Contents lists available at ScienceDirect

Primary Care Diabetes

Original research

Impact of COVID-19 lockdown on people living with diabetes: Experience from a low-middle income country in South Asia

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ARTICLE INFO

ABSTRACT

Aims: COVID-19 lockdown imposes many challenges to patients with diabetes. We aimed to assess the impact of COVID-19 lockdown on health-related behavior and disease control among patients with diabetes.

Materials and methods: A cross-sectional study was conducted among adults with diabetes attending a diabetes clinic in Colombo, Sri Lanka in June-July 2020. Lifestyle and disease control changes before and during the lockdown, were determined using an interviewer-administered questionnaire and review of medical records.

Results: Among 1727 participants mean HbA1c decreased by 0.30% (95% CI 0.24–0.36, p < 0.001). HbA1c improved in 37.6% but deteriorated in 18.8%. Male sex (OR 1.36, 95% CI 1.10–1.67), better education (OR 1.10, 95% CI 1.01–1.20) and being employed (OR 1.08, 95% CI 1.00–1.16) were sociodemographic predictors of improved control. Better dietary adherence (OR 1.55, 95% CI 1.13–2.12), night-time sleep (OR 1.46, 95% CI 1.13–1.88) and indoor exercise (OR 1.62, 95% CI 1.23–2.07) were behavioural determinants of improved glycaemia. Decreases in self-monitoring of blood glucose (OR 1.45, 95% CI 1.09–1.93), exercise (OR 1.7, 95% CI 1.32–2.20), medication use (OR 1.95, 95% CI 1.37–2.78), dietary adherence (OR 1.72, 95% CI 1.32–2.26) and family income (OR 1.45, 95% CI 1.12–1.88) predicted worsening glycaemia. Only 4.1% used telehealth services; 83.1% of them reported good satisfaction.

Conclusions: Mean HbA1c improved during the lockdown. Overall, 37.6% of participants improved their glycaemic control. Well-educated employed men were more likely to improve glycaemic status. Improving diabetes control through healthy lifestyle practices and self-monitoring are feasible even in resource limited settings.

1. Introduction

COVID-19 pandemic has rapidly spread around the world infecting more than 200 million and causing more than 4.3 million deaths

[1]. It has caused a dramatic change in lifestyle of individuals and function of healthcare systems [2]. South Asian region bears a large proportion of the global diabetes burden and is also experiencing a rapid rise in COVID-19 incidence [1,3]. Sri Lanka has the second highest (10.7%) age-adjusted diabetes prevalence in adults in the South East-Asia region exerting a significant healthcare burden to the nation [3].

People living with diabetes are at increased risk of adverse complications and death from COVID-19 [4]. This has been observed in multiple setting including in-hospital, intensive care [5] and even perioperative patients [6]. Although the exact mechanism is not known, it is presumed that concomitant pro-inflammatory, pro-thrombotic state, pre-existing risk for atherothrombosis and high stress mediate the excess risk [4,5]. Therefore, emphasis has been

made on continuing optimum care of chronic diseases including diabetes while adhering to the measures to prevent the spread of SARS-CoV-2 virus [7]. Despite the many challenges in continuing the care for people with diabetes, some studies have shown improvements in glycaemic control during the periods of lockdown [8,9]. However these studies are limited by small sample size. Furthermore, data from the South Asian region and from low-middle income countries on this regard are scarce. Little is known about the changes in health-related behaviours and metabolic and clinical parameters of people with diabetes who have not contracted the infection, but live in areas of high risk of COVID-19 [10].

The first wave of COVID-19 in Sri Lanka was observed between March and June 2020. During this time island-wide curfew was imposed (strict lockdown) to minimize community interaction and mitigate the disease spread. Impact of such changes on people with diabetes was unknown and anticipated to be negative. Therefore, we aimed to assess the diabetes control and its determinants including health related behavioural changes, among people with diabetes during the COVID-19 pandemic.

2. Materials and methods

2.1. Design, setting and participants

A cross sectional study was conducted in a specialized private sector diabetes clinic in Colombo district, Sri Lanka in June–July 2020, shortly after the strict lockdown was lifted (within a few weeks) following the first wave of COVID-19 pandemic. All clinic attendees were screened for eligibility and recruited by consecutive sampling.

