

# Abstract

## Background

The impact of lockdown measures can be widespread, affecting both clinical and psychosocial aspects of health. This study aims to assess changes in health services access, diabetes self-care, behavioral and psychological impact of COVID-19 and partial lockdown in Singapore.

## Methods

We conducted a cross-sectional online survey amongst people with diabetes with the Diabetes Health Profile-18 (DHP-18). Hierarchical regression analyses were performed for each DHP-18 subscale (Psychological Distress, Disinhibited Eating and Barriers to Activity) as dependent variables in separate models.

## Results

Among 301 respondents, 45.2% were women, majority were ethnic Chinese (67.1%), aged 40 to 49 years (24.2%), have Type 2 diabetes (68.4%) and on oral medications (42.2%). During the lockdown, nearly all respondents were able to obtain their medications, supplies (94%) and contact their doctors (97%) when needed. Respondents reported less physical activity (38%), checking of blood pressure (29%) and blood glucose (22%). Previous diagnosis of mental health conditions ( $\beta=11.44$ ,  $p=0.017$ ), diabetes-related comorbidities ( $\beta=3.98$ ,  $p=0.001$ ) and Indian ethnicity ( $\beta=7.73$ ,  $p=0.018$ ) were significantly associated with higher psychological distress. Comorbidities were associated with higher disinhibited eating ( $\beta=2.71$ ,  $p=0.007$ ) while mental health condition was associated with greater barriers to activities ( $\beta=9.63$ ,  $p=0.033$ ).

## Conclusion

Health services access were minimally affected but COVID-19 and lockdown had mixed impact on self-care and management behaviors. Greater clinical care and attention should be provided to people with diabetes with greater number of comorbidities and previous mental health disorders during the pandemic and lockdown.

## Highlights

- COVID-19 and lockdown have diverse impact on health services access, psychosocial well-being and self-management in people with diabetes, which needs to be contextualized to individual country responses and preparedness.
- In this Singapore-based study, access to healthcare services, medications and supplies were minimally affected for people with diabetes.
- People with diabetes with history of mental health conditions and multiple comorbidities are at higher risk of greater psychological and behavioral dysfunction.
- Physical activity is one of the most impacted self-care behaviors in the current pandemic whilst dietary management had mixed responses.

## Keywords

Diabetes, COVID-19, lockdown, health services access, psychological distress

## Introduction

The acute and long-term consequences of the coronavirus disease 2019 (COVID-19) pandemic and related public health measures such as mass quarantine with resultant social isolation on mental health are beginning to emerge.<sup>1-8</sup> The pandemic and quarantine measures may have led to many losses including a loss of loved ones, employment, financial security, direct social contacts, educational opportunities, recreation and social support. A review of the psychological impact of quarantine demonstrated a high prevalence of psychological symptoms and emotional disturbance.<sup>9</sup> A few groups of vulnerable individuals for adverse psychosocial outcomes have been identified, in particular people who have contracted the disease, those who are at higher risk for contracting the disease and pre-existing medical, psychiatric or substance use issues.<sup>10</sup>

The impact of lockdown can be widespread, affecting both clinical and psychosocial aspects of health. Psychosocial well-being of people with diabetes can be particularly affected due to COVID-19 specific worries as people with diabetes are considered at higher risk of more severe infection.<sup>11</sup> Adherence to medications and healthy behaviors were significantly reduced due to drastic changes in lifestyles brought about by lockdown measures.<sup>12,13</sup> In some instances, glycemic control in people with Type 1 diabetes (T1DM) were affected due to difficulty in obtaining medical supplies<sup>14</sup> whilst in other instances, glycemic control based on continuous glucose monitoring (CGM) metrics improved in people who had stopped working during the lockdown.<sup>15</sup> Others reported only minor changes brought on by COVID-19 on T1DM and type 2 diabetes (T2DM) self-care with the majority maintaining baseline physical activity and dietary habits.<sup>16</sup> Thus, the magnitude of the impact of this global pandemic must be contextualized to different government responses, health systems and population settings.

