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HEALTH MONITORING OF TYPE 2 DIABETIC PATIENTS CURED OF COVID-19 INFECTION IN DJIBOUTI AND MOROCCO: BIOMEDICAL ANALYSIS AND DIAGNOSTIC

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Abstract

The work presented in this report is a study carried out on a group of 49 African diabetic type 2 recovered from an infection affected by the COVID-19 virus according to a survey based on the statistical snowball sampling method. The study includes general characteristics and some general information on the condition of diabetic patients, in addition, some data after the contamination with COVID-19, such as: drugs, dietary supplements and biomedical blood tests, as well, the syndromes detected. The main results of this study showed that diabetic participants who recovered from COVID-19 infection have a decrease in glycohemoglobin, but they suffered after this period of hypertension, decreased immunity and anemia, which can give other syndromes such as: stress, fatigue, diarrhea, psychological problems, memory lapses, headache, myalgias, arthralgias and infections. This collected information may offer several solutions to manage the state of health of patients with type 2 diabetes in the form of specific medical treatments during and after infection with COVID-19.

Keywords: *Diabetic type 2, COVID-19, health monitoring, blood tests, syndromes.*

Introduction

The SARS-CoV-2 coronavirus (COVID-19) causing severe acute respiratory syndrome, responsible for the current global pandemic, is the subject of many questions, both for patients and for caregivers **[1-3]**. Due to the rapid spread of the virus and the forms of the mutations, little epidemiological data is currently available. In the previous two years COVID-19 had affected millions of people around the world, mainly in Africa **[4]**.

Djibouti is a small country situated in the horn of African, was not spared by the propagation of the COVID-19 pandemic. Since March 2020 and after the first cases were detected, the government of Djibouti pursued effective and strict policies starting by the preventive measures, thus it's proposed adequate solutions to limit the evolution of contamination on a national and international scale **[5-7]**. In addition, a remarkable reinforcement was made by the equipment and the human resources, particularly the support of scientific and technical research to find proposals with added value in this field.

On the other hand, some international scientific work has suggested that diabetes is one of the most common co-morbidities in affected patients by COVID-19, hence it has been described as a significant risk factor for adverse course **[8]**. Diabetic patients have a very weak immune system and they are prone to microbial infections have long lasting unwanted side effects which can lead to serious illnesses. Good blood sugar control is linked to the body's ability to manage immune and inflammatory defence and to fight infections in patients with diabetes **[9-11]**.

In this present report, we would describe a health monitoring study (blood analysis, pharmacotherapy, food supplements, syndromes, etc.) carried out on 49 diabetic patients who were cured after a COVID-19 infection.

Methods

Data source

All the COVID-19 data used in this study were collected through a collaboration between academics in two African countries (Djibouti and Morocco) in the period from March 2021 to September 2021. The report was prepared by Medicinal Research Institute of Djibouti in collaboration with EST-Khenifra of Morocco.

Methodology

Study size

We selected 49 patients from two African countries (Djibouti and Morocco) using the snowball sampling method **[12]**. The selection criteria are:

- Patients have had type 2 diabetes for more than 5 years.
- The patients were infected with COVID-19.

Indeed, one important condition was exaggerated, that all patients had blood tests before and after the infection such as: blood type, fasting blood sugar (FBS), hba1c, systolic blood pressure (SBP), diastolic blood pressure, total-cholesterol, ldl-cholesterol, hdl-cholesterol, triglycerides, serum creatinine , urea, uric acid, red blood cell count (RBC), hemoglobin (HgB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), white blood cell (WBC) platelet count, ferritin and vitamin D.

Quantitative variables

The data extraction model was designed using Microsoft Excel 2016 to capture the following details:

a) Age at diagnosis of diabetes, gender, marital status, duration of diabetes, physical activity, dietary plan, current smoking, alcohol use, duration of infection with COVID-19, COVID-19 infection type and body mass index (BMI).

b) Covid-19 pharmacotherapy protocol used.

c) Medication details of patients with type 2 diabetes.

d) Dietary supplements used for patients with type 2 diabetes.

e) Syndromes appearing in diabetics after infection with COVID-19.

