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Material

Questionnaire Survey of University Students Enrolled in Practical Physical Education Compulsory Subjects Utilizing Remote Learning during the COVID-19 Pandemic: Comparison of Spring 2020, Fall 2020, Spring 2021, and Fall 2021 Semesters

Tomoaki BUNYA[*1] **and Tomomi MONRI**[*2,3]

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Abstract

The authors conducted a questionnaire survey of 1,747 students enrolled in practical physical education compulsory subjects, which combined face-to-face and on-demand remote learning for first-year students. The survey spanned four periods during the COVID-19 pandemic: the spring and fall semesters of 2020 and the spring and fall semesters of 2021. The results were analyzed from the perspective of each semester and year. Significant differences were found between the four semesters regarding exercise implementation status ($p<0.05$), most important type of exercise ($p<0.001$), need for posting Q and A ($p<0.05$), need for posting my ingenuity and recommendations ($p<0.01$), exercise for ≥ 70 minutes per week ($p<0.01$), preferences for exercise recording methods ($p<0.05$), stiff shoulders ($p<0.001$), lower back pain ($p<0.001$), headache ($p<0.01$), eye fatigue ($p<0.001$), feelings of depression ($p<0.001$), falling asleep ($p<0.001$), waking up ($p<0.001$), flexibility ($p<0.05$), and muscle strength ($p<0.01$). Additionally, different trends were observed in the usage of Information and Communication Technology devices between the four semesters.

1. Introduction

The novel coronavirus disease (COVID-19), identified at the end of 2019, spread rapidly worldwide. The first case in Japan was confirmed on January 16, 2020[1)]. On April 16 of the same year, a state of emergency was declared nationwide[2)], forcing people to adopt a life of unprecedented self-restraint. The pandemic significantly impacted university education, making it challenging to maintain traditional class formats. Consequently, measures were implemented to support remote learning, which most universities had not previously experienced. Available physical activity promotion programs were also provided[3)]. A survey of class formats for the second semester (fall semester) of 2020 and the first semester (spring semester) of 2021

[*1] Kawasaki University of Medical Welfare, 288 Matsushima, Kurashiki, 701-0193, Japan
Part-time Lecturer
[*2] Comprehensive Education Center, Kawasaki University of Medical Welfare
[*3] Department of Health and Sports Science, Faculty of Health Science and Technology
Kawasaki University of Medical Welfare
E-Mail: monri@mw.kawasaki-m.ac.jp

revealed that approximately equal proportions of classes used a combination of face-to-face and on-demand remote learning (40.5% and 38.9%, respectively) and face-to-face only (38.9%, 46.6%, respectively), indicating utilization of on-demand learning to a certain extent[4]. Therefore, the authors conducted a questionnaire survey of students enrolled in practical physical education subjects, which are compulsory and taught via combining face-to-face and on-demand remote learning, during the 2020 and 2021 academic years, when the state of emergency or priority preventative measures[5] were in place.

2. Methods

2.1 Participants

The survey subjects were 1,747 students (496 male and 1,251 female) enrolled in practical physical education compulsory subjects for first-year students at K University in Okayama Prefecture in the spring and fall semesters of 2020 and the spring and fall semesters of 2021, and who provided complete responses to the questionnaire survey. The number of students in each of the four semesters was 431, 451, 451, and 414, respectively.

2.2 Class contents

The 2020 class was comprised of three face-to-face learning sessions (first, second, and final) and 15 weeks of on-demand remote learning. The 2021 class consisted of four face-to-face learning sessions (first, second, midterm, and final) and 14 weeks of on-demand remote learning. Face-to-face learning sessions included explanations of class content, a question-and-answer session, and stretching-based exercises. In the first class, students received exercise recording sheets (15 weeks' worth in 2020, 14 weeks' worth in 2021), and materials on basic stretching and resistance exercises. Additionally, fitness-related materials (including stretching, resistance exercises, aerobic exercises, comprehensive exercises, and other exercises) were distributed through the e-learning system every Monday. The materials provided in 2020 consisted of 14 still images, 17 videos (2 still images and videos featuring the same theme), and 1 PowerPoint presentation. In 2021, the materials included 21 still images and 28 videos (13 still images and videos featuring the same theme). Students were required to watch the materials, perform the exercises (with the option to only watch exercises that were difficult to practice), submit their impressions of the exercises through the system, and maintain a record of their exercises. Considering the varying physical fitness levels, physical conditions, and preferences among students, and with the expectation that they would continue to engage in activities voluntarily, actively, and enjoyably, students were allowed to record their self-styled exercises and exercises learned through video streaming services such as YouTube. Teachers consistently encouraged the students to practice according to their physical fitness level.

