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Original Article

Impact of Weight Reduction on Glycemic Control and Glomerular Filtration Rate Among Patients with Type 2 Diabetic Nephropathy

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Abstract:

BACKGROUND: Diabetic nephropathy is a microvascular diabetic complication affecting about 40% of diabetic patients all over the world.
OBJECTIVE: This study aimed to measure oxidative stress, systemic inflammation and kidney function response to exercise training in type 2 diabetes mellitus (T2DM) nephropathy patients.
MATERIAL AND METHODS: Seventy patients T2DM (42 males and 28 females), body mass index (BMI) mean was 32.96 ± 3.25 Kg/m2and the mean of diabetes chronicity was 13.17 ± 2.18 year and enrolled two groups; group I: practiced aerobic exercise training & diet regimen) and group II: practiced no training or diet regimen intervention.
RESULTS: There were significant reduction in the mean values of body mass index (BMI), glycosylated hemoglobin (HBA1c), Homeostasis Model Assessment-Insulin Resistance Index) HOMA-IR) , insulin, estimated glomerular filtration rate (eGFR) and creatinine, in the other hand there were significant increase in the mean values of the quantitative insulin-sensitivity check index (QUICKI) in patients of group (A) as a result of weight reducing program, in the other hand the results of the control group (B) were not significant (P<0.05).
CONCLUSION: Weight reducing program modulated glycemic control and renal function of patients with type 2 diabetic nephropathy.

Keywords:
Glomerular Filtration; Glycemic Control; Diabetic Nephropathy; Weight Reduction.

Introduction

Diabetic nephropathy (DN) affecting about 40% of diabetic patients [1,2]. Moreover, DN is a microvascular diabetic complication lead to renal replacement [3,4], where abnormal metabolic control [5] usually associated with abnormal systemic inflammation and oxidative stress induce progressive kidney dysfunction among diabetics [6,7]. In a previous meta-analysis study that involved 13 previous study that included two previous randomized studies, they proved that non-operative weight reducing programs reduced blood pressure

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and proteinuria which indicated prevention of further kidney damage [8,9]. Lifestyle intervention modification is a recommended line of treatment for type 2 diabetes mellitus (T2DM) [10]. Therefore, this study wasdesigned to measure the impact of weight reduction on glycemic control and glomerular filtration rate among patients with type 2 diabetic nephropathy.

Materials and Methods

Subjects

Seventy patients T2DM (42 males and 28 females), body mass index (BMI) mean was 32.96 ± 3.25 Kg/m2 and the mean of diabetes chronicity was 13.17 ± 2.18 year and enrolled two groups; group I: practiced aerobic exercise training & diet regimen) and group II: practiced no training or diet regimen intervention. Patients with heart failure, renal failure, hepatitis, pregnant and smokers were excluded from participation in this study.

Measurements

Laboratory analysis

A. Glucose control: Serum glucose was measured with Hitachi 912 Chemistry Analyzer, while serum insulin was measured with cobas immunoassay analyzer (Roche Diagnostics). In addition, Homeostasis model assessment (HOMA-IR) was the formula used to assess insulin resistance [11, 12] and The quantitative insulin-sensitivity check index (QUICKI) was the formula used to assess insulin sensitivity [13].

B. Creatinine and estimated glomerular filtration rate measurements (eGFR): Serum level of creatinine was measured using Hitachi Modular (Roche Diagnostics, Mannheim, Germany). Moreover, the Statement of the Japan Nephrology Society (JNS) used to calculate eGFR [14,15].

Procedures

Participants randomly assigned in two equal groups:

1. Group (A): Participants practiced aerobic treadmill exercise training for 12 weeks of standard exercise training [16]. Every training session consisted of 5 minutes warm up, thirty minutes of 60-70% of maximum heart rate aerobic exercise training that followed by 10 minutes cooling down. Participants had three training sessions weekly for three months. Moreover, a dietician supervised participants following 1200 Kilocalories/day diet regimen for three months [17,18].

2. Group (B): received no clinical intervention.

Statistical analysis

Paired "t" test was used to compare between pre and posttest values. While the unpaired “t" test was used for comparing between both groups (P<0.05).

Results

Analysis of baseline characteristics proved that the two groups were homogenous (table 1). There were significant reduction in the mean values of body mass index (BMI), glycosylated hemoglobin (HBA1c), Homeostasis Model

Table (1): Analysis of Baseline data for all participants.

