Original Article

Role of Spexin and Glucose Transporter Type 4 on Insulin Resistance in a Male Patient with Type 2 Diabetes Mellitus and Prediabetes

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is a condition that requires careful and mindful management, as well as prediabetes is a serum health condition that usually does not have any signs or symptoms insulin resistance is a global problem and the hormones responsible for it are complex net, adipocyte hormones as spexin and insulin may be our indication when there that indication is screening, diagnosis, or follow- up. These hormones control energy homeostasis and metabolism. **Objective:** This study aimed to investigate the role of serum spexin and serum glucose transporter type 4 (GLUT4) in insulin resistance as a screening hormone and there is a possibility of predicting the status of insulin resistance. **Materials and Methods:** The study involved 66 subjects, 22 patients with T2DM, 22 individuals diagnosed with prediabetes, and 22 healthy individuals with an age range between 41 and 63 years. In the study, each body mass index (BMI), serum fasting blood sugar, blood hemoglobin A1c %, body fat percent, serum spexin, serum GLUT4, serum insulin estimation (hemostatic model assessment insulin resistance), and the quantitative insulin-sensitivity check index were measured for all individuals. **Results:** All groups in terms of matching their general studies, their age, and BMI documented no significant differences ($P > 0.05$) among the studied groups. Serum insulin in prediabetes patients showed significant ($P \leq 0.05$, 29.9 ± 2.1 mIU/mL) elevation in individuals, whereas T2DM patients also found significant ($P \leq 0.05$, 20.3 ± 2.2 mIU/mL) elevation when compared with healthy groups, serum spexin showed significant elevation ($P \leq 0.05$,194.81 ± 51.06 ng/L) in the prediabetic individual show the highest significant elevation in there fat percentage ($16.23 \pm 4.11\%$). Serum GLUT4 showed decreased significance ($P \leq 0.05$) in T2DM patients when compared with other groups. In addition, GLUT4 showed a significant decrease with $P \leq 0.05$ in prediabetic subjects when compared with healthy groups, whereas, serum spexin showed significant elevation in T2DM patient with their fat percentage showed a significant decrease when compared with healthy subjects ($P \leq 0.05$, 141.51 ± 44.58 ng/L). **Conclusion:** Elevation of serum spexin and decreased serum GLUT4 may hold a sign of insulin resistance with obesity in prediabetic individuals.

Keywords: Insulin resistance, prediabetes, serum GLUT4, serum spexin, type 2 diabetes mellitus

Introduction

Insulin resistance is a pathological condition supporting several days of metabolic status including obesity and type 2 diabetes mellitus (T2DM), hyperlipidemia, atherosclerosis, and nonalcoholic fatty liver disease. Insulin resistance increase is highly associated with an increase in weight as obesity.[1] Insulin resistance is commonly linked with obesity, which is a pathophysiologic factor of T2DM an extreme adipose tissue expansion due to an increase in nutrient intake and insufficient energetic expenditure is considered as obesity.[2] Insulin resistance and hyperinsulinemia can contribute to the development of obesity and escalate the pathogenesis of T2DM

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through stimulation of insulin resistance; however, several studies described the association between mitochondrial dysfunction, inflammation, hyperinsulinemia, and lipotoxicity with insulin resistance. Endoplasmic reticulum stress, oxidative stress, genetic background, aging, hypoxia, and lipodystrophy are also stated in the pathogenesis of T2DM through the induction of insulin resistance.[2]

Around 1.4 million Iraqis have diabetes and reported T2DM prevalence in Iraq ranges from 8.5% to 13.9%. There are insufficient epidemiological studies and randomized controlled trials related to diabetes in Iraq; therefore, it remains difficult to fully understand the prevalence of diabetes in Iraq and the most effective treatments for the Iraqi population.[3]

Prediabetes is a condition, in which blood sugar levels are higher than normal but below the prescribed limits for diabetes. It is a dangerous disease, and the possibility of developing diabetes is high. Observational evidence suggests an association between prediabetes and the risk of diabetic complications (e.g., nephropathy and early retinopathy) and macrovascular disease.[3] Insulin resistance deals with a progressive decrease of insulin triggered by defective beta cells of the pancreas is significant in T2DM. Insulin deficiency and insulin resistance lead to hyperglycemia, with thirst, polyuria, and fatigue presenting symptoms and weight loss.