## COVID-19 Response Measures in Singapore

In Singapore, the 'Disease Outbreak Response System Condition' (DORSCON), a 4-tier color-coded framework provides general guidance to mitigate the transmission and impact of infectious diseases. Following Singapore's first index case of COVID-19 in January 2020, DORSCON risk assessment escalated from Yellow to Orange on 7 February 2020.<sup>17</sup> With rising numbers of positive COVID-19 cases, a partial lockdown, termed 'Circuit Breaker' began on 7 April 2020.<sup>18</sup> Several measures implemented during lockdown included restriction of movement and gatherings, stay-home orders, home-based learning for schools and closure of physical workplace premises, except for those providing essential services.<sup>18</sup> Use of face masks was made compulsory.<sup>18</sup> Within the healthcare sector, non-essential clinic appointments and procedures were postponed or moved to a teleconsultation platform.

A phased approach was adopted in the gradual resumption of services and activity<sup>19</sup> as Singapore entered Phase 1 of gradual re-opening on 1 June 2020. The public could leave home for essential activities, while seniors were encouraged to continue staying at home. Health and preventive health services resumed based on prioritization by medical needs while medical services for stable conditions continued to be deferred.<sup>20</sup> Phase 2 (19 June 2020) enabled further resumption of most activities, subject to safe distancing principles and in groups not exceeding 5 persons.<sup>21</sup> At the time of writing, the country was still under Phase 2.

Diabetes, along with age, other medical comorbidities such as hypertension, obesity, chronic heart and lung disease, has been identified as a significant risk factor for severe COVID-19 infection, including hospitalization, ICU admissions and worse outcomes.<sup>22-24</sup> Apart from the direct impact of diabetes on COVID-19 infection, the indirect risks of the pandemic and lockdown measures on people with diabetes include disruptions to follow-up care, access to medications and supplies, as well as changes to routine diabetes self-management strategies,

particularly diet and physical activity.<sup>25</sup> This study, conducted during Phase 1 and 2 of gradual re-opening, between June-October 2020, sought to firstly, assess changes in health services access and diabetes self-care practices of people with diabetes during COVID-19 and lockdown; and secondly, to analyze the relationship between sociodemographic factors, diabetes profile (medication status, diabetes type, duration and comorbidities) and previous diagnosis of mental health conditions on well-being of people with diabetes, using the Diabetes Health Profile-18 (DHP-18) questionnaire during COVID-19 and lockdown, through an online survey.

## Methods

### Study Design and Setting

This study is a cross-sectional survey of adults, aged 21 years and above, with clinician-diagnosed diabetes, residing in Singapore. Patients were recruited by study team members from two public hospitals in Singapore or learnt about the survey via recruitment posters. The study was also publicized via a diabetes voluntary welfare organization, electronic direct mailers and selected social media diabetes support groups. No personal identifiers were collected and the online survey was hosted on a government-approved secured digital form. Ethical approval for the study was obtained from our Institutional Review Board.

### Measures and Scales Collected

Sociodemographic information was collected: age range, gender, ethnicity, marital status, educational qualification, and employment status. Current housing status, number of persons residing in the same household and monthly household income per household member<sup>26</sup> were surveyed.

Diabetes history including diabetes type, diabetes duration, current medications for diabetes, presence of diabetes-related complications and comorbidities and prior diagnosis of mental health conditions and treatment were asked.

The usual site for follow-up diabetes care (specialist outpatient clinics in public hospitals, private care providers, general practitioners and/or public primary care), frequency of visits per year prior to COVID-19 and relative change in clinic visits (more frequently, less frequently or the same) following COVID-19 and lockdown were documented.