The recommended exercise time was 70 minutes per week (equivalent to 10 minutes per day) or more. To facilitate information sharing between teachers and students, teachers presented a "Questions and Answers (Q and A)" section to address students' queries. Additionally, teachers shared students' innovative exercise ideas and recommendations for their peers, showcasing "my ingenuity and recommendations to other students" and promoting a sense of community. Recording sheets were collected at the second and final classes in 2020, and at the midterm and final classes in 2021 (in the spring semester, the midterm class was canceled due to the declaration of a state of emergency, and all sheets were collected at the final class). The anonymized questionnaire survey was conducted in paper form at the final class.

2.3 Questionnaire

The multiple-choice format questionnaire contained questions regarding the following items: 1) Efforts in classes and exercise practice status; 2) opinions or judgments regarding class style; 3) changes in body condition; and 4) changes in physical fitness.

Item 1) consisted of the five questions. The questions and answer choices (in parentheses) were as follows. Information and Communication Technology (ICT) devices used (multiple answers allowed: desktop

Personal Computer [PC], laptop, tablet, smartphone), most common posture when taking remote learning (chairs and desks, sitting on the floor or tatami, standing), viewing status of still images and videos (diligently, modestly), exercise implementation status (diligently, modestly), and most important type of exercise (stretching, resistance exercise, aerobic exercise).

Item 2) consisted of the following five questions. Need for posting Q and A (rather Yes, rather No, neither), need for posting my ingenuity and recommendations (rather Yes, rather No, neither), exercise for 70 minutes or more per week (considerable burden, a little burden, just right, no burden [easily]), burden of recording the exercises performed (much hassle, a little hassle, not too much hassle, not a hassle at all), and preferences for exercise recording methods (handwritten on paper, input to ICT device, either is fine).

Item 3) included stiff shoulders, lower back pain, headache, eye fatigue, feelings of depression, falling asleep, and waking up. For the 2020 spring semester, students responded whether these issues were new (no change, worsened) or pre-existing (improved, no change, worsened). For the 2021 spring semester, students responded about their past (before the semester) and current (at the end of classes) situations, rating the frequency (included intensity) of these issues (a lot, a little, none), with trends (improved, no change, worsened) analyzed accordingly. For the 2020 and 2021 fall semesters, students responded about their past (spring semester) and current (at the end of classes) situations (a lot, a little, none) at the same time, and trends (improved, no change, worsened) were shown based on these results.

Item 4) included flexibility, muscle strength, and cardiorespiratory endurance, which were indicated by the responses (improved, unchanged, decreased) compared to before the start of the class.

2.4 Statistical analysis

The relationship between each item (excluding ICT devices used) and the four semesters was analyzed using the chi-square test and residual analysis. Statistical analysis was performed using IBM SPSS version 23.0 and p-values <0.05 were considered indicative of statistical significance.

3. Results

Data are presented as the sum of responses from males and females. For items showing significant differences in the chi-square test (excluding ICT devices used), a residual analysis was performed between the four semesters. Significantly higher adjusted standardized residuals are denoted by "↑" and significantly lower ones by "↓" in the table below.

3.1 Efforts in classes and exercise practice status

Efforts in classes and exercise practice status are shown in Table 1. Significant differences were observed between the four semesters in terms of exercise implementation status ($p<0.05$) and the most important type of exercise ($p<0.001$). However, no differences were observed in the most common posture during remote learning and the viewing status of still images and videos. Additionally, different trends were observed in ICT devices used across the four semesters.

3.2 Opinions or judgments regarding class style

Opinions or judgments regarding class style are presented in Table 2. Significant differences were observed between the four semesters regarding the need for posting Q and A ($p<0.05$), the need for posting my ingenuity and recommendations ($p<0.01$), exercising for 70 minutes or more per week ($p<0.01$), and preferences for exercise recording methods ($p<0.05$). However, no differences were observed regarding the burden of recording exercises.