T2DM is a multifunctional disease caused by genetic susceptibility linked to lifestyle factors, such as obesity and physical inactivity.[4] Glucose transporter type 4 (GLUT4), a predominant insulin-responsive glucose transporter, is sorted to the plasma membrane from peri-nuclear compartments, including GLUT4 storage vesicles. In resting skeletal muscle and fat cells, the majority of GLUT4 is sequestered to the per nuclear compartments, preventing its translocation to the cell surface.[5] The defective translocation of GLUT4 in muscle cells, adipocytes, and other cells is a key feature of insulin resistance GLUT4 translocation is deficient in most cases of T2DM.[5]

Spexin, a novel neuropeptide hormone composed of 14 amino acids, is a biomarker for pathological diseases, such as metabolic syndrome and diabetes.[6]

Spexin expression in various rat tissues, such as the liver, kidney, brain, hypothalamus, thyroid, ovary, testis, adrenal, skeletal muscle, heart, lung, pancreas, and gastrointestinal tract and found in these tissues indicates in numerous physiological processes and play roles in many metabolic processes, such as satiety, pubertal growth, and reproduction.[7] Spexin regulates the metabolism of obese rats by affecting lipolysis and lipogenesis in adipocytes. Other studies demonstrate that spexin modulates leptin synthesis and secretion from isolated adipocytes.[8] Spexin maintains glucose tolerance and decreases insulin resistance in obese mice with T2DM.[9] Spexin improves cell viability, proliferation of pancreatic cells, and upregulation of protein levels of proliferating cell nuclear antigen.[10] In the human body, spexin leads to inhibition of lipogenesis and glucose uptake and stimulation of lipolysis by phosphorylation of hepatic lipase. Hence, indicates that spexin is involved in the regulation of lipid metabolism.[10] The circulating spexin levels were lower in humans obese. Spexin when used as treatment reduces body weight gain by inhibiting food intake and gastrointestinal motility in obese patients.[11] Insulin resistance is characterized by impaired insulin responsiveness in target tissues, causing the β-cells in the pancreas to continue to produce extra insulin and increased circulating fatty acids and accumulation of lipids in the muscle with activation of inflammatory pathways, inhibition of insulin receptor signaling lead to defect in insulin action.[12] The lack of response of tissues to insulin results in a state of transient and unpredictable hyperglycemia and hyperinsulinemia, together with an inflammatory signature that predisposes an individual to metabolic syndrome and T2DM, and from here the decrease of spexin level leads to an increase of body fat and cause obesity and this cause insulin resistance.[12] GLUT4 is the dominant glucose transporter in striated muscle and adipose tissues and is the second most abundant transporter in cardiovascular tissue, GLUT4 is regulated by insulin as insulin binding receptors translocate GLUT4 to the cell surface.[13] GLUT4 has been linked to obesity, T2DM, and heart disease, causing inhibition of GLUT4. GLUT4 inhibition has been shown to cause cardioprotective effects and aided affected individuals to return to normal heart/body weight ratios[13]

Insulin resistance is a characteristic feature of T2DM involving both the oxidative and non-oxidative pathways of glucose metabolism. A defect proximal to these metabolic pathways, such as impaired glucose transport into the cell has therefore been suggested to explain the insulin resistance in T2DM.[14] Insulin-stimulated glucose transport in skeletal muscle is facilitated by an insulin-responsive GLUT4, which is encoded by a gene located on the short arm of chromosome 17.[14] If insulin resistance in T2DM is due to an inherited defect in glucose transport, this could be associated with a defect in the expression of the GLUT4 gene in the skeletal muscle of patients with T2DM.[14] The study aims to determine the level of serum spexin and GLUT4 in prediabetic, T2DM patients individuals, and healthy individuals, it can detect their importance in the predicting, and of the presence of insulin resistance, also determine the sensitivity and specificity of spexin and GLUT4 to find out which is more sensitive and specific it can help use as diagnostic tool of insulin resistance..