Disruptions and barriers in accessing care due to COVID-19 and lockdown were assessed with the following questions and dichotomous responses (yes/no) on whether patients: (1) perceive their clinics were still able to provide care safely, (2) can obtain advice from doctors through other means (phone, email, text-messaging) and (3) can receive diabetes medications, equipment and supplies in a timely manner. In addition, patients' willingness to explore telephone or video consultation with their doctor were examined.

We asked participants to compare diabetes self-care behaviors *during* COVID-19 period to *before* COVID-19: the ability to keep mentally and physically active, eat a healthy diet, adhere to medications, monitor blood glucose (BG) and blood pressure (BP) and confidence in diabetes self-management (less frequently, about the same or more frequently). We asked the frequency in which participants receive COVID-19 news updates, common information sources and whether participants continued to keep in contact with friends and family not living within the same household during the lockdown.

#### Diabetes Health Profile-18 (DHP-18)

The DHP-18 is an 18-item scale which assesses psychosocial and behavioral impact of living with diabetes in three domains: psychological distress (six questions), barriers to activity

(seven questions) and disinhibited eating (five questions).<sup>27</sup> Each item is measured on a 4-point Likert scale, corresponding to a score of 0 to 3, with 0 indicating 'no dysfunction'. The scores from each subscale is aggregated and transformed to a 0 to 100 score; higher scores representing greater levels of dysfunction.<sup>28</sup> The validity and reliability of DHP-18 has been previously assessed amongst local T2DM patients<sup>29</sup> and DHP-18 has been used for assessing psychological distress.<sup>30,31</sup>

## Statistical Analysis

Descriptive analysis of the results was performed. Continuous variables were expressed as mean( $\mu$ ) and standard deviation (SD) while categorical variables were presented in counts and proportion. Hierarchical Linear Regression was used to analyze DHP-18 scores, where blocks of variables are added progressively into the model to analyze the effect of a predictor variable after controlling for other variables.<sup>32,33</sup> The model tested for the relationship between each DHP-18 subscale with three blocks of independent variables which were added sequentially. Model 1 included sociodemographic factors: gender, age group, ethnicity, employment status, education status, household income and housing type. For Model 2, diabetes-related status comprising medication status, diabetes type and duration were added in addition to Model 1 variables. For Model 3, medical history variables, comprising number of comorbidities (0/1/2/3 or more) and previous diagnosis of mental health condition (binary: yes/no) were added in addition to variables in Model 2. Model 1 to 3 were created for each of the respective DHP-18 subscales.  $P < 0.05$  was considered statistically significant. Statistical analyses were completed using R software version 3.4.3.<sup>34</sup>

## Results

Data from 301 respondents were analyzed. There was no missing data. Table 1 shows the baseline and sociodemographic characteristics of the participants. Of the respondents, 45.2% were women, majority were of Chinese ethnicity (67.1%) and were in the 40-49 years age group (24.2%). Most respondents held university level education (41.2%), were employed (75.8%), married (61.1%) and stayed in public housing (82.4%). On average, respondents stayed with 4 other persons and the majority stayed with their partner (61.1%).

Table 2 presents the medical status and health services access of the respondents prior to COVID-19. Majority (68.4%) have T2DM, 26.2% have T1DM and the remaining were either unclear of their diabetes status or have other forms of diabetes. Most respondents indicated that they were diagnosed with diabetes for 5 to 9 years (24.9%) and were on oral medication for their diabetes (42.2%). Of the respondents, 68.2% have at least one of the six common diabetes comorbidities surveyed, nearly half of the respondents indicated having high cholesterol (48.5%) and hypertension (44.5%). A small number of patients indicated previous diagnosis of mental health condition (n=18, 6.0%), with 7 (2.3%) still on treatment at the time of survey. Most of the respondents received care in a specialist outpatient clinic under a public healthcare institution (89.7%) and visit their doctors around 3-4 times annually (72.4%) before COVID-19 and lockdown.

