

The Effect of War on the Control of Diabetes in Patients with Type 2 Diabetes Mellitus in Yemen: A Cross-Sectional Study

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Abstract

Background: The War in Yemen, which started in March 2015, has had many effects on patients with type 2 diabetes mellitus (DM). We conducted this study to analyze the effect of war on type 2 diabetics at our clinic.

Patients and methods: We studied 430 patients attending an endocrinology clinic in Sana'a, Yemen from September 2015 to January 2016. Of the total, 229 were female and 201 were male. Additionally, 111 patients had been coming to our clinic before the war, and 319 were new patients.

The glycated hemoglobin (HbA1c), blood sugar, body mass index (BMI) and blood pressure of the patients were measured. The patients who came during the war answered a questionnaire regarding their diabetes and the war. The data were presented as the mean with the standard deviation (SD) and 95% confidence interval (95% CI) of the mean. Frequencies and percentages were used to describe qualitative data. The mean, SD, and 95% CI were used to describe quantitative data.

Results: The mean HbA1c before the war was 7.7 (61 mmol/mol) (SD 1.9), whereas the mean HbA1c during the war was 9.4 (80 mmol/mol) (SD 2.4) (p value: <0.001). The mean BMI before the war was 28.1 (SD 4.7) and during the war was 27.6 (SD 4.8) (p-value: 0.015). The results showed that 22% of the patients were displaced, 16.4% had relatives at their home, 8.9% had damage to their homes and 10% had lost a relative. In total, 8.4% of the patients had discontinued some or all of their diabetes medications during the war.

Conclusion: Patients with type 2 DM in Yemen attending our clinic during the war had a higher HbA1c and a lower BMI compared to before the war. Many patients were displaced, had their homes damaged or lost a relative during the war.

Keywords: Type 2 diabetes mellitus; War; Airstrikes; Body mass index; Displacement; Glycated hemoglobin; Yemen

Introduction

The war in Yemen, which started on March 25th, 2015 and has lasted until now, has had many socioeconomic effects on the people, including patients with type 2 DM. On March 25th, 2015, an international coalition led by Saudi Arabia launched air strikes against the Huthi armed group in Yemen, sparking a full-blown armed conflict [1].

Over the following year, the conflict has spread and has engulfed the entire country. Horrific human rights abuses and war crimes are being committed throughout the country.

In addition to the relentless bombardment by coalition forces from the air, there is a battle being fought on the ground. On one side are the Huthis, who are allied with the supporters of Yemen's former president, Ali Abdullah Saleh. On the other side are anti-Huthi forces, which are allied with the current president, Abd Rabbu Mansour Hadi, and the Saudi Arabian-led coalition. Civilians are trapped in the middle-thousands of them have been killed and injured leading to a humanitarian crisis [2].

Between March 2015 and August 23rd, 2016, approximately 3,799 civilians have been killed and 6,711 injured as result of the war. At least 7.6 million people, including three million women and children, are suffering from malnutrition, and at least three million people have been forced to flee their homes [1]. Many examples of violations of international humanitarian law and international human rights law have occurred, including attacks on residential areas, medical and educational facilities, and public and private infrastructures; the use of landmines and cluster bombs, sniper attacks against civilians, deprivation of liberty, and targeted killings; and the recruitment and use of children in hostilities, and forced evictions and displacement [1].

Treatment of non-communicable diseases (NCDs) can be difficult during humanitarian crises, where insecurity and damaged health systems reduce access to treatment for patients [1]. There is a lack of informative NCD-related epidemiology in emergency settings [3]. Research and guidelines mainly focus on communicable diseases, such as measles and diarrheal disease [4]. NCD care is complex, and comorbidity is common in humanitarian settings [3]. We noticed that after the war started, the glycemic control in many of the patients attending our clinic worsened. The lack of electricity caused some of them to stop using insulin, and many wanted to stop using insulin because of the difficulties they had keeping the insulin vials cold in the absence of electricity. Therefore, some patients kept the insulin in a bottle of cold water or next to a bottle of cold water, while others wrapped the insulin vial in a wet towel or cloth (Figures 1 and 2). Although insulin can be kept at temperatures <30°C for over a month after opening the vial, most of our patients were unaware of this and believed that if the insulin was not kept in a refrigerator that it could not be used, causing many to stress over taking a medication that was not working; some patients believed it could actually cause them harm. Additionally, the blocking of commercial ships and airlines to Yemen

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Figure 1: Examples of some of the different ways to keep insulin vials cool, such as putting it next to a bottle of cold water or wrapping it in a wet cloth.



