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EFFECT OF THE COVID-19 PANDEMIC ON INDIVIDUALS WITH DIABETES

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ABSTRACT

Diabetes and COVID-19 have a complex and reciprocal connection. Having diabetes mellitus is one of the most significant risk factors for developing COVID-19. This risk factor is believed to be influenced by several variables that are frequently present, such as hyperglycemia, hypercoagulable and proinflammatory conditions, age, and other co-existing diseases. Alternatively, the drastic COVID-19 infection and the steroids used to treat it can specifically be involved in the worsening of hyperglycemia by raising insulin resistance and cell secretory activity. In consequences, increased blood sugar level, may have a negative impact on how COVID-19 develops.This research is conducted at Ibn-e-Siena Hospital, Multan Medical and Dental College. The total of 100 diabetics participated in the study but only 82 participants were approved based on inclusion criteria. Out of which (53.7%) participants are male and (46.3%) participants are female. Simple random sampling technique is used in this study and study design used is cross-sectional. The results of this study showed that out of 82 participants, (8.5%) were underweight, (41.5%) were of normal weight, (30.5%) were overweight and (19.5%) were obese. (18.3%) suffered from retinopathy, (13.4%) with nephropathy, (6.1%) with neuropathy, (6.1%) with foot ulcer, (29.3%) with heart disease. About (48.8%) had increased fasting blood glucose level, (56.1%) had increased random blood glucose level, (18.3%) had HbA1c level of above (7%). During COVID-19, vegetables and fruits consumption decreased, while sugary food or sweetened beverages consumption increased as compared to before lockdown.

Key words: *COVID-19, COVID-19 worries, Diabetic complications, Diabetes mellitus, Dietary pattern, Fasting blood glucose levels, HbA1C level, Lockdown, Nutritional status*

INTRODUCTION

On 11 March 2020, World Health Organization (WHO) announced the outbreak of coronavirus disease (COVID-19) as a global pandemic (Cucinotta and Vanelli, 2020). The cause of this deadly disease was the newly identified enveloped RNA beta corona virus known as SARS-COV-2 (Severe-acute respiratory syndrome corona virus 2) (Chen *et al.*, 2020). COVID-19 is transmitted from an infected individual to another through droplets and direct contact, feces or through breathing (Lai *et al.*, 2019; Xu *et al.*, 2020). Common symptoms seen in most people were common cold, but some were affected with severe respiratory infections such as pneumonia and multiple organ failure

(Rothan and Byrareddy, 2020). First case of COVID-19 was seen in China in December,2019 in Hubei province and within no time it spread globally. About 502,416 cases were reported and 10,644 deaths has been occurred in Pakistan (Lakhdir *et al.*, 2021).

A survey of 1210 respondents was conducted in China during COVID-19 outbreak and psychological impact of the outbreak in half of them was moderate or severe; 17% presented with moderate to severe depressive symptoms; 29% presented with moderate to severe anxiety symptoms; and 8% were experiencing moderate to severe stress levels (Ho *et al.*, 2020; Wang *et al.*, 2020). According to many reported studies, symptoms of stress, anxiety and depression were more severe in people with chronic illness than people without any chronic disease (Wang *et al.*, 2020). Diabetes has known to have a remarkable and deteriorating influence on the quality of life under normal conditions as well. Diabetic distress and increased prevalence of a range of psychosocial problems, including depression, anxiety, eating disorders and general stress compared with the normal population was seen in 40% of the people suffering from diabetes (Fisher *et al.*, 2016; Young-Hyman *et al.*, 2016). Diabetic distress and psychosocial stress due to COVID-19 when joined together increases the worries of diabetic patients.

Due to lockdown in the world, level of physical activities has been decreased or there is no activity all which is very important for diabetic patients as it aids in managing their glucose levels. All the above-mentioned consequences must be considered, otherwise many problems occur as these may increase the risk of infection, hospitalization and even death in diabetic patients (Rogers *et al.*, 2020). People suffering from diabetes must be cared and treated properly to protect them from other complications and COVID-19. Due to lack of proper information about the relationship between diabetes and COVID-19, people do not take care of themselves properly as a result they may suffered from many problems.

The main purpose of this research is (1) to find relationship between COVID-19 and diabetes related complications and their effect on blood sugar concentration, (2) to collect data regarding COVID-19 related worries as well as psychological effects seen in diabetic patients, and (3) to collect data regarding changes in the dietary patterns of diabetic patients and their level of physical activity and increased screen time during pandemic and compare this data to their normal routine dietary pattern and physical activity level before the lockdown.

Research Objectives:

Our objective of this research was to assess change in the dietary patterns and to find out the diabetic complication of diabetic patients during COVID-19 pandemic.

