Comorbidities role on death in diabetic patients with COVID-19

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Abstract

Purpose: According to the possible role of other comorbidities in increase the risk of mortality in diabetes patient, recent study was designed to manage complications and mortality rate in this group of patients.

Methods: In this cross-sectional study (25 February to 10 July 2020) total of 458 diabetic patients were enrolled based on their characteristics, symptoms and signs, and presence of underlying diseases. Multiple logistic regression and $\chi 2$ test analysis used to check the effectiveness of comorbidities on the mortality outcome among diabetic patients.

Results: Of 458 diabetic patients, 306 (67%) were with underlying diseases (200 (65.4%) hypertension, 103 (33.7%) cardiovascular diseases and 29 (9.5%) kidney diseases). The rate of fatality was significantly high in patients with chronic kidney and liver diseases. The odds of mortality outcome increase 3.1 fold for patients over 55 years as compared to under 55 years (P =0.011), and the odds of mortality outcome was more than 5.1 folds for those who had chronic kidney disease (P <0.001).

Conclusions: The presentation of SARS-CoV-2 in older diabetic patients with comorbidities (chronic kidney and liver diseases) is more severe in risk of mortality.

Introduction

From the end of December 2019, a novel respiratory viral disease outbreak was reported from Wuhan city of China, which was caused by a novel coronavirus and was officially named COVID-19 in Mar 11 by the World Health Organization (WHO).[1] Based on previous studies it has been proven that the presence of different underlying diseases may have important role in increasing threat of COVID-19 in this group of individuals.[2] One of the most important underlying diseases is un-controlled diabetes which has high prevalence in the world (>463 million people).[3] Due to this it is important to understand the special aspects of COVID-19 infection in people with this underlying criterion. From the first of the pandemic, many data about the association between diabetes and COVID-19 from various parts of the world have been accumulated. Based on these data, management of diabetes in cases with COVID-19 infection, and innovative strategies for medical consultation in view of limited access to healthcare facilities for patients with chronic diseases have been performed. According to the critical role of diabetes Mellitus (DM) as one of the leading causes of morbidity in the worldwide and its anticipated to rise substantially over the next decades, it is very important to evaluate the role of DM in COVID-19 infected patients to be able to manage the risk of this disease in the recent crisis.[4] In different meta-analysis studies it has been proven that significant correlation is exist between severity of COVID-19 and diabetes, either associated complications of diabetes can increase the risk of mortality rate due to suppressed innate and humoral immune functions. [5]

Although diabetes has been shown to be an effective underlying disease in increasing the risks associated with the COVID-19 crisis, the presence of other comorbidities such as hypertension and cardiovascular diseases may also increase the risk of mortality in this group of patients. [2, 6] Given that

other criteria such as older age, sex, chronic respiratory diseases, and cancer may have role in increase the complication of disease in patients with diabetic who developed COVID-19[7]. In the current study, we reviewed the role risk of different underlying diseases in diabetic patients with SARS-COV-II in the south of IRAN.

Materials And Methods

In this cross-sectional retrospective study (25 February to 10 July 2020), total of 4585 confirmed patients with SARS-CoV-2 infection were evaluated according to the inclusion criteria of the study. These patients were admitted to the referral hospitals in Fars province which affiliated with Shiraz University of Medical Sciences (SUMS). The data for this study were obtained from the electronic base registry which contained all of the related data due to hospitalized patients with confirmed COVID-19. (Ethical code: IR-SUMS-REC.1399.022) Data were contained demographic data including age, gender, and baseline characteristics such as symptoms and signs, and underlying diseases.

Included patients were considered according to the following specifications: I). positive for COVID-19 according to the qRT-PCR test, II). Confirmed for the previous diabetic, III). Present abnormalities in their chest CT images. We considered diabetic patients with or not comorbidities to investigate the impact of comorbidities on the diabetic patients. Based on these criteria, 458 patients were included. Then, effect of age, gender, smoking, opium, length of hospitalization stays and underlying diseases such as Hypertension, Cardiovascular disease, Chronic kidney disease, Chronic liver disease, Cancer, primary Immunodeficiency were considered in all included patients and were compared.

Categorical variables were expressed as frequency and percentages (%), and continuous variables were expressed as mean. Categorical variables between groups were compared by using the $\chi 2$ test. Continuous variables were analyzed by using Student's t test. Utilizing multiple logistic regression analysis was used to found the most powerful factors such as demographic data including age, gender and underlying diseases affecting the mortality outcome among diabetic COVID-19 patients with or without comorbidities. All statistical analyses were performed using the SPSS 18.0 software. P-value <0.05 was considered statistically significant.

