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The Prevalence Of High LDL-C Among Diabetic Patients Type 2 , Security Forces Hospital, Riyadh, Saudi Arabia

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ABSTRACT:

Introduction: Dyslipidemia is associated with a high risk of developing heart diseases and macrovascular diseases, such as stroke, particularly among diabetic patients. In Saudi Arabia, there is a need to evaluate the magnitude of dyslipidemia and aggravating factors that are associated with dyslipidemia among diabetic patients. The aim of this study is to assess prevalence of dyslipidemias, mainly high LDL, among T2DM diabetic patients.

Methods: This is a descriptive, hospital-based, and cross-sectional study recruited 100 patients with T2DM who have 2 readings of LDL, at least 6 months apart. Patients with diagnosed hypothyroidism or alcohol drinking were excluded from the study. A gender balanced sample of 50 males and 50 females at the age range of 18-75 years old were recruited from primary care department at Security Forces Hospital (SFH). The data was extracted form medical electronic records from 1st of January 2018 to 31st of December 2020. Multiple linear regression were used to determine the significant predictors of LDL level.

Results: A total of 100 patients with T2DM included with mean age of 57.3±7.7. About a third of the patients had high LDL level in both readings, compared to 21% had low level of HDL. The mean level of LDL was higher in females than in males but the differences were not statistically significant. An improvement in glycemic control among the included patients when comparing baseline and follow-up level of HbAc1. Concerning gender difference in dyslipidemia, the present study showed that levels of all dyslipidemia parameters were higher in females than in males but significant difference only detected in T. cholesterol and HDL. Change-rate in T. cholesterol level, change-rate in triglyceride level, and change-rate in HDL level were significant predictors for change-rate in LDL level. The change-rate in LDL level increased by 0.89 mg/dl for one unit rise in T. cholesterol change-rate. Differently, the change-rate in LDL level decreased by 0.36 or 0.54 mg/dl for one unit rise in triglycerides or HDL change-rate, respectively.

Conclusions: Based on robust estimations, a considerable proportion of diabetic patients had abnormal levels of dyslipidemia parameters, particularly LDL level. The change rate in lipid profile could be considered as a rough indicator for the effect of self-control or therapy in this study. An improvement in glycemic control was found when comparing baseline and follow-up level of HbAc1. Change-rate in T. cholesterol level, change-rate in triglyceride level, and change-rate in HDL level were significant predictors for change-rate in LDL level.

Keywords: Dyslipidemia, high cholesterol, atherosclerosis, glycemic control, hyperglycemia.

Introduction:

The prevalence of diabetes mellitus in Saudi Arabia was dramatically increased from 3.4 % in 1996 to more than 20% in the recent years which is attributed to change in the lifestyle. Saudi Arabia, ranked the seventh among top ten countries in regards to diabetic mellitus prevalence [1]. Diabetes associated complications increase the burden of disease globally due to prolonged morbidity. About 366 million people have developed diabetes in 2011 and 552 million are expected to be diabetic in 2030 [2]. People aged 40-59 years old are mostly affected and about 183 million (50%) diabetic patients are undiagnosed. It is estimated that about seven million of the Saudi population are diabetic and almost about three million are pre-diabetics [3]. The spread of sedentary lifestyles and adoption of western dietary habits – high in refined carbohydrates and fat – are driving an increase in the number of people with obesity-related type 2 diabetes. Diabetes, the most common non-communicable disease in Saudi Arabia, is having an increasing impact on rates of morbidity including higher risk of hypertension, atherosclerosis and dyslipidemia [3].
According to American Diabetes Association (ADA), a glycated hemoglobin level HbA1c≥6.5 is recommended for diagnosis of diabetes wile pre-diabetes could be diagnosed in the range of 5.7 to 6.4%. Reasons support use of HbA1c level in the diagnosis and monitoring of diabetes mellitus are small intra-individual variability, reflection of the average plasma glucose for previous 2-3 months, in addition to feasibility if the assessment without need to fasting [4]. However, the use of HbA1c is taking with caution due to lower test sensitivity in certain patients' groups, such as those with sickle cell anemia, or in certain population, such as Asian patients [5].

