Impact of sex differences on lifestyle and glycemic control in Japanese patients with diabetes during COVID-19 lockdowns

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Abstract

Background

Pneumonia of unknown pathogenesis detected in Wuhan, Hubei Province, China, in December 2019 was later found to be a new coronavirus infection that causes the now-named coronavirus disease 2019 (COVID-19). The onset of the pandemic has drastically changed global lifestyles. Some reports about lifestyle changes in patients with diabetes during COVID-19 pandemic have been published. However, these studies have not assessed sex differences. Thus, we analyzed three lifestyle changes during the COVID-19 pandemic to determine any sex differences.

Methods

We analyzed physical activity, snacking habits, and drinking habits in 323 patients with diabetes. Sex differences in the changes in these three lifestyle habits were analyzed using the χ^2 test, and the factors that influenced the deterioration of HbA1c were analyzed by paired t-test. The factors that influenced the deterioration of HbA1c were determined by univariate and multivariate logistic regression analyses.

Results

Of the 323 diabetic, 212 were male (65.6%) and 111 were female (34.4%). HbA1c values were higher in 2020 compared with those in 2019. Increased physical activity was higher in men, whereas decreased physical activity was higher in women. The factors that affected the deterioration in HbA1c were snacking habits for the overall population and in the male sex. No factors significantly affected HbA1c in the female population.

Conclusions

Our study confirmed that lifestyle changes differed between the sexes during the COVID-19 pandemic. Snacks influenced the deterioration of HbA1c in the overall study population and in the male population. A balanced diet and regular exercise are important for all patients with diabetes during this pandemic. This study demonstrates that more attention should be given on men's diet, whereas physical inactivity should be emphasized for women.

Background

Pneumonia of unknown pathogenesis was documented in Wuhan, Hubei Province, China, in December 2019 and was later identified as a new coronavirus infectious disease now-named coronavirus disease 2019 (COVID-19) [1]. The disease has since spread rapidly worldwide. On January 14, 2020, a patient with pneumonia who had stayed in Wuhan City was the first case reported in Japan [2]. In China and some

Western countries, where the number of infected people had first spread rapidly, strong measures, such as city lockdowns, were imposed. In Japan, schools were temporarily closed from February 28, 2020, and teleworking was recommended for companies. Based on the Act on Special Measures Law for COVID-19, which was enacted on March 13, 2020, a state of emergency was issued in Japan on April 7. The Japanese people were requested to refrain from going out unnecessarily, and the declaration lasted until May 25. Such declarations were issued repeatedly thereafter, and this has changed the people's lifestyles drastically.

Diabetes is a typical lifestyle-related disease, and lifestyle habits greatly influence the management of such diseases. Changes in the lifestyles of patients with diabetes have due to the COVID-19 pandemic have been reported [3–7]. Some studies found deterioration in lifestyle-related habits such as dieting, snacking habits, and exercise; increased stress; and an association between glycemic control and weight gain. Other studies reported no changes in body weight or HbA1c, but found an association between mental stress and lack of sleep with unhealthy eating habits, resulting in poor glycemic control in the study populations. However, these reports have not evaluated sex differences in lifestyle changes due to the COVID-19 pandemic. As an example of sex differences in living with diabetes, women may neglect their own health by prioritizing their household chores and family [8]. We therefore sought to bridge the gap and retrospectively analyzed three basic lifestyle-related changes during the COVID-19 pandemic to determine whether any sex differences exist and whether they are related to glycemic control.

Methods

We enrolled 323 patients with diabetes who were under regular follow-up and collected data by direct interview on changes in three subjective lifestyle habits (physical activity, snacking habits, and drinking habits) due to the COVID-19 pandemic during their visit to our hospital. Inclusion criteria were patients with diabetes who were visiting our hospital aged 20 years old and above. Any type of diabetes was included. Exclusion criteria were patients who could not answer our interview independently. The three lifestyle habits (physical activity, snacks, and drinking) were analyzed according to three stages, namely, decrease, unchanged, and increase. The categorization was based on the patient's subjective evaluation. In addition to changes in the three lifestyle habits, data on sex, age, employment status (telework status), and HbA1c were extracted from the medical records. The HbA1c values obtained were the quarterly values for January–March, April–June, July–September, and October–December and the annual average values for 2019 and 2020. In calculating the rate of change in the annual average HbA1c (2020 average HbA1c to 2019 average HbA1c), 0% or less was defined as the improvement group, and 0.1% or more was defined as the deterioration group. As this study was a retrospective study, we did not need to obtain informed consent. Instead, we presented an opt-out on our website that explained the following: ☐ purpose of use and method of use of information, ☐ items of information to be used, ☐ scope of users, ☐ name of the person responsible for managing information ☐ exclusion of information that identifies the research subject at the request of the research subject or his/her agent, and ☐ process of accepting the request of the research subject or his/her agent. This study was conducted with the approval of the Medical Ethics Review Board of Tokyo Medical University (Approval Code T2020-0381).