Materials and Methods

This study was conducted on diabetic patients during COVID-19 pandemic. The focus of this study was to assess change that occurred in dietary patterns, medical care, physical activity, screen time, blood glucose levels and the level of anxiety and stress, type of worries, support from family and friends, and feeling of loneliness among diabetic patients during pandemic. Effects and severity of COVID-19 infection in diabetics and the risk factors linking diabetes with COVID-19 were also included in this study.

This research was conducted at Ibn-e-sina Hospital, Multan Medical and Dental College.This study has been completed at Ibn-e-sina Hospital, Multan Medical and Dental College in the duration of 1 year after the approval of synopsis. The total of 100 diabetics participated in the study but only 82 participants were approved based on inclusion criteria. Out of which 44 participants are male and 38 participants are female. Simple Random sampling technique was followed in this study. The design of this study is Cross-sectional.

Exclusion criteria:

Non-diabetic patients, COVID-19 patients, hospitalized patients, drug addicts, smokers, Not willing to participate and those providing information of which they were not sure of were excluded form the research (Joensen *et al.*, 2020)

Ethical consideration:

The methods of current study were approved by the department of food and nutrition, Multan Medical and Dental College. A written consent form was also obtained from the participants after explaining the whole procedure and methodology of this research. The participants were selected from the random population according to the inclusion criteria and those failed to meet the criteria were excluded.

Research Questionnaire:

The research was started after granting permission from faculty of Multan College of Food and Nutrition Sciences. Research questionnaire consists of patient's personal history (name, age, gender etc.), medical history, physical examination (anthropometric measurements etc.), biochemical testing (fasting and random blood glucose level, HbA1c level etc.), stress and anxiety during pandemic, screen timing and level of physical activity during pandemic, sleep patterns and dietary history of patient. Anthropometric measurements included weight before and during covid pandemic of diabetic patients, height, waist circumference, waist to hip ratio and BMI.

Biochemical testing included random blood glucose (RBS) level, fasting blood glucose level (FBS), HbA1c level before and during lockdown due to COVID-19 pandemic.

Food frequency included all the dietary habits of diabetic patients and before and during pandemic. It included all the information about daily, weekly, and monthly intake of all the food groups, such as fruits and vegetables, dairy products, cereals and legumes, meat and meat products, junk food, sugary food, and beverages. It also includes all the information regarding how change in the dietary patterns before and during pandemic increases the risk of diabetes as well increase its severity.

Data collection:

The research was approved by the ethical group of ibn-e-sina hospital, Multan. After approval, further research was continued. Questionnaire was filled by diabetic patients during COVID-19. According to our inclusion criteria, almost 82 patients out of 100 patients were included in our research. Their nutritional status was calculated by taking BMI of an individual. We use different and advanced nutritional parameters in this study. In this research, different questions were included like their personal information, anthropometric measurements, clinical examination, physical examination, dietary patterns, duration or type of physical activity and screen time, pattern of sleep and their worries about pandemic.

Anthropometric measurement include present weight, height and BMI which was measured using weight scale and height was measured using stadiometer. After measuring both weight and height, BMI of every individual was calculated, and nutritional status was assessed through comparing the obtained values with BMI chart and percentile graphs.

Biochemical data includes tests needed for evaluating blood glucose level before and during COVID-19 pandemic. Tests include RBS, FBS and HbA1c level were conducted of every member before and during pandemic. Blood sample was collected from every member before and during pandemic and tests were conducted under supervision to avoid any error in the assessment needed for research.

Complications associated with diabetes comprised of complications seen in diabetics such as retinopathy, nephropathy, neuropathy, foot ulcer and heart disease. It was to assess the severity of diabetes in an individual due to any complication and to assess the total number of complications were also recorded in a single member. Mortality and morbidity rate is high in individuals with more than one complication or even with a single complication. Stress and anxiety seen in diabetics was recorded for every member to assess how the period of lockdown has affected them. Sleep patterns were recorded which was mainly associated with stress and anxiety levels. Level of physical activity was recorded as well as screen time to assess how active they are and how conscious they are about management of their blood glucose level and weight management of obese members.

Dietary patterns of every member were recorded before and during pandemic. This was to assess change in the dietary pattern of every individual and to link it with change in blood glucose level. Food frequency questionnaire was designed, and each member was asked individually about their dietary intake from every food group.

Statistical analysis:

The data that was collected was put into the excel sheet and the findings of the following study was analysed through SPSS version 23.0. Frequency distribution of categorical variables was made and mean as well as standard deviation of quantitative data was also evaluated. Chi-square test was applied to test the relationship between nutritional status and eating pattern, between gender and nutritional status, between type of diabetes and nutritional status, between nutritional status and complications of diabetes, between nutritional status and glucose monitoring done before and during pandemic as well as between intake of vegetables and nutritional status, between

nutritional status and dairy consumption and finally the association between snacking and nutritional status of the participants. Alternatively, paired t-test was also conducted to investigate the correlation between quantitative variables including BMI and fasting blood glucose levels, between BMI and random blood glucose levels, and between BMI and HbA1C levels of the respondents. P- value <0.05 was considered to be significant.