Diabetic patients are at high risk to develop dyslipidemia which is associated with macrovascular, such as heart diseases and stroke, and microvascular diseases, such as neuropathy and nephropathy [6,7]. Some studies suggested that HbA1c could be used as a reliable predictor of dyslipidemia and heart disease [8,9]. Despite the use of HbA1c as an indicator of glycemic control and associated diabetes complications, some studies doubt the association between HbAc1 and dyslipidemia [10]. Among Indian diabetic patients, no significant association was found between HbAc1 and lipid profile [11]. Additionally, some studies found a negative association between HbA1c and LDLC [12], while others found a positive relationship between and triglycerides [7]. These contradicting findings highlighted the need for farther investigations of the association between HbAc1 and lipid profile among diabetic patients. Only triglyceride was significantly associated with HbAc1 in a study conducted in in 206 diabetic patients in Saudi Arabia [13].

Aim of the study:

Primary objective: to assess the prevalence and determinants of high LDL among diabetic patients type 2 attending primary care department at Security Forces Hospital, Riyadh, Saudi Arabia

Objectives:

1: to assess the prevalence of dyslipidemias, mainly high LDL, among T2DM diabetic patients attending primary care department at Security Forces Hospital, Riyadh, Saudi Arabia

2: to determine the demographic and hematological determinants of high LDL among T2DM diabetic patients.

Methods:

This is a descriptive, hospital-based, and cross-sectional study. patients with T2DM who have 2 readings of LDL, at least 6 months apart, were included. Patients with diagnosed hypothyroidism or alcohol drinking were excluded from the study. The data was extracted form medical electronic records of the patients after applying the inclusion and exclusion criteria. A gender balanced sample of 50 males and 50 females at the ag range of 18-75 years old were recruited from primary care department at Security Forces Hospital (SFH). The data were collected retrospectively from 1st of January 2018 to 31st of December 2020 after getting the permission from local research committee (approval number : 2040719).

Operational definitions for dyslipidemia parameters used the criteria for abnormal lipid levels based on the American Diabetes Association 2004. Hypercholesterolemia refers to a total cholesterol (TC) level of ≥200 mg/dl, HDL-c was considered low when the level is <40 mg/dl; LDL-c was considered high when the level is ≥100 mg/dl; hypertriglyceridemia (TG) refers to a level ≥150 mg/dl; dyslipidemia is defined as the presence of one or more of the previous abnormalities in serum lipids, or normal level on treatment. To convert HDL-C values to mmol/L, we multiplied by a value of 0.0259.

Data were entered and analyzed by Statistical Package of Social Science SPSS, version 26. The descriptive statistics such as frequencies, percentages were calculated to summarize nominal data, while mean and standard deviation were used to describe numerical variables. Figures were used to present certain important findings. Inferential statistics such as chi-squared test was applied to evaluate the association between determinants, demographic and dyslipidemia variables, and the LDL level. Linear regression was used to determine significant predictors of LDL level. Any P-value < 0.05 was considered as an indication for a statistically significant association or difference.

Results:

A total of 100 patients with T2DM, a half of them is females, were included in this study. The mean age of all patients was 57.3±7.7 but it was slightly higher in females than in males. The mean level of HbAc1, either in the first or second readings, were significantly higher in females than in males. The mean level of HbAc1 dropped from 7.7% and 7.3% to 8.5% and 8.2% in males and females, respectively (figure 1). The mean titer of T. Cholesterol was significantly higher in females than in males. The mean level of T. Cholesterol dropped from 166.3 and 187.6 to 159.3 and 182.1 mg/dl in males and females, respectively (figure 2). Regarding the mean level of Triglycerides, readings were higher in females than in males but the differences were not statistically significant (figure 3). Similarly, the mean level of LDL was higher in females than in males but the differences were not statistically significant. The mean LDL decreased from 94.3 and 103.1 to 91.1 and 100.8 in males and females, respectively (figure 4). Differently, the mean level of HDL was significantly higher in females, in both readings, than in males with more than 10 mg/dl difference (figure 5), However, the mean level of HDL increased slightly and non-significantly from the baseline to the follow-up reading with less than 1 mg/dl(table1).