Adults aged over 18 years, with diabetes mellitus (type 1 and type 2) for 12 months or more were considered eligible for enrolment. Participants who did not have records of glycaemic control within the 12 months preceding COVID-19 pandemic, participants with acute illnesses or psychological disturbance that prevented from responding to the interview were excluded from the study.

Data on demography, diabetes type and duration, co-morbidities, health related behavior, impact of COVID-19 pandemic were collected using a structured interviewer administered questionnaire. Trained medical graduates conducted the interviews. Anthropometric and blood pressure measurements and biochemical indices of previous and current clinic visit were obtained through the clinical records.

All participants provided written informed consent. Participants had the autonomy to withdraw consent to participate at any point, by verbally expressing the dislike to participate to the study, with or without stating reasons. No identifiable data were collected, maintaining the confidentiality. Ethical clearance was obtained from Ethics Review Committee, Faculty of Medicine, University of Colombo, Sri Lanka (reference No: EC-20-EM012). Strict infection prevention measures were adhered to during the time of patient interview and data collection.

2.2. Statistical analysis

Statistical analysis was conducted with SPSS version 17. Comparison of continuous variables was conducted with paired sample t test. Associations of categorical variables were determined using Chi square test. Glycaemic control was considered improved or worsened if HbA1c decreased or increased by 0.5 percentage points respectively [11]. Association of lifestyle and behavioural factors with change in glycaemic control was determined by calculating odds ratios. Missing data were excluded pairwise. P values less than 0.05 were considered significant.

Table 1
Clinical and demographic characteristics of study participants (N = 1727).

	Male	Female	Total
Number (%)	933 (54.0)	794 (46.0)	1727
Mean age, years (SD)	56.1 (13.9)	58.9 (13.4)	57.4 (13.2)
Level of education, n (%)			
No formal education	8 (0.9)	13 (1.6)	21 (1.2)
Primary/secondary school	50 (8.9)	57 (6.2)	107 (6.2)
Passed Ordinary Level	178 (19.1)	188 (23.7)	366 (21.2)
Passed Advanced Level	289 (31.0)	287 (36.1)	576 (33.4)
Diploma/graduate or above	394 (42.2)	236 (29.8)	630 (38.0)
Not disclosed	14 (1.4)	13 (1.6)	27 (1.6)
Occupation, n (%)			
Unemployed	60 (6.4)	375 (47.2)	435 (25.2)
Unskilled labour	8 (0.9)	3 (0.4)	11 ((0.6)
Skilled labour	28 (3.0)	7 (0,8)	35 (2.0)
Armed forces	18 (1.9)	3 (0.4)	21 (1.2)
Clerical/technical/sales	125 (13.4)	52 (6.6)	177 (10.2)
Business	246 (26.4)	44 (5.5)	290 (16.8)
Professional/managerial	312 (33.4)	199 (25.1)	521 (29.6)
Retired	115 (12.3)	94 (11.8)	209 (12.1)
Other	10 (1.1)	5 (0.6)	15 (0.9)
Type 1 diabetes, n (%)	6 (0.6)	8 (1.0)	14 (0.8)
Duration of diabetes, years (SD)	12.4 (8.8)	11.4 (7.9)	11.9 (8.4)
Hypertension, n (%)	477 (51.1)	477 (59.9)	954 (55.2)
Ischaemic heart disease, n (%)	191 (20.5)	174 (21.9)	365 (21.1)
Dyslipidaemia, n (%)	761 (81.6)	643 (81.0)	1404 (81.3)
Chronic kidney disease, n (%)	235 (25.2)	183 (23.0)	418 (24.5)
Over 12 months preceding COVID-19 lock-down			
Mean HbA1c, % (SD)	7.5 (1.4)	7.5 (1.4)	7.5 (1.4)
Mean SBP, mmHg (SD)	135.0 (16.7)	134.4 (17.1)	134.7 (16.9)
Mean DBP, mmHg (SD)	78.9 (14.1)	78.5 (21.4)	78.8 (17.8)
Weight, kg (SD)	72.0 (12.9)	61.8 (10.4)	67.3 (12.9)
Immediately after the COVID-19 lockdown period			
Mean HbA1c, % (SD)	7.2 (1.5)	7.3 (1.4)	7.2 (1.5)
Mean SBP, mmHg (SD)	136.3 (20.0)	137.9 (20.5)	137.0 (20.3)
Mean DBP, mmHg (SD)	79.2 (11.2)	77.8 (10.8)	78.6 (11.0)
Weight, kg (SD)	71.8 (13.0)	62.2 (10.9)	67.4 (13.0)

3. Results

The study included 1727 patients with diabetes; 54.0% were males, mean age was 57.4 (±13.4) years, mean duration of diabetes was 11.9 (±8.4) years and mean HbA1c, blood pressure and body weight were 7.2 ± 1.5 % (55 mmol/mol), 135/79 (±17/18) mmHg and 67.3 (±12.9) kg respectively. Except body weight, all other parameters were comparable between males and females (Table 1).