Analysis 1

We assessed for sex differences the changes in three lifestyle habits caused by the COVID-19 pandemic.

Analysis 2

The factors that affected the deterioration of the mean HbA1c value were analyzed by sex by univariate and multivariate analyses.

Statistical analysis

The comparison of HbA1c values in 2019 and 2020 was analyzed by paired t-test. Sex differences in the changes in the three lifestyle habits were analyzed using the χ^2 -square test. Univariate and multivariate logistic regression analyses were used to analyze the data of the HbA1c improvement and deterioration groups. The outcome was the improvement/deterioration of the mean HbA1c value, and the explanatory variables were age, employment status, and changes in the three lifestyle habits.

Results

Of the 323 patients with diabetes, 212 were male (65.6%) and 111 were female (34.4%). Twenty-four patients had type 1 diabetes (7.4%), 291 patients had type 2 diabetes (90.1%), and 8 patients had another type of diabetes (2.5%). The mean age was 63.1 ± 13.1 years (male, 62.7 ± 11.8 years; female, 63.8 ± 15.3 years) (Table 1). The annual mean HbA1c value in 2019 was $7.6 \pm 1.1\%$ (male, $7.6\% \pm 1.1\%$; female, $7.5\% \pm 1.6\%$), whereas the annual mean HbA1c value in 2020 was $7.6 \pm 1.0\%$ (male, $7.6\% \pm 1.0\%$; female $7.6\% \pm 1.0\%$). No significant differences in the variables were found between the two years. When examined by quarter, the HbA1c levels increased significantly in 2020 compared with 2019 in the July–September period. (July–September HbA1c 2019 vs. 2020: $7.4\% \pm 1.0\%$ vs. $7.6\% \pm 1.1\%$; $p = 0.000058$) This tendency was observed in both sexes. (Male: 7.4 ± 1.0 vs. 7.6 ± 1.1 , $p = 0.001$; Female: 7.4 ± 1.1 vs. 7.7 ± 1.1 , $p = 0.006$) (Fig. 1).

Table 1
Patients' characteristics

Subjects	323	
Mean age	63.1 ± 13.1	
	Number	%
Male	212	65.6
Female	111	34.4
Type 1 diabetes	24	7.4
Type 2 diabetes	291	90.1
Other type of diabetes	8	2.5
Diabetes medication		
Biguanide	192	59.4
Thiazolidine	2	0.6
αGlucosidase inhibitor	20	6.2
SGLT2 inhibitor	111	34.4
DPP4 inhibitor	180	55.7
GLP-1 receptor agonist	34	10.5
Sulfonylurea	47	14.6
Glinide	22	6.8
Insulin	93	28.8

Analysis 1: Sex differences in changes in three lifestyle habits

Overall, for physical activity, the frequency of decrease was 47%, unchanged was 41%, and increase was 12%. Sex differences were observed in the frequency of changes in physical activity ($\chi^2(2) = 13.6$; $p = 0.001$) (Male vs. Female, Decreased/Unchanged/Increased: 40% /44%/16% vs. 60%/35%/5%; $p = 0.001$). In the residual analysis, the frequency of increased physical activity was significantly higher in men, and the frequency of decreased physical activity was significantly higher in women. Overall, for snacking habits, frequency of decreased was 6%, unchanged was 62%, and increase was 32%. Sex differences were observed in the frequency of changes in snacking habits ($\chi^2(2) = 7.67$; $p = 0.022$) (Male vs. Female, Decreased/Unchanged/Increased: 5%/67%/28% vs. 10%/52%/38%; $p = 0.001$). In the residual analysis, only the frequency of unchanged snacking habits was significantly higher in men. Overall, for drinking habits, the frequency of decrease was 14%, unchanged was 80%, and increase was 6%. Sex differences

were observed in the frequency of changes in drinking habits (χ^2 (2) = 14.8; p = 0.001) (Male vs. Female, Decreased/Unchanged/Increased: 17%/74%/9% vs. 6%/92%/2%; p = 0.001). In the residual analysis, the frequency of increase and decrease in drinking habits were significantly higher in men. The frequency of unchanged was significantly higher in women (Fig. 2).