Majority received daily COVID-19 news updates (76.1%). The most common sources of information were from local television channels (50.2%), social media (41.2%) and government official websites (38.2%). A large proportion continued to stay in touch with friends and family not residing in the same household during the lockdown (86.4%) (Table 3).



Figure 1: Health services access during COVID-19 and partial lockdown. Graphic created with 'likert' package in R software. <sup>35</sup>

In response to questions pertaining to health services access, nearly all (97%) were able to reach their doctor through either phone, messaging or email despite not attending clinic and obtain medication and medical supplies timely (94%) during lockdown(Figure 1). Over 81% of respondents indicated a willingness to explore tele-consultation options should physical visits not be possible and 82% indicated being able to receive care from their clinic safely during this period.

Subgroup analysis for age group and gender did not yield any significant findings. Across diabetes types, more T1DM (92.4%) compared to T2DM (80.1%) were able to reach their doctor even if they do not visit the clinic physically ( $p= 0.02$ ) (Appendix Figure 1). Similarly, patients on insulin injection-only treatment (92.6%) were more able to reach their doctor as compared to oral medication (77.2%) and oral medication plus insulin treatment (81.9%) ( $p= 0.015$ ) (Appendix Figure 2). Across different employment status, there is a significant association in the proportion of individuals indicating whether they were able to receive clinical care safely. All unemployed respondents (100%) were able to receive care safely, followed by employed respondents (94.7%) and lastly, non-applicable employment status (84.4%) (retired, housewives, schooling) ( $p= 0.016$ ).

Figure 2: Self-care behaviors for diabetes patients during COVID-19 and partial lockdown period. Graphic created with 'likert' package in R software. <sup>35</sup>

Most patients maintained diabetes self-care behaviors similar to pre-COVID-19 (Figure 2). More than two-thirds of patients reported similar frequencies to the statements “I am confident to manage my diabetes”, “I am able to take my diabetes medications as instructed”,

and “I am able to look after myself during sick days”. Over a third of patients kept themselves mentally active (33%) and think positively (32%) more frequently.

Ability to maintain a healthy diet appears to be mixed, with 25% indicating that they were able to do so more frequently and 17% stating otherwise (less frequently).

Physical activity involvement was most impacted by COVID-19 and lockdown; only 40% reported being able to keep the same level of physical activity. While 22% indicated they were more frequently able to keep themselves physically active, 38% responded they were less physically active.

Similarly, the impact on self-monitoring of blood glucose (SMBG) were mixed, with a similar proportion indicating checking BG both less and more frequently (22% vs 21%, respectively). Taking diabetes medications as instructed (76%) and looking after oneself when sick (75%) were largely unaffected. Around a fifth of respondents were more frequently able to take their medications as instructed (21%) and look after themselves during sick days (20%). Of all self-care behaviors examined, checking of BP had the lowest proportion of increased frequency (8%) and with 29% of respondents checking less frequently.

Subgroup analysis showed that there were no significant differences in self-care behaviors across gender and age-groups. Across the different types of diabetes, more T1DM patients (29.1%) as compared to T2DM patients (17.5%) monitored BG more frequently ( $p=0.019$ ). In addition, more T2DM indicated they monitored BG less frequently as compared to T1DM (25% vs 13%) (Appendix Figure 3). Likewise, there was a significant difference in BG checks across diabetes treatment type, with patients on insulin injections-only doing so more frequently (30%) as compared to oral medications (18%) and oral medication plus insulin users (17%) ( $p=0.047$ ) (Appendix Figure 4).

In DHP-18, amongst the three subscales, disinhibited eating had the highest score ( $\mu = 43.3$ ,  $SD = 17.2$ ), followed by barriers to activity ( $\mu = 34.5$ ,  $SD = 18.1$ ). Psychological distress score subscale was lowest, with mean 20.6 and  $SD = 20.0$  (Table 4). On average, patients on both oral medication and insulin scored higher compared to other treatment modalities (oral medication only, insulin only, unclear of medication /no medication) for all three DHP-18 subscales. This difference was significant for psychological distress and disinhibited eating subscale ( $p = 0.001$ ) but not significant after adjusting for other covariates in the hierarchical regression.

