicable' (0 points). The responses of 'do not know' or 'not applicable' were not scored or were excluded. Based on previous research, the total HLS-EUQ47 score and healthcare, disease prevention, and health promotion domain scores were standardised between 0 and 50 points ¹¹⁾. Four levels of HL were defined according to a previous study ¹¹⁾: 'inadequate' (0–25 points), 'problematic' (> 25–33 points), 'adequate' (> 33–42 points) and 'excellent' (> 42–50 points).

5. Data analysis

The evaluation item values were checked for normality using the Shapiro–Wilk test. Correlations between total physical activity and each assessment item were examined using the Spearman's test. Categorical regression analyses were also conducted with age, gender, place of residence, the DASS–D and DASS–S scores, fear of COVID–19 scale score, HL healthcare score, and sedentary activity time as explanatory variables, and total physical activity as an objective variable. Data were analysed using SPSS Ver. 27 (IBM Corp, Armonk, NY, USA). The significance level for the analysis was set at 5%.

6. Ethical considerations

This study was approved by the Ethics Committee of the International University of Health and Welfare in Okawa, Japan (approval number:21–Ifh–025). Written informed consent was obtained from each participant after they were provided complete information regarding the purpose of the study, associated risks and benefits, confidentiality, anonymity, and freedom of participation and withdrawal.

III. RESULTS

The vaccination rate of the students included in this study was 90.6%, the rate of commuting was 30.8%, and total physical activity was 1220.0 ± 1689.8 MET/min/week. The students were classified into categories of total physical activity based on previous studies ¹²⁾, and 9.3%, 29.9%, and 60.7% were in the high, moderate, and low categories, respectively. The students in this study scored 16.9 ± 4.9 points on the fear of COVID–19 scale, especially 3.3 points for 'Q1: I am most afraid of COVID–19', 3.3 points for 'Q4: I am afraid of losing my life because of COVID–19', 3.7 points, and 2.7 points for 'Q5: When watching news and stories about COVID–19 on social media, I become nervous or anxious', showing a high tendency for awareness of COVID–19. Depression, anxiety, and stress were observed in 27.1%, 2.8%, and 11.2% students, respectively. The percentage of patients whose HLS–EUQ47 total score indicated 'inadequate' HL was 34.6%. Regarding the assessments on the HLS–EUQ47 sub-items, 49.5%, 21.5% and 50.5% of the students were deemed to have 'inadequate' HL in the healthcare, disease prevention, and health promotion domains, respectively (Table 1). Correlations were found between total physical activity and age ($r = 0.35$), depression ($r = -0.22$), anxiety ($r = -0.28$), stress ($r = -0.30$), and sedentary activity time ($r = -0.28$). Furthermore, depression and stress were correlated with age ($r = -0.21, -0.21$) and the HL healthcare domain score ($r = -0.20, -0.26$). The results of the categorical regression analysis showed $R = 0.74$, $R^2 = 0.55$, and standardised coefficients for depression, stress, fear of COVID–19, place of residence, HL healthcare domain score, and sedentary activity time of 0.62, -0.52, 0.42, -0.41, -0.37 and -0.34, respectively (Table 2). Additionally, 87.9% of the students used stress reduction methods during the COVID–19 pandemic; 23.4% exercised, 18.7% talked with friends, 16.8% ate, 26.2% listened to music or watched videos, 24.3% slept and 6.5% sang to relieve their stress.

Table 1 Characteristics of study participants

Variables	Total (n = 107)
Age, year	21.0 ± 1.0
Women n (%)	66 (61.7)
Vaccination n (%)	97 (90.7)
Residence Category n (%)	
Around the university	74 (69.2)
Within 5 – 10 km	1 (0.9)
10 – 20 km	15 (14.0)
20 – 40 km	10 (9.4)
40 km ~	7 (6.5)
Fear of COVID-19 (score)	17.0 (14.0 – 20.0)
DASS-21 scale (score)	
Depression	4.0 (2.0 – 10.0)
Anxiety	2.0 (0.0 – 2.0)
Stress	4.0 (0.0 – 8.0)
Total score	10.0 (4.0 – 19.0)
HLS-EUQ47 (score)	
Healthcare	26.0 (21.4 – 30.2)
Disease prevention	31.1 (25.6 – 36.2)
Health promotion	26.0 (21.9 – 32.3)
Total score	27.3 (23.0 – 31.6)
Total physical activity (MET/min/week)	1220.0 ± 1689.8
Sedentary time (hour)	8.3 ± 4.1