Analysis 2: Factors affecting the deterioration of the mean HbA1c value

No significant associations were observed in age, telework, drinking habits, physical activity, and the deterioration of the mean HbA1c value. Snacking habits were significantly associated with the deterioration of the mean HbA1c value in the overall analysis (odds ratio [OR] 1.704, 95% confidence interval [CI]: 1.126–2.579) and with the male sex (OR 1.879, 95% CI: 1.063–3.320) in multivariate analysis. Employment status was also significantly associated with the male sex (OR 3.216, 95% CI: 1.605–6.443) analysis. On the other hand, in the female population, although no factors were significantly associated with changes in the HbA1c values, univariate analysis showed that unemployed women tended to exhibit a deterioration in HbA1c values (OR 0.492, 95% CI: 0.228–1.06; p = 0.07) Interestingly, the opposite trend was observed in the male population. Among the employed people, no significant association was observed between telework and the deterioration of mean HbA1c in the overall population and in both the male and female populations (Table 2).

Table 2
Univariate and multivariate logistic regression analysis of deterioration of mean HbA1c

Deterioration of mean HbA1c				
	Univariate significant variables (p < 0.05)		Multivariate significant variables (p < 0.05)	
Overall	OR (95%CI)	p value	OR(95%CI)	p value
work	1.431 (0.915-2.236)	0.116	1.540 (0.930-2.551)	0.093
snack	1.762 (1.175-2.642)	0.006	1.704 (1.126-2.579)	0.012
Male				
work	2.667 (1.499-4.744)	0.001	3.216 (1.605-6.443)	0.001
snack	1.925 (1.116-3.321)	0.019	1.879 (1.063-3.320)	0.03
Female				
work	0.492 (0.228-1.060)	0.07	0.483 (0.210-1.108)	0.86
snack	1.575 (0.858-2.891)	0.143	1.674 (0.870-3.220)	0.123

Discussion

Due to the COVID-19 pandemic, measures such as city lockdowns were imposed across the world. In Japan, people were mandated to refrain from going out unnecessarily and to work from home when possible, schools were closed. This has given people more time to spend at home and has associated physical, mental, and social stress. Many reports have been published on how these lockdowns affect lifestyle habits. An online survey of 1,033 Chinese people showed that 70% of participants increased their screen time, whereas 30% of participants increased in the frequency of their vegetable and fruit intake [9]. An analysis of 995 Indian people revealed that physical activity decreased, whereas sitting time and screen time increased. Improvement in dietary habits was seen in younger people. Body weights increased in one-third of participants. Quarantine-induced stress and anxiety increased in nearly one-fourth of the participants [10]. A study on young Saudi women (aged 19–30) showed that approximately half of the participants did not report a weight change, 30% reported weight loss, and 18% reported weight gain. The variables associated with increased weight gain were self-quarantine since COVID-19 started, age, and stress at baseline and during lockdown. The variables associated with reduced risk of weight gain were physical activity during lockdown, coffee consumption, and total sleep time [11]. According to a survey conducted at 35 research institutes in West Asia, North Africa, Europe, and the United States, which used the Internet to evaluate the psychological and lifestyle-related effects of home confinement due to COVID-19, the period of home confinement had a negative effect on mental health and emotions, and these were associated with unhealthy lifestyle (lack of physical activity + 15.2%; decreased social activity + 71.2%; deterioration of sleep quality + 12.8%; unhealthy eating habits + 10% compared with the period before confinement) [12]. In the general population, physical inactivity has been identified in many reports, although dietary habits varied. Many reports showed that increased stress leads to unhealthy eating habits. In a study on patients with diabetes in India, about 80% of people reported that their diet and physical activity remained unchanged. Body weight and HbA1c were unchanged, but mental stress and lack of sleep were associated with unhealthy eating habits, resulting in poor glycemic control in these populations. The importance of a mental stress approach was emphasized [7].

Four reports in Japan observed a relationship between lifestyle changes and glycemic control due to the COVID-19 pandemic. Munekawa et al. [3] investigated stress levels and lifestyle-related changes in 203 patients with type 2 diabetes using a questionnaire and found that 40% of the study population felt increased stress, and 50% had decreased physical activity. Increased stress was associated with decreased physical activity and increased dietary intake. Tanaka et al. [4] conducted a self-administered questionnaire survey of 463 patients with diabetes. They found an increase in snacking habits in 21%, a decrease in physical activity in 51.2%, and an increase in alcohol intake in 8.7%. People under the age of 65 years with increased snacking exhibited worsening HbA1c and weight gain, whereas in those over the age of 65 years, physical inactivity was a factor of weight gain. A difference depending on the age has been reported. Takahara et al. [5] observed the relationships among lifestyle-related changes, HbA1c, and body weight in 1402 patients with diabetes using an interview questionnaire. A decrease in leisure time exercise as associated with worsening HbA1c and weight gain, whereas an increase in dietary intake and snacking were each associated with weight gain. Differences in these relationships were found to vary