3.1. Changes of clinical and metabolic parameters during the COVID-19 lockdown period

Compared to the 12 months preceding COVID-19 pandemic, mean HbA1c had declined by 0.30 percentage points (7.51% (59 mmol/mol) vs 7.20% (55 mmol/mol), 95% CI 0.24–0.36, p < 0.001) immediately after the pandemic. Out of all participants studied, 37.6% had improved HbA1c (decline by 0.5 percentage points or more) while it remained the same in 43.6% and worsened (increased by 0.5 percentage points or more) in 18.8%. Fig. 1 shows changes in HbA1c, body weight and systolic blood pressure.

3.2. Changes in lifestyle and psychosocial wellbeing

Table 2 summarizes key changes reported by participants during the lockdown for COVID-19 pandemic.

3.2.1. Diet
Most participants continued to follow dietary advices and remained in control of their food choices. Majority decreased snacking from outside (Table 2). Among those who reported a change in their dietary practices, a decrease in adherence was commoner than an improvement (28.4% vs 13.2%).

3.2.2. Physical activity and sleep

Sedentary time (sitting, reclining) increased in most participants (41.1%). Time spent exercising indoors decreased in 43.4% while it increased only in 21.2%. Night time sleep remained unchanged in most, but sleeping time during daytime increased in 24.8% and decreased in 34.2%.

3.2.3. Impact on finances

Among the employed participants, 12.8% continued to attend to work, 20.1% worked from home and 37.5% did not work on most of the days while 2.6% lost their jobs. Decrease in income (in 38.5%), increase in expenses (in 50.2%) and in a minority, an increase in need for external monetary assistance for medication and food acquisition (in 23.2%) were notable changes.

3.2.4. Diabetes control and wellbeing

Majority continued to take glucose lowering medication and practiced self-monitoring of blood glucose as before. A notable proportion of participants had less laboratory tests and suffered less hypoglycaemic events during the lockdown period for COVID-19. Most considered their overall physical and mental health to have remained unchanged. However, among those who experienced a change, they were more likely to claim improved physical and mental wellbeing during the lockdown time.
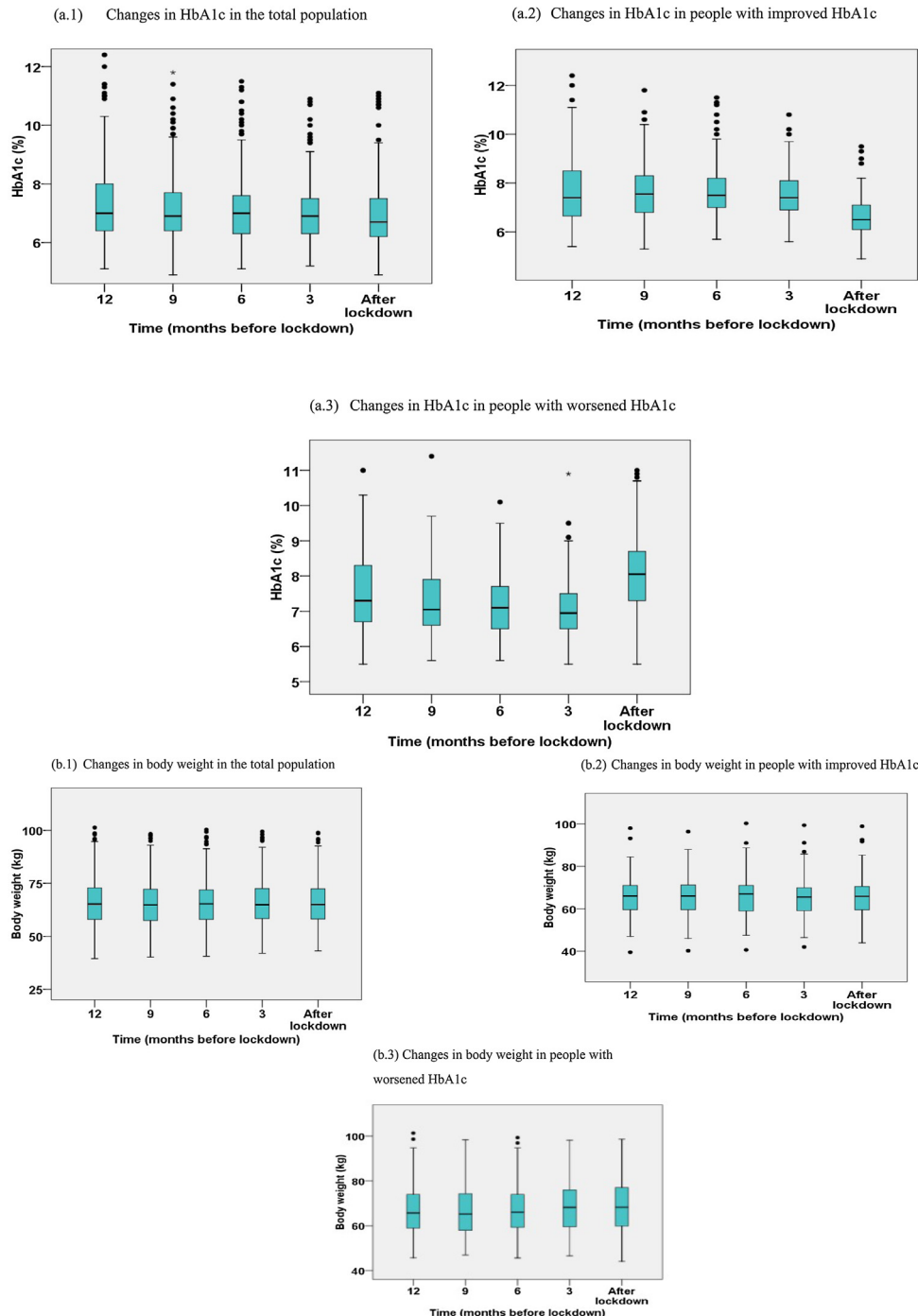