Data are shown as mean ± SD or median (25 percentile –75percentile). COVID-19: coronavirus disease 2019, DASS: Depression Anxiety Stress Scale, HLS-EUQ47: European Health Literacy Survey Questionnaire.

Table 2 Categorical regression analysis of factors related to physical activity during the COVID-19 pandemic in medical university students.

	Fear of COVID-19	DASS-21 Depression	DASS-21 Stress	HLS-EUQ47 Healthcare	Residence	Sedentary time
Standardised coefficients	0.42*	0.62*	-0.52*	-0.37*	-0.41*	0.34*

Dependent variable: total physical activity (R=0.74, R²=0.55). *: p <0.05, COVID-19: coronavirus disease 2019, DASS: Depression Anxiety Stress Scale, HLS-EUQ47: European Health Literacy Survey Questionnaire.

IV. DISCUSSION

This study investigated the association of physical activity with anxiety, fear of COVID-19, HL, and other factors among healthy university students during the COVID-19 pandemic. The results showed that physical activity was influenced by mental health, HL in the healthcare domain, place of residence, and sedentary activity time. Students were classified into categories of total physical activity (high, moderate, or low) based on previous studies ¹²⁾. Among the students in this study, 9.3%, 29.9%, and 60.7% showed low, moderate, and high total physical activity, respectively, indicating that the students enrolled in this study had lower physical activity and longer average sitting time than those in a previous study ¹²⁾. The results of the survey on stress reduction methods also showed that methods involving low physical activity,

such as listening to music or watching videos, sleeping, and eating, were common. With regard to eating, the majority of the content included eating sweets and other favourite foods at home, which could be related to the longer sedentary activity time and lower physical activity observed in this study.

The fear of COVID-19 scale assessment revealed a high level of anxiety and stress due to fear of death and information in media on COVID-19. Risk factors for mental health problems during COVID-19 pandemic also include high exposure to social and mass media related to COVID-19^{13, 14)}. However, the rates of depression, anxiety, and stress in this study were lower than those reported in previous studies^{2, 3)}. The reasons for this were considered to be differences in the methods used to assess depression and anxiety, and differences in the study population. A study of medical university students found that they were relatively mentally well and had high levels of professional pride during the pandemic¹⁵⁾. The participants in the present study were medical university students, which may have influenced the results. Depression and stress made large contributions to the level of physical activity and were weakly correlated with age and the HL healthcare domain score. Previous studies have reported that older age^{16, 17)}, higher awareness of COVID-19^{13, 18)}, and control of weight gain are¹⁸⁾ associated with reduced anxiety and depression among students. Furthermore, students living in urban areas^{17, 19)}, females^{16, 17)}, and those exposed to more negative information about the pandemic were more likely to be depressed. The majority of commuting students were from urban areas. The level of physical activity may be influenced by the place of residence due to the requirement for commuting to the university and attending face-to-face lectures. Students' fear of COVID-19 was associated with the time spent commuting to university and with other people at the university¹³⁾, which was thought to increase the risk of exposure to infection and anxiety associated with commuting to university. In contrast, 34.6% of the study participants had total HLS-EU-Q47 scores that indicated 'inadequate' HL, which was associated with physical activity. Those with higher comprehensive HL not only gathered more diverse information but were also less likely to have unhealthy lifestyle habits, such as smoking and physical inactivity²⁰⁾. However, in situations of high risk of COVID-19, this may be influenced by individual-level characteristics in the context of infection prevention. Previous studies have observed increased activity and sedentary activity during lockdown in relation to individual activity before COVID-19 pandemic^{21, 22)}. Therefore, it was originally considered that the total HL score may not show any relationship with the level of physical activity, because the situation was such that the more active participants increased their level of physical activity, whereas less active participants increased the time spent in sedentary activity. Additionally, approximately half of the participants had 'inadequate' HL in the healthcare domain, which was associated with lower levels of physical activity. The healthcare domain measures a participant's ability to obtain information about his or her preexisting illness and physical condition, choose coping strategies, and use them to improve adherence. Therefore, mental health programs may be effective in providing students with low HL with information on medical problems secondary to infection control and how to cope with them.