Materials and Methods

The study takes a cross-sectional design sample collected at the beginning of the study was men, depending on the criteria of the study. Criteria of patients depended on the history of T2DM; fasting blood sugar; and hemoglobin A1c (hbA1c) according to World Health Organization (WHO) criteria, age between 41 and 63 years, because the age more prone to T2DM; and body mass index (BMI; 27–31 kg/m^2), this ranges it causes insulin resistance that leads to prediabetes and T2DM. Exclusion criteria of all study groups included females to avoid the role of sex hormones. Type 1 diabetes mellitus (T1DM) includes another mechanism for diabetes to occur, age under 40 years because this age is often associated with T1DM. The study was conducted at the Department of Biochemistry, College of Medicine/ University of Baghdad and Diabetes Center at Al Mustansiriya University, Baghdad, Iraq, during the period from December 2020 to March 2021.

The sample was collected at the beginning of the study from 88 men, depending on the criteria of the study, only 66 of them were selected after making sure of the preliminary analyses; however, the models appropriate for the study were chosen and divided into 22 were patient T2DM, 22 were are prediabetes individual, and 22 were healthy men documented by lab investigation fasting serum glucose (74.0–109 mg/dL normal range, 110–125 mg/dL prediabetes, and HbA1c%; under 5.7% is normal, 5.7%–6.4% is prediabetes, and above 6.4 is diabetes). According to WHO criteria to distinguish between the four groups, this test hbA1c % was mainly relied on because it gives a more accurate indication over a long period and does not depend on the patient's condition in terms of fasting during the moments of measurement.[8] Serum spexin measurements were performed using an enzyme-linked immunosorbent assay (ELISA, MyBioSource, San Diego, CA, USA). Serum GLUT4 measurements were performed using an ELISA (CUSASBIO, Wuhan, China).

The hemostatic model assessment insulin resistance (HOMA-IR) procedure was used to estimate β-cell function (HOMA-β), and HOMA-IR was used to derive insulin differences by using the following equation.

HOMA-IR = (glucose × serum insulin)/22.5.[15]

Quantitative insulin-sensitivity check index

It is a novel mathematical transformation of fasting blood sugar and insulin levels. In persons with high fat and diabetes, the quantitative insulin-sensitivity check index (QUICKI)'s linear correlation with glucose clamp estimation of insulin sensitivity was significantly better than the minimum model estimate.

QUICKI = [(1/(log fasting insulin (μIU/mL) + log fasting glucose (mg/dL)] indexes.[16]

Ethical Approval

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. The study protocol was reviewed and approved by a local ethics committee at Al-Mustansiriya University, Baghdad, according to document No. 164/2023 on March 16, 2023.

Results

The successful matching of groups in terms of matching their general studies, their age, and BMI was documented by no difference of significance ($P > 0.05$) among the studied group and to confirm the correct selection of the studies groups, which is made through the significant difference $P \leq 0.05$, which is observed in T2DM, prediabetes, and healthy individual in the blood level of HbA1c %. Calculated HOMA and QUICKId are shown in Table 1. Figure 1 shows all the mean level of serum insulin, Figure 2 shows all the mean level of serum spexin, and Figure 3 shows sensitivity, specificity, the area under the curve, and cut-off point of studied marker between type 2 diabetes mellitus and healthy subjects.

As part of changes associated with insulin resistance, the serum level of lipids was studied, serum cholesterol, triglyceride, cholesterol low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) showed significance with ($P \leq 0.05$) elevation in its level in T2DM group when compared with others studied group. Serum high-density lipoprotein (HDL) showed the lowest

Table 1: Clinical characteristics (mean ± standard deviation) of age, body mass index, blood sugar, hemoglobin A1c %, HOMA-IR, and QUICKI in healthy subjects, prediabetes, and type 2 diabetes mellitus patients

Parameters	Healthy controls n = 22	Prediabetes n = 22	Type 2 diabetes mellitus N = 22	t Test P value
Age (year)	53.70 ± 10.91	52.40 ± 10.77	54.90 ± 9.97	>0.05
BMI (kg/m^2)	29.33 ± 4.4	30.04 ± 4.5	29.40 ± 5.2	>0.05
Serum FBS (mg/dL)	91.26 ± 5.54	121.43 ± 5.44	182.36 ± 6.57	≤0.05
Blood HbA1c (%)	4.89 ± 0.49	6.51 ± 0.68	7.88 ± 1.12	≤0.05
HOMA-IR	2.3 ± 0.3	7.1 ± 0.61	8.9 ± 0.65	≤0.05
QUICKI	0.26 ± 0.01	0.18 ± 0.07	0.22 ± 0.08	≤0.05