	Mean +SD		
	Group (A)	**Group (B)**	**Significance**
Age (year)	45.26 ± 7.11	47.18 ± 6.34	P >0.05
Gender (F/M)	21/14	22/13	P >0.05
Duration of diabetes (years)	14.22 ± 2.75	13.91 ± 2.68	P >0.05
BMI (kg/m^2)	35.25 ± 5.65	33.83 ± 5.41	P >0.05
Total cholesterol (mg/dl)	198.14 ± 17.32	192.26 ± 19.18	P >0.05
HDL-C (mg/dl)	33.85 ± 4.91	35.74 ± 4.22	P >0.05
LDL-C (mg/dl)	126.37 ± 12.13	123.81 ± 10.75	P >0.05
Triglycerides (mg/dl)	165.29 ± 15.46	161.97 ± 14.32	P >0.05
Body fat (%)	37.12 ± 3.84	35.43 ± 4.15	P >0.05
SBP (mmHg)	141.25 ± 13.47	143.76 ± 11.83	P >0.05
DBP (mmHg)	85.91 ± 6.54	84.22 ± 7.11	P >0.05

BMI: Body Mass Index; **SBP:** Systolic blood pressure; **DBP:** Diastolic blood pressure**; AST:** Aspartate aminotransferase; **ALT:** alanine aminotransferase; **AST/ALT:** Aspartate aminotransferase /alanine aminotransferase ratio; **HDL-c:** High-density lipoprotein cholesterol; LDL**-c:** Low density lipoprotein cholesterol.

Assessment-Insulin Resistance Index (HOMA-IR (, insulin, estimated glomerular filtration rate (eGFR) and creatinine, in the other hand there were significant increase in the mean values of the quantitative insulin-sensitivity check index (QUICKI) in patients of group (A) as a result of weight reducing program, however the results of the control group) were not significant (Table 2, a and b respectively). In addition, there were significant differences between both groups at the end of the study (Table 3) (P<0.05).

Table 2: Analysis of BMI, creatinine, eGFR, HBA1c, Insulin, QUICKI and HOMA-IR in group (A) before and after the study.

	Mean + SD		t- value	Significance
	Before	After		
a) Group (A)				
BMI (kg/m^2)	35.25 ± 5.65	28.63 ± 4.72*	8.14	P <0.05
Creatinine (µmol/mol)	86.64 ± 9.29	73.12 ± 7.41*	9.21	P <0.05
eGFR (mL/min/1.73(m^2)	65.23 ± 7.16	52.81±6.24	7.15	P <0.05
HBA1c (%)	8.62 ± 1.78*	6.73 ± 1.55	6.36	P <0.05
Insulin (mU/l)	15.76 ± 2.84	11.58 ± 2.41*	5.61	P <0.05
QUICKI	0.125 ± 0.016	0.171 ± 0.026*	5.13	P <0.05
HOMA-IR	6.14 ± 1.21	4.11 ± 0.98*	5.52	P <0.05
b) Group (B)				
BMI (kg/m^2)	33.83 ± 5.41	31.45 ± 4.57	2.31	P > 0.05
Creatinine (µmol/mol)	84.72 ± 7.85	85.53 ± 7.96	1.56	P >0.05
eGFR (mL/min/1.73(m^2)	63.54 ± 6.23	65.21 ± 6.45	1.47	P >0.05
HBA1c (%)	7.91 ± 1.43*	6.25 ± 1.64	1.13	P >0.05
Insulin (mU/l)	15.54 ± 2.67	15.92 ± 2.83	1.26	P > 0.05
QUICKI	0.131 ± 0.024	0.125 ± 0.019	0.63	P > 0.05
HOMA-IR	6.59 ± 1.17	6.17 ± 1.26	0.98	P > 0.05

BMI: Body Mass Index; **eGFR** : estimated glomerular filtration rate; **HBA1c:** glycosylated hemoglobin; **QUICKI:** The quantitative insulin-sensitivity check index; **HOMA-IR**: Homeostasis Model Assessment-Insulin Resistance Index; **(*)** indicates a significant difference, P < 0.05.

Table 3: Analysis of BMI, creatinine, eGFR, HBA1c, Insulin, QUICKI and HOMA-IR in group (A) and group (B) before and after the study.