Distribution of the hematological parameters of the T2DM patients based on operational definitions were demonstrated in table 2. As number of the included patients was 100, the frequency is corresponding to the percentage in this table. The percentage of high cholesterol level was 26% in only one reading versus 11% in both readings, respectively. Triglycerides' level was abnormal in few patients as only 4 patients had abnormal level in only one reading and nobody had abnormal level at both readings. Regarding LDL, high levels were reported in a considerable proportion of the patients either in the first or the second reading. About a third of the patients had high LDL level in both readings. Moreover, the level of HbA1c was high in the majority of the patients, however, the percentage of patients with high HbAc1 was dropped slightly from 91% in the first reading compared to 84% in the second reading.

Table 3 and 4 illustrate the association between baseline respondents' characteristics with baseline LDL and follow-up level, respectively. Only baseline T. cholesterol level was significantly associated with bassline level of LDL. About 89% of patients with hypercholesteremia had high level of LDL in comparison to only 26% of those who had normal T. cholesterol level. Other parameters, namely Triglycerides, HDL and HbA1c, had no significant association with LDL at baseline measurement. However, at the follow-up level, significant higher percentages were found in patients with younger age group versus older age group (54.4% versus 25%) or those with hypercholesterolemia versus normal level (90.5% versus 32.9%). Moreover, the bassline level of LDL was significantly associated with follow-up level as approximately 70% of those who had high baseline LDL level continued to have a high LDL at follow-up reading in comparison to 26.3% of those who had normal baseline level.

Differences and correlation between baseline and follow-up levels of hematological parameters among the included T2DM are shown in table 5. Difference between mean baseline and mean follow-up level was only significant in regards to HbAc1 and triglycerides level. LDL, HDL and T. Cholesterol did not differ significantly between mean baseline and follow-up measurements. However, correlation between the mean baseline and follow-up measurements were significant positive correlations with moderate to strong magnitude in each hematological parameter.

Findings of the linear regression model, predicting the effect of patients' characteristics with LDL change-rate, are presented in table 6. Change-rate in T. cholesterol level, change-rate in triglyceride level, and change-rate in HDL level were significant predictors for change-rate in LDL level. Age, gender and HbAc1 change-rate were non-significant predictors for change-rate in LDL.

Discussion:

Diabetic dyslipidemia is known as a high level of T. Cholesterol, triglyceride, or a low level of HDL. Dyslipidemia is associated with a high risk of developing heart diseases and macrovascular diseases, such as stroke, particularly among diabetic patients [14]. Clinical trials found that treating dyslipidemia is an important intervention for prevention of cardiovascular diseases in either diabetic and non-diabetic patients [15,16].

In Saudi Arabia, there is a need to evaluate the magnitude of dyslipidemia and aggravating factors that are associated with dyslipidemia among diabetic patients. Data about dyslipidemia, as a proxy outcome, will be very helpful in predicting future burden of diabetes mellitus in Saudi Arabia [17]. Moreover, there is a scarcity in researches investigating the relation between potential risk factors, such as glycemic control, and dyslipidemia. Hence, this study aimed to assess the patterns of dyslipidemia, particularly LDL level, and its relation with glycemic control among patients with N2DM in Riyadh, Saudi Arabia.

The findings of the present study showed that about a third of the patients had high LDL level in both readings, compared to 21% had low level of HDL. The mean level of LDL was higher in females than in males but the differences were not statistically significant. A higher percentage of diabetic patients (about 45%) had a high level of LDL (≥160) of patients recruited from primary health centers, in Almajmaah region [18]. Alzaheb et al. found a higher prevalence of high LDL (39%) among 400 diabetic patients in Tabuk region [19]

The prevalence of dyslipidemia parameters in the present study was calculated based on two abnormal readings with at least 6 months apart. Hence, it is expected to have a prevalence that much lower than that in studies where patients only had one reading. Moreover, at primary healthcare level, a considerable proportion of diabetic patients are new patients who still have no adequate modification of lifestyle and diet to control their disease.

Several studies in the literature, including Saudi study conducted in Tabuk, found that hypercholesterolemia is the most common lipid abnormality [19,20].

We found an improvement in glycemic control among the included patients when comparing baseline and follow-up level of HbAc1 (8.1% versus 7.8%). Males had significantly lower HbAc1 than females but the gender difference in change rate from baseline to follow-up reading was not significant. This gender difference could be attributed to the difference in age between the recruited males and females since the mean age was about 5 years higher in females. However, similar results revealed by a study, included 1000 diabetic patients, that conducted in King Khalid Hospital. They found that females had a significantly higher HbAc1 level than males, despite the fact that females were significantly younger than males [21].