Results

From a total of 4585 hospitalized confirmed positive patients for COVID-19, 458 (9.9%) individuals were considered with diabetic criteria. Included patients were categorized in two groups: I). 306 (67%) with underlying, and II). 152(33.2%) with no underlying diseases. The rate of mentioned underlying diseases in group I was as following: 200 (65.4%) hypertension, 103 (33.7%) cardiovascular diseases, 29 (9.5%) kidney diseases, 11 (3.6%) with Immunodeficiency, 10 (3.3%) with cancer, and 9 (2.9%) patients have chronic liver disease(Fig.1). Comparing included patients with and without underlying diseases, have showed that group one of diabetic patients were with older ages (62.9(61.7-64.3) vs 57.9(55.8-59.9)), which was statistically significant (p-value<0.001). The gender distribution was the same among two

groups. Although there was no difference between two groups in smoking habitat, there was no either significant difference in average of their length of hospitalization stay (table1). Total of 238(51.96) cases were cared in Intensive Care Unit (ICU), while, 32(7%) cases were intubated. Among total of cases, 13 patients were found with smoking, while 11 individuals were need to hospitalized in ICU (p-value =0.017). Among the smokers, 10 individuals were complicated and had respiratory distress. The most common symptoms among included patients, were as following: respiratory distress 273 (59.6%), Cough 229(50%), fever 179(39.1%), muscular pain 144 (31.4%) and chest pain 13(2.8%) (tabale1).

In analyzing symptoms among two groups (with and without comorbidities) it has been deduced that muscular pain has significant difference (28.4% vs 37.5%; P-value=0.049). It was interesting that muscular pain was the frequent symptom in included patients with hypertension (P-value= 0.027). Comparing the percentages of mortality, among two groups (with and without comorbidities) showed not significant differences (37 (12.1%) vs 13 (8.6%); P-value=0.253). (Table 1) Among total of patients, 50 (10.92%) individuals were died due to COVID-19, this is while 37 (74%) of them had at least one mentioned underlying disease (table1). The high frequency of underlying diseases in dead patients were as following respectively: hypertension, 21(42%); kidney, 10 (20%); cardiovascular, 9 (18%); and 3 (6%) of them had other introduced underlying diseases. Analyzing of underlying diseases among dead patients, showed that rate of fatality was significantly high in patients with chronic kidney (20% vs 4.9%) and liver (6% vs 1.5%) diseases respectively (p-value<0.001, p-value=0.029) (table 2). On the other hand, case fatality rate in patients with chronic kidney disease was more seen in ages over 55 years (p-value<0.001).

All of the above results have been confirmed either by multiple logistic regression analysis. In this analysis have been showed that age and chronic kidney disease are the most powerful factors affecting the mortality outcome among diabetic COVID-19 patients (Table 3). In the proposed model, it has been revealed that the odds of mortality outcome increase 3.1 fold for patients over 55 years as compared to under 55 years (P-value =0.011), and the odds of mortality outcome was more than 5.1 folds for those who had chronic kidney disease (P-value <0.001).

Discussion

Based on the results of current study it has been showed that diabetic patients with other comorbidities are more at risk of progression of COVID-19. According to the main results, it has been concluded that comorbidities in diabetic patients are a vital risk factor for the progression and prognosis of COVID-19. Awareness in this regard has a significant benefit for treatment, decreases the complications and mortality rate, and increases the quality of life of this group of patients. Due to many studies during the recent crisis it has been reported that diabetes has a critical role in outcome of SARS-CoV-2 pneumonia. [7, 8] On the other hand, according to the results of a few studies, it has been documented that diabetics are more prone to the other certain bacterial and viral infections and their complications. [4, 9-12] Therefore, it is necessary to get intensive attention to this group of patients, especially in the current new crisis. In a study in China it has been reported that of COVID-19 complications and presence of infection are more at hypertension (21.1%) and diabetic patients (9.7%).[13]

In the current study, it has been showing that hypertension (65.4%), cardiovascular (33.7%) and chronic kidney diseases (6.6%) are at most prevalent comorbidities in infected diabetic patients. Other than CKD, the same results for hypertension, and cardiovascular have been reported in other studies around the world either. [14-16] Comparison of the comorbidities during coronavirus infections such as SARS and Middle East Respiratory Syndrome Coronavirus (MERS) shows the same results [17] either.