BMI: body mass index, FBS: fetal bovine serum, HbA1c: hemoglobin A1c, HOMA-IR: hemostatic model assessment insulin resistance, QUICKI: quantitative insulin-sensitivity check index

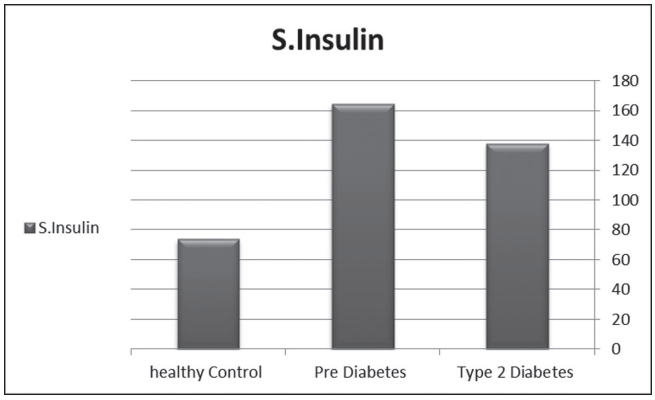

Figure 1: All mean serum insulin

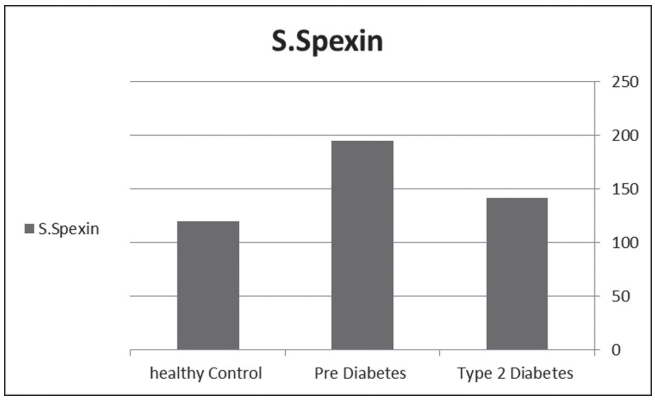

Figure 2: All mean serum spexin

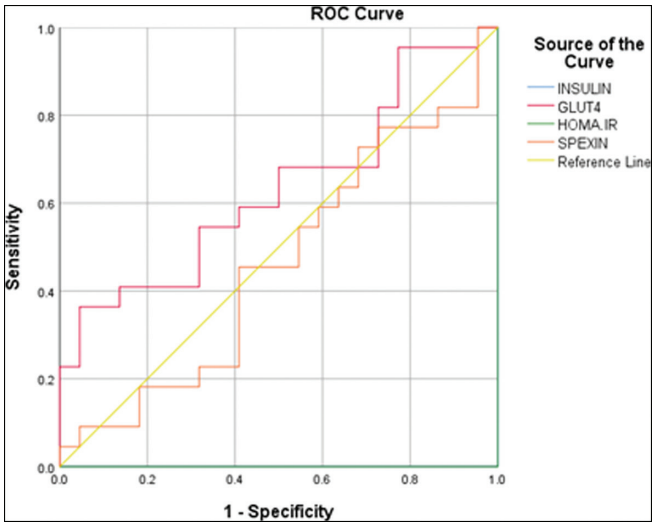

Figure 3: Sensitivity, specificity, the area under the curve, and cut-off point of studied marker between type 2 diabetes mellitus and healthy subjects (HOMA-IR, serum insulin, serum GLUT4, and serum spexin). GLUT4: glucose transporter type 4, HOMA-IR: hemostatic model assessment insulin resistance

significance level ($P \leq 0.05$) in T2DM patients when compared with other groups as shown in Table 2.

Serum insulin showed significant ($P \leq 0.05$) elevation in prediabetic individuals when compared with other groups, whereas T2DM patients also showed significant ($P \leq 0.05$) elevation when compared with the healthy groups. Table 3 shows the mean level of serum insulin.

Serum GLUT4 showed a common result of decreased significance ($P \leq 0.05$) in T2DM patients when compared with other groups. In addition, GLUT4 shows a significant decrease with $P \leq 0.05$ in prediabetic subjects when compared with healthy groups. Table 3 shows the mean level of serum GLUT4.