As the change rate in these hematological parameters could be considered as a rough indicator for the effect of self-control or therapy. This non-significant difference in change-rate of HbAc1, between males and females, is a sign of absence of a real gender difference in regards to glycemic control.

The mean level of HDL, in the present study, was significantly higher in females than in males with more than 10 mg/dl difference. Similarly, researchers in Almajmaah found median HDL level to be significantly higher among females than males with 52.2 versus 39.8 mg/dl [18]. However, this gender difference is commonly seen in regards to HDL and some researchers suggested using different cut-off points for male and female to determine abnormal level of HDL [22].

The findings of the present study revealed that the prevalence of high T. cholesterol level among the included T2DM was 11% in both readings, baseline and follow-up reading, while nobody had abnormal level of triglyceride in the both readings. In Tabuk, Alzaheb et al. found a higher prevalence of high T. Cholesterol as 47.8% of diabetic patients had 200 mg/dl or a higher of T. cholesterol [19]. Interestingly, abnormal triglyceride level was detected in 42.8% of those patients, while the current study had no patients with abnormal triglyceride in two subsequent readings.

In Almajmaah, a very high prevalence was reported as 67.4% of diabetic patients had abnormally high-level o f T. cholesterol (>200 mg/dl). This could be explained by the setting of healthcare from which patients were selected since they selected from primary healthcare in Almajmaah [18]. World Health Organization reported that hypercholesterolemia is prevalent in the Mediterranean region, as it ranked the third in the prevalence of High Cholesterol with 38.4%. In Gulf states, the prevalence of hypercholesterolemia is commonly above 50% of the general population [23]. The prevalence found in the present study is 11% which is much lower than that in gulf states because of an extended time of assessment with two readings at 6 months apart. This is supported by the findings that the prevalence of hyperchloremia in the first reading was 27% among the included diabetic patients.

Concerning gender difference in dyslipidemia, the present study showed that levels of all dyslipidemia parameters were higher in females than in males but significant difference only detected in T. cholesterol and HDL. Similar significant differences between males and female in all dyslipidemia parameters were reported by the study of King Khalid Hospital by Habib et al. [21]. Because of the high statistical power of Habib et al. study, due to large sample of 1000 patients, significant differences are more likely to be detected.

The findings of the linear regression revealed that age, gender and HbAc1 change-rate were non-significant predictors for change-rate in LDL. Differently Alzaheb et al. found that age>40 years old and poor glycemic control were significantly associated with dyslipidemia. However, in Alzaheb et al. study, the dependent variable was an aggregated outcome of all dyslipidemia parameters, while the present study focused on LDL alone.

Limitation of this study is mainly related to relatively small sample size (100 patients) which resulted in wide confidence intervals of hematological estimations. However, statistical power in this study was adequate to detect some significant associations. Change-rate in T. cholesterol level, change-rate in triglyceride level, and change-rate in HDL level were significant predictors for change-rate in LDL level. The change-rate in LDL level increased by 0.89 mg/dl for one unit rise in T. cholesterol change-rate. Moreover, the change-rate in LDL level decreased by 0.36 or 0.54 mg/dl for one unit rise in triglycerides or HDL change-rate, respectively. Each association was estimated after adjusting confounding effects of other predictors using multiple linear regression.

Conclusions:

Based on robust estimations, tow measurements with 6 months apart, a considerable proportion of diabetic patients had abnormal levels of dyslipidemia parameters, particularly LDL level. An improvement in glycemic control was found when comparing baseline and follow-up level of HbAc1. Change-rate in T. cholesterol level, change-rate in triglyceride level, and change-rate in HDL level were significant predictors for change-rate in LDL level. However, age, gender and HbAc1 change-rate were non-significant predictors for change-rate in LDL.