The limitations of the study include its cross-sectional design, which made it impossible to assess the physical activity and mental health of the participants before the spread of COVID-19. Additionally, university students often obtain information via mobile phones and the internet, which may necessitate the use of e-HL and digital HL assessment instruments. University students with higher e-HL are more active in health behaviours related to COVID-19²³⁾. Therefore, future longitudinal studies that include assessments of physical activity, related factors, and e-HL are needed to test the reproducibility of the results.

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Original Article

An exploratory examination of factors that influence the retention of knowledge and confidence of students who completed a CPR seminar

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Abstract: [Purpose] The aim of this study was to investigate the factors that influence the retention of knowledge and confidence on performing cardiopulmonary resuscitation in an emergency after completed a cardiopulmonary resuscitation (CPR) seminar. [Participants and Methods] A total of 175 students in medical-related departments who had ever joined a CPR seminar and had certification of the seminar completion participated in this study. The participants were given a written examination and a self-assessment questionnaire on their confidence in performing CPR, which were the same as those given at the CPR seminar. [Results] Valid answers were obtained from 154 participants. The average number of correct answers for the 20 questions was 13.9 ± 2.8 . Significant correlation was recognized in a correlation analysis for the number of correct answers and confidence ($\rho = 0.272$, $p < 0.001$). The level at which participants can obtain certification of the seminar completion was extracted as a factor that influences written examination. The number of months the participants spent after the seminar and the level at which participants can obtain certification of the seminar completion were extracted as factors that influence the participants' confidence. We created a receiver operating-characteristic curve for the number of months passed after the seminar and their confidence, and obtained a cutoff value, which was 6 months. [Conclusion] The participants' confidence on emergent CPR execution decreased 6 months after joining the CPR seminar. On the other hand, it has been revealed that involvement of scores of the written examination is small. Therefore, it was thought promotion of educational measures such as having the students attend a re-training class within 6 months after the seminar attendance would lead to the retention of students' confidence.

Keywords: Cardiopulmonary resuscitation training, Knowledge, Confidence

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I. INTRODUCTION

According to "White Paper on Fire Service 2021" issued by Fire Defense Agency, one-month survival rate of casualties with cardiogenic cardiopulmonary arrest who were raced to hospitals in 2020 was 15.2% in the case that first aid treatment was performed by residents, which was 1.9 times higher than that in the case that such treatment was not performed ¹⁾. Further, the rehabilitation rate after 1 month was 2.7 times higher in the case that such treatment was performed than in the case that it was not ¹⁾. In this way, to

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improve the lifesaving rate and rehabilitation rate of the casualties who had cardiac arrest outside the hospital, it is important that a citizen rescuer executes basic life support such as cardiopulmonary resuscitation (CPR) before an ambulance arrives at the emergency scene ²⁾ and therefore cooperation by citizen rescuers is essential ³⁾. However, correct knowledge and skill are necessary for execution of high-quality basic life support and in addition confidence on CPR execution is required for taking actual actions.

The purpose of the first aid seminar is to enable persons who took a training class to be involved with rescue operation actively and provide high quality first aid treatment in an actual emergency scene. It is believed that participants' anxiety for knowledge and technical aspects is disappeared by joining a seminar, leading to their confidence. Further, the rate of basic life support execution in actual emergency scene by persons having experience in joining such a seminar is high. Tanaka et al. ⁴⁾ state that persons with higher number of seminar attendance have higher confidence on knowledge and techniques of emergency correspondence, CPR and automated external defibrillator (AED). This corresponds to the report that persons who have taken training classes more than three times have confidence on providing basic life support ⁵⁾. On the other hand, as Barick ⁶⁾ and Bhanji et al. ⁷⁾ point out, their techniques and knowledge may decline over time after taking CPR classes. Moreover, factors that affects retention of the knowledge and confidence after seminar attendance have not been clarified. Clarification of such factors that affects retention of the knowledge and confidence after seminar attendance would allow us to grasp actions needed for seminar attendants to retain their knowledge and confidence.