Statistical analysis

Student's t-test is a statistical test for comparing the means of two groups of samples **[13]**. It is

therefore a question of whether the means of the two groups are statistically significantly different. A P <0.05 was considered statistically significant at the 95% confidence interval. The XLSTAT software package is used to perform the statistical analysis.

Ethical approval

This study was conducted using data from anonymous voluntary patients complying with standards in force according to the instructions of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). Therefore, no ethical approval was needed.

Results & Discussion

49 diabetic patients type 2 including 42 men recovered from COVID-19 were included in our study of Djibouti and Morocco (Table 1). The median age of the patients was 41 years (IQR: 30 - 55) and most are of married status (89%). 73% of the diabetic patients follow a dietary on a well-adapted plan and all has a moderate physical activity (93.87%) with a very low consumption of tobacco and alcohol. The latter two factors may alter the risk of diabetes through long-term effects on insulin secretion and insulin resistance in type 2 diabetics **[14-15]**. All type 2 diabetic participants were infected with the COVID-19 virus in the period from March 2020 to August 2021 with a moderate type (71.43%), whose average illness duration is 25.4 days. During this period, the BMI experienced a small decrease which implies the decrease of the risk of occurrence of certain diseases, in particular: cardiovascular diseases and pulmonary diseases **[16]**.

The clinicians ordered 90% of the patients in this study to follow the international treatment protocol (Table 2), also, which is applied in most African countries and which consists of the prescription of hydroxychloroquine and Azithromycin to infected patients with moderate and / or severe symptoms, in addition to the use of dietary supplements such as: vitamin C, vitamin D and zinc **[17-18]**.

About 80% of the patients in our study used oral metformin diabetes therapy at a dose of 850 mg per day during a year before infection, although half were dissatisfied with the use of this drug due to poor blood sugar control (Table 1). The role of this drug is to decrease the insulin resistance of the organism intolerant to carbohydrates and to decrease hepatic gluconeogenesis, that is to say exerts its antihyperglycemic action mainly by reducing the production of glucose by the liver, without stimulating insulin secretion. It does not cause hypoglycemia or weight gain **[19-21]**. Generally, Metformin has a mechanism of action on molecular level that activates AMP-activated protein kinase (AMPK) in hepatocytes by causing its phosphorylation **[22]**. This is the main mechanism by which metformin brings about favorable effects on glucose and lipid metabolism. Several scientific works show that metformin has benefits in reducing the death rate from COVID-19 infections **[23-24]**. On the other side, other studies have highlighted a potential safety signal for metformin, the use of which was associated with a higher risk of severe COVID-19, thus, they propose that the withdrawal of metformin in patients with COVID -19 be considered to prevent disease progression **[25-26]**.

In addition, the patients used with moderate monthly amounts of food supplements in the form of vitamins and minerals in particular: vitamins C, D, E, B1, B2, B6, B9, B12, β-carotene, zinc, magnesium, calcium, iron, selenium (Table 3). Several studies have shown that nutritional supplements may be beneficial for the prevention and treatment of effects symptoms of type 2 diabetics, especially zinc and magnesium, also, consumption of metformin requires type B vitamins, especially vitamin B12 **[27-29]**.

The blood analysis tests were requested from patients before and after the contamination to know the evolution of their state of health, generally biochemical, hematological and immunochemical analyzes (Table 4). All the results mention in the report carried out a difference in the values of the analyzes between the two periods, particularly: HbA1c, Systolic blood pressure (SBP), Diastolic blood pressure (DBP), White Blood Cell (WBC), Platelet count, Ferritin and Vitamin D which show a significant difference. There are two reasons for the decrease in HbA1c in diabetic patients during infection, either to the diet applied during this period or to loss of appetite. An increase in both SBP and SBP parameters that exceed the internationally recommended threshold which means having hypertension, the latter is difficult to

diagnose given the similar symptoms seen in patients infected with COVID-19 **[30]**.