Table (1): Demographic and clinical characteristics of the T2DM patients

Characteristics	Male		Female		P value	Total	
	Mean	SD	Mean	SD		Mean	SD
Age	55.5	6.8	59.0	8.2	0.022*	57.3	7.7
HbA1c							
First reading	7.7	1.2	8.5	1.9	0.014*	8.1	1.7
Second reading	7.3	1.2	8.2	1.6	0.004*	7.8	1.5
Change rate	-0.4	1.2	-0.3	1.8	0.947	-0.4	1.5
T. Cholesterol							
First reading	166.3	45.8	187.6	42.1	0.018*	177.0	45.0
Second reading	159.3	41.1	182.1	35.7	0.004*	170.7	40.0
Change rate	-7.1	42.1	-5.5	39.3	0.844	-6.3	40.5
Trig							
First reading	66.4	32.4	69.2	30.0	0.652	67.8	31.1
Second reading	58.7	27.4	64.6	26.9	0.284	61.7	27.2
Change rate	-7.7	26.8	-4.7	24.5	0.557	-6.2	25.6
LDL							
First reading	94.3	38.9	103.1	34.4	0.234	98.7	36.8
Second reading	91.1	36.6	100.8	30.8	0.154	96.0	34.0
Change rate	-3.2	36.8	-2.3	31.0	0.952	-2.7	33.9
HDL							
First reading	41.0	7.5	52.9	14.4	<0.001*	47.0	12.9
Second reading	41.5	8.4	53.3	13.0	<0.001	47.4	12.4
Change rate	0.4	6.8	0.3	8.6	0.952	0.4	7.7

Table (2): Distribution of the hematological parameters of the T2DM patients based on operational definitions

Parameters	Frequency	Percent (%)
T. Cholesterol		
Abnormal in the first reading	27	27.0
Abnormal in the second reading	21	21.0
Abnormal in only one reading	26	26.0
Abnormal in both readings	11	11.0
Trig		
Abnormal in the first reading	2	2.0
Abnormal in the second reading	2	2.0
Abnormal in only one reading	4	4.0
Abnormal in both readings	-	-
LDL		
Abnormal in the first reading	43	43.0
Abnormal in the second reading	45	45.0
Abnormal in only one reading	28	28.0
Abnormal in both readings	30	30.0
HDL		
Abnormal in the first reading	32	32.0

Abnormal in the second reading	29	29.0
Abnormal in only one reading	19	19.0
Abnormal in both readings	21	21.0
HbA1c		
Abnormal in the first reading	91	91.0
Abnormal in the second reading	84	84.0
Abnormal in only one reading	21	21.0
Abnormal in both readings	77	77.0

Table (3): Association between baseline respondents' characteristics and baseline LDL level

Characteristics	LDL level (cut-off point of LDL≥ 100 mg/dl)		Chi-square	P value
	Normal	High		
Gender				
Female	27	23	0.37	0.545
	54.0%	46.0%		
Male	30	20		
	60.0%	40.0%		
Age				
≤60	35	33	2.65	0.103
	51.5%	48.5%		
>60	22	10		
	68.8%	31.3%		
T. Cholesterol				
Normal	54	19	31.78	<0.001*
	74.0%	26.0%		
Hypercholesterolemia	3	24		
	11.1%	88.9%		
Trig				
Normal	55	43	1.54	0.215
	56.1%	43.9%		
hypertriglyceridemia	2	0		
	100.0%	0.0%		
HDL				
Normal	37	31	0.58	0.446
	54.4%	45.6%		
Low HDL	20	12		
	62.5%	37.5%		
HbA1c				
Normal	5	4	0.01	0.927
	55.6%	44.4%		
High level	52	39		
	57.1%	42.9%		

Table (4): Association between follow-up respondents' parameters and follow-up LDL level

Characteristics	LDL level (cut-off point of LDL≥ 100 mg/dl)		Chi-square	P value
	Normal	High		
Gender				
Female	26	24	0.36	0.546
	52.0%	48.0%		
Male	29	21		
	58.0%	42.0%		
Age				
≤60	31	37	7.6	0.006*
	45.6%	54.4%		
>60	24	8		
	75.0%	25.0%		
T. Cholesterol				
Normal	53	26	22.2	<0.001*
	67.1%	32.9%		
Hypercholesterolemia	2	19		
	9.5%	90.5%		
Trig				
Normal	54	44	0.02	0.886
	55.1%	44.9%		
hypertriglyceridemia	1	1		
	50.0%	50.0%		
HDL				
Normal	36	35	1.83	0.177
	50.7%	49.3%		
Low HDL	19	10		
	65.5%	34.5%		
HbA1c				
Normal	8	8	0.19	0.661
	50.0%	50.0%		
High level	47	37		
	56.0%	44.0%		
Baseline LDL				
Normal	42	15	18.7	<0.001*
	73.7%	26.3%		
High LDL	13	30		
	30.2%	69.8%		