	Mean + SD		t- value	Significance
	Group (A)	Group (B)		
BMI (kg/m^2)	28.63 ± 4.72*	31.45 ± 4.57	4.52	P <0.05
Creatinine (µmol/mol)	73.12 ± 7.41*	85.53 ± 7.96	6.14	P <0.05
eGFR (mL/min/1.73(m^2)	52.81±6.24	65.21 ± 6.45	5.23	P <0.05
HBA1c (%)	6.73 ± 1.55	6.25 ± 1.64	4.27	P <0.05
Insulin (mU/l)	11.58 ± 2.41*	15.92 ± 2.83	3.64	P <0.05
QUICKI	0.171 ± 0.026*	0.125 ± 0.019	4.21	P <0.05
HOMA-IR	4.11 ± 0.98*	6.17 ± 1.26	4.16	P <0.05

BMI: Body Mass Index; **eGFR** : estimated glomerular filtration rate; **HBA1c:** glycosylated hemoglobin; **QUICKI:** The quantitative insulin-sensitivity check index; **HOMA-IR**: Homeostasis Model Assessment-Insulin Resistance Index; **(*)** indicates a significant difference, P < 0.05.

Discussion

Type 2 diabetes and obesity impair kidney function [19,20]. There are many risk factors for DN includes abnormal glycemic control, diabetes chronicity and life style [21]. Therefore, this study was designed to measure the influence of weight loss on glycemic control and glomerular filtration rate among patients with T2DM nephropathy. However, the principle finding of this study was that weight loss associated with modulated kidney function and glycemic control among T2DM with DN; these findings agreed with many previous trails.

Concerning renal function, our results proved the benefits of weight loss on serum creatinine and estimated glomerular filtration rate. These findings lined with Giordani et al. enrolled observed significant correlation between the increase in GFR and glucose control among 14 obese patients with T2DM after a 7-day very low-calorie diet (VLCD) [22] and Jesudason et al. randomly assigned seventy-six obese patients with T2DM to either a moderate-protein weight-loss diet or a standard-protein weight-loss diet for 12 months and found that Weight loss improved renal function [23]. However, Saiki and colleagues proved that weight reduction using 4-week low-calorie diet improved renal function and proteinuria in obese patients with diabetic nephropathy [24]. While Motie and coworkers proved that intentional weight loss resulted in no significant reduction in serum creatinine and glomerular filtration rate (GFR) after 3-month intensive behavioral weight management intervention among fifty overweight and obese patients with heart failure [25]. In addition, He and coworkers proved that GFR was negatively correlated with BMI among Chinese subjects that means that maintaining healthy level of BMI prevent renal damage [26]. Moreover, Zhiqing and colleauges reported that rats with streptozotocin (STZ)-induced diabetes experienced improved kidney function as a result of operative weight reduction with duodeno-jejunal bypass (DJB) [27].

Regarding glycemic control, our results proved that weight loss associated with improved insulin sensitivity. These findings lined with Angelico et al. stated that modest weight loss led to improved insulin resistance among metabolic syndrome patients [28], Similarly, Bacchi et al. proved that nonalcoholic fatty liver patients with T2DM experienced improved insulin sensitivety following 4 months of exercise training [29]. However, Look AHEAD Research Group reported that behavioral weight loss interventions modulated HbA1c, and systolic blood pressure among patients with T2DM [30]. Moreover, Chertow and colleagues reported that weight loss associated with improved metabolic control and renal function of obese T2DM with renal insufficiency [31].

Conclusion

Weight reducing program modulated glycemic control and renal function of patients with type 2 diabetic nephropathy.

Ethical approval statement

This study was approved by the Ethical Committee for Scientific Research, Faculty of Applied Medical Sciences, King Abdulaziz University.

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This study was conducted without external financial support.

Conflicts of interest

There are no conflicts of interest**.**

References

1. Organization WH. Prevalence of diabetes Worldwide 2010; vol [World Health Organization website].
2. Leiter LA, Fitchett DH, Gilbert RE, et al. Identification and management of cardiometabolic risk in Canada: a position paper by the cardiometabolic risk working group (executive summary). Can J Cardiol 2011; 27:124-31.
3. DeFronzo RA. Insulin resistance, lipotoxicity, type 2 diabetes and atherosclerosis: the missing links. The Claude Bernard Lecture 2009. Diabetologia 2010; 53(7): 1270–87.
4. Seshasai SR, Kaptoge S, Thompson A, et al. Diabetes mellitus, fasting glucose, and risk of cause-specific death. N Engl J Med 2011; 364:829-41.
5. Besler C, Luscher TF, Landmesser U. Molecular mechanisms of vascular effects of High-density lipoprotein: alterations in cardiovascular disease. EMBO Mol Med 2012; 4:251-68.
6. Farbstein D, Levy AP. HDL dysfunction in diabetes: causes and possible treatments. Expert Rev Cardiovasc Ther 2012; 10:353e61.
7. Chen,G.;McAlister,F.A.;Walker,R.L.;Hemmelgarn,B.R.; Campbell,N.R.C. Cardiovascular outcomes in Framingham participants with diabetes : the importance of blood pressure. Hypertension 57:891–897; 2011.
8. Greenberg AS, Obin MS. Obesity and the role of adipose tissue in inflammation and metabolism. Am J Clin Nutr 2006; 83(2):461S–5S.
9. Murdolo G, Smith U. The dysregulated adipose tissue: a connecting link between insulin resistances, type 2 diabetes