Results and Discussions

Our study revealed that BMI was positively correlated to the fasting blood sugar levels, with a Mean±SD of 23.93±4.76, significance of <0.05 and a t-value of 45.529 amongst a degree of freedom of 81, indicating that our results were significant. A similar study conducted on white women in the University of Adelaide, Australia reported similar findings whereas they projected that BMI had a positive (r=0.206) and significant (*P*<0.05) correlation with fasting blood sugar. Another similar study in post pubertal Nigerian females reported similar values whereas a mean FBS of 83.65 mg/dl was positively and significantly correlated with BMI (r=0.15, P<0.05) (Akinola *et al.*, 2014). Contemporary literature has consistently supported our findings, and all suggest that a fasting blood glucose level is directly related to one's BMI.

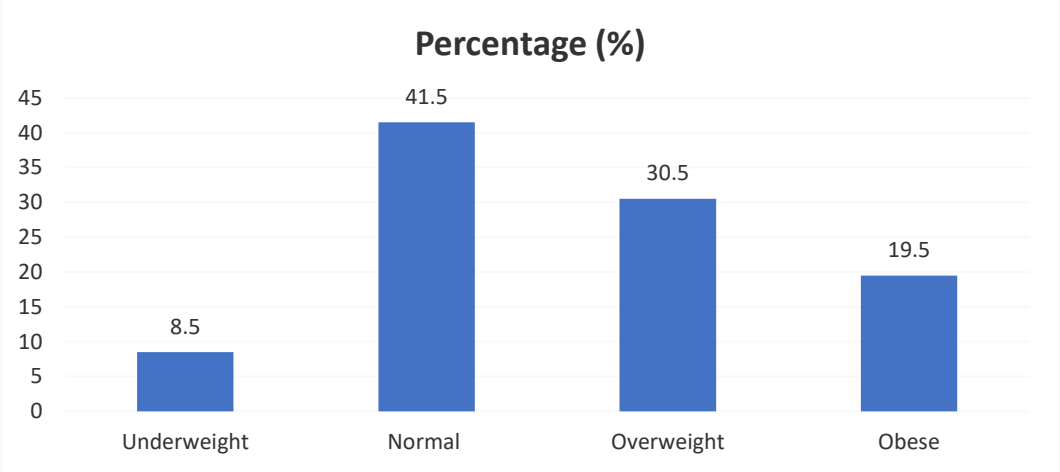

Figure 1: Nutritional status distribution of diabetic patients (n=82)

We also found that BMI was positively correlated to random blood sugar levels, with a Mean±SD of 24.01±4.72, significance of <0.05 and a t-value of 46.046 amongst a degree of freedom of 81, suggesting that our results are significant. Our study is corroborated with the findings of a Nigerian study on undergraduates where the results projected that BMI had a significant and positive correlation among both male (r=0.43, n=151 and p≤0.05) and female (r=0.53, n=102 and p≤0.05) subjects (Koga *et al.*, 2007). The results here show that female with a higher BMI is more at risk of an increased random blood sugar level than their male counterparts.

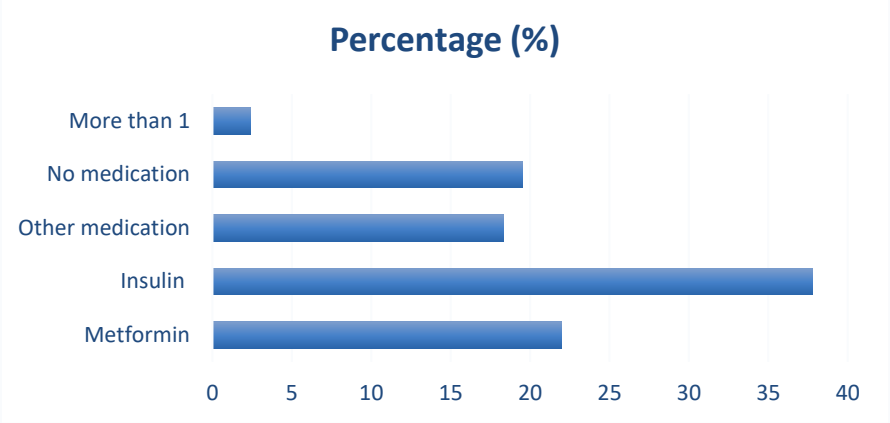

Figure 2: Type of medications status distribution of diabetic patients (n=82)

It was also noticed that BMI had a positive correlation with HbA1c levels, with a Mean±SD of 23.44±4.57, significance of <0.05 and a t-value of 46.505 amongst a degree of freedom of 81, again indicating that our correlation came out to be significant. Similar findings have been reported in contemporary literature whereas a study conducted at the Kinki Central Hospital, Itami, Hyogo, Japan found that a positive and significant correlation (r= 0.280, P<0.05) existed between BMI and HbA1c levels in Japanese patients that visited this clinic. Another study conducted at Pt. B. D. Sharma PGIMS, Rohtak also found that BMI had a significant and positive correlation with HbA1c level (r=0.439, P<0.05) among female patients suffering from PCOS as well as females with no history of PCOS or other ailments (Bala *et al.*, 2017). Thus, it can be safely concluded that BMI has a direct and significant correlation with HbA1c, regardless of the presence of other diseases that usually exist.

