Effect of COVID-19 pandemic on the lifestyle and glycemic control in patients with type 1 diabetes: A retrospective cohort study

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Research Article
Abstract

Background: To investigate the acute effects of the coronavirus disease 2019 (COVID-19) on the lifestyle and metabolic parameters in patients with type 1 diabetes mellitus (T1DM).

Methods: This retrospective cohort study induced 34 patients who received our hospital from April 16 to May 1, 2020. Data regarding stress levels, sleep time, exercise, and total diet, snack, and prepared food intake were obtained from the questionnaires. To evaluate the pandemic effect on the changes in the body weight or HbA1c levels, we evaluated those differences of the values at the time the questionnaire was administered to those noted 3 months ago and those differences of 12 months ago and 15 months ago using paired t test.

Results: Increased stress levels and decreased exercise levels were observed in approximately 60%, and 50% of the participants, during the COVID-19 pandemic. There was a negative correlation between stress and exercise ($r = -0.407, p = 0.021$). Decreased sleep duration were associated with increased body weight ($r = -0.40, p = 0.042$). Furthermore, compared with 1 years ago, HbA1c was become worse (this year 0.12 [0.33] % in this year vs.-0.09 [0.39] % in 1 years ago, $p = 0.027$).

Conclusions: Many patients experienced stress and decreased exercise due to the COVID-19 pandemic. The glycemic control of patients with T1DM was worse than last year. Given that the pandemic is ongoing, we should pay more attention to the management of stress and lifestyle factors in patients with T1DM.

Background

Coronaviruses (CoV) is one of the common viruses of respiratory infections in humans [1]. Generally, human CoV infections are not severe; however, two major outbreaks of CoV infection have occurred in the past, namely severe acute respiratory syndrome coronavirus (SARS-CoV) infection in 2002–2003 and Middle East respiratory syndrome coronavirus (MERS-CoV) infection in 2012 [2-4]. Nowadays, a new coronavirus, SARS-CoV-2, was recognized as the pathogen causing CoV disease COVID-19 in Wuhan, China in December 2019 [5]. On March 11, 2020, the World Health Organization declared COVID-19 a pandemic [6].

European countries have significantly curbed public life to halt the spread of COVID-19. In Japan, a state of emergency, with request-based measures of encouraging the populace to remain at home and businesses to limit operations, was declared on April 7, 2020. Therefore, the Japanese are also becoming more restrictive in their behavior. Infectious disease outbreaks, including COVID-19, are associated with increasing of stress levels of general population [7]. Previous studies showed that disasters were associated with increased stress and worse glycemic control in patients with type 1 diabetes mellitus (T1DM) [8,9].
Patients with diabetes mellitus are more likely to infected by COVID-19 and are at a higher risk of mortality [10,11]. Although patients with diabetes mellitus should be careful to avoid COVID-19 infection, there is a possibility that forcing these patients to restrict their life leads to worsen their glucose control. However, little is known about the effect of the COVID-19 pandemic on the glycemic control of patients with T1DM [12,13]. Therefore, this retrospective cohort study investigated the effects of the COVID-19 pandemic on the glycemic control of patients with T1DM and the effect of COVID-19 pandemic on change of stress and lifestyles.

**Methods**

**Study Patients**

We are performing an ongoing opt-out survey among the patients with diabetes mellitus to clarify the natural history of the patients with diabetes mellitus. This study was approved by the ethics committee of Kyoto Prefectural University of Medicine (KPUM) (ERB-C-1297). In this retrospective cohort study, a questionnaire was administered to the patients with T1DM who visited a clinic at the Department of Endocrinology and Metabolism, KPUM from April 16 to May 1, 2020. Patients, whose data were incomplete, were excluded.

**Data collection and measurements**

Type 1 diabetes mellitus was diagnosed by the Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus [14]. Insulin treatment, such as multiple daily injections (MDI) and continuous subcutaneous insulin infusion (CSII) were checked from medical record. According to the self-administered questionnaire, the patients were classified as a non-, past-, or current smoker and patients who regularly played any type of sport for more than once per week, before COVID-19 pandemic, were defined as regular exercisers. Nephropathy was defined according to the report of the Joint Committee on Diabetic Nephropathy [15]. The criteria for diabetic neuropathy suggested by the Diagnostic Neuropathy Study Group was used for neuropathy [16]. Retinopathy was classified, as no diabetic-retinopathy (NDR), simple diabetic-retinopathy (SDR), and proliferative diabetic retinopathy (PDR), which included pre-proliferative retinopathy. Data regarding the body weight and HbA1c levels at the time the questionnaire was administered and the values noted 3 months ago, 12 months ago, and 15 months ago were obtained from medical records. The difference between the values corresponding to at the time the questionnaire and 3 months ago was calculated as the change in the body weight or HbA1c levels. In addition, the difference between the values corresponding to 12 months ago and 15 months ago was calculated as the change in the body weight or HbA1c levels of 1 years ago.