The novel peptide related to energy hemostasis spexin showed significant elevation (with $P \leq 0.05$) in prediabetic individuals showing the highest significant elevation in their fat percentage (16.23 ± 4.11) when compared with other groups. Serum spexin showed significant elevation in T2DM patients with $P \leq 0.05$. Their fat percentage showed a significant decrease when comparing the healthy subjects with other groups. Table 3 shows the mean level of serum spexin.

Serum spexin shows a nonsignificant correlation with serum blood sugar in three study groups, T2DM ($r = 0.032$, $P = 0.88$), prediabetic patients ($r = 0.069$, $P = 0.65$), respectively, it can be noted all of these correlation goes in the positive line.

Serum spexin shows a nonsignificant correlation with glycated hemoglobin (HbA1c %) in three study groups, T2DM ($r = 0.114$, $P = 0.61$), prediabetic patients ($r = 0.026$, $P = 0.90$), and healthy groups ($r = 0.221$, $P = 0.32$), respectively, it can be noted all of these correlation goes in the positive line.

Serum spexin shows a nonsignificant correlation with serum insulin in three study groups, T2DM ($r = -0.137$, $P = 0.54$), prediabetic patients ($r = -0.188$, $P = 0.40$), and healthy groups ($r = -0.092$, $P = 0.96$), respectively, it can be noted all of these correlation goes in negative line.

Sensitivity, specificity, the area under the curve (AUC), and cut-off point of studied markers between T2DM and healthy subjects.

Receiver operating characteristics (ROC), which is frequently used to show graphically the connection/tradeoff between clinical sensitivity and specificity for every possible cut-off for a test combination. In addition, the AUC and the ROC curve give an idea about the benefit of using the test in diagnosis. There is evidence that serum insulin and HOMA-IR are still the most useful diagnosis tools of T2DM and that it has a sensitivity (100%), which is more than the sensitivity of serum spexin (95%). Whereas serum GLUT4 showed the most specific tool in the diagnosis of T2DM (81%) as shown in Table 4 and Figure 4.

Sensitivity, specificity, the AUC, and cut-off point of studied markers between prediabetes and healthy subjects.

ROCs, which is frequently used to show graphically the connection/tradeoff between clinical sensitivity and

Table 2: Mean ± SD for lipid profile in studied groups

Studied parameters	Studied group	Mean ± SD	*t* Test *P* value
Serum cholesterol (mg/dL)	Healthy individual	170.0 ± 47.26	≤0.05
	Prediabetes individual	176.0 ± 40.0	
	T2DM patients	184.0 ± 44.87	
Serum triglyceride (mg/dL)	Healthy individual	140.0 ± 49.4	≤0.05
	Prediabetes individual	170.18 ± 42.49	
	T2DM patients	212.36 ± 50.86	
Serum HDL (mg/dl)	Healthy individual	45.26 ± 10.3	≤0.05
	Prediabetes individual	41.26 ± 4.11	
	T2DM patients	35.52 ± 3.46	
Serum LDL (mg/dL)	Healthy individual	91.73 ± 10.63	≤0.05
	Prediabetes individual	104.0 ± 13.86	
	T2DM patients	134.64 ± 13.71	
Serum VLDL (mg/dL)	Healthy individual	28.24 ± 5.81	≤0.05
	Prediabetes individual	34.04 ± 2.37	
	T2DM patients	42.4 ± 2.78	

HDL: high-density lipoprotein, LDL: low-density lipoprotein, SD: standard deviation, T2DM: type 2 diabetes mellitus, VLDL: very low-density lipoprotein

Table 3: Mean ± SD level of spexin, insulin, GLUT4, and body fat %

Parameters	Healthy controls	Pred	Type 2 diabetes mellitus	*t* Test *P* value
Serum insulin (mIU/mL)	10.5 ± 1.7	29.9 ± 2.1	20.3 ± 2.2	≤0.05
Serum spexin (ng/L)	119.76 ± 50.69	194.81 ± 51.06	141.52 ± 44.58	≤0.05
Body fat (%)	11.4 ± 5.035	16.23 ± 4.11	8.42 ± 6.00	≤0.05
Serum GLUT4 (pg/L)	147.44 ± 66.58	145.86 ± 55.97	118.92 ± 29.68	≤0.05

GLUT4: glucose transporter type 4

specificity for every possible cut-off for a test combination. In addition, the AUC and the ROC curve give an idea about the benefit of using the test in diagnosis. There is evidence that HOMA-IR and serum insulin are still the most useful diagnosis tools for prediabetes it has a sensitivity of 100%, which is more than the sensitivity of serum spexin and serum GLUT4 (81%) as shown in Table 5 and Figure 4.