Therefore, in this study, the authors aimed to perform a self-evaluation-type questionnaire with regard to knowledge obtained after the seminar attendance and confidence on CPR execution in emergency for people who completed CPR seminars and identify factors related to them.

II. PARTICIPANTS AND METHODS

1. Participants

Total 175 students who belonged to medical-related departments participated in this study. Those who had ever attended CPR seminars and had certification of seminar completion were included for the study. Each participant attended the CPR seminars at a different time, and there was variation in the time between attending the CPR seminars and participating in this study. Those who did not agree with participation in the study were excluded for the study. The purpose of this study and methods applied in this study were explained to the participants, and written informed consent was obtained from them. Further, this study has been approved by the Ethical Review Board of Kobe International University (Approval No.: 2011-020).

2. Survey items and measurement items

A written examination and self-evaluation-type questionnaire survey were conducted for those who consented to participate in the study. We distributed sheets containing examination questions and questionnaire to the participants, had them answer on the spot, and collected them after completion.

The number of correct answers in the written examination was used as a performance index that reflects degrees of knowledge related to CPR. The written examination ⁸⁾ consisted of 20 questions, with 1 point for 1 question. All of the participants had experience in taking written examinations at the past CPR seminars they participated. Further, their confidence on CPR execution was measured by self-evaluation-type questionnaire. The belief that one can successfully execute a specific activity in order to obtain a certain outcome was defined self-efficacy ⁹⁾, which was considered a situationally specific self-confidence ¹⁰⁾. Therefore, we conducted a survey based on whether participants believed they could execute CPR effectively using the correct procedures as their confidence in CPR execution. The participants were asked to provide their answers for their confidence for CPR execution with four-point scale of "1. I cannot do at all", "2. I cannot execute following the procedure but can execute partially", "3. I can execute following the procedure but not effectively" and "4. I can execute following the procedure effectively".

In addition, the authors asked the participants about their basic attributes such as age, sex, the number of CPR seminars they had joined (hereinafter called "Number of participations"), the number of months passed since the last seminar participation (hereinafter called "Number of months") and certification levels (normal, advanced, instructor).

3. Statistical analysis

Descriptive statistics were performed for the survey items and measurement items. Next, in order to verify relationships between the number of correct answers in the written examination and the participants' confidence on CPR execution, Spearman's rank correlation analysis was performed. After that, in order to search for factors that influenced the number of correct answers in the written examination, a multiple regression analysis (stepwise method) was performed with the number of correct answers as a dependent variable and number of participations, number of months and certification levels as independent variables. In that case that the relationships between among the explanatory variables are too close in a multiple regression analysis, multicollinearity becomes an issue, and therefore Variance Inflation factor (VIF) was obtained to confirm multicollinearity. Next, in order to search for factors that influenced confidence on CPR execution, an ordinal logistic regression analysis was performed with scores of the self-evaluation-type questionnaire as a dependent variable, and number of participations, number of months and certification levels as independent variables. In the case that the number of participation or that of months was extracted as a significant variable in the multiple regression analysis or ordinal logistic regression analysis, cutoff values were obtained from the receiver operating characteristic curve (ROC curve). In such a case, "4. I can execute following the procedure effectively" and other options were classified into "Have confidence" and "Have no confidence", respectively.

Here, analysis software (Social Survey Research Information Co., BellCurve for Excel) was used for the statistical analysis, with significance level as 5%.

III. RESULTS

1. Participants' basic attributes (Table 1)

Valid answers were obtained from 154 participants (collection ratio: 88%), 106 of whom were male and 48 of whom were female, with the average age of 19.8 ± 0.9 . The average number of participations was 1.9 ± 1.5 times, and the average number of months was 12.1 ± 11.4 months. For the participants' certification levels, 131 were normal level, 12 were advanced level and 11 were instructor level.