Figure 2: Some patients kept their insulin cool by keeping the vials in a bottle of cold water, or if cold water was not available, they kept their insulin vial in any bottle of water, not necessarily a bottle of cold water.

caused a shortage in many of the medications and supplies needed for diabetic patients. Many patients lost their jobs and health insurance, which added to the stress from the continuous airstrikes on the city of Sana'a.

Many patients were displaced because of the war, had damage to their homes and lost relatives who died either in the battles going on in different areas of the country or as a result of the airstrikes [3].

Wars in other countries have been shown to be associated with worsening of glycemic control with an increase in HbA1c [5,6] other studies have not shown any significant change in glycemic control due to war [7,8].

We conducted this study to analyze the effect of war on patients with type 2 diabetes in Yemen.

Patients and Methods

A cross-sectional study was conducted on a total of 430 patients with type 2 DM attending a private, specialized endocrinology clinic in Sana'a, Yemen from August 2015 to January 2016. Of the total, (229 were female). Additionally, 111 patients had been coming to our clinic from before the war, and 319 were new patients.

The patients paid for a visit unless they were covered by an insurance company, which was only a small number of the patients attending the clinic. All patients gave their written, informed consent, and confidentiality was assured for the patients.

HbA1c was measured during the patient's visit along with random blood sugar and body mass index (BMI) measurements. The HbA1c

was measured using a Bio-Rad D-10 Hemoglobin A1c analyzer (Bio-Rad Laboratories., CA, USA). BMI was measured in kg/m^2 (the height of each patient was taken at the first visit for all patients attending the clinic and the weight of each patient was also measured for all patients attending the clinic at each visit). Type 2 DM was diagnosed according to the American Diabetes Association/European Association for the Study of Diabetes 2012 criteria for diagnosing diabetes, which are an HbA1c $\geq 6.5\%$ (48 mmol/mol) or fasting plasma glucose ≥ 126 mg/dl (7.0 mmol/L) or a 2-hour plasma glucose ≥ 200 mg/dl (11.1 mmol/L) during an oral glucose tolerance test [9], or in those patients who had been previously diagnosed with diabetes. The blood pressure was measured by the same nurse at each patient visit by a manual mercury sphygmomanometer.

The patients attending the clinic during the war were asked to answer a questionnaire regarding their diabetes and the effect of war, which included questions about displacement, loss of a relative and damage to their homes. They were also questioned regarding their diet, exercise, medications, khat chewing (khat (*Catha edulis*) leaves are commonly chewed by a large proportion of the population in Yemen and East Africa; it has a mild stimulant effect) [10], income and health insurance. The datasets used and analyzed during this study are available from the corresponding author upon reasonable request.

Statistical Analysis

The data were presented as the mean with the standard deviation (SD) and 95% confidence interval (95% CI) of the mean.

A total of 430 patients were seen in the clinic during the study period, after the start of the war. We collected data on these patients, and they were asked to answer the questionnaire of these patients, 111 had been followed-up in the clinic from before the war, so we had data on those patients from before the war and during the war.

The data are presented in the tables and graphs. Frequencies and percentages were used to describe the qualitative data. The mean, SD, and 95% CI were used to describe the quantitative data. Independent t-tests and paired t-tests were used to test for significant differences between qualitative and quantitative data at a 0.05 level of significance and 95% CI. The data were processed using SPSS for windows version 18 (SPSS Inc., Chicago, IL). Ethical approval of the research was obtained from the Ethical Committee at the medical school at Sana'a University.

Results

Characteristics of the patients

A total of 430 Yemeni patients with type 2 DM, ages 20 years and older, attended a specialized endocrinology clinic from August 2015 to January 2016. In total, 229 (53.3%) were females and 201 (46.7%) were males. Additionally, 111 (25.8%) of the patients had been following up regularly for at least a year before the war, with the last visit not more than 6 months prior to the war. Thus, 319 (74.2%) were new patients or patients who were not following up regularly in the clinic.

The mean age of the patients was 51.5 years (SD: 10.9 years), the mean duration of the disease was 7 years (SD: 6 years), and the mean age at the onset of DM was 44.5 years (SD: 10.6 years). The general characteristics of these patients are shown in Table 1.

The characteristics of the patients that came for follow up (n=111) during the war can be seen in Table 2.