**Questionnaire**
The questionnaire consisted of 6 short questions regarding stress and lifestyle factors (Supplemental Table). A visual analog scale (VAS; 0 = considerably reduced, 5 = no change, and 10 = considerably increased) was used for all questions and patients were asked to score how their stress levels, sleep time, exercise levels, and total diet, snack, and prepared food intakes have changed due to the COVID-19 pandemic. Based on the patient’s VAS scores, we further classified them as meeting or not meeting the following categories: increased stress (VAS ≥6), shortened sleep time (VAS ≤4), decreased exercise (VAS ≤4), increased total diet intake (VAS ≥6), increased snack consumption (VAS ≥6), and increased prepared food intake (VAS ≥6).

**Statistical analysis**

The JMP version 13.2 software (SAS Institute Inc., Cary, NC) was used for statistical analyses and p-values <0.05 were considered statistically significant. The mean or frequency of potential confounding variables was calculated. The continuous and categorical variables were presented as the means (±standard deviations) and absolute numbers, respectively. The differences in the change in body weight or HbA1c levels and the change in the body weight or HbA1c levels of 1 years ago were evaluated using the paired t-test.

**Results**

In this study, among 564 patients who were scheduled to visit our department, 87 patients received telemedicine and 127 patients did not visit. Among 350 patients who visited our department, 34 patients had T1DM (Figure 1).

The clinical characteristics of the study patients are shown in Table 1. The mean age and duration of diabetes of the study patients were 59.1 (±16.0) years and 14.5 (±16.0) years, and 31 patients received MDI and 3 patients received CSII. Increased stress levels and decreased exercise levels were observed 59.3% (19/32), and 50% (16/32) of the participants during the COVID-19 pandemic.

The results of correlations of the change in stress and lifestyle factors during the COVID-19 pandemic is shown in Table 2. There was a negative correlation between exercise levels and stress or snack consumption and there was a positive correlation between snack consumption and prepared food intake.

Furthermore, compared with 1 years ago, HbA1c was become worse in this year (this year 0.12 [0.33] % in this year vs.-0.09 [0.39] % in 1 years ago, \( p = 0.027 \) (Table 3 and Figure 2).

**Discussion**

This study investigated the acute influence of the COVID-19 pandemic on the lifestyle of patients with T1DM. Based on our findings, patients with T1DM reported increased stress and decreased their exercise
levels from the COVID-19 pandemic. Furthermore, change of glycemic control for 3 months of patients with T1DM was worse than last year.

Recent studies revealed that the COVID-19 pandemic is associated with increased stress in general populations [7]. External stress may lead to less physical activity [17,18]. Stress can also affect metabolic parameters in patients with diabetes mellitus [19,20]. In fact, previous studies showed that earthquakes were associated with increased stress and worse glycemic control in patients with T1DM [8,9]. Unlike these previous disasters, the COVID-19 pandemic is ongoing and there are concerns that the impact on patients with diabetes mellitus will continue or become worse. It has been reported that high glucose levels are associated with increased mortality in COVID-19 infection [10,11]. Therefore, we should pay attention to glycemic control of patients with T1DM.

In this study change of glycemic control for 3 months of patients with T1DM was worse than last year. A previous study revealed that there is no negative effect of lockdown due to COVID-19 pandemic on glycemic control in people with T1DM [12,20,21]. These studies also showed that the reason why there is no negative effect of lockdown due to COVID-19 might be because that many patients with T1DM don't have to work due to lockdown. Thus, there is a possibility that many of the participants in this study were elderly and thus they did not have job and were only have negative aspect, such as reducing exercise and increasing stress.

There are several limitations of this study. First, the sample size was relatively small, and the participants were limited to a single center. In addition, this study only included the patients who visited our department in the period of COVID-19 pandemic. Therefore, the data of patients who did not visit were not included. There is a possibility that patients who did not visit our department experienced more stress or changes in lifestyle and, therefore, poor glycemic control. Second, the questionnaire of this study was subjective and did not include quantitative evaluation. However, under the pandemic situation, the decreased contact time is essential to reduce the risk of disease transmission. Therefore, we only asked the patients simple and a minimal number of questions. Third, we did not have a data of self-monitoring of blood glucose and/or flash glucose monitoring. Fourth, we did not have data of change the dosage of insulin, although patients with T1DM are likely to change the dosage of insulin on their own. However, despite the possibility of self-titration, the glycemic control became worse, compared to the last year. Furthermore, we Lastly, this study included only Japanese patients; therefore, it is not clear whether our findings can be generalized to the populations of other countries.

