Communication

Changes in Physical Activity and Glycemic Control before and after the Declaration of the State of Emergency Due to the COVID-19 Pandemic in Japanese Adult Females with Type 1 Diabetes: A 1-Year Follow-Up Study

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Abstract: This preliminary study aimed to investigate physical activity (PA) and glycemic control changes in Japanese adult females with type 1 diabetes (T1D) before the COVID-19 pandemic and one year later. Twelve females with T1D who used continuous glucose monitoring devices and initially volunteered for the study between February and March 2020 were included. PA data, obtained using a triaxial accelerometer, and glycemic control, including glycated hemoglobin (HbA1c), glycoalbumin (GA), mean 24-h sensor glucose (SG), time above range (TAR > 180 mg/dL), time in range (TIR 70–180 mg/dL), and time below range (TBR < 70 mg/dL), were analyzed. One year later, long (>10 min) bouts of moderate-to-vigorous-intensity PA and daily steps decreased by 35.1% and 6.0%, respectively, and TAR increased from 23.5% to 29.0%. Additionally, an increase in prolonged (>30 min) sedentary behavior correlated with a decrease in TBR and an increase in mean 24-h SG, GA, and the GA/HbA1c ratio. Furthermore, a decrease in daily energy consumption correlated with a decrease in TIR. These results indicate that some forms of PA in Japanese T1D adults have not returned to their pre-pandemic status, even in the same season one year later, which could worsen glycemic control.

Keywords: COVID-19; physical activity; sedentary behavior; glycemic control; type 1 diabetes

1. Introduction

Due to the new coronavirus infection (COVID-19), since the beginning of 2020, restrictions on various activities have been put in place worldwide. In Japan, the first declaration of the state of emergency due to the COVID-19 pandemic was issued in April 2020, which restricted classes at schools, commuting to workplaces, participation in sports and music events, traveling, and visiting restaurants and stores. As a result, it has been shown that Japanese individuals’ physical activity (PA) levels, regardless of disease, decreased during the period [1,2].

Several retrospective studies have reported changes in PA in Japanese patients with diabetes. A study of 168 patients (4.2% with type 1 diabetes [T1D]), conducted between 1 April and 13 June 2020, showed that 61.9% of the participants perceived a decrease in PA during the declaration period, compared with the pre-pandemic period, and this decrease was related to worsening glycemic control [3]. A study of 1000 patients (5.3% T1D), conducted between 10 July and 23 September 2020, also found that 55.0% of the participants perceived decreases in the amount of exercise and PA after the declaration,
compared with before. However, there was no significant change in ≥ 30 min per bout of sedentary behavior (SB), although time spent watching television increased by 0.6 h/day [4]; in the study, the status of PA also affected glycemic control. Furthermore, a study focusing on T1D, conducted between 16 April and 1 May 2020, reported that 50.0% of 34 patients felt that they had a decreased exercise volume during the declaration compared with before, although there was no association between changes in PA and glycemic control [5].

Conversely, no reports have prospectively examined changes in objectively assessed PA before the first declaration (from April to May 2020) due to the COVID-19 pandemic and one year later (the same season after lifting the declaration) in individuals with T1D. Since glycemic control and PA can easily fluctuate within seasons [6–9], we believe that it is important to evaluate them in the same season. Additionally, accurate changes in PA due to the pandemic are unclear because previous studies assessed self-reported PA [1–5]. Furthermore, in individuals with T1D, the association between PA and glycemic control is unclear [10]. Therefore, in this preliminary study, we aimed to reveal changes in objectively assessed PA using a triaxial accelerometer, along with glycemic control, before the declaration of the COVID-19 pandemic and one year later in Japanese adults with T1D.