The war and HbA1c

The mean HbA1c in the patients following up before the war

Parameter	Minimum	Maximum	Mean	Standard Deviation
Age of patients (year)	22.0	80.0	51.5	10.9
Duration of the disease (year)	0.1	35.0	7.0	6.0
Age of DM onset (year)	20.0	78.0	44.5	10.6
Height (cm)	1.4	1.8	1.6	0.1
Weight during the war (Kg)	33.8	137.5	66.8	13.0
BMI during the war (Kg/m ²)	12.6	59.5	26.6	4.8
HbA1c during the war%(mmol/mol)	4.8(28)	17.5(167)	9.4(79)	2.4

Table 1: The general characteristics of the patients attending the clinic after the start of the war (n=430).

Parameter	Before war		After war		p-value
	Mean (sd)	95% CI	Mean (sd)	95% CI	
Weight (kg)	69.7 (12.7)	67.2 - 72.0	68.5 (12.5)	66.1 - 70.9	0.015
BMI (kg/m ²)	28.1 (4.7)	27.2 - 28.9	27.6 (4.7)	26.7 - 28.5	0.015
HbA1c %	7.7 (1.9)	7.3 - 8.1	8.6 (2.2)	8.2 - 9.0	<0.001
RBS (mg/dl)	199.3 (92.9)	181.5 - 217.1	207.3 (85.7)	190.9 - 223.7	0.415

Table 2: The mean HbA1c in the patients following up before the war (N=111) was 7.7% (61 mmol/mol) (SD 1.9), and during the war, the HbA1c had increased by a mean value of 8.6% (70 mmol/mol) (SD 2.2) in the 111 patients who came for follow-up (p-value <0.001). The test used is the paired t-test.

(N=111) was 7.7 % (61 mmol/mol) (SD 1.9), and during the war, the HbA1c had increased by a mean value of 8.6%(70 mmol/mol) (SD 2.2) in the 111 patients who came for follow-up. This can be seen in Table 3.

When the HbA1c during the war was distributed according to the different age groups we found that the patients aged ≥ 65 (N=57 patients) had the highest mean HbA1c when compared to the other age groups but this didn't reach a significant value.

Among all the patients (n=430) who came during the war the HbA1c was <7% (53 mmol/mol) in only 17.7%, 30.9% had an HbA1c between 7(53 mmol/mol) and 8.9% (73 mmol/mol) and 51.4% of the patients had an HbA1c ≥ 9%(75mmol/mol).

Among the 111 patients that continued to follow up from before the war we found a decrease in the patients that were controlled HbA1c <7% (53 mmol/mol) and an increase in the patients that had an HbA1c >9%(75mmol/mol). This can be seen in Figure 3.

In the group of patients that had an HbA1c of <7(53mmol/mol) before the war (n=53) the mean HbA1c was 6.3% (46 mmol/mol) (SD 0.45) before the war, this increased to a mean HbA1c 7.7% (61 mmol/mol)(SD 1.9) (p-value <0.001) during the war. Among these patients only one patient had stopped his medication and 5 patients had been displaced.

BMI and the war

The mean BMI (kg/m²) before the war was 28.1 and after the war it dropped to 27.6 (p-value 0.015). When the BMI was checked in females and males we found a significant decrease in the BMI in females but not in males.

Blood pressure and the war

The mean systolic blood pressure (SBP) before the war among the patients attending the clinic was 120.5 and after the war it was 116.5 (p-value 0.007). The mean diastolic blood pressure was 67.2 before the war and 59.8 mmHg after the war (p-value <0.001).

Patients who were displaced, had lost relatives and had damage to their homes

The patients were asked about displacement, and 22.1% (N=95) of

the patients had been displaced at some time after the war. Out of these patients, 54.7% were displaced from Sana'a to another city, 15.8% were displaced from one house to another and 29.5% were displaced from another city to Sana'a. Additionally, 16.3% (N=72) of our patients had displaced people staying at their homes.

A total of 8.9% (N=38) of the patients had damage to their homes from the airstrikes, and 10% had lost a 1st or 2nd degree relative from the war.

We compared the HbA1c of these patients before and after the war and found a significant increase in the HbA1c among those who had been displaced (p-value 0.035) and those who had damage to their homes (p-value 0.024) in comparison to their HbA1c before the war.

We also compared the HbA1c of the patients who had been displaced, had damage to their homes or lost a relative after the war to the other patients with diabetes after the war to see if they had a higher HbA1c, but we did not find any significant difference in the HbA1c levels between the two groups

Continuation of diabetes medications

Among the patients who came for follow-up, 85.6% stated that they had continued all their diabetes medications, and 8.4% had stopped either one or all of their diabetes medications (3.6% of the patients on insulin had stopped insulin); an additional 6% had not started any medications yet.