The significant decrease in the number of white blood cells occurs first, this decrease leads to an increased risk of infection because the body's defenses are reduced **[31]**. The second factor in the platelet count which has also experienced a significant decrease, this variation increases the risk of bruising and bleeding **[32]**. The decrease in these last two parameters can anticipate the decrease in red blood cells as a result can lead to the problems of anemia, the explanations of which have been justified by the decrease in the two immunochemical analyzes: ferritin and vitamin D **[33-35]**. Anemia has a significant impact on the quality of life of patients, it is therefore essential to diagnose and correct it, particularly in diabetics who have been infected with COVID-19. Indeed, it can be responsible for a decrease in physical and cognitive performance, fatigue, headaches, dizziness, thus, it would prevent infectious diseases **[36]**. Since the start of the COVID-19 epidemic, vitamin D has been at the heart of the questions. Some studies assure that vitamin D would indeed have a protective effect against severe forms of COVID-19 but the data remains insufficient to state this with certainty **[37-38]**. Vitamin D cannot be considered a preventive or curative treatment for infection with SARS-CoV-2, but by mitigating the inflammatory storm and its consequences, it could be considered an adjunct to any form of therapy **[39]**.

The consequences in type 2 diabetic patients after recovery from COVID-19 infection can be indicated in figure 1. The main syndromes listed are stress and fatigue with a percentage of 97.96%, also, diarrhea (95.92 %), psychological problems (91.84%), memory lapses (85.71%), headache (85.71%), myalgias and arthralgias (77.55%) and infections (73.47%). Other syndromes were declared in one or two patients which represent very low percentages such as: hair loss, taste and smell problems, sleep disorders, ...

Conclusion

This report provides new information regarding type 2 diabetics infected with the COVID-19 virus in two regions of Africa. The results found show that patients on metformin for glycemic therapy (approximately 80%) were cured after a period of 25 days. The blood tests confirm a significant decrease in glycated hemoglobin resulting from the obstruction of appetite, on the other hand, all the cases studied had undesirable complications such as: blood pressure and appearance of anemia following immunochemical blood tests which have been proven by the decrease in ferritin and vitamin D. Also, some syndromes have been recorded in patients, among them stress, fatigue, diarrhea, psychological problems, memory lapses (85.71%), headache (85.71%), myalgias and arthralgias (77.55%) and infections. Finally, these data give specialists a new vision on the phytotherapeutic protocol to be followed during the period of COVID-19, particularly type 2 diabetics.

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Table 1. Characteristics of diabetic patients included in this report.

Variables	Mean ± SD (Number %)
Age at diagnosis of diabetes (years)	41.3 ± 14.2
Gender (male)	42 (85.71%)
Marital status	Married 44 (89%) Single/widowed/divorced 5 (11%)
Duration of diabetes (years)	7.84 ± 4.21
Medication	Metformin 850mg 39 (79.59%) Other 10 (20.41%)
Satisfactory glycemic control	27 (55.1%)
Physical activity	Moderate 46 (93.87%)
Dietary plan	On a plan 36 (73.47%) Not on a plan 13 (26.53%)
Current smoking (yes)	6 (12.24%)
Alcohol use (yes)	1 (2.04%)
Duration of infection with COVID	25.4 ± 5.8 days
COVID-19 infection type	Asymptomatic 5 (10.20%) Moderate 35 (71.43%) Severe 7 (14.29%) Critic 2 (4.08%)
Body mass index (BMI)	30.25 ± 5.54 Kg/m^2 (*) 29.77 ± 4.91 Kg/m^2 (**)

(*) Before infection COVID-19.
(**) After infection COVID-19.

Table 2. Covid-19 pharmacotherapy protocol used (*).

Active pharmaceutical ingredient	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15
Hydroxychloroquine 200 mg × 2															
Azithromycin 500 mg															
Azithromycin 250 mg															
Vitamin C 1000 mg × 2															
Vitamin D 100 000 UI															
Zinc 45 mg															

(*) The protocol was used for 44 out of 49 patients from two African countries.

