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Study of dyslipidemia in blood serum and sweat fluid of men with diabetic nephropathy in Mosul city

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Abstract
The objective of this study was the determine Creatinine, eGFR, Total cholesterol (TC), Triglycerides (TG), High Density lipoproteins-cholesterol (HDL-C), low Density lipoproteins-cholesterol (LDL-C), Very Low-Density lipoproteins-cholesterol (VLDL-C) and Atherogenic Index (AI) in Serum Blood and Sweat fluid. The results showed increased in Creatinine, Total cholesterol, Triglycerides, very low-Density lipoproteins-cholesterol and Atherogenic Index in Serum and Sweat fluid. Also, increased in low Density lipoproteins-cholesterol in Serum and Decline in eGFR and High-Density lipoproteins cholesterol in Diabetic type 2 without Nephropathy group and all stages of Diabetic Nephropathy comparison with control group. (The deference between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy were significant at p0.05).

Keywords: Diabetic nephropathy, dyslipidemia, sweat fluid

Introduction
Diabetic Nephropathy (DN) is one of the principal long-term micro vascular complications of Diabetes Mellitus (DM) Types1 and Types2, It remains a leading cause of End Stage Renal Disease (ESRD) in the United states and elsewhere requiring renal replacement therapy (Xu *et al.*, 2022) [1], The rising incidence and prevalence of DM worldwide creates a pressing need for earlier diagnosis and effective treatment of DM and its complications including DM. Diabetic Nephropathy is considered to be progressive disease characterized by significant urinary protein excretion, hyper filtration and decline of the glomerular filtration rate, leading eventually to renal failure (Lu *et al.*, 2020) [2]. Dyslipidemia is an important clinical abnormality seen in patients with diabetes mellitus.
The characteristic features of diabetic dyslipidemia are high concentration TG, LDL-C, VLDL-C and AI and low concentration HDL-C. Insulin resistance leads to mobilization of free fatty acid from adipose tissue to liver which causes increased TG production (Packard, 2003) [3]. Dysfunction of lipoprotein lipase due to long-standing diabetes would further increase TG level causing accumulation of large TG rich LDL-C in type2 diabetes mellitus (T2DM) patients, they still have a preponderance of atherogenic LDL-C particles (Haffner, 2003) [4]. Dyslipidemia is shown to accelerate the rate of renal damage leads to progressive loss of renal function among Diabetic Nephropathy, that lipids may damage vascular, mesangial and tubular cell of kidneys (Trevisan *et al.* 2006) [5]. Sweat Glands They are a type of exocrine glands that produce and secrete substances on the surface of the epithelial cells of the epidermis through ducts, which are small tubular structures of the skin that produce sweat fluid (Hayakawa *et al*, 2022) [6].
There are three main types of sweat glands: Eccrine sweat glands. Apocrine sweat glands and Apoeccrine sweat glands (Jana & Dimitros, 2022) [7]. Three basic roles of eccrine glands include: Regulating body temperature Sweat plays an important role in maintaining and controlling body temperature through heat loss by evaporation, which leads to cooling the surface of the skin and
reducing body temperature (Urso *et al*., 2018) [8], Excretion of fluids These glands can provide an important pathway for the excretion of water, electrolytes and nitrogenous waste and Protection These glands help maintain the skin's acid mantle which helps protect the skin from bacterial colonization and other disease-causing organisms (Kbashima *et al*., 2019) [19]. Sweat fluid it is a fluid secreted by the sweat glands to regulate body temperature and remove harmful waste products by secreting water, sodium salts, and nitrogenous wastes such as urea onto the surface of the skin.

Eccrine sweat glands Eccrine sweat glands A clear (Baker & Wolfe, 2020) [10] odorless liquid containing mainly water 99-98% as well as sodium chlorid, Lactate, amino acids, glucose, fatty acids, lipids, steroids, uric acid, citric acid, ascorbic acid and calcium bicarbonate constitute approximately 1% of the total amounts of sweat proteins such as immunoglobulins (proteins that act as antibodies) and glycoproteins (Baker & Wolfe, 2020) [10], the acidity of the sweat fluid ranges between 4-6 (Barnes *et al*., 2019) [27]

Materials and Methods

Subjects

The study was conducted from July to October 2021 included (150) men aged between (45 to 65) year, (20) of them wear Healthy men as (control) the first Not suffering from any diseases and (16) of them wear Diabetic type 2 without Diabetic Nephropathy and (114) patients with Diabetic Nephropathy. The Diabetic Nephropathy patients wear divided in to five stages (Stage 1, Stage 2, Stage 3 A, Stage B, Stage 4, Stage 5).