Conclusion

In conclusion, many patients with T1DM reported increased stress levels and changes in lifestyle factors, especially exercise, during the COVID-19 pandemic. Furthermore, the glycemic control of patients with type 1 diabetes mellitus was worse than last year. Given that the pandemic is ongoing, we should pay more attention to the management of stress and lifestyle factors in patients with type 1 diabetes mellitus to prevent the worsening of their glycemic control.
Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of Kyoto Prefectural University of Medicine (KPUM) (ERB-C-1297). This study was opt-out survey and opt-out survey was approved by the ethics committee.

Consent to publication: Not applicable.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. We affirmed that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as originally planned.

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Tables

Table 1. Clinical characteristics of the study participants
|                |        |        |
|----------------|--------|--------|
| N              | 34     |        |
| Age (year)     | 59.1 (16.0) |        |
| Sex (men/ women) | 11/ 23  |        |
| Duration of diabetes (year) | 14.5 (8.0) |        |
| Smoking (non-/ past-/ current smoker) | 25/ 3/ 6 |        |
| Exercise habit (no/ yes) | 20/ 14 |        |
| Nephropathy stage (1/ 2/ 3/ 4/ 5) | 22/ 8/ 1/ 1/ 1 |        |
| Neuropathy (no/ yes) | 24/ 9  |        |
| Retinopathy (NDR/ SDR/ PDR) | 24/ 2/ 7 |        |
| Treatment (MDI / CSII) | 31/ 3  |        |

**Questionnaires (n = 32)**

|                                |        |        |
|--------------------------------|--------|--------|
| Feel stress                    | 6.7 (2.1) |        |
| Increasing of stress (no/ yes) | 13/ 19 |        |
| Sleep time                     | 4.4 (1.4) |        |
| Shorten sleep time (no/ yes)   | 23/ 9  |        |
| Exercise                       | 3.5 (2.2) |        |
| Decreasing of exercise (no/yes) | 16/ 16 |        |
| Total diet intake              | 5.1 (1.4) |        |
| Increasing of total diet intake (no/ yes) | 26/ 6 |        |
| Snack consumption              | 5.0 (1.9) |        |
| Increasing of snack consumption (no/ yes) | 22/ 10 |        |
| Prepared food intake           | 5.2 (1.2) |        |
| Increasing of prepared food intake (no/ yes) | 26/ 6 |        |

NDR, non-diabetic retinopathy; SDR, simple diabetic retinopathy; PDR, proliferative diabetic retinopathy; MDI, multiple daily injections; CSII, continuous subcutaneous insulin infusion. All items of the change of stress and lifestyles factors were evaluated by used visual analog scale. 0 = considerably reduced, 5 = no change, 10 = considerably increased.

Data are presented as the means (±standard deviations) and absolute numbers.
Table 2. The correlations of the change of stress and lifestyles factors

|                      | Stress | Sleep time | Exercise | Total diet intake | Snack consumption | Prepared food intake |
|----------------------|--------|------------|----------|-------------------|-------------------|----------------------|
| Stress               | —      | —          | —        | —                 | —                 | —                    |
| Sleep time           |        | —          | —        | —                 | —                 | —                    |
|                      | $r = -0.152$ | $p = 0.404$ |          |                   |                   |                      |
| Exercise             |        |            | —        | —                 | —                 | —                    |
|                      | $r = -0.407$ | $r = 0.140$ | $p = 0.021$ | $p = 0.445$ | —                 | —                    |
| Total diet intake    | $r = 0.146$ | $r = 0.029$ | $r = -0.151$ | —                 | $r = 0.317$ | —                   |
|                      | $p = 0.425$ | $p = 0.875$ | $p = 0.410$ |                  | $p = 0.077$ | —                   |
| Snack consumption    | $r = 0.161$ | $r = 0.176$ | $r = -0.365$ | $r = 0.317$ | —                 | —                   |
|                      | $p = 0.379$ | $p = 0.334$ | $p = 0.040$ | $p = 0.077$ |                   |                      |
| Prepared food intake | $r = 0.110$ | $r = 0.278$ | $r = -0.057$ | $r = -0.181$ | $r = 0.393$ | —                  |
|                      | $p = 0.548$ | $p = 0.124$ | $p = 0.758$ | $p = 0.320$ | $p = 0.026$ | —                  |

Pearson's correlation coefficient was performed to investigate the correlations. All items were evaluated by using visual analog scale. 0 = considerably reduced, 5 = no change, 10 = considerably increased.

Table 3. Change of body weight or HbA1c
|                      | This year          | One year ago       |
|----------------------|--------------------|--------------------|
|                      | 3 months ago       | Baseline           | Difference | 15 months ago | 12 months ago | Difference |
| HbA1c (n = 28)       | 7.7 (0.9)          | 7.8 (0.9)          | 0.12 (0.33)| 7.5 (0.9)     | 7.4 (1.0)   | -0.09 (0.39)|
| Body weight (n = 19) | 60.0 (13,2)        | 60.2 (13.4)        | 0.16 (0.97)| 58.9 (13.2)   | 59.4 (13.0) | 0.47 (1.54)|