Fig. 1. Changes in HbA1c (a.1, a.2 and a.3), body weight (b.1, b.2 and b.3) and systolic blood pressure (c.1, c.2 and c.3) in total population, people with improved or worsened HbA1c.
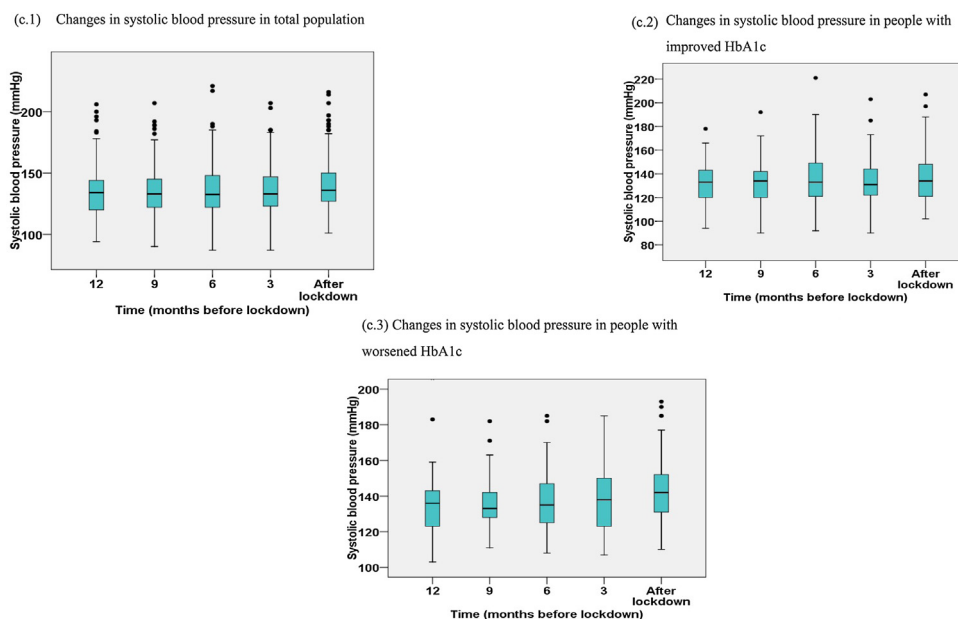
(c.1)   Changes in systolic blood pressure in total population

(c.2)   Changes in systolic blood pressure in people with improved HbA1c

(c.3) Changes in systolic blood pressure in people with worsened HbA1c

Fig. 1. (*Continued*)

3.2.5. Access to healthcare and related behaviour

During the time of curfew, 26.2% of the participants ran out of medications for at least 1 day at any time point. Common reasons were inability to attend the clinic due to curfew (58.0%), inability to go to the pharmacy due to curfew (37.8%), unavailability of medication in the pharmacies (23.3%), reluctance to go to the clinic due to fear of contracting COVID-19 (23.1%) and reluctance to go to the pharmacy due to fear of contracting COVID-19 (16.0%).