Discussion

In this study, subjects' age and sex were successfully matched as Table 1 showed that it was chosen in this way to avoid the effect of age and hormonal change associated with gender and age-related research results indicated that women are protected against central insulin resistance, due to circulation estrogen, which protects against insulin resistance sensitivity.[17]

The blood sugar level of diabetic patients is high. As expected, the blood sugar level of diabetic patients is high compared with the rest of the people and is accompanied by the level of HbA1c % in diabetes mellitus. Increased blood sugar (hyperglycemia) affects patients who have diabetes. More factors can contribute to hyperglycemia in patients with hyperglucose, including food and physical activity choices, illness, nondiabetes treatment, or skipping or not taking enough glucose-decrease treatment. Studies pointed out that prediabetics have the highest level of insulin the likely reason for people with insulin resistance, the cell is unable to use insulin effectively when the cell cannot absorb glucose, these conditions include long-term stress, infection, long-term sleep deprivation, and obesity, these conditions release the stress hormone in the body, stress hormones, which cause of insulin resistance.[18]

Prediabetes is known as the opposite case that elevation an individual risk for the evolution of diabetes. Lifestyle risk factors for the development of risk factors for prediabetes include weight gain and exercise.[19]

In the first stage of the disease after draining of carbohydrates but at a later stage of prediabetes the pancreatic beta cells become tired and cannot produce enough insulin to prevent elevation of sugar after the individual eats a meal high in carbohydrates. In many cases, prediabetes can be treated effectively with exercise, caloric restriction, and weight reduction at least in the early stages, and no exogenous administration of insulin is needed.[20]

In the present study, a prediabetic individual has the highest level of body fat percentage (BF%), and in the

Table 4: Sensitivity, specificity, the area under the curve, and cut-off point of studied marker between type 2 diabetes mellitus and healthy subjects (HOMA-IR, serum insulin, serum GLUT4, and serum spexin)

Parameters	Cut-off value	Sensitivity (%)	Specificity (%)	AUC
HOMA-IR	2.0	100	77	1.000
Serum insulin (mIU/mL)	10.3	100	95	0.994
Serum spexin (ng/mL)	64.0	95	90	0.461
Serum GLUT4 (pg/mL)	90.1	81	95	0.632

GLUT4: glucose transporter type 4, HOMA-IR: hemostatic model assessment insulin resistance

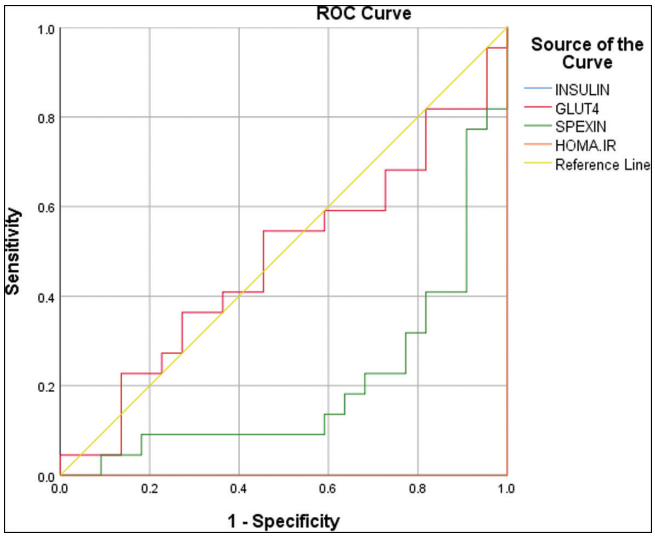

Figure 4: Sensitivity, specificity, the area under the curve, and cut-off point of studied marker between prediabetes and healthy subjects (HOMA-IR, serum insulin, serum GLUT4, and serum spexin). GLUT4: glucose transporter type 4, HOMA-IR: hemostatic model assessment insulin resistance

body, insulin serves a variety of crucial functions. It controls blood sugar levels, encourages fat accumulation, and even aids in the breakdown of proteins and lipids. However, taking diabetic medication or having too much insulin owing to insulin resistance can result in weight gain.[21]