Collection of blood samples

Blood samples (10 ml) wear collected from 10-12 h from fasted men. Serum samples wear separated and stored in capped tubes under (-20) to be used later.

Collection of Sweat fluid samples

The facial area was thoroughly cleaned with water and dried immediately before starting the experiment. The subjects were allowed to stay in ambient temperature ranging from 40-45 ˚C. Which is the normal day temperature during the Iraqi summer months. After 2-3 minutes drops of sweat accumulated on the skin of the subjects and were immediately withdrawn with a syringe 5 ml of sweat were collected in this way. Samples were then divided into 2-3 portions and kept in thoroughly washed capped glass tubes (rinsed times with distilled water and dried). They were then kept frozen at (-20 °C) to be used later.

Estimation of creatinine in serum and sweat fluid

Creatinine concentration was estimated by using read- made analysis (kit) from French company BIOLABO based Colorimetric reaction (Jaffe reaction) of creatinine with alkaline picrate (Tietz *et al.*, 1999) [11].

Estimation glomerular filtration Rate (eGFR) in serum

The eGFR is calculated by using the MDRD Study Equation (National Kidney foundation) eGFR = 175 × (standardized S_{cr})$^{-1.154}$ × (age)$^{-0.203}$ × 0.742 [if female] ×1.212 [if Black] (Levey *et al.* 2007) [12]

Estimation of total cholesterol (TC) in serum and sweat fluid

Total cholesterol concentration was estimated by using read-made analysis (kit) from French company BIOLABO based on the enzymatic method (Young, 1995) [14, 29].

Estimation of triglycerides (TG) in serum and sweat fluid

Triglycerides concentration was estimated by using read-made analysis (kit) from French company BIOLABO based on the enzymatic method (Fossati & Prencipe, 1982) [15].

Estimation of high density lipoproteins-cholesterol (HDL-C) in serum and sweat fluid

of High Density lipoproteins-cholesterol concentration was estimated by using read- made analysis (kit) from French company BIOLABO based on the sedimentation method (Young, 1995) [14, 29].

Estimation of low Density lipoproteins-cholesterol (LDL-C) in serum

By using fried Ewald equation LDL-C was calculated (Friedewald *et al*., 1972) [17]

LDL Conc. (mg/dl) = Conc. Of Cholesterol – HDL Conc. – TG/5

Estimation of very low density lipoproteins-cholesterol (VLDL-C) in serum and sweat fluid

The VLDL-C is calculated by using the following equation (Osei-Yeboah *et al*., 2017) [18]

VLDL Conc. (mg/dl) = Triglycerides/5

Estimation of atherogenic index (AI) in serum and sweat fluid

The Atherogenic Index is calculated by using the following equation (Osei-Yeboah *et al*, 2017) [18]. Atherogenic Index (AI) = TC/HDL-C

Statistical analysis

The result was analyzed statistically by mean of the statistical program SPSS 26 the data were statically analyzed according to the analysis of variance (ANOVA) TEST using the statistical program and the arithmetic means were compared using Duncan Multiple Range Test and below the level of significance $p \leq 0.05$.

Results and Discussion

Concentration of Creatinine in Serum and Sweat fluid

Table 1: Comparison of Creatinine Concentration in serum and sweat fluid between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (Creatinine µmol/L)							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	61.350±0.743 A	61.933±0.593 A	76.671±0.731 B	92.885±1.430 C	117.703±1.908 D	148.167±5.452 E	244.864±6.869 F	698.727±17.583 G
N	20	16	21	46	16	8	8	15
Sweat	54.780±0.990 A	55.291±1.417 A	67.850±1.204 B	80.070±0.851 C	99.741±1.895 D	123.100±2.741 E	151.500±3.145 F	198.000±4.648 G
N	16	10	12	16	10	8	8	10
Serum/sweat	1.119	1.120	1.130	1.160	1.180	1.204	1.616	3.529

*The different letters in the serum and sweat fluid rows show that there are differences that are significant at the level $p \leq 0.05$.