Table 1: Mean of blood glucose levels and BMI

Variables	Mean± SD	95% CI (Lower-upper)	t	Df	p-value
BMI- FBS level	23.93±4.76	22.89-24.98	45.53	81	0.00
BMI-RBS level	24.01±4.72	22.98-25.06	46.05	81	0.00
BMI-HbA1C level	23.44±4.57	22.44-24.45	46.51	81	0.00

In our study, we also investigated the effects of COVID on the eating patterns of underweight, normal weight, overweight and obese patients and any changes that were found reported and quantified. It was revealed in our results that out of the underweight population (who made up 8.53% of the population), 1 (14.28%) participant was eating more than usual, 3 (42.86%) had no change in eating habits and 3 (42.86%) were eating less than usual. In the normal weight population, 5 (14.71%) were eating more than usual, 20 (58.82%) had no change in their eating habits and 9 (26.47%) were eating less than usual. In the overweight population, 4 (16%) were eating more than usual, 17 (68%) had no change in their eating habits and 4 (16%) were eating less than usual. In the obese population, 5 (31.25%) were eating more than usual, 8 (50%) had no change in their eating habits and 3 (18.75%) were eating less than usual. Our results are substantiated by the findings of other contemporary papers. One study conducted online on the Italian population found that 52.9% of study participants reported that they were eating more during confinement than they had been before lockdown was implemented. Moreover, 19.5% of them reported that they had gained weight during lockdown (Scarmozzino and Visioli, 2020). Another similar Italian study found that in women, 40.2% reported under-eating, 27.3% reported no changes in dietary habits and 32.6% reported overeating after they had been exposed to long tern confinement. Men also showed similar changes in their dietary habits where 40.9% reported under-eating, 24.0% showed no changes

while 35.1% of the men showed increases in dietary habits (Prete *et al.*, 2021).

Another study conducted on Italian university students showed detailed results. The BMI of the participants was 22.2 ± 4 kg/m2; (81.9%) of the participants had normal weight, 14.2% were overweight while 3.8% were obese. 228 (43.8%) of these responders reported that they had gained weight. About 117 participants (22%) increased their body weight by 1–2 kg and 111 (21.5%) participants increased their body weight by 3–5 kg or more. Furthermore, females reported less weight gain than men, who in turn reported a significantly higher increases in their body weight (47% for women versus 57% for men; P = 0.041). The diet of those who gained weight changed in a more negative direction compared to those who reported no changes in the increase in body weight. Participants with a higher BMI gained more weight than those having normal BMI (77% vs. 44%, respectively; P < 0.001) (Mazza *et al.*, 2021).

Another study conducted on the Polish population showed that in the underweight population, 40.7% showed an increase in their eating habits, in the normal weight population, 30.6%, in the overweight population, 48.8% while in the obese population 55.3% of the responders reported an increase in their eating habits. In general, 43.5% of surveyed individuals reported eating more during quarantine, and 51.8% admitted to snacking between meals more frequently. Compared to the group not reporting modifications, increased food consumption and snacking was reported by individuals with higher BMI (mean ± SD, 22.9 ± 4.6 vs. 24.1 ± 5.1) (Sidor and Rzymski, 2020).

Table 2: Correlation between nutritional status and eating pattern

Eating pattern	Nutritional Status				P-value
	Underweight 7 (8.53%)	Normal weight 34 (41.46%)	Overweight 25 (30.49%)	Obese 16 (19.51%)	
					0.58
Eat more than usual	1 (14.28%)	5 (14.71%)	4 (16.0%)	5 (31.25%)	
No change	3 (42.86%)	20 (58.82%)	17 (68.0%)	8 (50.0%)	
Eat less than usual	3 (42.86%)	9 (26.47%)	4 (16.0%)	3 (18.75%)	

In comparison to those of normal weight, the prevalence of diabetes rose in male and female by 125% and 84%, respectively, in people who were obese and 59.4% and 68.7%, respectively, in people who were overweight (Zhang *et al.*, 2019). There is some growing research that suggests women may be more at risk for obesity than men (Park and S., 2017).