2. Materials and Methods
2.1. Participants

This study’s data were based on our prospective observational study, which was registered with the UMIN Clinical Trials Registry (UMIN000043008). The protocol was approved by the Institutional Review Board of Aino University (Ibaraki, Japan; approval number: 2017-017) in accordance with the Helsinki Declaration of 1964 and later versions. The registered study recruited Japanese adults with T1D between December 2018 and June 2020 who were diagnosed over one year before each recruitment (duration of type 1 diabetes: ≥ 1 year) and regularly visited Kobe University Hospital, Hyogo Brain and Heart Center, Yodogawa Christian Hospital, and Shinko Hospital. Individuals with advanced diabetic complications (e.g., nephropathy) and other diseases affecting PA were excluded. We extracted the study participants who volunteered for the registered study between February and March 2020. Finally, 12 adult females aged 30–70 years (30s: n = 3; 40s: n = 3; 50s: n = 5; 60s: n = 1) were included in the study population and no males were analyzed (Figure 1 and Table 1).

![Flowchart of the study population selection, including patient recruitment.](image-url)
Table 1. Characteristics of the study participants (12 females) before the first declaration of the state of emergency.

| Variables                                                 | Values                  |
|-----------------------------------------------------------|-------------------------|
| Age (years)                                               | 48.3 (41.8, 54.9)       |
| Duration of type 1 diabetes (years)                       | 10.2 (6.9, 13.5)        |
| Insulin therapy and glucose monitoring                    |                         |
| -MDI and intermittently scanned CGM (n) (%)              | 4 (33.3)                |
| -CSII and intermittently scanned CGM (n) (%)              | 2 (16.7)                |
| -MDI and real-time CGM (n) (%)                            | 1 (8.3)                 |
| -CSII and real-time CGM (SAP) (n) (%)                     | 5 (41.7)                |
| Oral anti-diabetic agents                                 |                         |
| -Sodium-glucose cotransporter-2 inhibitor (n) (%)         | 2 (16.7)                |
| Diabetes complication                                     |                         |
| -Neuropathy (n) (%)                                       | 5 (41.7)                |
| -Retinopathy (n) (%)                                      | 0 (0.0)                 |
| -Nephropathy (n) (%)                                      | 0 (0.0)                 |
| Hypertension (n) (%)                                      | 1 (8.3)                 |
| Dyslipidemia (n) (%)                                      | 5 (41.7)                |
| Occupation                                                |                         |
| -Homemaker (n) (%)                                       | 2 (16.7)                |
| -Sedentary worker (n) (%)                                 | 3 (25.0)                |
| -Other (n) (%)                                            | 6 (50.0)                |
| -Unemployed (n) (%)                                       | 1 (8.3)                 |
| Exercise habits § (n) (%)                                 | 3 (25.0)                |

Values are presented as the mean (95% confidence interval) or number (percentage). MDI: multiple daily injections; CGM: continuous glucose monitoring; CSII: continuous subcutaneous insulin infusion; SAP: sensor-augmented pump. § Performing regular moderate-to-vigorous-intensity exercise for ≥30 min/day and ≥2 days/week.

Five participants had mild numbness of the toes or superficial sensory insensitivity of the plantar due to diabetes; however, they had no motor nerve disorders affecting PA. Of the 12 participants, six used real-time continuous glucose monitoring (CGM) and six used intermittently scanned CGM: MiniMed®640G system (Medtronic, Northridge, CA, USA) (n = 5), Guardian™ Connect system (Medtronic, Northridge, CA, USA) (n = 1), and Free Style Libre (Abbott Diabetes Care, Alameda, CA, USA) (n = 6). The medication and nutritional conditions of the participants were stable, with no major changes (e.g., adding oral hypoglycemic agents) throughout the study period. Written informed consent was obtained from all the participants.