*Similar letters in the serum and sweat fluid rows show that there are no significant differences

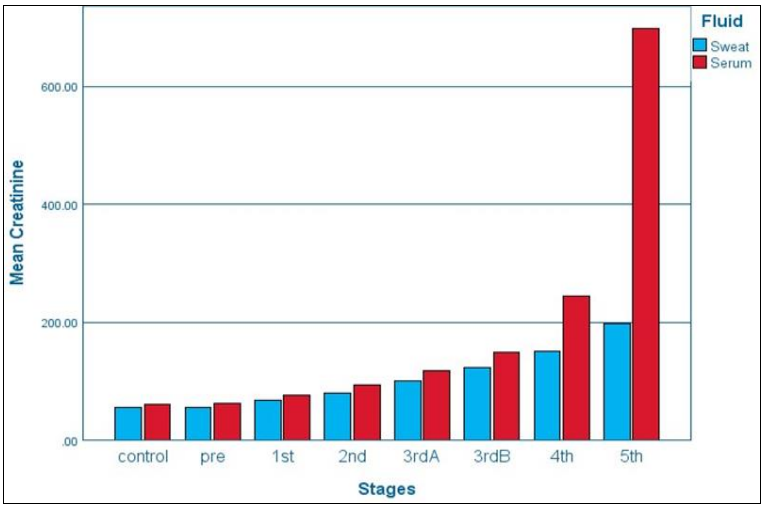

Fig 1: Concentration of Creatinine in Serum and Sweat fluid

The results in the table (1) show that serum and sweat fluid Creatinine in Diabetic without Nephropathy group and all stages of Diabetic Nephropathy was higher than the control group

The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum and sweat fluid was significant at $p \leq 0.05$ except differences between control group and Diabetic without Nephropathy group in serum and sweat fluid was not significant. This result agree with (Badawy Othman *et al*., 2021) [19] which indicates that the level of creatinine in blood serum increases in the stages of diabetic nephropathy as a result of a loss in kidney function. this result agree with (Al-Tamer & Hadi. 1997) [20] The level of creatinine in sweat fluid was lower than serum This is because sweat fluid is filtered from the blood and the amount of creatinine that is excreted in sweat depends on the concentration of creatinine in the blood and the permeability of the sweat gland to creatinine molecules.

The secretion of creatinine by this concentration in the sweat fluid helps the body to get rid of the high concentrations of creatinine that are harmful to the body, especially in patients with kidney disease and failure, as the role of the sweat glands compensates for the imbalance that occurs in kidney functions.

Estimation Glomerular filtration Rate (eGFR) in Serum

Table 2: comparison of Estimation Glomerular filtration Rate in serum between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE GFR mL/min/1,73m2L							
groups	Healthy	Diabetic without Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	124.500±0.555 A	122.333±0.422 A	93.000±0.859 B	73.860±1.317 C	55.313±0.850 D	42.167±1.701 E	23.375±0.800 F	7.364±0.244 G
N	20	16	21	46	16	8	8	15

*The different letters in the serum rows show that there are differences that are significant at the level $p \leq 0.05$.

*Similar letters in the serum rows show that there are no significant differences.

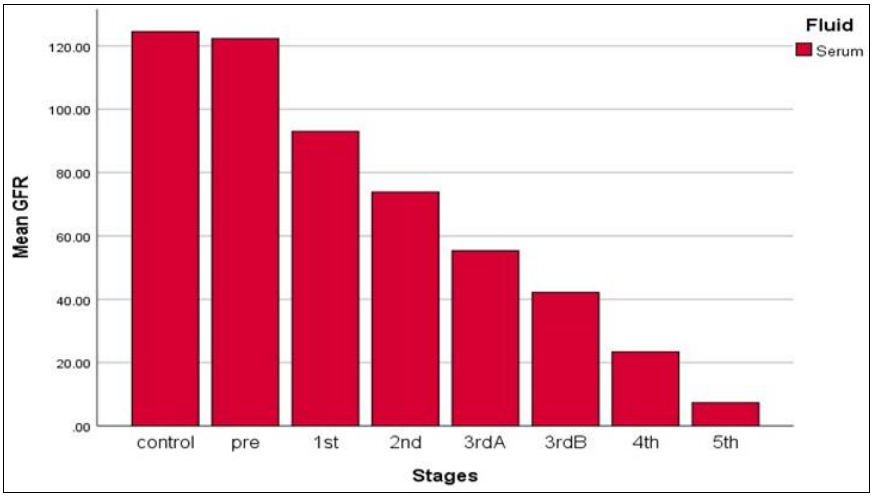

Fig 2: value eGFR in Serum

The result in the table (2) show that serum eGFR in Diabetic without Nephropathy group and all stages Diabetic Nephropathy was lower than the control group. The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum was significant at $p \leq 0.05$ except differences between control group and Diabetic without Nephropathy group in serum and was not significant diabetic nephropathy is evidenced by decline in glomerular function rate (eGFR) this result agree with (Li *et al*., 2020) [21].