Results of the hierarchical regression is presented in Table 5. Under the psychological distress domain, older adults in the 50-59 and 60 years and above age groups were associated with lower psychological distress scores ( $\beta = -9.98$ ,  $p = 0.021$  and  $\beta = -9.75$ ,  $p = 0.034$  respectively). Individuals in 61<sup>st</sup> to 90<sup>th</sup> percentile income had lower psychological distress score ( $\beta = -8.63$ ,  $p = 0.037$ ). Indian ethnicity ( $\beta = 7.73$ ,  $p = 0.018$ ), diagnosis of mental health conditions ( $\beta = 11.44$ ,  $p = 0.017$ ) and diabetes-related comorbidities ( $\beta = 3.98$ ,  $p = 0.001$ ) were significantly associated with higher psychological distress scores.

Under the disinhibited eating domain, the age groups between 40-49 and 50-59 years were associated with lower disinhibited eating score ( $\beta = -7.07$ ,  $p = 0.045$  and  $\beta = -9.32$ ,  $p = 0.011$  respectively). Being unemployed and having no employment ( $\beta = -10.33$ ,  $p = 0.001$  and  $\beta = -8.52$ ,  $p = 0.015$  respectively) were associated with less disinhibited eating. Diabetes duration more than 20 years had an association with lower disinhibited eating score ( $\beta = -6.90$ ,  $p = 0.042$ ) whilst diabetes-related comorbidities were associated with higher disinhibited eating score ( $\beta = 2.71$ ,  $p = 0.007$ ).

Under the barriers to activity domain, low income (income percentile < \$600) and diabetes duration 15-20 years were associated with lower barriers to activity score ( $\beta = -8.64$ ,  $p = 0.034$

and  $\beta = -8.14$ ,  $p = 0.035$  respectively). Diagnosis of mental health conditions were found to be strongly associated with higher barriers to activity scores ( $\beta = 9.63$ ,  $p = 0.033$ ).

## Discussion

The present study assesses changes in health services access, diabetes self-care practices, behavioral and psychological function of people with diabetes due to COVID-19 and lockdown measures in Singapore.

### Health services access

In our study, the majority of people with diabetes were able to access health services and obtain medications and diabetes medical supplies during the pandemic. This reflects Singapore's strategy in managing the pandemic and level of preparedness, drawing from experience with the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak. Despite postponing non-critical appointments, patients with chronic diseases continued to receive medications and supplies via home delivery.<sup>36</sup>

Nearly all respondents were able to reach their clinical team through physical or alternative means (email, text messaging or teleconsultations). More people with T1DM and those on insulin treatment were able to reach their doctor as compared to T2DM and on oral medications, which may be attributed to clinicians' bias in reaching out to those with higher complexity needs.

A small minority of patients expressed unwillingness to explore teleconsultation and this unwillingness was highest amongst the oldest age group. Similarly, in a global survey distributed via social media<sup>37</sup>, the majority (79%) reported no issues in accessing diabetes supplies and medications although only 32% reported no change in medical follow-up

frequency. Only 28% received care via teleconsultation (telephone/video call) and like our study, a small percentage of respondents, those older than 65 years and of male gender, were unwilling to explore teleconsultation. Possible barriers for older age groups to utilize teleconsultation services include fear of technology, lack of support to use technology, access to devices, internet connectivity and preference for face-to-face encounters. Patients with hearing and/or visual impairments may also find it challenging to use technology devices.