Table 1. Basic attribute (n = 154)

Sex (the number of participants)	
Male	106
Female	48
Average age (year)	19.8 ± 0.9
Seminar participation number of times (time)	1.9 ± 1.5
Number of months passed from previous one attendance (months)	12.1 ± 11.4
Certification level (number of people) *	
General lifesaving training class (Normal level)	131
Upper lifesaving training class (Advanced level)	12
First aid spreader training class (Instructor level)	11
Number of correct answers in the written examination (up to 20 points)	13.9 ± 2.8

* Participants of seminars hosted by Fire Defense Agency, Ministry of Internal Affairs and Communications.

2. Number of correct answers in the written examination and confidence on CPR execution (Table 2)

The average number of correct answers in the written examination was 13.9 ± 2.8 points. For confidence on CPR execution, 5 answered "1. I cannot do at all", 61 answered "2. I cannot execute following the procedure but can execute partially", 58 answered "3. I can execute following the procedure but not effectively" and 30 answered "4. I can execute following the procedure effectively". A Spearman's correlation analysis for the number of correct answers in the written examination and confidence on CPR execution has revealed significant weak correlation ($\rho = 0.272$, $p < 0.001$).

Table 2. Confidence on CPR execution (n = 154)

I cannot do at all	5 (3.2)
I cannot execute following the procedure but can execute partially	61 (39.6)
I can execute following the procedure but not effectively	58 (37.7)
I can execute following the procedure effectively	30 (19.5)

Present the number of persons (%).

3. Factor that influence the number of correct answers in the written examination

As a result of multiple regression analysis, only the certification levels were extracted as significant variable (partial regression coefficient = 2.449, $p < 0.001$) (Table 3). The number of participation and number of months were not selected as a variable to explain the number of correct answers in the written examination.

Table 3. Results of the multiple regression analysis with the number of correct answers in the written examination as a dependent variable (stepwise method)

Variable	B	SEB	t value	p value
(Constant)	10.958	0.493	22.247	< 0.001
Certification level	2.449	0.367	6.680	< 0.001

$F(1, 152) = 44.627, p < 0.001, R^2 = 0.227$

B: Partial regression coefficient, SEB: standard error of B

4. Factors that influence confidence on CPR execution

As a result of the ordinal logistic–regression analysis, the number of months (odds ratio = 0.961, $p = 0.004$) and certification levels (odds ratio = 2.697, $p = 0.009$) were extracted as significant variables. The number of participation (odds ratio = 1.186, $p = 0.290$) was not significant (Table 4).

Since the number of months was extracted as a significant variable, a receiver operating–characteristic curve was created for confidence on CPR execution based on the number of months, which revealed that the number of months at which confidence would be identified was 6 months as a cut–off value (Sensibility = 0.629, Specificity = 0.667, Area under the curve = 0.679 [95% confidence interval: 0.570–0.788], $p = 0.001$) (Fig 1).

Table 4. Result of the ordinal logistic–regression with confidence on CPR execution as a dependent variable analysis

	B	SEB	OR	95%CI	p value
Number of participations	0.171	0.161	1.186	0.865–1.627	0.290
Number of months	-0.040	0.014	0.961	0.936–0.988	0.004
Certification level	0.992	0.380	2.697	1.280–5.682	0.009

B: Partial regression coefficient, SEB: standard error of B, OR: odds ratio, 95%CI: 95% confidence interval