Prior to lockdown period, most participants purchased medicines from a pharmacy by themselves (73.7%) while others purchased through a relative or friend (27.4%) or received from a state sector hospital (8.0%).

During the lock down period, only 44.1% purchased medicines from a pharmacy by themselves while 33.6% utilized a home delivery service and 30.3% purchased medicine from a pharmacy through a relative or friend.

Throughout the period of lockdown, 10.9% of the participants adjusted their glucose lowering therapies. Majority of them (53.7%) did so by themselves. Others sought medical assistance by visiting the general practitioner (13.3%), routine diabetes care provider (15.4%), through telephone advice from the general practitioner (5.9%) routine diabetes care provider (10.6%) or used a formal specified telehealth service (7.4%).

Of the total studied population, only 4.1% had used telehealth services during the period of lockdown. Most of them (53.5%) felt it to be 'same as a usual consultation' while 29.6% found it better and 16.9% found it worse. Among those who used telehealth 70.0% were convinced to opt for a telehealth consultation for diabetes care if needed in the future with 80.8% stating that they would recommend telehealth for diabetes care for their relatives or friends.

3.3. Determinants of glycaemic control

Improvement in glycaemic control (i.e. HbA1c reducing by 0.5 percentage points or more) were more likely in males (40.9% vs 33.8%, OR 1.36, 95% CI 1.10–1.67), better educated (above advanced level) (41.4% vs 35.6%, OR 1.10, 95% CI 1.01–1.20), employed (39.4% vs 34.8%, OR 1.08, 95% CI 1.00–1.16) and those with a higher HbA1c (>8%; >64 mmol/mol) in the preceding year (61.1% vs 29.5%, OR 3.75, 95% CI 2.95–4.77). Mean difference in HbA1c reduction did not dif-

fer between younger and older adults (Fig. 2). Furthermore, in a multinomial logistic regression model, education above Advanced Level (AL) (p = 0.005), male sex (p = 0.009) and mean HbA1c >8% (>64 mmol/mol) in the preceding year (p < 0.001) were the independent predictors of improved glucose control.

Participants who reported to have improved adherence to dietary advice (OR 1.55, 95% CI 1.13, 2.12), better control over food choices (OR 1.38, 95% CI 1.01, 1.89), increased night time sleep (OR 1.46, 95% CI 1.13, 1.88) and increased time on indoor exercise (OR 1.62, 95% CI 1.23, 2.07) were more likely to have improved glycaemic control. Less frequent self-monitoring of blood glucose (SMBG) (OR 1.45, 95% CI 1.09, 1.93), decreased time on exercise (OR 1.7, 95% CI 1.32, 2.20), decreased adherence to medication (OR 1.95, 95% CI 1.37, 2.78) and dietary advices (OR 1.72, 95% CI 1.32, 2.26) and decreased family income (OR 1.45, 95% CI 1.12, 1.88) predicted worsening glycaemic control.

4. Discussion

Our study aimed at identifying the impact of COVID-19 lockdown on glycaemic control and changes is relevant lifestyle, social, psychological, health-related behavioral determinants among people living with diabetes. Above results indicate that glycaemic control either remained stable or improved in a majority. This is despite difficulties in adhering to healthy diet, engaging in exercise and accessing laboratory and self-monitoring facilities. People who achieved an improved control were more likely to have had better adherence to diet, engaged in indoor exercise and had longer sleeping time at night. Notably, better control was observed in employed, better educated males who had a poor control in the preceding year. This may reflect more time at home, less snacking, less work-related stress and increased attention to own wellbeing. Decreased adherence to diet, exercise, medication, less frequent SMBG and decreased family income were associated with worsening glycaemic control.