Based on the findings of the following study, almost 14.29% of underweight individuals suffered from type 1 diabetes and 87.71% suffered from type 2 diabetes. In the case of normal weight participants, 38.24% suffered from type 1 diabetes and 61.76% had type 2 diabetes. Weight is not a danger element for type 1 diabetics. The only hazard for type 1 diabetics is having a family history of diabetes and most of the people with type 1 diabetes have a normal BMI (18.5-24.9). It is mostly diagnosed in children, however, despite increasing cases of childhood obesity, research suggests that weight is not an important factor of this form of diabetes. Type 2 diabetes may occur due to obesity, and it was estimated that 87.5% of US adults suffer from type 2 diabetes who all are obese. However, obesity is not a single factor that can contribute to type 2 diabetes. It is also reported that about 12.5% of adults with type 2 diabetes are of normal weight consisting of normal BMI levels.

Various studies already confirmed that obesity is one of the major factors leading to many diseases (Valent *et al.*, 2016). Obesity is also associated with diabetes (Zeng *et al.*, 2016). However, conflicting interpretation of the affiliation between obesity and diabetic retinopathy has been detected in preceding epidemiological studies. A cross-sectional study was done on 501 adults with Type 1 diabetes, and it was observed that one of the main risk factors for retinopathy is obesity (BMI> 30 kg/m^2). However, when multinomial logistic regression analysis was done in cross-sectional clinic-based study, it was reported that there is an inverse relationship between BMI and diabetic retinopathy. It means raised BMI level acts as a protection layer against diabetic retinopathy. According to a current study, no participant with retinopathy was underweight; 17.65% participants were of normal weight; 12.0% were over-weight and 37.5% participants were obese. There is a close

association between obesity and diabetic neuropathy. Among the five elements of metabolic syndromes, weight problems are the major attributes for diabetic peripheral neuropathy in relation to diabetes (Oh *et al.*, 2019). Former studies confirmed that weight reduction reduced the prevalence of diabetic peripheral neuropathy (DPPRG, 2015; harvard.edu, 2017). Based on the findings of the previous study, relationship between BMI and diabetic peripheral neuropathy was revealed, according to which, people with less BMI had lesser chances of developing diabetic peripheral neuropathy (18.5%) and obese people had greater chances of developing it (66.7%) (Oh *et al.*, 2019). Current study revealed that 14.29% of people with diabetic nephropathy were underweight, 17.65% were of normal weight, 12.0% were over-weight and 6.25% were obese.

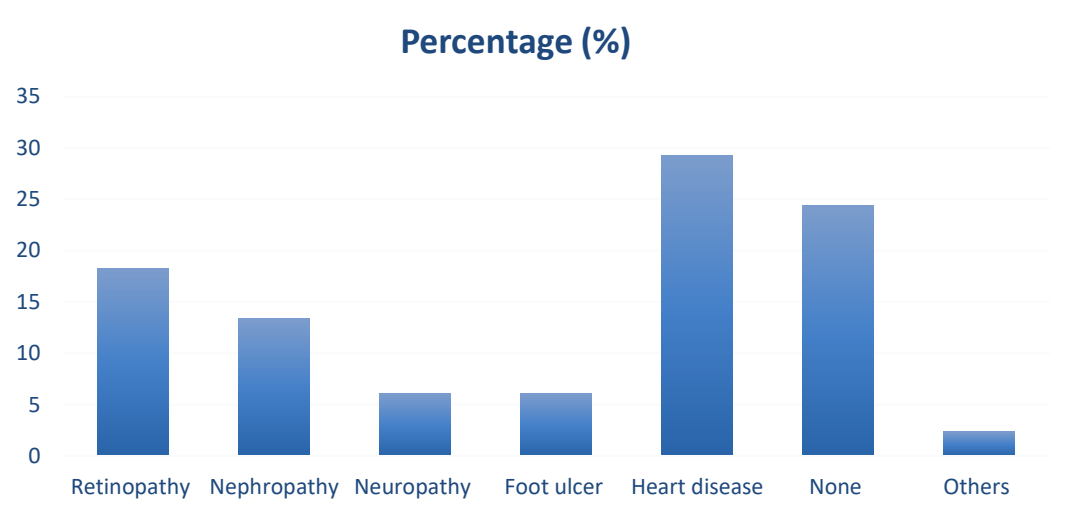

Figure 3: Diabetes complications status distribution of diabetic patients (n=82)