3.3 Changes in body condition

Changes in body condition are presented in Table 3. Significant differences were observed between the four semesters in all items: stiff shoulders ($p<0.001$), lower back pain ($p<0.001$), headache ($p<0.01$), eye fatigue

Table 1 Effort in classes and exercise practice status

Variables	2020 Spring n=431	2020 Fall n=451	2021 Spring n=451	2021 Fall n=414	Analysis
ICT devices used (multiple answers allowed)					
Desktop PC	50 (11.6)	47 (10.4)	34 (7.5)	16 (3.9)	
Laptop	279 (64.7)	316 (70.1)	321 (71.2)	271 (65.5)	
Tablet	52 (12.1)	50 (11.2)	28 (6.2)	31 (7.5)	
Smartphone	325 (75.4)	308 (68.3)	315 (69.8)	328 (79.2)	
Most common posture when taking remote learning					
Chairs and desks	290 (67.3)	274 (60.7)	277 (61.4)	264 (63.7)	
Sitting on the floor or tatami	129 (29.9)	159 (35.3)	151 (33.5)	127 (30.7)	$\chi^2(6)=8.83$
Standing	12 (2.8)	18 (4.0)	23 (5.1)	23 (5.6)	
Viewing status of still images and videos					
Diligently	246 (57.1)	260 (57.6)	267 (59.2)	244 (58.9)	$\chi^2(3)=0.56$
Modestly	185 (42.9)	191 (42.4)	184 (40.8)	170 (41.1)	
Exercise implementation status					
Diligently	227 (52.7)	233 (51.6)	276 (61.2) ↑	229 (55.3)	$\chi^2(3)=9.96$ *
Modestly	204 (47.3)	218 (48.4)	175 (38.8) ↓	185 (44.7)	
Most important type of exercise					
Stretching	215 (49.9) ↑	243 (53.8) ↑	168 (37.2) ↓	147 (35.5) ↓	
Resistance exercise	82 (19.0)	78 (17.3)	71 (15.8)	69 (16.7)	$\chi^2(6)=61.02$ ***
Aerobic exercise	134 (31.1) ↓	130 (28.9) ↓	212 (47.0) ↑	198 (47.8) ↑	

Numbers (%), Statistical analysis: Chi-square test *p<0.05 ***p<0.001
Adjusted standardized residuals: significantly higher denoted by " ↑ " and significantly lower ones by " ↓ "

(p<0.001), feelings of depression (p<0.001), falling asleep (p<0.001), and waking up (p<0.001).

3.4 Changes in physical fitness

Changes in physical fitness are presented in Table 4. Significant differences were observed between the four semesters in terms of flexibility (p<0.05) and muscle strength (p<0.01), while no significant differences were observed regarding cardiorespiratory endurance.

4. Discussion

4.1 Effort in classes and exercise practice status

As the semester progressed, the proportion of students using desktop PCs and tablets tended to decrease, while the proportion of those using laptops and smartphones remained consistently high throughout. These results likely reflect that in 2020, most students experienced remote learning for the first time and utilized all ICT devices available at home (including shared use by family). In contrast, 2021 saw a shift toward portable devices over desktop PCs, which were limited to home use.

Regarding the proportion of the most important exercises, stretching was prominent in 2020, while aerobic exercise was more prevalent in 2021. This shift may be attributed to the changing circumstances surrounding the COVID-19 pandemic. In 2020, the declaration of a state of emergency in Japan severely