In a meta-analysis study report, hypertension, cardiovascular, and chronic kidney diseases were respectively the most prevalent underlying diseases among hospitalized patients with COVID-19.[2] The results of a previous study in Saudi Arabia (2020) showed that diabetes is associated with common comorbidities such as ischemic heart disease, hypertension and dyslipidemia[18] so, in the recent infection crisis (COVID-19), we must consider all diabetic patients with other underlying diseases and manage their treatment totally.

In addition to our study results we found that no significant difference is present between male and female diabetic patients with COVID-19 (49.6% vs 50.4%). This is while the rate of mortality was higher in male, which were consistent with a recent report (men who died from COVID-19 is 2.4 times that of women).[19] Furthermore, in Italy, higher risks have also been reported in men than in women [20]. According to the results of another study a large number of diabetics with COVID-19 was male (54.1%) Vs Female (45.9%). [7] In our study results, we found no significant difference in tobacco consumption and average length of hospitalization stay between diabetics. By contrast, it has been reported that the presence of diabetes has tripled the risk of hospitalization and ICU admission by the Influenza A (H1N1) infection. [21] However, some studies indicated the increase risk of ICU admission in diabetic patients, in our study, risk of intensive care was high just among diabetic patient smokers. [22-25]

In our study, among patients with COVID-19, the rate of mortality was 3.5% higher in diabetics with underlying diseases. Mortality rate in patients with MERS who had diabetes was reported 35%. [26, 27] Case fatality rate have been reported 7.3% in patients with diabetes in China. [3]

Furthermore, the prevalence of signs and symptoms such as cough, fever, headache, chest pain, and respiratory distress in diabetic patients with or without comorbidities were not different significantly, another study has verified that signs and symptoms among diabetic and non-diabetics had no significant difference. [7] Meanwhile, some previous studies confirmed that the wide range of signs and symptoms (nonproductive cough, fever, diarrhea, and nausea/vomiting) are generally associated with COVID-19[28]. In the current study, we found patients with hypertension have muscular pain significantly.

The results of our research indicated that the prevalence of diabetes is significantly high among patients over 55 years. Also, the mortality rate in diabetic patients over 55 years was detected significantly high which was 3.1 times higher than Youngers. Based on another study, the mean case fatality rate for aged under 60 is estimated to be less than 0.2%, while this range in aged over 80 is 9.3% [29]. Based on our results, among all diabetic patients, hypertension, chronic kidney disease and cardiovascular were the most important factors influencing the mortality rate of these patients and the mortality rate in patients with chronic kidney disease is about 5.1 folds as compared to those who hadn’t this underlying disease.

Although the main result of the severity of COVID-19 is not known mainly in people with diabetes, chronic kidney disease, or other chronic diseases it may be explainable with an expression of angiotensin-converting enzyme-2 (ACE2) in other organs such as liver and kidney tissues [30]. All in all, it seems that the presentation of SARS-CoV-2 in diabetic patients is more severe and those who have comorbidities are at higher risk of mortality. Chronic kidney and liver diseases are two major factors in the increasing mortality rate of diabetic patients with COVID-19.

Conclusion

From the recent study we can conclude that diabetics with older ages and some comorbidities such as chronic kidney diseases are more at risk of mortality during COVID-19 crisis. Cause of that the role of symptom screening of underlying diseases in the current new crisis is so vital, there is a need to further study of COVID-19 in patients with diabetes and to understand the individual, regional and ethnic variations in disease prevalence.

Declarations

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Conflicts of interest/Competing interests

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Authors' contributions

Emami review the literature, result and manuscript drafts and have primary responsibility for final content. Alimohamadzadeh and Akbari had full access to all of the data in the study. Falahati contributed to the study design and formulated the hypothesis. Basirat did data collection, drafting of manuscript and analysis data, Zare participated in counseling in the discussion of diabetic patients. All authors read and approved the final manuscript.

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References

1. Mohammadi MT: **Psychological Impacts of Covid-19 Outbreak on Mental Health Status of Society Individuals: A Narrative Review**. *Journal Mil Med* 2020, **22**(2):184-192.