Diabetes Self-care practices:

- a) BG, BP monitoring, sick day management and adherence to medications

Our results showed that self-care and diabetes management behaviors amongst diabetes patients were impacted in both directions (positively and negatively), were highly varied and differed across subgroups. Adherence to diabetes medications, self-care during sick days and confidence in managing diabetes were largely unaffected, with a small but sizeable proportion (~20-25%) reporting being better able to engage in these behaviors more frequently. More than half of participants continued monitoring BG at the same frequency with one-fifth monitoring BG more frequently. Many were working from home, or had to stop work during the lockdown period, resulting in more time spent at home, possibly reduced work stress and this could have enabled greater adherence to medications and SMBG.

Checking of BP was one of the most negatively affected self-care behaviors identified, with almost one-third of respondents reporting a reduction in checking frequency. One possibility may be the lack of a BP machine at home and hence, the reliance on their respective healthcare providers in this aspect of care.

In a study looking at the impact of lockdown on glycemic control in 307 people with T1DM using flash glucose monitoring (FGM), there was an improvement in glycemic control with

increased time-in-range. The authors postulated that the lockdown could have contributed to more time for self-management from greater stability in schedules, healthier meals and more time for treatment adjustments.<sup>38</sup> Our study did not analyze changes in glycemic control nor specifically ask for the BG monitoring method. It would have been interesting to note the different methods and whether the use of cloud-based BG data sharing systems with healthcare teams resulted in improved glycemic parameters.

#### b) Physical activity

In our study, physical activity involvement was the most negatively affected, with close to 40% of respondents less frequently able to keep physically active. This finding is not surprising since over 80% of Singaporeans live in public housing comprising flats<sup>39</sup> with limited space for physical activity. With communal spaces and sports facilities closed during the lockdown period, it would have been difficult to maintain usual physical activities.

Our findings are similar to others reporting reductions in physical activity and weight gain in people with diabetes.<sup>12,40,41</sup> Assaloni et al looked specifically at physical activities and variation in glycemic values in T1DM during this pandemic and found negative outcomes with decreased physical activity and increased glycemic levels.<sup>40</sup>

Given the unexpected and prolonged duration of safe distancing measures during this period, advice and guidance on home-based exercises should be emphasized.

#### c) Dietary changes

Dietary changes during the pandemic can be influenced by several factors and were found to be mixed in our study. While over a quarter of participants reported being able to eat healthier more frequently, there was a small proportion (17%) reporting otherwise.

A study done in diabetes individuals in Japan also found similar results, where both negative and positive changes to diet were noted.<sup>42</sup> Ruiz-Roso et al reported increased intake of vegetables but also snacks and sugary foods during the lockdown period in a Spanish population.<sup>12</sup> A hospital-based survey from South India noted increased consumption of fruits and vegetables and reduced unhealthy snacking<sup>16</sup>, whereas a study in North India reported increased carbohydrate consumption and snacking.<sup>41</sup>

Evidently, the changes to food intake is very variable, and may be dependent on lockdown measures in different countries as well as cultural practices. During the lockdown in Singapore, restaurants and food outlets were only catering for takeaways and deliveries. Dining-in was prohibited. As most people were telecommuting, the approach to food can go both ways. Some found themselves with more time to engage in self-preparation of meals, whereas others found the convenience of ordering different varieties of food at their fingertips.

#### DHP-18

Prior diagnosis of mental health conditions and diabetes-related comorbidities were associated with greater dysfunction in two DHP-18 domains. Previous mental health condition, number of diabetes-related comorbidities and Indian ethnicity were found to be significantly associated with greater psychological distress. The association between depressive symptoms and Indian ethnicity were identified in another local study using the Center for Epidemiologic Studies Depression Scale.<sup>43</sup> In comparison with other locally conducted studies utilizing DHP-18, poor glycemic control, indicated by higher glycated hemoglobin level, were found to be associated with higher psychological distress.<sup>30</sup> However, the association with Indian ethnicity was not observed.<sup>29,30</sup>