Concentration of total cholesterol (TC) in serum and sweat fluid

Table 3: comparison of Total cholesterol in serum and sweat fluid between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (TC) mg/dL							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	143.594±2.857 A	160.310±2.839 B	176.640±2.158 C	185.020±1.343 D	197.110±2.606 E	205.119±4.178 F	221.018±2.571 G	236.811±1.322 H
N	20	16	21	46	16	8	8	15
Sweat	4.871±0.075 A	5.390±0.123 B	5.980±0.129 C	6.381±0.110 CD	6.780±0.193 D	7.280±0.261 E	7.800±0.177 F	8.300±0.209 G
N	16	10	12	16	10	8	8	10
Serum/Sweat	29.479	29.742	29.538	28.995	29.072	28.176	28.336	28.531

*The different letters in the serum and sweat fluid rows show that there are differences that are significant at the level $p \leq 0.05$.
*Similar letters in sweat fluid rows show that there are no significant differences

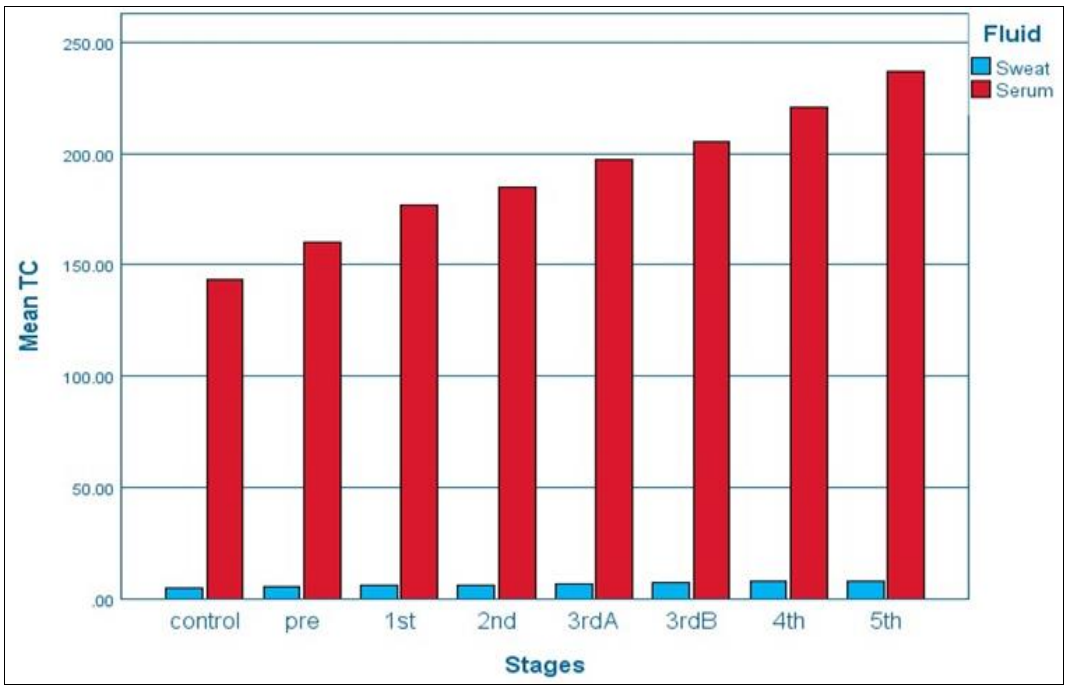

Fig 3: Concentration of Total cholesterol (TC) in Serum and Sweat fluid

The results in the table (3) show that serum and sweat fluid total cholesterol in Diabetic without Nephropathy group and all stages of Diabetic Nephropathy was higher than the control group.

The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum and sweat fluid was significant at $p \leq 0.05$ except differences between stage 1and stage2 and between stage2 and stage3A of Diabetic Nephropathy in sweat fluid was not significant. This result agree with (Mitrofanova *et al*., 2020) [22] Which indicates that the level of cholesterol increases in the serum of diabetic patients as a result of the abnormal metabolism of lipoproteins It affects the impairment of kidney function and metabolic control, and leads to sclerosis of the renal glomeruli and damage to blood vessels and msangel cells. We also noticed this increase in the level of cholesterol in the sweat fluid, because the sweat fluid is the filter from the blood, and the permeability of the sweat gland to cholesterol leads to its secretion in these concentrations.

The secretion of cholesterol through thermal sweating is of great benefit to the body to get rid of high concentrations of cholesterol and thus to maintain the health of the arteries and blood vessels and reduce the incidence of heart disease.