Table (5): Differences and correlation between baseline and follow-up levels of hematological parameters among the included T2DM

Parameters	Mean	SD	p value (Paired sample t-test)	Correlation	p value (For correlation)
HbA1c					
Baseline level	8.1	1.7	0.021*	0.54	<0.001*
Follow-up level	7.8	1.5			
T. Cholesterol					
Baseline level	177.0	45.0	0.124	0.55	<0.001*
Follow-up level	170.7	40.0			
Trig					
Baseline level	67.8	31.1	0.018*	0.62	<0.001*
Follow-up level	61.7	27.2			
LDL					
Baseline level	98.7	36.8	0.420	0.55	<0.001*
Follow-up level	96.0	34.0			
HDL					
Baseline level	47.0	12.9	0.626	0.81	<0.001*
Follow-up level	47.4	12.4			

Table (6): Findings of the linear regression model predicting the effect of patients' characteristics with LDL change-rate

Predictor	Lower limit (95% C.I)	Risk difference	Upper limit (95% C.I)	p value
Gender	-3.85	0.52	4.90	0.815
Age	-0.29	0.002	0.29	0.988
Change-rate in HbA1c	-0.89	0.62	2.12	0.422
Change-rate in T. Cholesterol	0.82	0.89	0 .96	<0.001*
Change-rate in Trig	-0.46	-0.36	-0.26	<0.001*
Change-rate in HDL	-0.86	-0.54	-0.21	<0.001*

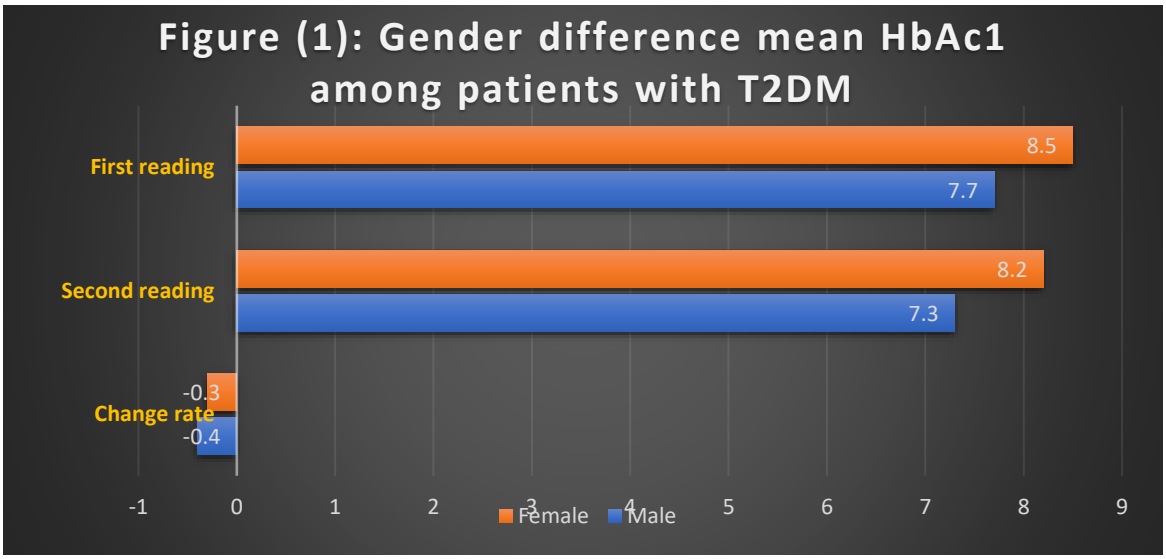


Figure (1): Gender difference mean HbAc1 among patients with T2DM
First reading
Second reading
Change rate
8.5
7.7
8.2
7.3
-0.3
-0.4
-1
0
1
2
3
4
5
6
7
8
9
Female
Male