The number of diabetes-related comorbidities was also positively associated with disinhibited eating domain. Interestingly, we noted a reduction in disinhibited eating scores amongst

unemployed respondents (including students, housewives, retirees) as compared to employed individuals. A possible reason for this finding is that employed individuals have higher stress levels, which has been shown to result in changes in eating behavior <sup>44</sup>; greater perceived stress was associated with consumption of foods higher in sugar and fat.<sup>45</sup> Previous diagnosis of mental health condition was also associated with greater barriers to activity score, indicating greater dysfunction in ability to undertake social or usual role activities. In contrast to previous association studies <sup>30</sup>, we did not observe a significant association for type of diabetes treatment with higher disinhibited eating and barriers to activity dysfunction.

Due to the cross-sectional and anonymous nature of the study, we were unable to obtain pre-COVID-19 estimates of the DHP-18 scores. We referenced DHP-18 scores reported from local literature pre-COVID-19 for comparison.<sup>29</sup> Both psychological distress and disinhibited eating domain scores did not differ substantially between the current and reference study. However, barriers to activity score was significantly higher (mean difference = +7.12) in our study (Table 4). The referenced study comprised only T2DM patients, unlike our study which has over a quarter of T1DM patients and twice as many Indian respondents (27.9% vs 12.0% in present study). Thus, the higher barriers to activity score should be interpreted with caution as it may be attributed to pandemic mitigation measures, such as restricted social gatherings, change in dietary patterns, stay-home measures during lockdown and the added risk for severe outcomes for COVID-19 infections amongst people with diabetes.

### Implications for clinical practice

Our study highlights that people with diabetes with previous diagnosis of mental health conditions and more comorbidities are associated with dysfunction in all domains of DHP-18. Greater support and attention should be provided to these individuals.



Indian ethnicity was also associated with higher psychological distress. This finding should be interpreted with caution as the number of Indians (N=36) in our study was low. Despite this, the ethnic distribution in our study i.e. Chinese (67.1%), Malays (15.3%) and Indians (12%), is similar to a previous report on health status in adults with self-reported diabetes, where the ethnic distribution was 65.2%, 18.5%, 14.9% respectively.<sup>46</sup> Although we were not able to uncover the cause for this in our study, this finding suggests that ethnic-specific organizations providing socio-cultural and community support may be able to play a larger role.

### Strengths and Limitations

This study is important and relevant during the current pandemic and included a detailed questionnaire assessing health services access and well-being for people with diabetes, a chronic disease, in Singapore. However, there are a few limitations which limit generalizability of our findings to other study populations. Due to the cross-sectional<sup>47</sup> and anonymous nature of the study, we were unable to ascertain baseline DHP-18 before COVID-19 and perform follow-up assessment. The study recruited English-literate respondents via an online survey requiring a degree of IT savviness and most were receiving care from specialist outpatient clinics and thus, may not be representative of all people with diabetes. Lastly, we were not able to correlate clinical parameters such as glycated hemoglobin to identify associations with clinical outcomes.

### Conclusion

Although health services delivery may have been modified and adapted, people with diabetes in Singapore continued to be able to access health services and medical care during the COVID-19 pandemic and lockdown. While majority of patients remained confident in managing their health and medications, other aspects such as physical activity involvement, checking of BP

and BG were performed less frequently. People with diabetes with prior mental health conditions and multiple comorbidities are at higher risk of greater psychological and behavioral dysfunction. The disproportionate psychological and behavioral impact of the pandemic suggest that certain patient groups may require additional support.

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## Conflict of interest Statement

All authors declare no conflict of interest.

## Author contributions

E.Y. conceived and designed the study, collected the data and wrote the manuscript. T.S.G. and W.H.L. contributed to the design of the study, performed data analysis and wrote the manuscript. L.Y.Y., T.H.H., L.Y.S., L.S.C., S.C.F., T.S. contributed to data collection and writing of the manuscript. All authors approved the final manuscript.

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