Table 2 Opinions or judgments regarding class style

Variables	2020 Spring n=431	2020 Fall n=451	2021 Spring n=451	2021 Fall n=414	Analysis
Need for posting Q and A					
Rather Yes	253 (58.7)	301 (66.7) ↑	248 (55.0) ↓	251 (60.6)	
Rather No	54 (12.5)	50 (11.1)	51 (11.3)	48 (11.6)	$\chi^2(6)=16.62$ *
Neither	124 (28.8)	100 (22.2) ↓	152 (33.7) ↑	115 (27.8)	
Need for posting my ingenuity and recommendation					
Rather Yes	298 (69.1) ↑	311 (69.0) ↑	266 (59.0) ↓	249 (60.1) ↓	
Rather No	30 (7.0) ↓	38 (8.4)	46 (10.2)	53 (12.8) ↑	$\chi^2(6)=21.48$ **
Neither	103 (23.9)	102 (22.6)	139 (30.8) ↑	112 (27.1)	
Exercise for 70 minutes or more per week					
Considerable burden	7 (1.7)	13 (2.9)	17 (3.8)	12 (2.9)	
A little burden	75 (17.4) ↓	119 (26.4)	128 (28.4)	121 (29.2) ↑	$\chi^2(9)=27.49$ **
Just right	195 (45.2)	193 (42.8)	179 (39.6)	168 (40.6)	
No burden (easily)	154 (35.7) ↑	126 (27.9)	127 (28.2)	113 (27.3)	
Burden of recording the exercises performed					
Much hassle	48 (11.1)	62 (13.7)	74 (16.4)	50 (12.1)	
A little hassle	281 (65.2)	289 (64.1)	299 (66.3)	284 (68.6)	$\chi^2(9)=13.62$
Not too much hassle	91 (21.1)	91 (20.2)	74 (16.4)	75 (18.1)	
Not a hassle at all	11 (2.6)	9 (2.0)	4 (0.9)	5 (1.2)	
Preferences for exercise recording methods					
Handwritten on paper †	142 (32.9) ↑	122 (27.1)	129 (28.6)	96 (23.2) ↓	
Input to ICT device	125 (29.0)	145 (32.2)	158 (35.0)	145 (35.0)	$\chi^2(6)=12.73$ *
Either is fine	164 (38.1)	184 (40.7)	164 (36.4)	173 (41.8)	

Numbers (%), Statistical analysis: Chi-square test *$p<0.05$ **$p<0.01$
Adjusted standardized residuals: significantly higher denoted by " ↑ " and significantly lower ones by " ↓ "
† Adopted in this class

restricted outdoor activities, resulting in a greater emphasis on stretching exercises. In 2021, priority preventative measures were also implemented, which are less enforceable[5]. As a result, students became less averse to engaging in outdoor activities, such as walking and jogging, leading to a greater emphasis on aerobic exercises. Incidentally, the proportion of students who reported exercising "diligently" was somewhat higher in the spring semester of 2021 (61.2%) compared to other semesters. Although the exact reason for this is unclear, it may be attributed to various coincidental factors, including the characteristics of the students during that semester (differences in departments, etc.).

4.2 Opinions or judgments regarding class style

Regarding the need for posting my ingenuity and recommendations, the proportion of students who responded "rather Yes" was approximately 10% higher in the spring semester than in the fall semester in both 2020 and 2021. This trend may be attributed to the unique circumstances of 2020, the first year of

Table 3 Changes in body condition

Variables	2020 Spring n=431	2020 Fall n=451	2021 Spring n=451	2021 Fall n=414	Analysis
Stiff shoulders					
Improved	79 (18.3)	98 (21.7)	93 (20.6)	61 (14.8) ↓	
No change	284 (65.9)	317 (70.3)	284 (63.0) ↓	328 (79.1) ↑	$\chi^2(6)=47.27$ ***
Worsened	68 (15.8) ↑	36 (8.0) ↓	74 (16.4) ↑	25 (6.1) ↓	
Lower back pain					
Improved	41 (9.5)	64 (14.2)	71 (15.7) ↑	33 (8.0) ↓	
No change	352 (81.7)	348 (77.1)	333 (73.8) ↓	358 (86.4) ↑	$\chi^2(6)=26.13$ ***
Worsened	38 (8.8)	39 (8.7)	47 (10.5)	23 (5.6) ↓	
Headache					
Improved	15 (3.5) ↓	33 (7.3)	39 (8.6) ↑	23 (5.6)	
No change	389 (90.2) ↑	394 (87.4)	372 (82.5) ↓	368 (88.8)	$\chi^2(6)=17.68$ **
Worsened	27 (6.3)	24 (5.3)	40 (8.9) ↑	23 (5.6)	
Eye fatigue					
Improved	36 (8.4) ↓	69 (15.3) ↑	46 (10.2)	47 (11.3)	
No change	261 (60.6) ↓	339 (75.2) ↑	283 (62.7) ↓	336 (81.2) ↑	$\chi^2(6)=127.41$ ***
Worsened	134 (31.0) ↑	43 (9.5) ↓	122 (27.1) ↑	31 (7.5) ↓	
Feelings of depression					
Improved	27 (6.3) ↓	62 (13.8) ↑	50 (11.1)	52 (12.5)	
No change	335 (77.7)	347 (76.9)	343 (76.0)	332 (80.2)	$\chi^2(6)=30.27$ ***
Worsened	69 (16.0) ↑	42 (9.3)	58 (12.9)	30 (7.3) ↓	
Falling asleep					
Improved	43 (10.0)	59 (13.1)	47 (10.4)	61 (14.7)	
No change	303 (70.2)	332 (73.6)	302 (67.0) ↓	325 (78.5) ↑	$\chi^2(6)=50.53$ ***
Worsened	85 (19.8) ↑	60 (13.3)	102 (22.6) ↑	28 (6.7) ↓	
Waking up					
Improved	43 (10.0) ↓	48 (10.6)	85 (18.8) ↑	49 (11.9)	
No change	313 (72.6)	339 (75.2)	301 (66.7) ↓	320 (77.3) ↑	$\chi^2(6)=50.53$ ***
Worsened	75 (17.4) ↑	64 (14.2)	65 (14.5)	45 (10.9) ↓	