Contrasting observations had been made in similar studies from different parts of the world. Bonora et al. [12] reported that the glycaemic control improved in patients with type 1 diabetes suggesting short term interval in routine activities may have beneficial effects on disease management. In contrast, Ghosal et al. [13]

Table 2
Changes in lifestyle and psychosocial wellbeing.

| Parameter	Percentage				P value*
	Total sample	Participants with improved glycaemic control	Participants with unchanged glycaemic control	Participants with deteriorated glycaemic control	
Adherence to dietary advice					
Improved	13.2	15.2	11.5	7.8	**<0.001**
Unchanged	58.5	59.5	62.1	54.6	
Decreased	28.4	25.3	26.4	37.5	
Having control over food choices					
Improved	13.3	14.7	11.5	10.1	**<0.001**
Unchanged	51.5	52.8	56.1	43.8	
Decreased	35.3	32.5	32.5	45.1	
Snacking outside					
Increased	8.4	8.6	7.6	8.6	0.392
Unchanged	17.5	18.7	15.6	19.9	
Decreased	74.1	72.7	76.8	71.6	
Sleeping time at night					
Increased	21.0	24.5	16.1	22.7	**<0.001**
Unchanged	62.7	62.2	67.2	56.4	
Decreased	16.3	13.3	16.6	21.0	
Sleeping during day time					
Increased	24.8	26.7	21.7	26.9	0.176
Unchanged	41.0	41.9	42.0	39.5	
Decreased	34.2	31.3	36.3	33.7	
Sedentary time (time spent sitting, reclining etc)					
Increased	41.1	43.3	39.5	40.1	0.394
Unchanged	40.8	40.4	44.2	40.1	
Decreased	18.0	16.2	16.3	19.7	
Time spend on exercise in in-door					
Increased	21.2	26.1	20.4	12.8	**<0.001**
Unchanged	35.5	35.4	36.6	33.2	
Decreased	43.4	38.4	43.0	54.0	
Continuing glucose lowering medication as prescribed					
Improved	4.4	3.7	3.9	5.7	**0.002**
Unchanged	83.6	86.6	86.4	77.0	
Decreased	12.0	9.7	9.7	17.3	
Self-monitoring of blood glucose					
Increased	6.7	7.2	5.4	7.0	**0.012**
Unchanged	69.9	73.9	70.6	64.4	
Decreased	23.4	18.8	24.0	28.5	
Laboratory tests for diabetes/co-morbidities					
Increased	2.5	3.0	1.3	2.7	0.217
Unchanged	24.2	22.9	25.9	24.8	
Decreased	73.2	74.1	72.8	72.4	
Hypoglycaemic events (symptomatic and/or recorded <70 mg/dL on home glucose monitor)					
Increased	7.7	9.2	5.6	9.1	0.055
Unchanged	31.1	32.7	30.2	28.2	
Decreased	61.2	58.1	62.8	62.8	
Family income					
Increased	2.1	2.2	2.1	1.4	**0.003**
Unchanged	59.4	58.0	65.8	54.0	
Decreased	38.5	39.8	32.2	44.7	
Family expenses					
Increased	50.2	52.3	47.9	48.6	0.353
Unchanged	41.4	39.4	44.5	41.4	
Decreased	8.4	8.3	7.6	9.9	
Need for external monetary assistance for medication/food					
Increased	23.2	8.1	12.8	15.3	**0.007**
Unchanged	58.0	69.6	68.2	70.9	
Decreased	18.9	22.3	19.0	13.8	
Overall physical health					
Improved	21.2	25.4	19.0	17.2	**<0.001**
Unchanged	61.1	58.9	66.5	57.1	
Decreased	17.7	15.7	14.5	25.7	
Overall mental health					
Improved	25.1	28.2	23.4	21.6	0.056
Unchanged	57.7	57.0	60.1	57.4	
Decreased	17.2	14.8	16.5	20.9	

* P values are for association between the different parameter outcomes and state of glycaemic control, assessed using Pearson Chi square test.

showed that lockdown was directly associated with deterioration in HbA1c; longer the duration of lockdown, higher the HbA1c observed. Whereas, D'Onofrio et al. [14] reported no change in glycaemic control during lockdown. However, to the best of our knowledge, this is the largest series from a South Asian region and

from a low-middle income country looking at glycaemic status in a cohort predominantly comprised of people with type 2 diabetes during a lockdown period.