mellitus and atherosclerosis. Nutr Metab Cardiovasc Dis 2006; 16(Suppl 1):S35–8.
10. Bukhari SA, Shamshari WA, Ur-Rahman M, Zia-Ul-Haq M, Jaafar HZ. Computer aided screening of secreted frizzled related protein 4 (SFRP4): a potential control for diabetes mellitus. Molecules 2014; 19:10129e36.
11. Grace, B.S., Clayton, P., McDonald, S.P., 2012. Increases in renal replacement therapy in Australia and New Zealand: understanding trends in diabetic nephropathy. Nephrology (Carlton) 17, 76–84.
12. Schaffer, S.W., Jong, C.J., Mozaffari, M., 2012. Role of oxidative stress in diabetes mediated vascular dysfunction: Unifying hypothesis of diabetes revisited. Vascular Pharmacology 57 (5–6) 139–139.
13. Katz A, Nambi SS, Mather K, Baron DA, Follman DA, Sullivan F, et al. Quantitative insulin sensitivity check index: a simple, accurate method for assessing insulin sensitivity in humans. J Clin Endocrinol Metab 2000; 85:2402–2410.
14. Kotur-Stevuljevic J, Simic-Ogrizovic S, Dopsaj V, et al. A hazardous link between malnutrition, inflammation and oxidative stress in renal patients. Clin Biochem. 2012;45(15):1202–1205.
15. Massy ZA, Stenvinkel P, Drueke TB. The role of oxidative stress in chronic kidney disease. Semin Dial. 2009;22(4):405–408.
16. Navaneethan SD, Yehnert H, Moustarah F, Schreiber MJ, Schauer PR, Beddhu S. Weight loss interventions in chronic kidney disease: a systematic review and metaanalysis. Clin J Am Soc Nephrol 2009; 4:1565–1574.
17. Afshinnia F, Wilt TJ, Duval S, Esmaeili A, Ibrahim HN. Weight loss and proteinuria: systematic review of clinical trials and comparative cohorts. Nephrol Dial Transplant 2010; 25:1173–1183.
18. Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care 2012; 35: 1364–79.
19. Belhatem N, Mohammedi K, Rouzet F, Matallah N, Al Baloshi A, Travert F, Velho G, Roussel R, Le Guludec D, Marre M, Hansel B. Impact of morbid obesity on the kidney function of patients with type 2 diabetes. Diabetes Res Clin Pract. 2015 Apr;108(1):143-9.
20. Ward A, Alvarez P, Vo L, Martin S. Direct medical costs of complications of diabetes in the United States: estimates for event-year and annual state costs (USD 2012). J Med Econ 2014; 17:176–83.
21. Badal SS, Danesh FR. Diabetic Nephropathy: Emerging Biomarkers for Risk Assessment. Diabetes. 2015; 64:3063-5.
22. Giordani I, Malandrucco I, Donno S, Picconi F, Di Giacinto P, Di Flaviani A, Chioma L, Frontoni S. Acute caloric restriction improves glomerular filtration rate in patients with morbid obesity and type 2 diabetes. Diabetes Metab. 2014 Apr;40(2):158-60.
23. Jesudason DR, Pedersen E, Clifton PM. Weight-loss diets in people with type 2 diabetes and renal disease: a randomized controlled trial of the effect of different dietary protein amounts. Am J Clin Nutr. 2013 Aug;98(2):494-501.
24. Saiki A, Nagayama D, Ohhira M, Endoh K, Ohtsuka M, Koide N, Oyama T, Miyashita Y, Shirai K. Effect of weight loss using formula diet on renal function in obese patients with diabetic nephropathy. Int J Obes (Lond). 2005 Sep;29(9):1115-20.
25. Motie M, Evangelista LS, Lombardo D, Hoi J, Horwich TB, Hamilton M, Fonarow GC. Effect of weight loss on renal function in overweight and obese patients with heart failure. Diabetes Metab Syndr. 2017 Apr - Jun;11(2):95-98.
26. He Y, Liu D, Tan W, Ma X, Lian F, Xu X. Association Between Body Mass Index and Mildly Decreased Estimated Glomerular Filtration Rate in Chinese Adults with Early Chronic Kidney Disease. J Ren Nutr. 2016 Nov;26(6):367-372.
27. Zhiqing W, Jing W, Haili X, Shaozhuang L, Chunxiao H, Haifeng H, Hui W, Sanyuan H.Renal function is ameliorated in a diabetic nephropathy rat model through a duodenal-jejunal bypass. Diabetes Res Clin Pract. 2014 Jan;103(1):26-34.
28. Angelico F, Loffredo L, Pignatelli P, Augelletti T, Carnevale R, Pacella A, Albanese F, Mancini I, Di Santo S, Del Ben M, Violi F. Weight loss is associated with improved endothelial dysfunction via NOX2-generated oxidative stress downregulation in patients with the metabolic syndrome. Intern Emerg Med 2012; 7: 219-227
29. [29]. Bacchi E, Negri C, Targher G, Faccioli N, Lanza M, Zoppini G, et al: Both resistance training and aerobic training reduce hepatic fat content in type 2 diabetic subjects with nonalcoholic fatty liver disease (the RAED2 randomized trial). Hepatology 2013; 58: 1287–1295.
30. [30]. Look AHEAD Research Group. Effect of a long-term behavioral weight loss intervention on nephropathy in overweight or obese adults with type 2 diabetes: a secondary analysis of the Look AHEAD randomized clinical trial. Lancet Diabetes Endocrinol. 2014 Oct;2(10):801-9.
31. [31]. Chertow GM, Appel GB, Block GA, Chin MP, Coyne DW, Goldsberry A, Kalantar-Zadeh K, Meyer CJ, Molitch ME, Pergola PE, Raskin P, Silva AL, Spinowitz B, Sprague SM, Rossing P. Effects of bardoxolone methyl on body weight, waist circumference and glycemic control in obese patients with type 2 diabetes mellitus and stage 4 chronic kidney disease. J Diabetes Complications. 2018 Sep 13. pii: S1056-8727(18)30811-0.