Numbers (%), Statistical analysis: Chi-square test **p <0.01 ***p <0.001
Adjusted standardized residuals: significantly higher denoted by " ↑ " and significantly lower ones by " ↓ "

the coronavirus pandemic, where students experienced social isolation and had limited contact with others. As a result, they may have had a stronger desire to learn about their peers' experiences of the program. Regarding exercise for 70 minutes or more per week, a greater number of students perceived it as a burden in 2021 compared to 2020. This may be attributed to the fact that in 2021, the second year of the COVID-19 pandemic, face-to-face learning gradually increased, making it challenging for students to balance their schedules between remote and in-person classes[6]. Additionally, with the return to in-person classes,

Table 4 Changes in physical fitness

Variables	2020 Spring n=431	2020 Fall n=451	2021 Spring n=451	2021 Fall n=414	Analysis
Flexibility					
Improved	231 (53.6) ↑	217 (48.1)	204 (45.2)	173 (41.8) ↓	
Unchanged	177 (41.1) ↓	210 (46.6)	215 (47.7)	208 (50.2)	$\chi^2(6)=14.39$ *
Decreased	23 (5.3)	24 (5.3)	32 (7.1)	33 (8.0)	
Muscle strength					
Improved	195 (45.2) ↑	196 (43.5)	162 (35.9) ↓	152 (36.7)	
Unchanged	192 (44.5)	201 (44.5)	208 (46.1)	205 (49.5)	$\chi^2(6)=19.59$ **
Decreased	44 (10.3) ↓	54 (12.0)	81 (18.0) ↑	57 (13.8)	
Cardiorespiratory endurance					
Improved	117 (27.1)	128 (28.4)	134 (29.7)	112 (27.1)	
Unchanged	247 (57.3)	233 (51.6)	217 (48.1)	217 (52.4)	$\chi^2(6)=9.70$
Decreased	67 (15.6)	90 (20.0)	100 (22.2)	85 (20.5)	

Numbers (%), Statistical analysis: Chi-square test *p＜0.05 **p＜0.01
Adjusted standardized residuals: significantly higher denoted by " ↑ " and significantly lower ones by " ↓ "

students had to allocate time for commuting[7], leaving less time available for exercise.

Regarding preferences for exercise recording methods, the proportion of students who preferred "handwritten on paper" was high in the 2020 spring semester, but decreased by the 2021 fall semester. Generally, there was a slight tendency for the proportion of students who preferred "input to ICT device" to be higher in 2021 than in 2020. This shift may be attributed to the accelerated development of ICT environments in school education due to the COVID-19 pandemic[8,9]. Notably, students who entered in 2021 had experienced the coronavirus pandemic for a year during their high school days and were likely accustomed to using ICT devices.

Regarding the need for posting Q and A, the proportion of students who responded with "rather Yes" was higher in the 2020 fall semester compared to other semesters. Conversely, the proportion of students who responded with "neither" was higher in the 2021 spring semester. Although the exact reason for this trend is unclear, it may be related to the degree of alignment between the information students sought and the information provided by teachers.