2. Emami A, Javanmardi F, Pirbonyeh N, Akbari A: **Prevalence of underlying diseases in hospitalized patients with COVID-19: a systematic review and meta-analysis**. *Archives of academic emergency medicine* 2020, **8**(1).
3. Wu Z, McGoogan JM: **Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention**. *Jama* 2020, **323**(13):1239-1242.
4. Knapp S: **Diabetes and infection: Is there a link?-A mini-review**. *Gerontology* 2013, **59**(2):99-104.
5. Guo L, Shi Z, Zhang Y, Wang C, Moreira NCDV, Zuo H, Hussain A: **Comorbid diabetes and the risk of disease severity or death among 8807 COVID-19 patients in China: a meta-analysis**. *Diabetes research and clinical practice* 2020:108346.
6. Emami A, Javanmardi F, Akbari A, Moghadami M, Bakhtiari H, Falahati F, Hashemi Zadeh Fard Haghighi L, Rezaei T: **Characteristics of deceased patients with CoVID-19 after the first peak of the epidemic in Fars province, Iran**. *Infection Ecology & Epidemiology* 2020, **10**(1):1781330.
7. Guo W, Li M, Dong Y, Zhou H, Zhang Z, Tian C, Qin R, Wang H, Shen Y, Du K: **Diabetes is a risk factor for the progression and prognosis of COVID-19**. *Diabetes/metabolism research and reviews* 2020:e3319.
8. Bloomgarden ZT: **Diabetes and COVID-19**. *Journal of Diabetes* 2020, **12**(4):347-348.
9. Shah BR, Hux JE: **Quantifying the risk of infectious diseases for people with diabetes**. *Diabetes care* 2003, **26**(2):510-513.
10. Muller L, Gorter K, Hak E, Goudzwaard W, Schellevis F, Hoepelman A, Rutten G: **Increased risk of common infections in patients with type 1 and type 2 diabetes mellitus**. *Clinical infectious diseases* 2005, **41**(3):281-288.
11. Das S, Barai A: **A possible alternate pathway for intravascular thrombosis-Investigation of the circumstantial evidence by microfluidics**. *Medical Science and Discovery* 2017, **4**(1):1-11.
12. Yang J, Feng Y, Yuan M, Yuan S, Fu H, Wu B, Sun G, Yang G, Zhang X, Wang L: **Plasma glucose levels and diabetes are independent predictors for mortality and morbidity in patients with SARS**. *Diabetic medicine* 2006, **23**(6):623-628.
13. Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, Ji R, Wang H, Wang Y, Zhou Y: **Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis**. *International Journal of Infectious Diseases* 2020, **94**:91-95.
14. Guan W-j, Liang W-h, Zhao Y, Liang H-r, Chen Z-s, Li Y-m, Liu X-q, Chen R-c, Tang C-l, Wang T: **Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis**. *European Respiratory Journal* 2020, **55**(5).
15. Singh AK, Gupta R, Ghosh A, Misra A: **Diabetes in COVID-19: Prevalence, pathophysiology, prognosis and practical considerations**. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* 2020.
16. Alanazi KH, Abedi GR, Midgley CM, Alkhamis A, Alsaqer T, Almoaddi A, Algwizani A, Ghazal SS, Assiri AM, Jokhdar H: **Diabetes mellitus, hypertension, and death among 32 patients with MERS-CoV infection, Saudi Arabia**. *Emerging infectious diseases* 2020, **26**(1):166.