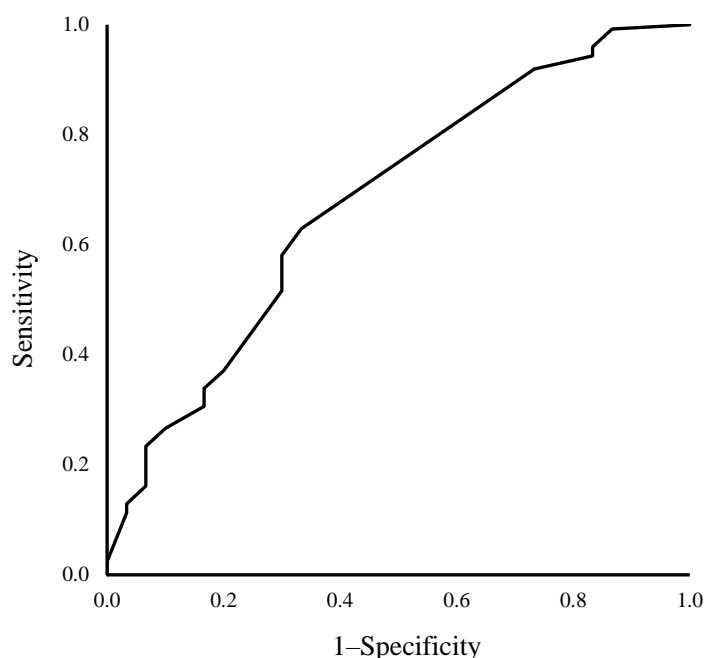


Figure 1. Receiver operating-characteristic curve of the number of months at which participants' confidence on CPR execution is identified

IV. DISCUSSION

1. Relation between the number of correct answers in the written examination and confidence on CPR execution

In this study, significant weak correlation between the number of correct answers written examination and confidence on CPR execution was recognized. Moreover, since correlation between the number of correct answers written examination and confidence on CPR execution was small in our previous study¹¹⁾, the relationship between knowledge and confidence on CPR execution is weak, we presume. However, various researchers¹²⁻¹⁵⁾ have reported on confidence risen after seminar participation. Further, Akizuki et al.¹⁶⁾ and Sumitomo et al.¹⁷⁾ have reported that experience and improvement of the practical skill raised confidence on CPR. Hayashi et al.¹⁸⁾ reported that the number of students who answered that they could perform CPR was significantly high after receiving instruction for practical skill, and therefore performed an analysis to clarify which stage such confidence was formed at separating the practical skill instruction into "Description" and "Practical training". The result revealed that it was formed significantly more by practical training than by description. Tsumura et al.¹⁹⁾ have reported that students with experience in practical skill of CPR were motivated for CPR at emergency more significantly than those without such experience, indicating that what one can learn about CPR by theory based on text books is limited. From the above, influence of general knowledge on confidence on emergent CPR execution is small, we presume.

2. Factors that influence the number of correct answers in the written examination

Although it is supposed that factors that influence the number of correct answers in the written examination include time passed after seminar participation and the number of seminar participation, they did not have influence in this study and it was strongly related to acquisition of certification. The certification is classified into General lifesaving class I of 3 hours and First aid spreader class of 8 hours for the advanced level and of 24 hours, and class hours are longer for higher levels. Therefore, quality and quantity of the classes influence the relations between the number of correct answers in written

examination and acquisition of certification, we presume. Further, it is supposed that motivation for first aid such as wish for acquiring certifications of advanced levels influences it.

3. Factors that influence confidence on CPR execution

According to Japan Resuscitation Council (JRC) Resuscitation Guideline 2015, one of the factors that citizen rescuers hesitate CPR is that they do not have confidence on CPR. Our past survey ¹²⁾ revealed that one's confidence on CPR rises after seminar participation. A number of precedent studies reported that confidence raised after seminar participation. Takahashi ²⁰⁾ has stated that the reason why people have fear of CPR is lack of sufficient knowledge and skills, and lack of sufficient knowledge and skills led to reduction of confidence through sense of fear.

In the present study, time passed after CPR training and certification levels influenced confidence on CPR. For confidence on CPR execution, the authors created a receiver operating–characteristic curve based on the number of months, which revealed that the number of months at which confidence would be identified was 6 months as a cut–off value.

It has been revealed that confidence after seminar participation declined over time with or without certifications ^{21–23)}. Connolly et al. ²⁴⁾ and Hiramatsu et al. ²⁵⁾ have reported that confidence on CPR declines 6 months after seminar participation. Since the present study has revealed that the number of months at which confidence is identified is 6 months, it is necessary for participants to take measures such as retaking CPR classes within 6 months after the last seminar participation so as to maintain confidence on emergent CPR execution.