The distribution of medication use after the war among the patients was that 20.1% were on insulin as a single medication or in addition to oral agents, 68.3% were on oral hypoglycemic agents, and 11.6% were not on medications for their diabetes.

sex	HbA1c% before war(mmol/mol)		HbA1c %after war (mmol/mol)		p-value
	Mean	SD	Mean	SD	
Male	7.7(61)	2.00	8.5(69)	2.36	0.034
Female	7.7(61)	1.87	8.7(72)	2.15	<0.001
Total	7.7(61)	1.92	8.6(70)	2.24	<0.001

Table 3: The females had a slightly higher mean HbA1c during the war, which was 8.7% (72 mmol/mol), compared to the males, whose mean HbA1c was 8.5% (69 mmol/mol). However, both groups had a significant increase in their HbA1c during the war. The test used is the paired t-test.

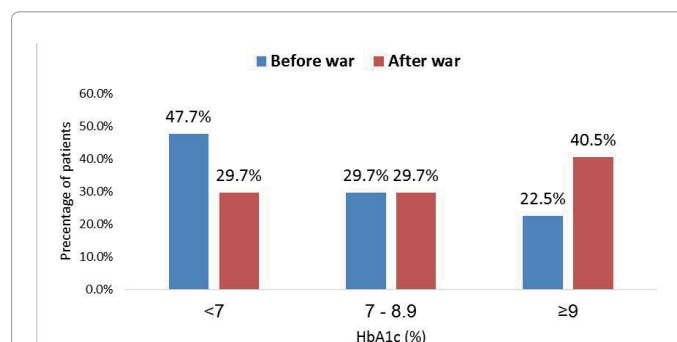


Figure 3: A bar graph showing the distribution of the HbA1c levels among the patients who were coming for a regular follow-up (n=111). Before the war, 47.7% had an HbA1c of <7%. This dropped to 29.9% after the war. 29.7% of the patients had an HbA1c of 7-8.9% before the war, and this did not change during the war. Additionally, 22.5% of the patients had an HbA1c of ≥ 9 before the war, and this increased to 40.5% after the war (p-value <0.001).

Exercise and diet among the patients

The patients were questioned regarding their exercise and diet during the war. The results showed that 53% answered that they usually exercised, and among those, 94.3% continued to exercise during the war. Regarding their following of a diet, 74.7% said that they followed a diabetic diet, and 98% stated they had not changed their diet during the war.

Income and health insurance during the war

The majority of the patients, 97.9%, reported that their income had decreased during the war. Approximately 25% following up in our clinic before the war had health insurance, but this number dropped to 16% after the war, since many companies had stopped providing health insurance after the war started.

Khat chewing and the war

Khat chewing (*Catha Edulis* leaves) is very common among adults in Yemen. We found that 78.6% of the males and 52.4% of the females attending the clinic were regular chewers.

These patients were asked whether they had continued to chew khat during the war, as it is expensive to chew khat on a daily basis. We found that 94.9% of the males and 87.5% of the females had continued to chew khat, while only 8.3% of the patients had stopped chewing khat after the war had started. They were also asked if they had continued to chew at the same rate as they had prior to the war, and 7% of the khat-chewing patients said that they chewed khat less frequently, and 2% chewed khat more frequently.

Discussion

In this study, we found a significant increase in HbA1c after the war in Yemen had started, in comparison to that of the same patients before the war (N=111). Studies done in other countries during war have shown different results, with some having an increase in HbA1c during war and others showing no change in diabetes control [5-8]. There has been a worsening of diabetes control after other disasters, such as extensive flooding [11], earthquakes and tsunamis [12,13]. Additionally, acute psychological stress has been found to cause hyperglycemia in studies in animals and humans [14,15]. Veterans with post-traumatic stress disorder (PTSD) were found to have a higher rate of diabetes than those who did not have PTSD, and those with PTSD were also found to have a higher fasting blood glucose level compared to those without PTSD [16].

The BMI in our study dropped significantly among females but to a lesser extent among males. This could be related to stress or food insecurity. Stress has been shown to cause weight loss when studied in rats [14]. In humans, stress induced by an earthquake initially showed an increase in BMI among preschool children in Japan [17], whereas in healthy females, stress was found to increase weight in some females and decrease weight in others [18]. Additionally, other areas of war studies showed an initial increase in weight during the war [6,19].

Our patients had significantly lower SBP and DBP after the war compared to those of before the war. This has been shown in another study, but without a clear explanation [18]. In our study, we did not ask about the exact time that patients with hypertension had started taking antihypertensive agents, and being on medications might explain the lower blood pressure after the war in our patients.