2.2. Measurements

PA data, obtained using a triaxial accelerometer (Active style Pro HJA-750C, Omron Healthcare, Kyoto, Japan), and metabolic functions, including glycated hemoglobin (HbA1c) and glycoalbumin (GA), were analyzed before the first declaration (between February and March 2020) and one year later (between February and March 2021) when the second declaration (from January to February 2021 in locations of this study) was lifted. On the day the metabolic functions were assessed, the participants were instructed to wear the accelerometer while awake, except for bathing and sleeping, for at least seven days, and spend their awake period as usual. Data from the accelerometer were adapted when recording for ≥10 h/day and ≥4 days, including ≥2 days on weekdays and ≥1 day at the weekend [11]. The type of PA measured by the accelerometer was defined according to intensity: SB (≤1.5 METs), light-intensity PA (LPA 1.6–2.9 METs), and moderate-to-vigorous-intensity PA (MVPA ≥ 3.0 metabolic equivalents [METs]). Regarding SB and MVPA, prolonged (≥30 min) SB and short (<10 min) and long (≥10 min) bouts of MVPA were extracted. Additionally, steps, daily energy consumption, and a total PA volume of ≥3 METs (MET × min per day) were recorded based on the accelerometer data. CGM data measured during the same period of PA assessment were as follows: mean 24-h sensor glucose (SG) values, time above range (TAR > 180 mg/dL), time in range (TIR 70–180 mg/dL), and time below range (TBR < 70 mg/dL).
2.3. Statistical Analysis

Values are reported as the mean (95% confidence interval) or median (lower and upper quartiles). The normality of the distributions was checked using the Shapiro–Wilk test. The paired t-test or Wilcoxon signed-rank test was performed to analyze the outcomes before the first declaration and one year later. Additionally, we analyzed correlations between the extent of changes in PA, body mass index, and glycemic control for one year using the partial Pearson product-moment correlation coefficient or partial Spearman’s rank correlation coefficient after controlling for age and duration of diabetes. All analyses were performed using IBM SPSS Statistics (version 27.0; IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$.

3. Results

The longitudinal changes in each outcome over one year are shown in Figure 2 (each type of PA and steps) and Table 2. Compared with before the declaration, long bouts of MVPA and steps decreased by 35.1% and 6.0% one year later ($p = 0.029$ and $p = 0.028$, respectively), while there were no significant differences in other PA outcomes. Regarding glycemic control, for total daily insulin dose, and other parameters, only TAR increased from 23.5% to 29.0% one year later ($p = 0.032$).

![Figure 2](image-url). Changes in physical activity (PA) by intensity type and steps in each participant (12 females) from before the first declaration of the state of emergency to 1 year later. (A) Sedentary behavior (SB). (B) Light-intensity PA (LPA). (C) Moderate-to-vigorous-intensity PA (MVPA). (D) Steps.
Table 2. Comparison of outcomes before the first declaration of the state of emergency and 1 year later.