17. Simonson DC: **Etiology and prevalence of hypertension in diabetic patients**. *Diabetes care* 1988, **11**(10):821-827.
18. Gazzaz ZJ, Iftikhar R, Jameel T, Baig M, Murad MA: **Association of Dyslipidemia and Comorbidities with Risk Factors Among Diabetic Patients: A Retrospective Analysis**. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 2020, **13**:935.
19. Jin J-M, Bai P, He W, Wu F, Liu X-F, Han D-M, Liu S, Yang J-K: **Gender differences in patients with COVID-19: Focus on severity and mortality**. *Frontiers in Public Health* 2020, **8**:152.
20. Livingston E, Bucher K: **Coronavirus disease 2019 (COVID-19) in Italy**. *Jama* 2020, **323**(14):1335-1335.
21. Allard R, Leclerc P, Tremblay C, Tannenbaum T-N: **Diabetes and the severity of pandemic influenza A (H1N1) infection**. *Diabetes care* 2010, **33**(7):1491-1493.
22. Cao J, Hu X, Cheng W, Yu L, Tu W-J, Liu Q: **Clinical features and short-term outcomes of 18 patients with corona virus disease 2019 in intensive care unit**. *Intensive care medicine* 2020:1-3.
23. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X: **Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China**. *The lancet* 2020, **395**(10223):497-506.
24. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y: **Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China**. *Jama* 2020, **323**(11):1061-1069.
25. Jin J-M, Bai P, He W, Wu F, Liu X-F, Han D-M, Liu S, Yang J-K: **Gender Differences in Patients With COVID-19: Focus on Severity and Mortality**. *Frontiers in Public Health* 2020, **8**(152).
26. Al-Tawfiq JA, Hinedi K, Ghandour J, Khairalla H, Musleh S, Ujayli A, Memish ZA: **Middle East respiratory syndrome coronavirus: a case-control study of hospitalized patients**. *Clinical Infectious Diseases* 2014, **59**(2):160-165.
27. Alraddadi BM, Watson JT, Almarashi A, Abedi GR, Turkistani A, Sadran M, Housa A, Almazroa MA, Alraihan N, Banjar A: **Risk factors for primary Middle East respiratory syndrome coronavirus illness in humans, Saudi Arabia, 2014**. *Emerging infectious diseases* 2016, **22**(1):49.
28. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X: **Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study**. *The lancet* 2020.
29. Ferguson N, Laydon D, Nedjati Gilani G, Imai N, Ainslie K, Baguelin M, Bhatia S, Boonyasiri A, Cucunuba Perez Z, Cuomo-Dannenburg G: **Report 9: Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand**. 2020.
30. Ma RCW, Holt RIG: **COVID-19 and diabetes**. *Diabetic medicine : a journal of the British Diabetic Association* 2020, **37**(5):723-725.

Tables

Table 1. Demographics and baseline characteristics of diabetic patients infected with SARS-CoV-2

	variables	No. (%) Total (n =458)	Without other comorbidities (n =152)	With comorbidities (n =306)	P-value[a]
Age	**Mean (CI)**	61.3(60.2-62.4)	57.9(55.8-59.9)	62.9(61.7-64.3)	**<0.001**
	<=55 years				
	>55 years	136 (29.7%) 322 (70.3%)	60 (39.5%) 92 (60.5%)	76 (24%) 230 (75.2%)	**0.001**
Gender	Male				
	Female	227(49.6) 231(50.4)	85(55.9) 67(44.1)	142(46.4) 164(53.6)	0.055
Base line Characteristics	**Smoking**	13 (2.8)	5(3.3)	8 (2.6)	0.767
	Opium	7 (1.5)	4 (2.6)	3 (1)	0.227
	Length of Stay (days)	6.9(6.3-7.5)	6.2 (5.4-7)	7.3 (6.5-8.03)	0.087
	Intensive Care Units(ICU)	238(51.96)	81(53.3)	157(51.3)	0.734
	Intubation	32(7)	2 (6.2)	30 (93.8)	**0.001**
Signs and symptoms	**Fever**	179(39.1)	60(39.5)	119(38.9)	0.904
	Cough	229(50)	78 (51.3)	151 (49.3)	0.691
	Headache	58(12.7)	17 (11.2)	41 (13.4)	0.512
	Chest pain	13(2.8)	2 (1.3)	11 (3.6)	0.249
	Muscular Pain	144(31.4)	57 (37.5)	87 (28.4)	0.049
	Respiratory-distress	273(59.6)	91 (59.9)	182 (59.5)	0.936
	Diarrhea	24(5.2)	4 (2.6)	20 (6.5)	0.107
	mortality	50 (10.9)	13 (8.6)	37 (12.1)	0.253

Table 2. The relationship between demographics, underlying disease and mortality rate in diabetic COVID-19

Variables		No. (%) Total (n =458)	Alive N=408	Dead N= 50	P Value
Age					
	<=55	136 (29.7%)	129 (31.6%)	7 (14%)	**0.01**
	>55	322 (70.3%)	279 (68.4%)	43 (86%)	
Gender	Male				
	Female	227 (49.6)	197 (48.3%)	30 (13%)	**<0.001**
		231 (50.4)	211 (51.7%)	20 (8%)	
Comorbidities	**HTN**	200 (43.7%)	179 (43.9%)	21 (42%)	0.801
	CVD	103 (22.5%)	94 (23%)	9 (18%)	0.421
	Cancer	10 (2.2%)	8 (2%)	2 (4%)	0.352
	CKD	30 (6.6%)	20 (4.9%)	10 (20%)	**<0.001**
	CLD	9 (2%)	6 (1.5%)	3 (6%)	**0.029**
	PI	11(2.4%)	8 (2%)	3 (6%)	0.108