Table 3. Monthly doses of dietary supplements used for patients with type 2 diabetes.

Vitamins/Minerals	Number of patients (percentage %)	Monthly quantity (Mean ± SD)
Vitamin C (Ascorbic Acid)	38 (77.55)	8600 mg
Vitamin D (calciferol)	35 (71.43)	100 000 UI
Vitamin E	15 (30.61)	40 mg
Vitamin B1 (Thiamine)	17 (34.69)	2150 mg
Vitamin B2 (Riboflavin)	21 (42.86)	13.76 mg
Vitamin B6 (Pyridoxine)	21 (42.86)	267.2 mg
Vitamin B9 (Folic Acid)	33 (67.35)	1.591 mg
Vitamin B12 (Cobalamin)	36 (73.74)	15.48 mg
β-carotene	14 (28.57)	20.64 mg
Zinc	20 (40.82)	193.5 mg
Magnesium	32 (65.31)	2580 mg
Calcium	33 (67.35)	8600 mg
Iron	33 (67.35)	172 mg
Selenium	16 (32.65)	50 µg

(*) The patients had used the dietary supplements at least a year before infection.

Table 4. Blood tests of diabetic patients before and after infection by COVID-19.

Tests	Normal range	Before infection *	After infection **	P-value
Blood type	A+ 38 (77.55%) O+ 4 (8.16%) Others (14.29%)			
Biochemical blood tests				
Fasting Blood Sugar FBS (mg/dl)	70 - 110	181 ± 20	174 ± 18	0.068
HbA1c (%)	4.7– 8.5	8.51 ± 0.26	7.97 ± 0.19	<0.001
Systolic blood pressure SBP (mmHg)	<120	122.2 ± 13.7	141.8 ± 13.7	<0.001
Diastolic blood pressure DBP (mmHg)	<80	70.4 ± 7.5	85.1 ± 9.2	<0.001
Total-cholesterol (mg/dl)	150–199	188 ± 25	179 ± 28	0.093
LDL-cholesterol (mmol/l)	≤ 130	113 ± 11	112 ± 14	0.697
HDL-cholesterol (mmol/l)	≥ 40	48 ± 10	42 ± 10	0.003
Triglycerides (mmol/l)	< 250 mg/dL	126 ± 14	120 ± 22	0.107
Serum creatinine (mg/dl)	0.7 - 1.3	0.9 ± 0.1	0.9 ± 0.1	1
Urea (mg/dl)	18 - 55	27 ± 4	26 ± 4	0.215
Uric acid (mg/dl)	2.5–8	4.2 ± 0.2	4.3 ± 0.3	0.052
Hematological blood tests				
Red Blood Cell Count (RBC) (x 10^{12} cells/L)	4.2–5.9	5.24 ± 1.02	5.00 ± 1.33	0.317
Hemoglobin (HgB) (g/dl)	13 - 17	16.3 ± 4.1	15.2 ± 2.3	0.101
Hematocrit (HCT) (%)	38 - 50	43.7 ± 8.1	42.1 ± 7.9	0.322
Mean Corpuscular Volume (MCV) (μ^3)	80–100	90.4 ± 14.1	88.3± 11.5	0.418
Mean corpuscular hemoglobin concentration (MCHC) (%)	32–36	34.8 ± 5.1	33.2 ± 4.3	0.093
White Blood Cell (WBC) (x 109 cells/L)	4.5–11	6.8 ± 0.5	6.5 ± 0.4	<0.001
Platelet count (103/µl)	150–350	281 ± 25	259 ± 22	<0.001
Immunochemistry blood tests				
Ferritin (ng/ml)	30 - 250	110.78 ± 31.21	69.52 ± 19.82	<0.001
Vitamin D (25-OH) (ng/ml)	15–80	45.1	22.8	<0.001

(*) The data of the blood tests were collected as the last results obtained by the patients in the year 2019.
(**) Blood tests performed reported by patients after at least 1 month after recovery from the disease.

Figure 1. Main syndromes appearing in diabetics after infection with COVID-19.