| Variables                          | Before                              | After                              | ES (Cohen’s $d$, $r$) | $p$-Value |
|-----------------------------------|-------------------------------------|------------------------------------|------------------------|-----------|
| PA Total SB time (min/day)        | 475.1 (400.1, 550.0)               | 495.7 (440.8, 550.5)              | 0.311                  | 0.304     |
| -Total time (min/day) †           | 104.0 (64.4, 202.7)                | 149.8 (111.9, 183.1)              | 0.181                  | 0.530     |
| -Frequency per day (times/day)    | 2.7 (1.8, 3.5)                     | 3.3 (2.5, 4.1)                    | 0.456                  | 0.142     |
| -Duration per prolonged SB (min/time) † | 46.1 (40.6, 51.8)               | 44.4 (39.3, 55.0)                 | 0.023                  | 0.937     |
| LPA (min/day)                     | 423.6 (367.0, 480.2)              | 448.3 (381.0, 515.6)             | 0.443                  | 0.153     |
| MVPA                              |                                     |                                    |                        |           |
| -Total time (min/day)             | 81.7 (53.8, 109.7)                 | 67.8 (47.7, 87.9)                 | 0.611                  | 0.058     |
| -Long bouts of MVPA (min/day)     | 17.1 (8.6, 25.6)                   | 11.1 (5.4, 16.7)                  | 0.724                  | 0.029 *   |
| -Duration per prolonged SB (min/time) † | 46.1 (40.6, 51.8)               | 44.4 (39.3, 55.0)                 | 0.023                  | 0.937     |
| LPA (min/day)                     | 423.6 (367.0, 480.2)              | 448.3 (381.0, 515.6)             | 0.443                  | 0.153     |
| MVPA                              |                                     |                                    |                        |           |
| -Total time (min/day)             | 81.7 (53.8, 109.7)                 | 67.8 (47.7, 87.9)                 | 0.611                  | 0.058     |
| -Long bouts of MVPA (min/day)     | 17.1 (8.6, 25.6)                   | 11.1 (5.4, 16.7)                  | 0.724                  | 0.029 *   |
| -Duration per prolonged SB (min/time) † | 46.1 (40.6, 51.8)               | 44.4 (39.3, 55.0)                 | 0.023                  | 0.937     |
| LPA (min/day)                     | 423.6 (367.0, 480.2)              | 448.3 (381.0, 515.6)             | 0.443                  | 0.153     |
| Glycemic control                  |                                     |                                    |                        |           |
| HbA1c (%)                         | 7.5 (7.2, 7.9)                     | 7.6 (7.2, 8.1)                    | 0.319                  | 0.293     |
| GA (%)                            | 21.6 (19.3, 24.0)                  | 21.5 (19.4, 23.6)                 | 0.067                  | 0.821     |
| GA/HbA1c ratio                    | 2.9 (2.7, 3.1)                     | 2.8 (2.6, 3.0)                    | 0.229                  | 0.444     |
| Mean 24-h SG (mg/dL)              | 145.8 (137.2, 154.3)              | 152.4 (144.6, 160.3)              | 0.417                  | 0.177     |
| TAR (%)                           | 23.5 (17.6, 29.5)                  | 29.0 (22.4, 35.6)                 | 0.709                  | 0.032 *   |
| TIR (%)                           | 69.5 (62.1, 76.8)                  | 66.6 (59.4, 73.7)                 | 0.455                  | 0.143     |
| TBR (%)                           | 3.0 (1.2, 16.3)                    | 4.3 (0.7, 7.0)                    | 0.308                  | 0.286     |
| Other parameters                  |                                     |                                    |                        |           |
| Total daily insulin dose (U) †    | 30.0 (22.7, 40.3)                  | 31.1 (23.5, 40.4)                 | 0.202                  | 0.484     |
| Waist circumference (cm)          | 80.7 (74.5, 86.9)                  | 80.0 (73.7, 86.4)                 | 0.159                  | 0.593     |
| Triglyceride (mg/dL) †            | 62.5 (51.8, 120.8)                 | 55.5 (46.3, 84.0)                 | 0.374                  | 0.195     |
| LDL-cholesterol (mg/dL)           | 115.1 (101.3, 128.9)              | 107.9 (91.7, 124.2)               | 0.324                  | 0.285     |
| HDL-cholesterol (mg/dL)           | 73.8 (66.4, 81.1)                  | 75.8 (66.4, 85.1)                 | 0.240                  | 0.423     |
| Total protein (g/dL) †            | 7.2 (6.8, 7.5)                     | 7.0 (6.7, 7.3)                    | 0.503                  | 0.082     |
| Serum creatinine (mg/dL)          | 0.61 (0.57, 0.65)                  | 0.61 (0.57, 0.65)                 | 0.064                  | 0.828     |
| eGFR (mL/min/1.73m$^2$)           | 82.4 (75.8, 88.9)                  | 81.5 (75.8, 87.1)                 | 0.233                  | 0.436     |