It has been reported that the greater number of participations in basic life support classes will lead to better participants' understanding and confidence on the techniques ²⁶⁾, their self–efficacy rises after CPR training, and their feeling of anxiety for executing CPR decreases ²⁷⁾. In this study, its relation with the number of participation has not been clarified.

It has also been reported that even nurses, medical students and nursing students would not be able to perform satisfactory CPR unless they take training continuously ^{28–30)}. Wenzel et al. ³¹⁾ have reported that only 5% of medical students who took CPR classes maintained their techniques for 6 months after taking the last CPR class. Sakoda et al. ³²⁾ have reported that attending training again within 3 months after the last CPR class attendance would prevent decline of the participants' skills. The need of retaking classes for retention of the techniques has been mentioned in a number of precedent studies ^{25, 33, 34)}. In this study, need of continuous learning such as retaking classes 6 months after the last seminar attendance has been suggested.

The participants in this study were medical–related university students and therefore their medical knowledge and will for CPR are presumably higher than those of general citizens. In the future, it is necessary to perform surveys for participants of various ages and occupations. Further, it is needed to investigate factors that influence citizen rescuers' confidence on CPR execution, we believe.

FUNDING AND CONFLICT OF INTEREST

There is not conflict of interests which needs be disclosed in this study.

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Report

Player Injury Analysis in Professional Basketball Leagues in Japan

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Abstract: [Purpose] This study aimed to determine the injury situations of Japanese professional basketball league players based on publicly available data. [Subjects and Methods] A total of 522 basketball league players during the 2021-2022 season (October 2021-May 2022) were included in the study. The research method involved collecting diagnoses of player injuries from information published on each team's official website. The injury rate, number of injuries (including multiple injuries), and percentage of injury sites were calculated based on the player injury data. [Results] There were 108 injured players and 124 injuries. Ninety-three players were injured once, 14 were injured twice, and 1 was injured three times. The percentage of injury sites was 8.1% (10 times) in the head and face, 20.2% (25 times) in the upper extremities, 7.3% (9 times) in the trunk, and 64.5% (80 times) in the lower extremities. Injuries to the lower extremities, including multiple diagnoses, were reported 90 times, with injuries to the knee joint and lower leg being the most common. [Conclusion] The results showed that the percentages of injuries to the thigh, knee joint, lower leg, and ankle joint were similar, suggesting the importance of injury prevention not only for the ankle joint but also for the entire lower limb.

Keywords: Professional Basketball League, Players, Injury

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I. INTRODUCTION

Basketball is one of the most popular sports in Japan, with the FIBA Basketball World Cup held in Japan in 2023. In 2016, the Japan Professional Basketball League (B-League) was established, making basketball the third professional sport in Japan after baseball and soccer. The B-League has two divisions: the B1-League (B1) and the B2-League (B2). The regular season is from September to May of the following year. The top teams then compete in the B-League Championship, which determines the annual champion team in B1, and the B-League Playoffs in B2.

Basketball involves significant contact between players. Injuries are likely to occur due to mechanical stress on the joints and parts of the body when running while controlling the ball, stopping suddenly to make turns, or jumping for shots or rebounds. Depending on the parts and severity of the injury, it may take a long time for players to return to play, which can have a significant impact on their career and team.

Many studies have been conducted on basketball injuries. Injuries to the lower extremities, especially the ankle joints, are the most common among professional basketball players ¹⁻³⁾. The incidence of ankle joint injuries is also high among high school and college basketball players ⁴⁻⁶⁾. However, there have been no reports on player injuries since the inception of the B-League, and there is currently a lack of basic data on injury prevention.

Therefore, this study aimed to clarify the injury situation in professional basketball in Japan by conducting an analysis based on player injury data reported on each team's official website. This study will help prevent professional basketball players from becoming injured.

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II. PARTICIPANTS AND METHODS

1. PARTICIPANTS

Players who were listed on the official B-League website during the 2021-2022 season (October 2021-May 2022) or whose injuries were announced on each team's official website were included. The number of players was 522, consisting of 316 players (22 teams) in B1 and 206 players (14 teams) in B2.