تأثير إنقاص الوزن على التحكم في نسبة السكر في الدم ومعدل الترشيح الكلوي للكرياتينين بين المرضى الذين يعانون من اعتلال الكلية السكري من النوع الثاني

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مستخلص

الخلفية: يعتبر اعتلال الكلية السكري هو أحد مضاعفات مرض السكري الوعائية الدقيقة التي تؤثر على حوالي 40٪ من مرضى السكري في جميع أنحاء العالم.

الهدف: تهدف هذه الدراسة إلى قياس الإجهاد التأكسدي والالتهاب الجهازي واستجابة وظائف الكلى لممارسة التدريب على مرضى اعتلال الكلية من داء السكري النوع الثاني.

المواد والطرق: سبعون مريضا من داء السكري النوع الثاني ، وكان متوسط مؤشر كتلة الجسم 3.25 ± 32.96 كجم/متر مربع وكان متوسط مزمن مرض السكري 13.17 ± 2.18 سنة وسجلت مجموعتين. المجموعة الأولى: ممارسة التدريب على التمارين الهوائية ونظام النظام الغذائي والمجموعة الثانية: لم تمارس أي تدريب أو تدخل في نظام غذائي

النتائج: كان هناك انخفاض معنوي في القيم المتوسطة لمؤشر كتلة الجسم ، ومستوي السكر الهيموجلوبين ، تقييم نموذج التوازن – مؤشر مقاومة الأنسولين في الدم ، نسبة الأنسولين في الدم ، معدل الترشيح الكلوي للكرياتينين، من ناحية أخرى كانت هناك زيادة معنوية في القيم المتوسطة لمؤشر فحص حساسية الأنسولين الكمي في مرضى المجموعة الأولي نتيجة لبرنامج إنقاص الوزن، من ناحية أخرى، لم تكن نتائج المجموعة الثانية الضابطة ذات دلالة.

الخلاصة: يساعد برنامج تخفيض الوزن في التحكم بمستوي السكر في الدم ووظائف الكلى للمرضى الذين يعانون من اعتلال الكلية السكري من النوع الثاني.

الكلمات الدالة: معدل الترشيح الكلوي للكرياتينين ; التحكم في نسبة السكر في الدم ; اعتلال الكلي السكري; تخفيض الوزن; داء السكري النوع الثاني.

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