Data are presented as the mean (95% confidence interval) or median (lower and upper quartiles) †. ES: effect size; PA: physical activity; SB: sedentary behavior; LPA: light-intensity PA; MVPA: moderate-to-vigorous-intensity PA; LMVPA: light-to-vigorous-intensity PA; MET: metabolic equivalent; HbA1c: glycated hemoglobin; GA: glycoalbumin; SG: sensor glucose; TAR: time above range; TIR: time in range; TBR: time below range; BMI: body mass index; LDL: low-density lipoprotein; HDL: high-intensity lipoprotein; eGFR: estimated glomerular filtration rate. * $p < 0.05$, the paired t-test or the Wilcoxon signed-rank test †.

The results for the partial correlation coefficients are presented in Table 3. As a visual presentation, the significant correlations between prolonged SB and glycemic control are presented in Figure 3. An increase in the total time of prolonged SB correlated with an increase in the mean 24-h SG and a decrease in TBR ($p = 0.023$ and $p = 0.009$, respectively), and an increase in duration per prolonged SB correlated with increases in GA and the GA/HbA1c ratio ($p = 0.038$ and $p = 0.021$, respectively). Furthermore, a decrease in daily energy consumption correlated with a decrease in TIR ($p = 0.032$). Conversely, no correlations were found between glycemic control and other PA outcomes, including total SB time, LPA, MVPA, and steps.
Table 3. Partial correlation coefficients (after controlling for age and duration of diabetes) between the 1-year change in PA, BMI, and glycemic control.

| Variables                  | BMI          | HbA1c        | GA           | GA/HbA1c Ratio | Mean 24-h SG | TAR          | TIR          | TBR          |
|----------------------------|--------------|--------------|--------------|---------------|--------------|--------------|--------------|--------------|
| Total SB time              | −0.251       | −0.057       | −0.189       | −0.151        | 0.473        | 0.258        | 0.427        | −0.567       |
| Prolonged SB               |              |              |              |               |              |              |              |              |
| -Total time                | −0.005       | −0.090       | 0.249        | 0.281         | 0.703        | 0.485        | 0.378        | −0.771       |
| (0.990)                    | (0.804)      | (0.488)      | (0.432)      | (0.023) *     | (0.155)      | (0.281)      | (0.009) **   |
| -Frequency per day         | −0.269       | 0.029        | −0.186       | −0.216        | 0.620        | 0.428        | 0.185        | −0.569       |
| (0.453)                    | (0.936)      | (0.606)      | (0.549)      | (0.056)       | (0.217)      | (0.610)      | (0.086)      |
| -Duration per prolonged SB | 0.149 (0.680)| −0.105       | 0.661        | 0.713         | 0.134        | 0.087        | 0.365        | −0.364       |
| LPA                       | −0.100       | 0.084        | 0.227        | 0.169         | −0.100       | 0.007        | −0.048       | 0.013        |
| (0.783)                    | (0.817)      | (0.528)      | (0.640)      | (0.782)       | (0.985)      | (0.895)      | (0.970)      |
| MVPA                      |              |              |              |               |              |              |              |              |
| -Total time †              | −0.244       | −0.067       | 0.073        | 0.155         | −0.406       | −0.112       | −0.021       | 0.537        |
| (0.498)                    | (0.853)      | (0.841)      | (0.670)      | (0.244)       | (0.758)      | (0.954)      | (0.109)      |
| -Long bouts of MVPA †      | −0.362       | 0.102        | 0.259        | 0.347         | 0.140        | 0.354        | −0.287       | 0.040        |
| (0.303)                    | (0.883)      | (0.814)      | (0.671)      | (0.244)       | (0.758)      | (0.954)      | (0.109)      |
| -Short bouts of MVPA       | −0.175       | −0.118       | 0.225        | 0.271         | −0.345       | −0.301       | 0.057        | 0.265        |
| (0.628)                    | (0.780)      | (0.470)      | (0.326)      | (0.700)       | (0.316)      | (0.421)      | (0.913)      |
| LMVPA                     | −0.162       | 0.029        | 0.307        | 0.270         | −0.167       | −0.057       | −0.055       | 0.086        |
| (0.654)                    | (0.937)      | (0.388)      | (0.451)      | (0.644)       | (0.877)      | (0.879)      | (0.813)      |
| Total PA volume of ≥3 METs | −0.302       | −0.368       | 0.197        | 0.399         | −0.330       | −0.295       | 0.017        | 0.277        |
| (0.396)                    | (0.295)      | (0.585)      | (0.253)      | (0.352)       | (0.407)      | (0.962)      | (0.438)      |
| Steps                      | −0.468       | −0.353       | 0.301        | 0.487         | 0.292        | 0.257        | −0.004       | −0.269       |
| (0.172)                    | (0.317)      | (0.398)      | (0.153)      | (0.413)       | (0.474)      | (0.991)      | (0.452)      |
| Energy consumption         | −0.120       | −0.194       | 0.262        | 0.359         | −0.289       | −0.364       | 0.677        | −0.132       |
| (0.742)                    | (0.391)      | (0.465)      | (0.309)      | (0.417)       | (0.301)      | (0.032) *    | (0.717)      |