4.3 Changes in body condition

In all four semesters, the highest proportion of students reported "no change" for all items (stiff shoulders, lower back pain, headache, eye fatigue, feelings of depression, falling asleep, and waking up). A notable trend was observed in both 2020 and 2021, where the proportion of students who reported "worsened" exceeded those who reported "improved" in the spring semester compared to the fall semester, with this tendency being more pronounced in 2020. Typically, first-year university students face various stresses as they adapt to their new academic environment[10]. However, the 2020 spring semester was uniquely challenging due to the compounding effect of the COVID-19 pandemic, which made university life even more physically and mentally demanding[11]. One possible reason for students' worsening feelings of depression may be the lack of face-to-face interactions with their peers and teachers.

Regarding eye fatigue, in both 2020 and 2021, the proportion of students who reported "worsened" was higher in the spring semester, while the proportion of those who reported "improved" was higher in the fall

semester. This may be attributed to the increased screen time in the spring semester, as students likely spent more time looking at ICT devices for online classes and assignments than in high school days. These findings are consistent with existing research[12] showing a strong correlation between screen time and eye fatigue. Additionally, the high proportion of students who reported difficulty falling asleep and waking up in the 2020 spring semester seems to support this notion.

Incidentally, the proportion of students who reported "improved" was higher than those who reported "worsened" for stiff shoulders and lower back pain in all four semesters. Additionally, in the fall semesters of 2020 and 2021, the proportion of students who reported "improved" eye fatigue was also higher. These findings suggest that the materials delivered in this class (stretching and self-massage) may have helped improve the students' physical condition.

4.4 Changes in physical fitness

A questionnaire survey conducted in July 2020 among students, primarily those belonging to official athletic clubs and athletic circles, revealed significant declines in physical fitness during the self-restraint period due to the COVID-19 pandemic. Specifically, the survey found that muscle strength decreased by approximately 70% and cardiorespiratory endurance decreased by approximately 87%[13]. In addition, a report on the results of in-person physical fitness tests conducted from August to October 2020 revealed that flexibility (measured by the back-saver sit-and-reach test) and muscle strength (measured by grip strength) had significantly decreased compared to students in the previous two years[14]. These findings demonstrate that physical fitness generally declined during the period of self-restraint and reduced outdoor activities due to the COVID-19 pandemic. Because this survey asked subjective questions about comparisons before and after class, it is not possible to determine whether students' physical fitness before class was lower than it was prior to the COVID-19 pandemic. There was no significant difference in cardiorespiratory endurance between the four semesters, but flexibility and muscle strength showed improvement or a trend toward improvement in 2020 compared to 2021. This may be attributed to the fact that 2020 was the first year of the COVID-19 pandemic, during which students likely spent more time at home performing stretching and resistance exercises, leading to improved flexibility and muscle strength.

Incidentally, approximately half of the students reported "no change" in flexibility, muscle strength, and cardiorespiratory endurance across all four semesters. However, the ratio of "improved" to "decreased" was consistently above 1 for all items. The authors are grateful to see that the materials provided in this class, specifically those regarding stretching and resistance exercises, may have helped improve the students' physical fitness.

4.5 Study limitations

This survey had two main limitations. First, it only captured the grand totals of responses at the end of the class. Therefore, the temporal changes in body condition and physical fitness during the class period were not captured. Second, cross-tabulation was not performed, precluding in-depth analysis.

5. Conclusion

The authors conducted a questionnaire survey of 1,747 students enrolled in practical physical education compulsory subjects for first-year students during four periods (spring and fall semesters of 2020 and spring and fall semesters of 2021) of the COVID-19 pandemic. The results were examined from the perspective of each semester and year.

The main findings were as follows: As the semester progressed, the proportion of students using desktop PCs decreased. Stretching was the most important exercise in 2020, while aerobic exercise took precedence in 2021. There was a higher need for posting my ingenuity and recommendations in 2020 than in 2021. In the spring semester of 2020, students reported a lower sense of burden regarding exercising for 70 minutes or more per week. Eye fatigue worsened more frequently in the spring semester than in the fall semester.

Flexibility and muscle strength showed improvement or a trend toward improvement in 2020 compared to 2021.

Ethical considerations

This study was approved by the Ethics Committee of Kawasaki University of Medical Welfare (No. 20-50, 20-83 and 21-031).

Conflict of interest

The authors declare no conflict of interest.

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