Of the patients following up in our clinic after the war, 22.1% had

been displaced from their homes because of the war, which has been found to be a risk factor for uncontrolled diabetes in other studies [6,13]. In our study, 10% of the patients had lost a first- or second-degree relative and 8.9% had damage to their homes because of the war. This has also been shown to cause a worsening of diabetes control in a study done after an earthquake in Japan [20].

Most of the patients in our study reported that they had not changed their diet habits after the war, with 98% of those following a diet saying that they had continued the diet after the war. Additionally, 94.3% of those that exercised reported that they had continued exercising after the war. This seems to be overestimated by the patients, since many of them had been displaced, were staying with relatives and were probably unlikely to stay on their usual diet. A study in Japan after a tsunami showed that patients had to change their diet due to the unavailability of fresh foods, and they mostly subsisted on preserved foods [13]. Fresh food was unavailable in some cities during the war, but in Sana'a, fresh food was available at all times.

In our study, only 8.4% had stopped some or all their medications for diabetes as a result of the war. This is probably an underestimation of the number of patients who actually stopped their medications because many of our patients did not come for a follow-up after the war had started. A study in Iraq during the war reported that over 50% of patients blamed their uncontrolled diabetes on the unavailability of medication supply from the primary care centers [5]. In Sana'a, the only medications supplied by the ministry of health for diabetic patients are insulin and glibenclamide, so most medications still have to be bought by the patients or supplied by medical insurance for the few patients who have it. Only 3.6% of the 80 patients who were on insulin reported stopping it, and this was mainly due to a lack of electricity and the worry that it was unfit for use if not kept in a refrigerator.

Khat chewing is a common habit in Yemen. It has a mild stimulant effect. Users chew it habitually for its euphoric effects and as a recreational drug to improve performance [21,22]. Many people chew it on a daily basis, mostly in the afternoon and evening periods, and among our patients (mostly from Sana'a and the surrounding areas), khat chewing was only mildly affected by the war among the patients coming to our clinic, with 94.9% of the males and 87.5% of the females who were khat chewers before the war continuing to chew khat after the war, even though their income had decreased. In our study, the numbers of patients who chewed khat before the war was similar to what we had shown in a previous study, with over 50% of the females and almost 80% of the males being regular chewers [23]. Most of the patients that continued to follow up in our clinic after the war started were probably better off economically than the patients who discontinued follow up, since this was a private clinic where patients had to pay for the doctor's visit. This might explain why most of them were still able to afford to buy khat.

The limitations of our study are that it was a small study done in one private clinic in Sana'a. The patients had to pay to visit the doctor and have their investigations done, so many of the patients who had been affected economically by the war did not come for a follow-up. Most of the patients presenting in our clinic were patients who were coming for a follow-up, but after the war, we found that it was mainly new patients who were coming because of their uncontrolled diabetes. We did not look into the long term complications of diabetes since this was a small study done soon after the war had started and for a short period of time. There were probably more patients in other areas of Yemen that were experiencing fighting who had uncontrolled diabetes and more patients who had discontinued their medications. This is a small sample

size of a group of patients who were able to seek medical attention, and most of them had continued their medications. Therefore, this is not a representative sample of patients throughout the whole country. We do not have any information on the patients who did not come for their regular follow-up, but they are most likely doing much worse than the patients who continued follow-up after the war.

Conclusion

This study is, to our knowledge, the first study in Yemen to show the effect of the war on diabetes control in patients. Studies in other countries during wars have shown different effects on diabetes. Some showed an increase of uncontrolled diabetes and other studies showed no effect on uncontrolled diabetes [5-8]. Our patients showed a worsening of diabetes control, which seems to be multifactorial (stress, stopping medications, and displacement all seem to be factors). The decrease in BMI could be related to the stress from the war or food insecurity, which may be a factor in patients coming from other parts of Yemen where there was fighting, causing the unavailability of fresh food at the time the study was conducted. This would apply to patients who were coming from Aden and Taiz, where there was fighting in addition to the airstrikes. We also found that over one fifth of our patients had been displaced at some time because of the war. Larger studies need to be done in other areas of the country where patients do not have access to many of their medications and are living under worse conditions than those in Sana'a.

Authors Contribution

BS and BT conceived the study. BS designed the study and wrote the manuscript, and BT planned the data analysis. BS gave the questionnaire to the patients to answer. BT revised the manuscript. All the authors read, revised and approved the final manuscript.

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Competing Interest

The authors declare that they have no competing interests.

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