Concentration of triglycerides (TG) in serum and sweat fluid

Table 4: comparison of triglycerides in serum and sweat fluid between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (TG) mg/dL							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	94.828±2.271 A	188.708±4.837 B	194.463±4.278 BC	202.285±2.508 C	219.676±2.425 D	238.552±8.016 E	257.219±6.063 F	275.708±4.048 G
N	20	16	21	46	16	8	8	15
Sweat	350.106±5.848 A	559.187±16.264 B	569.54±11.642 BC	601.688±10.556 C	641.750±15.694 D	689.167±20.173 E	732.750±17.064 F	777.500±15.791 G
N	16	10	12	16	10	8	8	10
Sweat/Serum	3.692	2.963	2.929	2.974	2.921	2.889	2.849	2.820

*The different letters in the serum and sweat fluid rows show that there are differences that are significant at the level $p \leq 0.05$.
*Similar letters in the serum and sweat fluid rows show that there are no significant differences

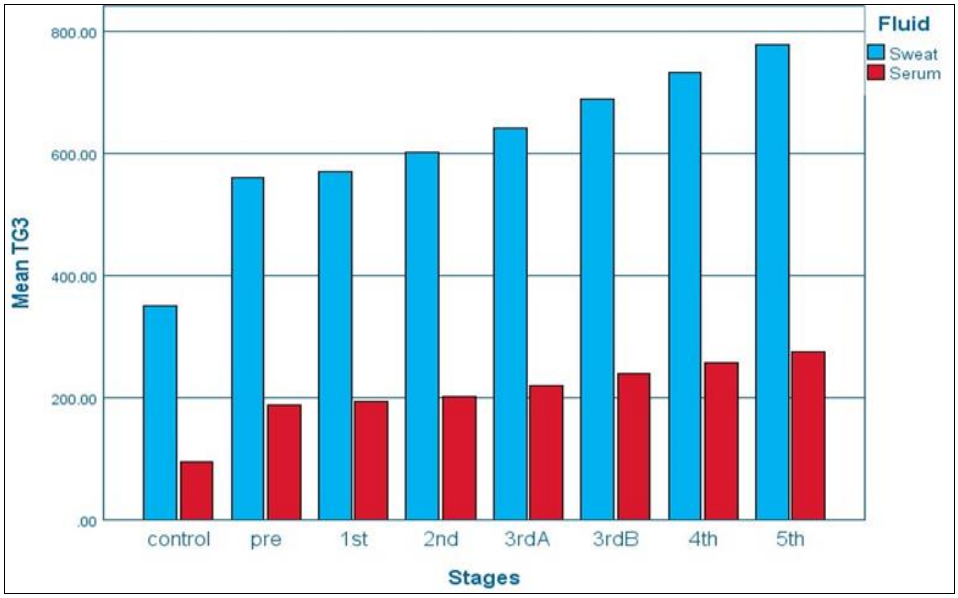

Fig 4: Concentration of triglycerides in Serum and Sweat fluid

The results in the table (4) show that serum and sweat fluid triglycerides in Diabetic without Nephropathy group and all stages of Diabetic Nephropathy was higher than the control group.

The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum and sweat fluid was significant at $p \leq 0.05$ except differences between stage1 of Diabetic Nephropathy and Diabetic without Nephropathy group and between stage1 and stage2 of Diabetic Nephropathy in serum and sweat fluid was not significant. This result agree with (Eid *et al.*, 2019) [2] The level of triglycerides increases in the serum of patients with type 2 diabetes due to insulin resistance, which leads to the movement of fatty acids to the liver and the dysfunction of lipoprotein lipase. Because the insulin hormone promotes the absorption of fatty acids by muscles and adipose tissue, the rise in triglycerides affects the tubular cells and the lining of blood vessels, and the narrowing of the renal artery It results in impaired renal function.

We also noticed this increase in the level of triglycerides in the sweat fluid more. From serum, as well as treatment of obesity and getting rid because the sweat fluid is a filter from the blood, as well as the permeability of the sweat gland of the triglycerides leads to its secretion in these concentrations.