2. METHODS

Information on the injury situations (diagnostic names) of the players was collected from information published on the official websites of each team between February and September 2023. Each team's website contains information, such as the name of the injury, name of the injured player, and date of the injury. Injuries that had been ongoing since the 2020-2021 season and those that occurred outside of games or team practices were excluded.

In this study, the injury percentages, number of injuries (including multiple injuries), and injury sites were calculated based on the players' injury data. The injury rate was calculated as the percentage of injuries to each injured part, when the total number of injuries was set to 100%. Lower extremity injuries were further categorized by injury site, and their percentages were calculated. If the injuries involved multiple diagnoses, they were collected separately.

III. RESULTS

In the 2021-22 season, 522 players (316 in B1 and 206 in B2) were registered in the B-League, and 108 players (20.7%) were injured, including 93 players injured once, 14 players injured twice, and 1 player injured three times (Table 1). Injuries occurred 124 times: 8.1% (10 times) on the head and face, 20.2% (25 times) on the upper limbs, 7.3% (9 times) on the trunk, and 64.5% (80 times) on the lower limbs (Table 2). Lower extremity injuries, including multiple diagnoses, were reported 90 times: 0 (0%) for the hip joint, 19 (21.1%) for the thigh, 21 (23.3%) for the knee joint, 21 (23.3%) for the lower leg, 19 (21.1%) for the ankle joint, and 10 (11.1%) for the foot (Table 3).

Table 1. The number of injuries of the players

Total number	108	
One injury	93	86.1%
Two injuries	14	13.0%
Three injuries	1	0.9%

Table 2. The number of injury sites

Total number	124	
Head and face	10	8.1%
Upper limbs	25	20.2%
Trunk	9	7.3%
Lower limbs	80	64.5%

Table 3. The number of injuries to the lower limb

Total number	90	
Hip joints	0	0.0%
Thigh	19	21.1%
Knee joints	21	23.3%
Lower leg	21	23.3%
Ankle joints	19	21.1%
Foot	10	11.1%

IV. DISCUSSION

This study aimed to clarify injuries among Japanese professional basketball players, and the results revealed that injuries to the lower extremities occurred most frequently.

The results showed that the lower limbs were the most common injury sites (64.5%, 80 injuries), followed by the upper limbs (20.2%, 25 injuries), head/face (8.1%, 10 injuries), and trunk (7.3%, 9 injuries). Injuries to the lower extremities, including multiple diagnoses, were reported 90 times, with the knee joint and lower leg being the most common site of injury, each accounting for 23.3% (21 times), followed by the thigh and ankle joints (21.1%, 19 times), foot (11.1%, 10 times), and hip (0%, 0 times). A study of Japanese male college basketball players⁵⁾ reported that lower extremity injuries accounted for the majority (73.5%) of all injuries among college students, particularly ankle (35.8%), thigh (12.1%), and trunk (11.0%) injuries, and knee injuries accounted for 10.2%. Studies of the National Basketball Association (NBA)²⁾ and high school girls' basketball teams⁶⁾ also showed that injuries to the lower extremities are common, with the ankle joint having the highest rate of injury. The results of these studies are similar to those of the present study in that the lower extremities were most frequently injured. However, in the present study, the thigh, knee joint, lower leg, and ankle joints showed similar proportions. This suggests the importance of injury prevention not only in the ankle joint but also in the entire lower extremity.

A limitation of this study is that information on players on the official B-League website is updated regularly, and there is a possibility that some players were not included as subjects of this study. In addition, this study only analyzed data published on official websites, and there is a possibility that there were injuries that were not publicized by the teams. Therefore, caution should be exercised when interpreting the results of this study as an injury trend in professional Japanese basketball players. This study examined only one season and did not compare injuries in other seasons. In addition, more detailed analysis would be possible by utilizing data such as time of injury, age, and position. Therefore, it is necessary to continue the study and analyze player injuries in the future.

FUNDING AND CONFLICT OF INTEREST

There is not conflict of interests which needs be disclosed in this study.

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