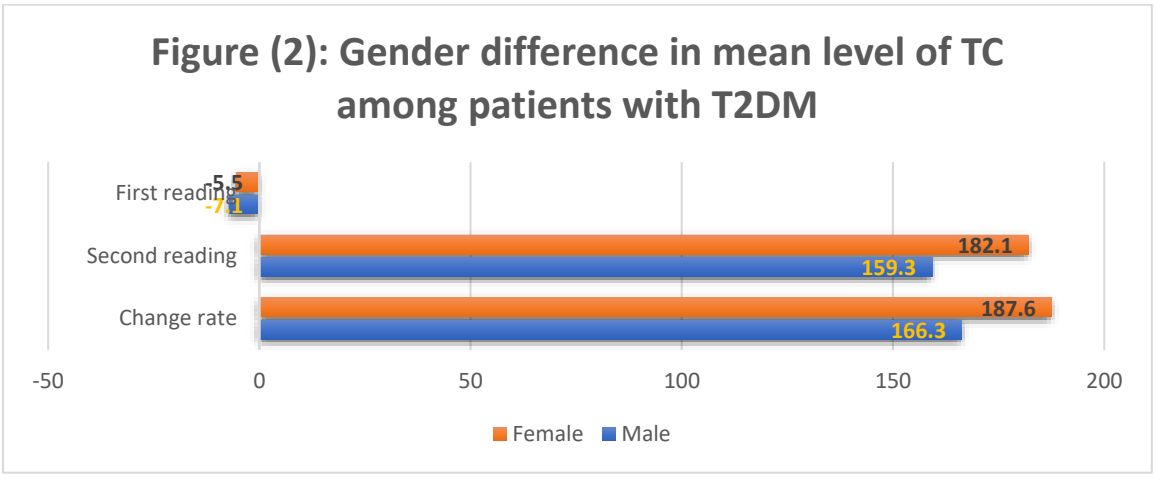


Figure (2): Gender difference in mean level of TC among patients with T2DM
First reading
Second reading
Change rate
-5.5
-7.1
182.1
159.3
187.6
166.3
-50
0
50
100
150
200
Female
Male