Determinants of glucose control have also been investigated in a few previous studies. Increased snacking, poor dietary habits and
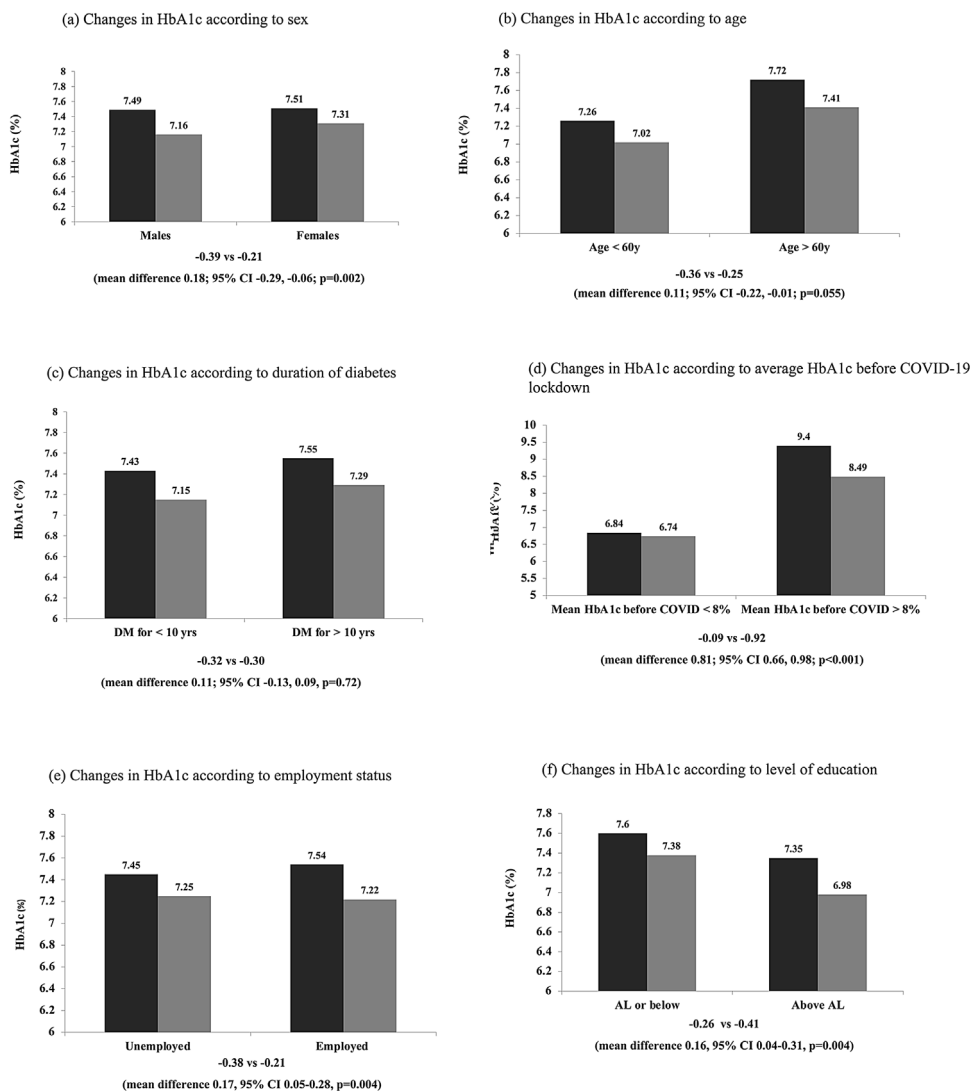
Fig. 2. Changes in HbA1c according to (A) sex, (B) age, (C) duration of diabetes (D) average HbA1c before COVID-19 lockdown, (E) employment status and (F) level of education. ■ Before COVID-19 pandemic; ■ Soon after lockdown was lifted.
AL: Advanced level examination, DM: diabetes mellitus
*The mean difference of HbA1c before and after COVID-19 are indicated below each graph. The mean difference is te mean of differences of each individual participant.

reduced physical activity have been shown to contribute for worsening of glycaemic status [15,16], and is comparable with our study. Ruiz-Roso et al. [17] demonstrated that patients aged 63 years or younger significantly increased their sugar intake, whereas Falcetta et al. [18] showed that older patients (>80 years) were at risk of worsened glycaemic control during the COVID-19 lockdown. However, age was not an independent predictor of glycaemic control in our study. In fact, employed males were more likely to achieve improved glycaemic status. Male sex was an independent predictor of glucose control in our study. Increased food cravings among females compared to males [17], disparities in eating behaviours, food choices [19] and lower physical activity among females during lockdown [20] may have contributed to the above observation. Financial constraints were common among the study participants. This added burden may have caused distress in people with diabetes. Diabetes distress is closely linked with poor disease control [21]. Other emotional and psychological stressors like isolation and restrictions on travel may add to the burden setting up a vicious cycle, contributing to deterioration in control [22].