Excretion of triglycerides through thermal sweating has a great benefit for the body to get rid of excess weight, as an example of treatment by using sauna baths

Concentration of high density lipoproteins -cholesterol (HDL-C) in serum and sweat fluid

Table 5: comparison of High Density lipoproteins -Cholesterol in serum and sweat fluid between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (HDL-c) mg/dL							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	55.288±0.884 A	43.557±0.587 B	39.616±0.550 C	36.556±0.308 D	33.021±0.396 E	29.169±0.747 F	25.708±0.499 G	21.535±0.402 H
N	20	16	21	46	16	8	8	15
Sweat	5.408±0.071 A	2.782±0.055 B	2.601±0.049 C	2.450±0.036 CD	2.290±0.054 D	2.110±0.069 E	1.170±0.024 F	0.999±0.020 G
N	16	10	12	16	10	8	8	10
Serum/Sweat	10.223	15.657	15.231	14.921	14.420	13.824	21.973	21.557

*The different letters in the serum and sweat fluid rows show that there are differences that are significant at the level $p \leq 0.05$.
*Similar letters in sweat fluid rows show that there are no significant differences

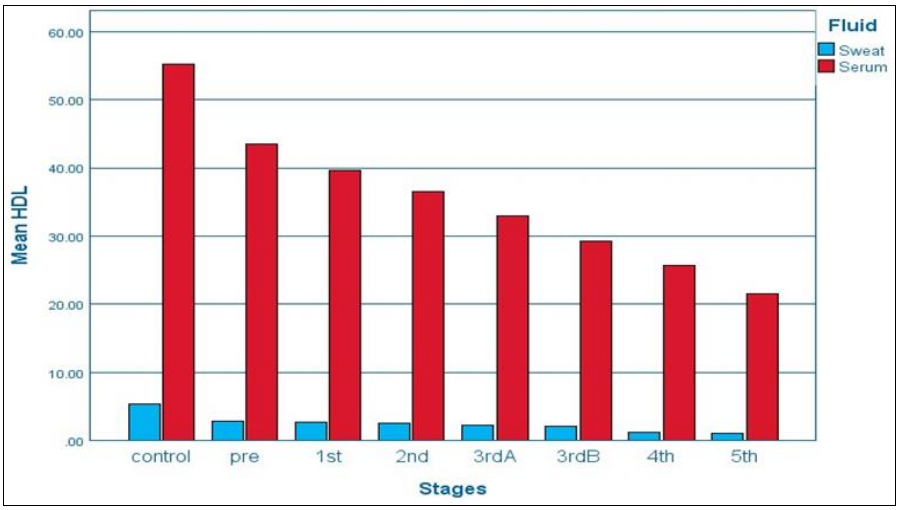

Fig 5: Concentration of High

Density lipoproteins cholesterol in serum and sweat fluid

The result in the table (5) show that serum and sweat fluid High Density lipoproteins -Cholesterol in Diabetic without Nephropathy group and all stages Diabetic Nephropathy was lower than the control group. The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum and sweat fluid was significant at $p \leq 0.05$ except differences between stage 1and stage2 and between stage2 and stage3A of Diabetic Nephropathy in sweat fluid was not significant.

this result agree with (Russo *et al*., 2020) [30] This leads to a decrease in high-density lipoproteins of cholesterol in the blood serum of patients with type 2 diabetes as a result of hyperlipidemia, and this leads to damage to the body because the high-density lipoproteins of cholesterol work to capture excess cholesterol in the blood to the liver, and when it decreases, cholesterol increases in the blood and thus is deposited on the surface of the arteries. And other blood vessels leading to the condition of atherosclerosis.

We also noticed this decrease in the level of high-density lipoproteins of cholesterol in the sweat fluid, because the sweat fluid is a filter from the blood, as well as the permeability of the sweat gland of high-density lipoproteins leads to its secretion in these concentrations.

Concentration of low density lipoproteins -cholesterol (LDL-C) in Serum

Table 6: comparison of Low Density lipoproteins -Cholesterol in serum between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (LDL-c) mg/dL							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	69.340±2.951 A	79.011±2.798 B	98.131±2.137 C	108.031±1.244 D	120.155±2.552 E	128.239±5.222 F	143.866±2.559 G	160.134±1.168 H
N	20	16	21	46	16	8	8	15

*The different letters in the serum rows show that there are differences that are significant at the level P ≤ 0.05.