Values are presented as $r$ or $\rho$ ($p$-value). PA: physical activity; BMI: body mass index; HbA1c: glycated hemoglobin; GA: glycoalbumin; SG: sensor glucose; TAR: time above range; TIR: time in range; TBR: time below range; SB: sedentary behavior; LPA: light-intensity PA; MVPA: moderate- to vigorous-intensity PA; LMVPA: light- to vigorous-intensity PA; MET: metabolic equivalent. * $p < 0.05$, ** $p < 0.01$, the partial Pearson’s product moment correlation coefficient or the partial Spearman’s rank correlation coefficient. 


Figure 3. Correlations between the 1-year change in prolonged sedentary behavior (SB) and glycemic control. (A) Total time of prolonged SB and mean 24-h sensor glucose (SG). (B) Total time of prolonged SB and time below range (TBR). (C) Duration per prolonged SB and glycoalbumin (GA). (D) Duration per prolonged SB and GA/glycated hemoglobin (HbA1c) ratio. The partial Pearson’s product-moment correlation coefficient.

4. Discussion

To the best of our knowledge, although a preliminary examination, this is the first study to prospectively examine changes in objectively assessed PA, along with glycemic control, before the first declaration of the state of emergency due to the COVID-19 pandemic and one year later in T1D adults. As mentioned above, previous studies reported that lifestyles in individuals with diabetes, including T1D, changed during and after the first declaration, compared with before [3–5]; however, there were no data on PA in the same season one year later, when the declaration was lifted. A previous retrospective study, which recruited a Japanese population of 40–69 years old (n = 1986, 38.9% females), reported that self-reported PA time decreased by 32.4% in April 2020 (during the declaration) and remained 15.5% lower in October 2020 (after the declaration was lifted), compared with October 2019 (before the advent of COVID-19) [12]. Thus, the study showed that PA had not returned to its previous status, compared with the same season in the pre-pandemic year, even after the declaration was lifted. This was probably due to the restrictions on various activities (e.g., commuting to workplaces and participation in sports) and fear of infection. Therefore, in the present study, although comparisons with other control groups were not performed, PA levels were observed to be lower one year later compared to PA levels before the first declaration. Moreover, the second declaration might have impacted PA levels because the outcomes were assessed shortly after the second declaration was lifted.
Although a higher TAR one year later was observed, other glycemic control outcomes did not change significantly. Previous reports showed that there might be no adverse effects of the COVID-19 pandemic on glycemic control in individuals with T1D if they managed their lifestyles and glycemic control using CGM devices [13,14]. Hence, changes in total PA volume, which tended to decrease with an increasing trend in SB (not significantly) and a significant reduction in prolonged MVPA and steps, might induce high TAR, while there were no significant differences in other glycemic controls before the declaration and one year later. Additionally, HbA1c and GA levels reflect average blood glucose levels over approximately three months [15] and 2–3 weeks [16], respectively; however, the CGM data were obtained immediately after assessing those indicators in this study. Therefore, the increase in TAR may influence future HbA1c and GA levels.