Table 3. Multiple logistic regression analysis of risk factors leading to mortality

variable	subgroup	β estimate	SE	Wald	Odds Ratio	CI(OR)	P value
Age	<=55	Baseline	0.44	6.54	3.1	(1.3-7.3)	**0.011**
	>55	1.12					
Gender	Male	0.355	0.323	1.2	1.43	(0.76-2.69)	0.273
	Female	Baseline					
HTN	Yes	0.317	0.334	0.9	1.37	(0.71-2.64)	0.343
	No	Baseline					
CVD	Yes	0.62	0.419	2.2	1.9	(0.82-4.23)	0.138
	No	Baseline					
Cancer	Yes	0.908	0.845	1.16	2.5	(0.47-12.99)	0.282
	No	Baseline					
CKD	Yes	1.63	0.461	12.55	5.1	(2.07-6.6)	**<0.001**
	No	Baseline					
CLD	Yes	1.31	0.794	2.72	3.7	(0.78-7.61)	0.099
	No	Baseline					
PI	Yes	0.521	0.773	0.454	1.6	(0.37-7.7)	0.501
	No	Baseline					

*Hypertension (HTN), Chronic Cardiovascular Disease (CVD), Chronic Kidney Disease (CKD), Chronic Liver Disease (CLD), Primary Immunodeficiency (PI)

Figures

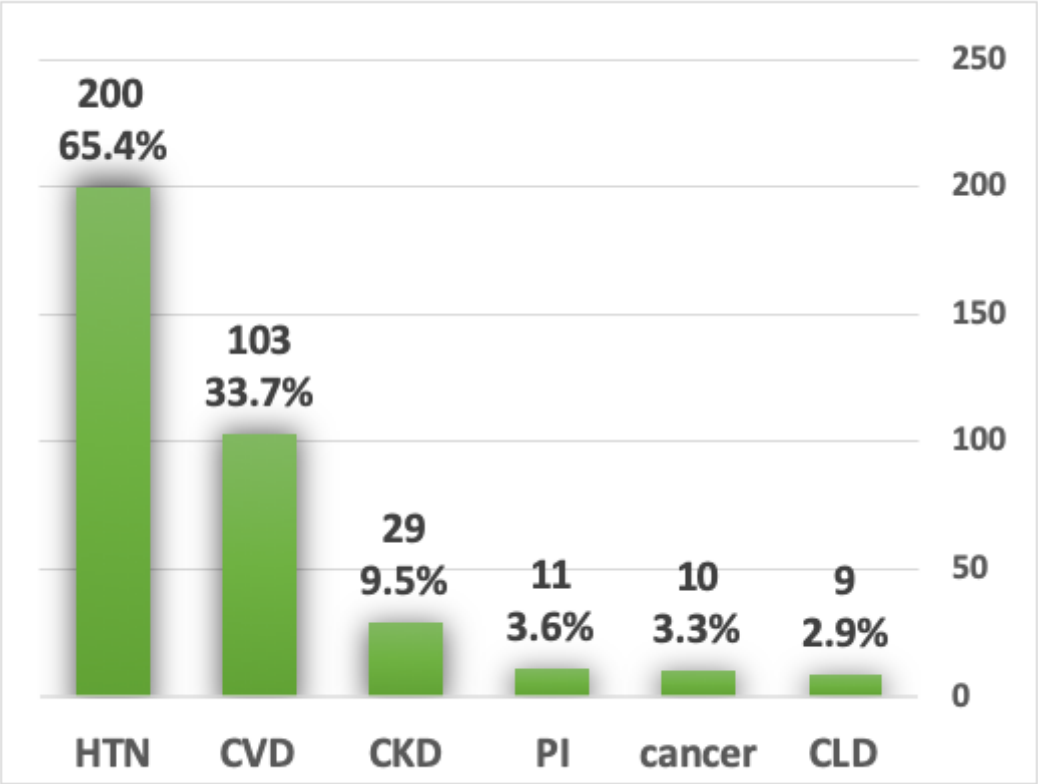

Figure 1

Frequency of comorbidities among diabetic patients