A study was conducted in India, according to which, there is a positive correlation between diabetic ulcer and increased BMI (Zubair *et al.*, 2019). It could possibly be because the higher the BMI, the larger is the probability of developing vascular diseases and hyperlipidemia, that, in return, decreases the flow of blood to lower parts of the body. Also, higher BMI leads to severe diabetes which in turn causes diabetic complications like foot ulcer. But our study results were somewhat different, that is because 14.29% of the respondents with diabetic foot ulcer were underweight, 11.76% were of normal weight and no participants having diabetic foot disease were overweight or underweight. It is noted that almost 75% individuals with coronary heart disease were overweight or obese. Decreased chances of coronary heart disease were observed in individuals with BMI of 27 kg/m^2. Increased chances were at lower and upper ends of BMI. Considering a previous study, 13.1% patients with heart disease had a BMI less than 20, 8.9% lie in the range of BMI between 20-25, 9.4% had BMI level of 25-30, 10.2% belonged to the category of 30-35 BMI level range and 11.3% had BMI levels above 35 (Held *et al.*, 2022). Our study revealed the same results as 57.14% individuals with heart disease were underweight, 23.53% were of normal weight, 36.0% were over-weight and 18.75% were obese. It is also observed that some participants do not have any complications although their BMI levels were not normal.

Table 3: Correlation between nutritional status, gender, diabetes type and complications

Variables	Nutritional Status				P-value
	Underweight 7 (8.53%)	Normal weight 34 (41.46%)	Overweight 25 (30.49%)	Obese 16 (19.51%)	
Gender					0.05
Male	7 (100.0%)	17 (50.0%)	14 (56.0%)	6 (37.5%)	
Female	0 (0.00%)	17 (50.0%)	11 (44.0%)	10 (62.5%)	

Type of diabetes					0.58
Type 1	1 (14.29%)	13 (38.24%)	6 (24.0%)	6 (37.5%)	
Type 2	6 (85.71%)	21 (61.76%)	18 (72.0%)	10 (62.5%)	
GD	0 (0.00%)	0 (0.00%)	1 (4.0%)	0 (0.00%)	
Diabetic complications					0.03
Retinopathy	0 (0.00%)	6 (17.65%)	3 (12.0%)	6 (37.5%)	
Nephropathy	1 (14.29%)	6 (17.65%)	3 (12.0%)	1 (6.25%)	
Neuropathy	1 (14.29%)	0 (0.00%)	2 (8.0%)	2 (12.5%)	
Foot ulcer	1 (14.29%)	4 (11.76%)	0 (0.00%)	0 (0.00%)	
Heart disease	4 (57.14%)	8 (23.53%)	9 (36.0%)	3 (18.75%)	
None	0 (0.00%)	10 (29.41%)	8 (32.0%)	2 (12.5%)	
Others	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (12.5%)	

Following study highlights the correlation between nutritional status and glucose monitoring, determine the effects of glucose monitoring on nutritional status of diabetic patients before and during pandemic. A study conducted on type 1 diabetics highlighted that the patients with high triglycerides levels before lockdown were unable to manage their blood glucose levels during COVID-19. On the other hand, some studies emphasised that the better glucose control was observed in type 1 diabetic patients during lockdown due to diminished work stress, more time available for self-management and glucose monitoring (Aragona *et al.*, 2020). In addition to this, insufficient sleep pattern is observed in type 1 diabetics and previous studies have confirmed that glycaemic control as well as self-management of blood glucose levels are negatively influenced by inadequate sleep (Frye *et al.*, 2019).

Another study also implied that the increased frequency of meals each day and caloric rich foods, fried items, pastries baked at home, and decreased levels of self-glucose monitoring as glucose monitoring devices were not available during the period of pandemic. All these factors lead to BMI levels enhancement and thus increased in seriousness of COVID-19 among diabetic patients (Błaszczyk *et al.*, 2020).

Table 4: Correlation between glucose monitoring and nutritional status

Glucose monitoring	**Nutritional Status**				**P-value**
	Underweight 7 (8.53%)	Normal weight 34 (41.46%)	Overweight 25 (30.49%)	Obese 16 (19.51%)	
Before COVID					0.68
Daily	1 (14.29%)	4 (8.82%)	7 (28.0%)	3 (18.75%)	
Weekly	2 (28.57%)	11 (32.35%)	4 (16.0%)	4 (25.0%)	
Monthly	3 (42.86%)	13 (38.24%)	9 (36.0%)	4 (25.0%)	
Sometimes	1 (14.29%)	3 (8.82%)	5 (20.0%)	4 (25.0%)	
Never	0 (0.00%)	3 (8.82%)	0 (0.00%)	1 (6.25%)	
During COVID					0.56
Daily	1 (14.29%)	7 (20.59%)	6 (24.0%)	1 (6.25%)	
Weekly	1 (14.29%)	7 (20.59%)	4 (16.0%)	5 (31.25%)	
Monthly	4 (57.14%)	15 (44.12%)	10 (40.0%)	4 (25.0%)	
Sometimes	1 (14.29%)	4 (8.82%)	5 (20.0%)	4 (25.0%)	
Never	0 (0.00%)	1 (2.94%)	0 (0.00%)	2 (12.5%)	