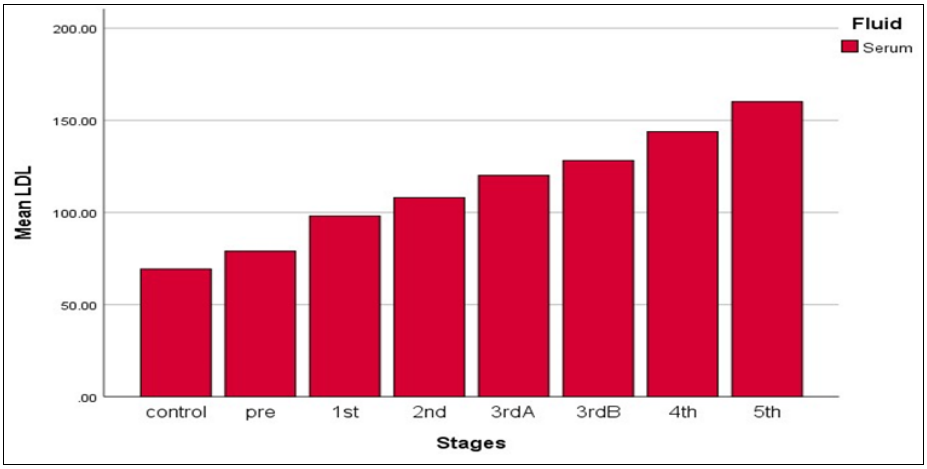

Fig 6: Concentration of low Density lipoproteins -Cholesterol in serum

The results in the table (6) show that serum Low Density lipoproteins -Cholesterol in Diabetic without Nephropathy group and all stages of Diabetic Nephropathy was higher than the control group.

The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in

serum and sweat fluid was significant at $p \leq 0.05$.
Serum LDL-C was calculated without sweat fluid because Friedwald's equation does not apply when TG is greater than 400 mg/dL. This result agree with (Palazhy & Viswanathan 2017) [25] this leads to a increased in Low density lipoproteins of cholesterol in the blood serum of patients with type 2 diabetes

Concentration of very low density lipoproteins -cholesterol (VLDL-C) in serum and sweat fluid

Table 7: comparison of Very Low Density lipoproteins -Cholesterol in serum and sweat between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (VLDL-c) mg/dL							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	18.966±0.454 A	37.742±0.967 B	38.893±0.856 BC	40.433±0.501 C	43.935±0.485 D	47.710±1.603 E	51.444±1.213 F	55.142±0.810 G
N	20	16	21	46	16	8	8	15
Sweat	70.021±1.170 A	111.837±3.253 B	113.908±2.328 BC	120.338±2.111 C	128.350±3.139 D	137.833±4.035 E	146.550±3.413 F	155.500±3.158 G
N	16	10	12	16	10	8	8	10
Sweat/Serum	3.692	2.963	2.929	2.976	2.921	2.889	2.849	2.820

*The different letters in the serum and sweat fluid rows show that there are differences that are significant at the level $P \leq 0.05$.
*Similar letters in the serum and sweat fluid rows show that there are no significant differences

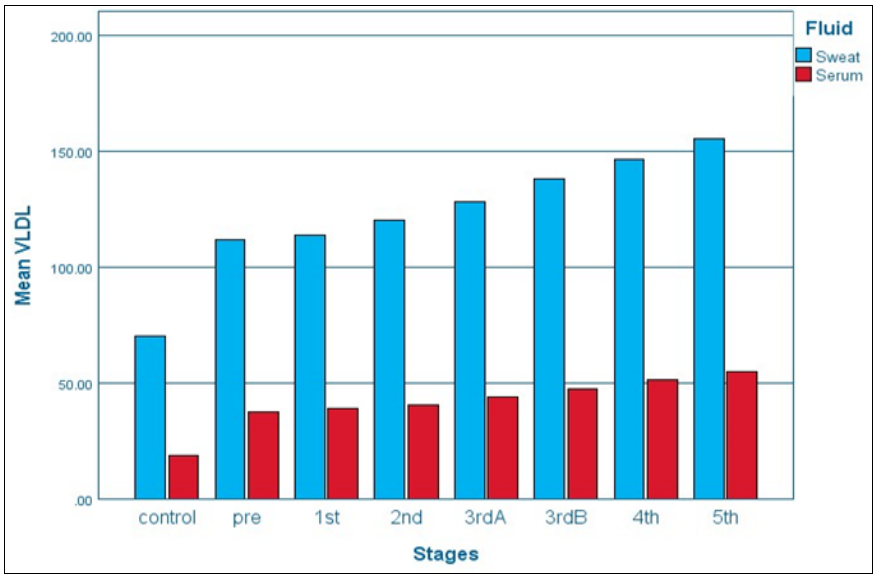

Fig 7: Concentration of Very low Density lipoproteins -Cholesterol in serum and sweat fluid

The results in the table (7) show that serum and sweat fluid very Low Density lipoproteins -Cholesterol in Diabetic without Nephropathy group and all stages of Diabetic Nephropathy was higher than the control group.
The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum and sweat fluid was significant at $p \leq 0.05$. Except differences between stage 1and Diabetic without Nephropathy group and between stage1 and stage2 of Diabetic Nephropathy in serum and sweat fluid was not significant.
this result agree with (Palazhy & Viswanathan 2017) [25] This leads to an increase in serum very-low-density ipoproteins (VLDL) cholesterol in patients with T2DM as a result of increased TG