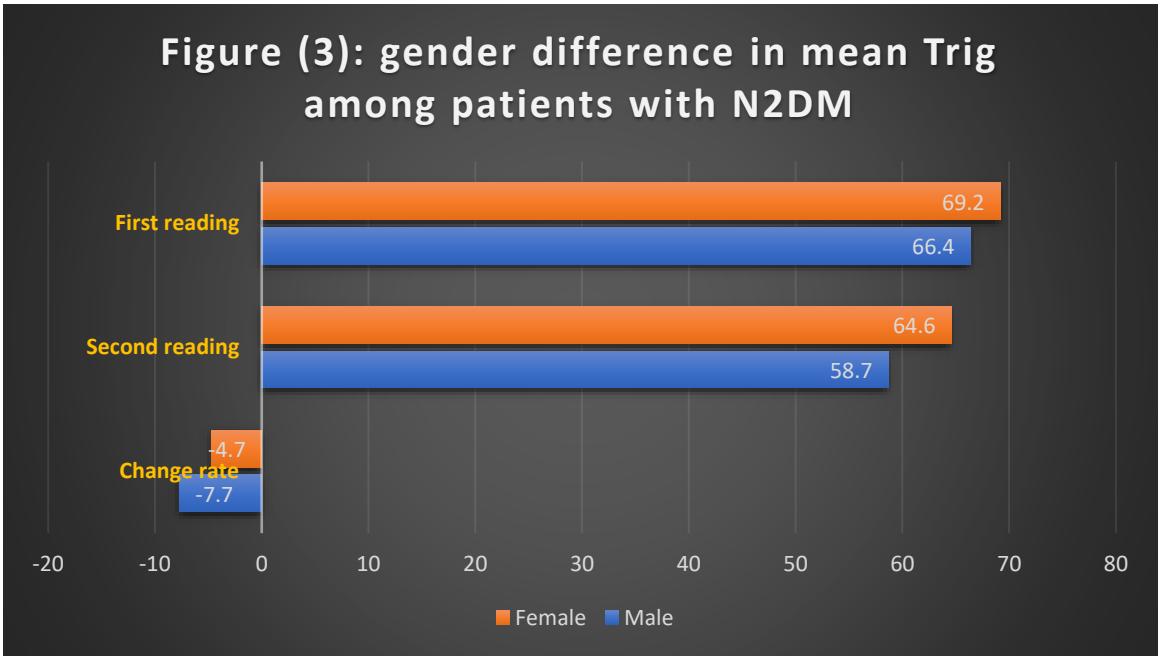
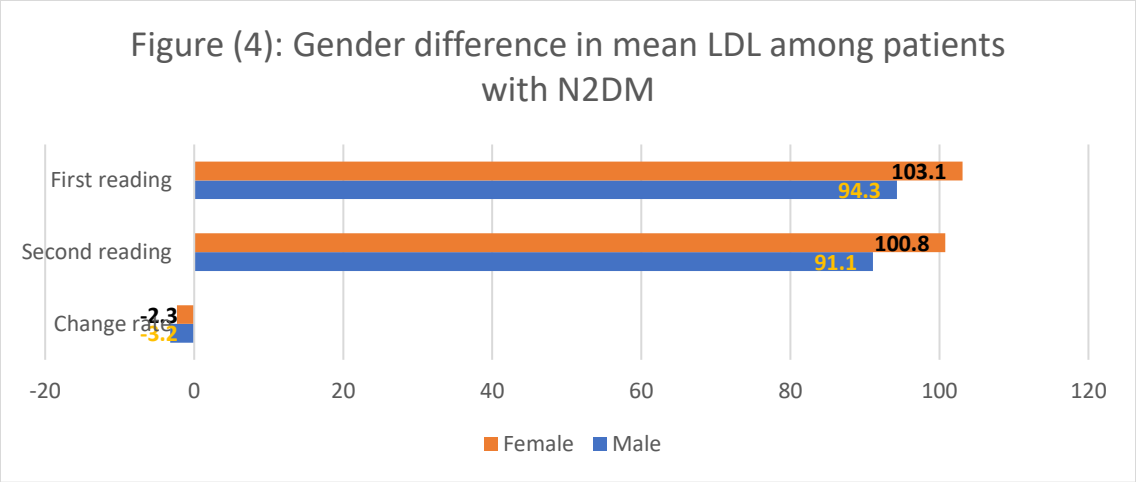
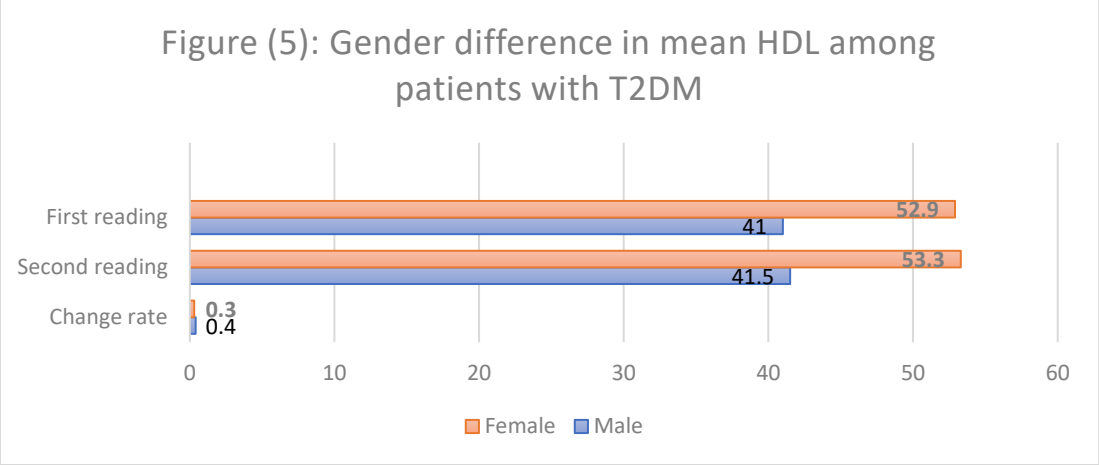


Figure (3): gender difference in mean Trig among patients with N2DM
First reading
Second reading
Change rate
69.2
66.4
64.6
58.7
-4.7
-7.7
-20
-10
0
10
20
30
40
50
60
70
80
Female
Male





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