A study conducted on 469 type 2 diabetic patients at Dar es Salaam, to collect evidence regarding poor glycemic control in diabetics. Healthy meal plan was not followed by 120 (31.2%) of the participants. About 53% of the respondents stated that health care professionals advised them to

consume 5 or more servings of fruits and vegetables. On the other hand, 18.6% of the respondents reported to have not received any guidance. Moreover, three servings of fruits and vegetables were consumed daily by 63.3% of the participants of the study and 90 (19.2%) diabetics consumed five or more servings each day. Additionally, 17.1% diabetics were consuming foods rich in fat like red meat and whole dairy products without removing fat. In this study, no significance was observed between healthy eating pattern and glycemic control (Kamuhabwa and Charles, 2014).

Present study indicates the daily and weekly consumption of vegetables were increased in those participants with a normal BMI level during lockdown as compared to before lockdown whereas others had the same consumption pattern as before. Daily consumption of dairy was increased in underweight as well as in overweight individuals during lockdown as compared to before lockdown, but the weekly consumption levels remained the same. No significant change was observed in the snacking levels during and before lockdown.

Similar study was conducted in on type 2 diabetic adults in Spain in which dietary patter on the patients was correlated with their BMI levels. Based on the findings of this study, nuts (p-value= 0.003) as well as meat, eggs, and fish (p-value = 0.002) consumption were significantly influenced by BMI due to the COVID-19 pandemic. BMI and weekly fruits intake were inversely correlated. Participants with a BMI of 30-35 kg/m^2 showed decreased sugary food consumption as compared to the participants with a BMI of 35-40 kg/m^2 who had a higher intake of sugary food (p-value= 0.001). Those with a lower BMI showed adherence to the proper recommended weekly snack and sugary food intake pattern. Increase in the level of food cravings led to increase in the consumption of vegetables, dairy as well as snacking during the pandemic. Home confinement was the major factor that led to increase in food cravings and ultimately to increased snack and dairy consumption, but no association was found between food cravings and sugary food intake. According to the findings of a meta-analysis study consisting of a sample of 3292 respondents stated increased food cravings were observed in the patients having increased weight and a higher BMI (Ruiz-Roso *et al.*, 2020).

According to another study, having snacks in the form of vegetables was significantly correlated with lower BMI (P-value=0.044) and snacks in the form of sweets and desserts were significantly linked with higher BMI levels (*p-value* =0.017). Snacking in the form of fruits and fruits juice (p-value=0.001) and nuts consumption (p-value =0.008) were significantly correlated with the quality of diet in a positive manner (Barnes *et al.*, 2015).

Table 5: Correlation between food groups and nutritional status

Food groups	**Nutritional Status**				**P-value**
	Underweight 07(8.53%)	Normal weight 34(41.46%)	Overweight 25(30.49%)	Obese 16(19.51%)	
Vegetables consumption before COVID					0.03
Daily	0(0.00%)	13(38.24%)	10(40.0%)	05(31.25%)	
Weekly	05(71.4%)	19(55.88%)	15(60.0%)	11(68.75%)	
Monthly	01(14.28%)	02(5.88%)	0(0.00%)	0(0.00%)	
Sometimes	01(14.28%)	0(0.00%)	0(0.00%)	0(0.00%)	
Vegetable consumption during COVID					0.07
Daily	01(14.28%)	15(44.12%)	10(40.0%)	5(31.25%)	
Weekly	05(71.4%)	17(50.0%)	15(60.0%)	11(68.75%)	
Monthly	0(0.00%)	02(5.88%)	0(0.00%)	0(0.00%)	
Sometimes	01(14.28%)	0(0.00%)	0(0.00%)	0(0.00%)	
Dairy consumption before COVID					0.02
Daily	03(42.86%)	22 (64.71%)	22 (88.0%)	11 (68.75%)	
Weekly	01(14.28%)	7 (20.59%)	3 (12.0%)	4 (25.0%)	
Monthly	02(28.57%)	1 (2.94%)	0 (0.00%)	0 (0.00%)	
Sometimes	01(14.28%)	4 (11.76%)	0 (0.00%)	1 (6.25%)	

Dairy consumption during COVID					0.29
Daily	2 (28.57%)	22 (64.71%)	20 (80.0%)	12 (75.0%)	
Weekly	4 (57.14%)	7 (20.59%)	4 (16.0%)	3 (18.75%)	
Monthly	0 (0.00%)	1 (2.94%)	1 (4.0%)	0 (0.00%)	
Sometimes	1 (14.29%)	4 (11.76%)	0 (0.00%)	1 (6.25%)	
Snacks consumption before COVID					0.09
Daily	1 (14.28)	8 (23.53%)	7 (28.0%)	5 (31.25%)	
Weekly	2 (28.57%)	14 (41.18%)	8 (32.0%)	4 (25.0%)	
Monthly	4 (57.14%)	5 (14.71%)	2 (8.0%)	1 (6.25%)	
Sometimes	0 (0.00%)	7 (20.59%)	8 (32.0%)	6 (37.5%)	
Snacks consumption during COVID					0.31
Daily	1 (14.29%)	9 (26.47%)	7 (28.0%)	5 (31.25%)	
Weekly	3 (42.89%)	14 (41.18%)	7 (28.0%)	4 (25.0%)	
Monthly	3 (42.89%)	4 (11.76%)	3 (12.0%)	1 (6.25%)	
Sometimes	0 (0.00%)	7 (20.59%)	8 (32.0%)	6 (37.5%)	