Atherogenic index in serum and sweat fluid

Table 8: comparison of Atherogenic Index in serum and sweat between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy

	Mean ± SE (AI) mg/dL							
groups	Healthy	Diabetic with out Nephropathy	Diabetic Nephphropathy (DN)					
	Control	Pre	1st	2nd	3rd(A)	3rd(B)	4th	5th
Serum	2.611±0.078 A	3.689±0.079 B	4.473±0.075 C	5.072±0.046 D	5.983±0.109 E	7.057±0.235 F	8.616±0.165 G	11.032±0.198 H
N	20	16	21	46	16	8	8	15
Sweat	0.900±0.004 A	1.943±0.060 B	2.315±0.093 BC	2.623±0.083 CD	2.986±0.155 D	3.489±0.238 E	6.705±0.276 F	8.358±0.375 G
N	16	10	12	16	10	8	8	10
Serum/Sweat	2.901	1.899	1.932	1.934	2.004	2.023	1.285	1.320

*The different letters in the serum and sweat fluid rows show that there are differences that are significant at the level $P \leq 0.05$.
*Similar letters in sweat fluid rows show that there are no significant differences

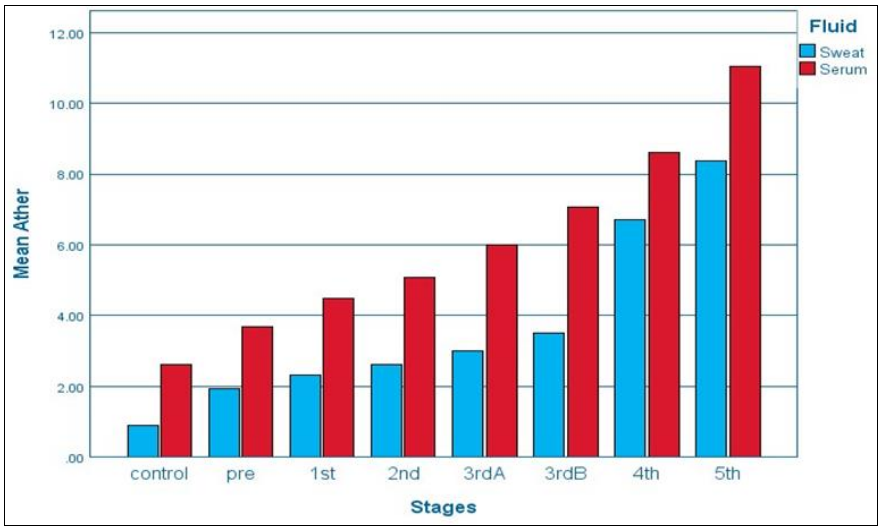

Fig 8: Value of Atherogenic Index in serum and sweat fluid

The results in the table (8) show that serum and sweat fluid Athrogenic in Diabetic without Nephropathy group and all stages of Diabetic Nephropathy was higher than the control group. The differences between control group and Diabetic without Nephropathy group and all stages of Diabetic Nephropathy in serum and sweat fluid was significant at $P \leq 0.05$ except differences between stage 1and Diabetic without Nephropathy group and between stage1 and stage2 and between stage2 and stage 3A of Diabetic Nephropathy in sweat fluid was not significant. This result agree with (Huang *et al*., 2021) [26] Who confirmed that the coefficient of atherogenicity increases in patients with diabetes and its complications in the blood serum as a result of the increase in triglycerides and cholesterol and increases the risk of a significant decrease in kidney function and helps in a decrease in the glomerular filtration rate (eGFR).

Conclusions

Dysglycemia among diabetic patients increases the speed of renal damage caused by dyslipidemia and thus works Dyslipidemia to a gradual loss of renal function among diabetic patients through damage to the blood vessels, mesangial and tubular cells of the kidneys.

The renal function deterioration was significant among diabetic patients with high cholesterol and triglycerides and low HDL-C. We noticed increase in the level of triglycerides in the sweat fluid more. From serum, has a benefit treatment of obesity and weight loss and protect the kidneys from damage. The secretion of creatinine by this concentration in the sweat fluid helps the body to get rid of the high concentrations of creatinine that are harmful to the body, especially in patients with kidney disease and failure, as the role of the sweat glands compensates for the imbalance that occurs in kidney functions. Creatinine the blood measurements are readily available tests for this purpose, which can help in the early detection and prevention of diabetic kidney disease and can slow end-stage renal disease (ESRD) development.

Conflict of Interest

Not available

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