Increases in the total time and duration of prolonged SB caused deterioration in the mean 24-h SG, GA, and the GA/HbA1c ratio, and an increase in the total time of prolonged SB correlated with decreased TBR in the present study. Prolonged SB can reduce the number of muscle contractions and glucose uptake in skeletal muscles, inducing a deterioration in blood glucose levels, such as persistent hyperglycemia and high glycemic variability [17–19]. Therefore, we considered that high glucose levels due to prolonged SB might worsen glycemic control and reduce the period of hypoglycemia. Furthermore, a decrease in daily energy consumption, which is affected by the amount of PA, was correlated with a decrease in TIR; it could also be caused by a reduction in PA and an increase in TAR. One matter of note for interpretation here is a multiplicity issue in the correlation analysis in this study. The analysis contained 96 (8 columns × 12 rows) individual tests (Table 3), and 4.8 tests of 96 would be expected to be significant by chance alone; indeed, five tests were significant. Thus, although the absolute $r$-values were large (0.66–0.77), we must be careful in interpreting their significance.

We believe that our findings will contribute to the management of T1D during and after the COVID-19 pandemic. However, this preliminary study has some limitations. First, we analyzed a small sample of only female participants with uncomplicated T1D and did not compare these with a control group. As mentioned above, this study was based on our registered observational study (from December 2018) recruiting T1D patients; hence, only participants enrolled during the target period of this study were included. Regarding gender difference, a previous Spanish study showed that there were decreases in the quantity and intensity of PA for both sexes during the COVID-19 pandemic and that the change in the quantity of PA was greater in females than in males [20]; thus, as in the present study, a decrease in PA may not be observed in males. Furthermore, health consciousness and adherence to the management of T1D in our study participants might be higher than in general T1D patients because the participants voluntarily participated in the registered study and were relatively young and working. Hence, the decrease in PA might be larger in the general and older patient population. Second, the results of this study might be affected by dietary habits during the observation period due to the COVID-19 pandemic [3], which were not assessed, and PA during other seasons was not measured. The previous study reported that the HbA1c levels could be elevated due to increased amounts of snacks, sweets, total diet, and alcohol intake during the COVID-19 pandemic in diabetic patients, compared with the pre-pandemic period [3]. In that study, PA decreased in 61.9% of the patients, while diet deteriorated in 29.8%. Additionally, of the patients whose PA decreased, less than half (39.4%) had poor dietary habits during the pandemic; thus, the deterioration in dietary habits due to the pandemic may be small compared to the decrease in PA. Concerning seasonal influences, a previous Japanese study reported that energy intake was higher in winter than in spring and summer [21]. Moreover, as mentioned previously, PA can also change seasonally (e.g., higher volume in summer) [7,9]; however, we considered that seasons had little influence on the results in the present study because we analyzed the before and after data in the same season. Additionally, we measured PA data for at least seven days, but the device used to obtain PA data in this study can record PA for up to 45 days. Therefore, more extended period
measurements may be needed to obtain more reliable PA data that reflects an individual’s usual lifestyle. Further studies with a longer investigation period are needed to confirm the influence of the COVID-19 pandemic on PA and glycemic control in individuals with T1D.

5. Conclusions

We found that there were decreases in prolonged MVPA and steps due to the COVID-19 pandemic and that an increase in prolonged SB might worsen glycemic control in adult females with T1D. Although further studies are needed based on these preliminary results, we propose that it is important to consider these characteristics when managing T1D during and after the COVID-19 pandemic.

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