Conclusions

Type 2 diabetes is rapidly approaching the status of a possible epidemic in Pakistan, with over 14 million expected diabetics by 2030. Many factors influence the prevalence of T2D across the country and identifying them is essential to manage those factors. T2D is instigated by amalgamation of hereditary and environmental factors, such as obesity linked to rising living standards, persistent consumption of high glycemic foods, and changes in lifestyle, poor dietary habits with little or no physical activity.

COVID-19 is a pandemic which appeared in the form of pneumonia with unknown cause in China and later declared as novel corona virus. It spread globally within limited time. It is a respiratory disease that is communicable and one of the risk factors of diabetes. This study explains the link between corona virus and diabetes as high blood sugar level and compromised immune system of diabetics make them vulnerable to infections. Rising cases of COVID-19 has appeared to be a threat for diabetics and lockdown imposed by WHO worldwide made it difficult for them to manage their FBS. According to this conducted research, out of 82 diabetic patients 48.8% had increased fasting blood glucose levels, 35.4% had no change in their fasting blood glucose level and 15.9% had decreased level. In case of RBS, 56.1% had increased random blood glucose level, 34.1% had no change in their random blood sugar level and 9.8% had decreased level. When HbA1C levels were observed, 34.1% participants had 6.5% HbA1C level, 23.2% had more than 6.5%, and about 18.3% had HbA1C level above 7%. Severity of complications associated with diabetes has increased and those with no complications has started developing them. Regarding diabetes related complications, 46.3% had hypertension, 14.6% had heart disease, 13.4% had other complications, 8.5% had more than 1 complication and 4.9% had mental illness. This is due to poor dietary habits and lack of physical activity during lockdown.

Glucose monitoring was affected during corona crisis due to lack of resources, lack of diabetic medical care and equipment used. Access to medication, diabetic medical care, counselling, and live session with health care workers became limited which added to the worries of diabetics and their stress level increased. When COVID-19 related worries were observed in diabetic patients, 29.3% were worried about not being able to manage blood glucose level, 29.3% were worried about not being able to manage diabetes if infected, 20.7% were worried about lack of diabetic medical care, 9.8% were worried about lack of medications and equipment, 7.3% were worried about lack of food, and 3.7% had no worries. Some of the participants showed a positive response regarding the support received from family and friends whereas other complained about the loneliness they felt often. Regarding sleeping patterns, most of the participants had normal sleep as they were free from the stress faced by them at their workplaces whereas some had insomnia and others had shorter duration of sleep. Overall physical activity level was decreased during lockdown and some of the participants reported no activity at all. Increased screen time is another factor in addition

to low physical activity level adding to the severity of diabetes during lockdown.

This study also focuses on the dietary patterns of diabetics before and during pandemic. According to the research conducted, almost 23.2% members eat less than normal during COVID-19, 18.3% people eat more than normal and 58.5% people had no change in their dietary patterns. Considering consumption of vegetables, it was increased during COVID-19 as compared to prior to lockdown, 58.5% members consumed vegetables weekly during pandemic, 37.8% consumed daily, 2.4% consumed monthly. Fruits consumption during COVID-19 was also changed as before pandemic almost 48.8% participants consumed fruits daily, 42.7% consumed weekly, 4.9% consumed monthly and 3.7% consumed fruits sometimes or never. During COVID-19, daily consumption of fruits observed is 58.5%, weekly consumption is 30.5%, monthly consumption is 9.8% and 1.2% people consumed fruits sometimes. There was no significant change seen in the consumption of cereals, meat/fish/egg during pandemic as compared to before lockdown. Intake of dairy products was also changed during COVID-19 as before pandemic, 70.7% participants consumed dairy products daily, 18.3% consumed weekly, and 3.7% consumed monthly and during pandemic, 68.3% participants consumed dairy products daily, 22% consumed it weekly and remaining 2.4% people consumed it monthly. Snack consumption as well as intake of sugary food, sugar-sweetened beverages also increased during pandemic as late-night snacking became common during lockdown and stress eating was observed in some of the participants which led to weight gain in some individuals. There was no significant change observed in the consumption of junk food during pandemic.

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