The rates of laboratory testing for diabetes and comorbidities decreased drastically during the lockdown period (in 73.2%). A most recent study in England showed the frequency of HbA1c testing

in people with type 2 diabetes mellitus were markedly reduced in April 2020 (RR 0.77 95% CI 0.76 to 0.78) [23]. This reduction in laboratory testing could be a major issue for clinicians in primary care for proper management and care of the disease and complications.

COVID-19 lockdown greatly influenced the physical activity of individuals with diabetes and was associated with worsened glycemic control. Rowlands et al. [20] demonstrated during the lockdown period, the accelerometer-assessed physical activity was reduced by 800 steps/day with an increase in inactive time of 21.9 min/day in people with type 2 diabetes. At the time of writing, Sri Lanka is currently experiencing a rapid increase in COVID-19 cases and reports of more transmissible variant of COVID-19 (Delta/B.1.617.2) were reported from the country. With the high-risk areas under lockdown, it is predicted that people with underlying conditions are likely to self-isolate leading to decline in physical activity and health outcomes [20].

Moreover, the lockdown can also affect the dietary habits of patients. Although majority of participants indicated unchanged dietary habits, among those who reported a change in their dietary practices, poor adherence was commoner than an improvement (28.4% vs 13.2%). Increased food cravings due to restrictions, psy-

chological stress and limited access to food could have contributed to the above pattern.

Sleep has a significant impact on disease management since sleep deprivation could affect the patient's compliance to exercise, diet and medication [10]. Although majority of the participants (56.4%) stated no change in sleeping pattern, 21.0% of the participants reported decrease in night time sleep. While previous studies similarly reported unchanged sleeping habits among majority of the participants [10,20,24], it is noteworthy that 27.0% [10] and 23.6% [24] reported sleep deprivation during lock down in the respective studies done in South Asia.

Nevertheless, results of this study should be interpreted with caution due to several limitations. Firstly, the data on lifestyle and psychological wellbeing may be vulnerable to recall and reporting bias. However, the data collection took place in the immediate aftermath of the first wave of COVID-19 lockdown which has lasted for about 3 months. Therefore, we assume this risk is low. Secondly, the study was done in a private sector diabetes clinic and does not capture the more socio-economically deprived and less educated communities of the country. Furthermore, the study included patients who attended the clinic for follow up visits after the COVID-19 lockdown and therefore may have introduced a selection bias. Thirdly, the metabolic control was determined by HbA1c level alone, which may not reflect the glycaemic variability.

Despite these limitations, findings of this study highlight that maintaining good disease control and wellbeing is possible despite the widespread implementation of infection control measures and lockdown. Healthcare providers should identify the patients who are at increased risk of deteriorating control. Mechanisms should be developed to ensure delivery of medication to patients. Telehealth services appear to be well accepted among patients and should be adopted to provide health education as well as one to one consultations where necessary.

In conclusion, COVID-19 lockdown has imposed many challenges for people with diabetes and their healthcare providers. However, a significant proportion of people achieved a better glycaemic control. Well educated, employed males were more likely to achieve improved glucose control. It is predicted by better adherence to diet, in-door exercise, continued medication and better sleep at night. This is irrespective of the difficulties in attending routine clinics and having less glucose monitoring through laboratories or at home. Telehealth services were under-utilized but among those who used it, majority had a positive attitude and is likely to be useful at a wider scale.

Author contributions

PK conceived the research question. PK, HD, PS developed the research protocol. HD, PS and LDS developed the data collection tool. PS, NS and TS supervised the data collection and data entry. HD, LDS and CP conducted the statistical analysis. HD, CP and TS wrote the manuscript. PK critically reviewed the paper. All authors read and approved the final manuscript.

Ethics

Written informed consent was obtained by all participants. Ethics Review Committee of Faculty of Medicine, University of Colombo granted ethical clearance.

Data availability

Data set is available with the principle investigator (PK) and can be provided upon request

Conflicts of interests

The authors declare that they have no competing interests.

Funding

Acknowledgement

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