with age and with exercise habits. Kishimoto et al. [6] surveyed 168 diabetic patients. Patients with reduced exercise due to teleworking or gym closure had worse glycemic control, but patients with improved diet, regardless of exercise, reported improved glycemic control. In this study, 32% showed increased snacking, whereas 47% showed decreased physical activity. In the overall analysis, the factor statistically associated with worsening glycemic control was increased snacking, indicating the importance of diet management during the COVID-19 pandemic, as demonstrated by Kishimoto et al.

In this study, we examined the factors that influence the deterioration of HbA1c during the COVID-19 pandemic according to sex to determine whether lifestyle changes differed according to sex. In the male population, many of the employed had worsened HbA1c, whereas no association between employment status and worsened HbA1c was observed. However, the unemployed subjects exhibited worsened HbA1c, and a sex difference was observed.

Sex differences were observed in the changes in the three lifestyle habits (physical activity, snacking habits, and drinking habits). Comparing the physical activity between the sexes especially indicated that it decreased among the women answered but increased among the men. Thus, women may be more likely to be less physically active than men during the pandemic.

Much research has been done on sex differences in normal conditions, but not during the COVID-19 pandemic. According to demographic and behavioral data from a cohort study in 20 countries, the “PURE-Saudi” study, women were more likely to experience some form of stress [13]. In real life, women may neglect their own health by prioritizing their household chores and family [8]. Since ancient times, men have been hunting, and women have been collecting to secure food. Men and women in that period were said to vary in their dietary behaviors. The Hadza tribe of Tanzania still maintain these traditional, sex-based hunter-gatherer roles. Reports on the differences in dietary behaviors between the men and women of the Hadza stated that males consumed a higher proportion of meat in total calories, whereas females consumed a higher proportion of tubers (plant roots). Women were also reported to eat more often than men [14].

In addition, while women are highly interested in healthy eating and form their own weight and eating habits, men tend to eat fatty foods because they prioritize the joy of eating [15]. These sex differences in eating behavior are influenced by sex hormones. Estrogen, a female hormone, is said to have anti-obesity and anti-feeding properties. Chronic increased stress is known to cause a bias toward a high-energy diet (rich in sugars and lipids), which is said to be more pronounced in men [16]. The cortisol-secreting response to stress may increase food intake and sweets [17]. Unproductive time or spells of boredom also affects eating behavior. Boredom is known to increase the desire for snacking, which is considered an avoidance behavior from self-loathing caused by boredom [18]. Chronic psychological stress and boredom as a result of lockdowns during the COVID-19 pandemic, therefore, increase the tendency for a high-energy dietary intake and snacking, and the effects can be significant, especially in men. The present study also indicates that snacking contributes to the deterioration of HbA1c in men. The effects of lifestyle-related changes on HbA1c were associated with an increase in snacking in the overall and male

population analyses. Patients with diabetes need to maintain balanced diet and regular exercise during the COVID-19 pandemic period. Furthermore, this study emphasized the need for glycemic control in men with diabetes, whereas the need to engage in physical activity was identified in women.

The data obtained on the changes in lifestyle habits were not quantitative evaluations but were subjective responses of the subjects. No dietary intake or nutritional survey other than snacking was investigated. Patient information such as complications and duration of diabetes were not sufficiently investigated. In addition, because this study is a retrospective medical record survey, the medications were administered at the discretion of the attending physician and thus varied among the patients. These limitations must be thoroughly addressed in future studies to obtain more conclusive results.

Conclusion

This study found sex differences in lifestyle changes in patients with diabetes during the COVID-19 pandemic. The findings suggest that treatment for diabetes should be tailored in consideration of sex differences.

Abbreviations

COVID-19, coronavirus disease 2019

Declarations

Ethics approval and consent to participate

This retrospective study was approved by the Medical Ethics Review Board of Tokyo Medical University (Approval Code: T2020-0381).

Consent for publication

Not applicable.

Availability of data and material

The datasets analyzed during this study are available from the corresponding author on reasonable request.

Competing interests

The authors have no conflicts of interest to declare.

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Authors' contributions

Conception or design: JS and YN. Acquisition, analysis, or interpretation of data: JS, YN, MS, KU, and RI. Discussion and writing this manuscript: JS and RI. Supervision of entire this research: TM and RS.

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Figures

Figure 1

Quarterly obtained HbA1c values in 2019 and 2020

Figure 2

Sex differences in changes in three lifestyle habits