Contrary to the expected, insulin level decrease in diabetic patients, the possible explanation for this finding is the impaired insulin secretion found in T2DM could be due to a decline in the cellular secretion rate (this is individual B-cell function) or, to decrease in B-cell mass (the product B-cell size and number) or both.[22]

Reduced or incorrect insulin secretion, which may be caused by a deficiency in islet cell function or B-cell bulk, is a hallmark of T2DM. Long-term diabetes in T2DM causes an islet cell mass reduction of up to 30%, which is mostly linked to islet amyloid deposition and the degree of amyloidosis. The longer the dosages, the lesser the insulin.[23]

In the study, the BF% in the prediabetic group was higher than in the diabetic group. The high BF% is more likely to develop prediabetes body weight loss in patients with diabetes. The resultant declines in lean mass that often occur together with the loss of fat mass by potentially detrimental for the functionally limited older adult with diabetes.[24] The level of GLUT4 in study groups can be explained depending on that insulin increases the steady-state plasma membrane level of GLUT4 to 5- to 30-fold,[25] which means that insulin stimulates glucose transporter by promoting translocation of the insulin-sensitive GLUT4 isoform from an intracellular compartment to the cell surface this movement is accomplished by stimulation of GLUT4 exocytosis as well as inhibition of endocytosis[25]. It can be noted that this interpretation is with the result of insulin in the studied group. In the study, serum GLUT4 decreased when compared with healthy individuals, whereas increased more than T2DM. Insulin resistance is characterized by reduced cell-surface GLUT4 in response to insulin. The trafficking itinerary that moves GLUT4 to and from the cell surface is complex, evidence suggests that this trafficking pathway itself is a crucial determinant of insulin resistance meriting independent characterization.[13] The reduced insulin-stimulated cell-surface GLUT4 is generally due to an impairment in GLUT4 trafficking rather than a simple reduction in total GLUT4 levels, impaired GLUT4 translocation may be independent, in part, from changes to the insulin signaling nodes that control GLUT4 trafficking.[13] Impaired insulin-stimulated translocation of GLUT4 to the cell surface is the major defect in muscle and adipose tissue insulin resistance, leading to dysregulated glucose homeostasis and predisposing individuals to T2DM. Despite this, there are no existing therapies for T2DM, metabolic disease, or insulin resistance that specifically target GLUT4. Developing such therapies necessitates a detailed understanding of the cellular machinery that choreographs GLUT4 movement throughout the cell and, critically, how this machinery is altered in insulin resistance.[13]

T2DM is one of the reasons leading causes of hyperlipidemia and co-exists with obesity, hypertension, and dyslipidemia but dyslipidemia is common in diabetes mellitus as both insulin deficiency and resistance affected enzyme pathway of lipid metabolism. This study shows the increased level of serum cholesterol, triglyceride, VLDL, and LDL cholesterol in T2DM patients. Other study shows the characteristic abnormalities in lipid T2DM include elevated serum triglyceride, serum

Table 5: Sensitivity, specificity, the area under the curve, and cut-off point of studied marker between prediabetes and healthy subjects (HOMA-IR, serum insulin, serum GLUT4, and serum spexin)

Parameters	Cut-off value	Sensitivity (%)	Specificity (%)	AUC
HOMA-IR	2.0	100	100	1.000
Serum insulin (mIU/mL)	10.3	100	100	1.000
Serum spexin (ng/mL)	91.6	81	95	0.200
Serum GLUT4 (pg/mL)	94.6	81	90	0.481

GLUT4: glucose transporter type 4, HOMA-IR: hemostatic model assessment insulin resistance

cholesterol, cholesterol HDL, and LDL cholesterol.[26] While healthy athletics showed the lowest level serum lipid profile, the exercise not only has positive effects on individuals with dyslipidemia but can also help improve lipid profile anaerobic exercise is defined as any form of physical activity that produces an increase in heart rate and respiratory volume to meet the oxygen requirement of the activity muscle.[27] The study showed a decreased level of serum HDL in patients with T2DM, HDL acts by enhancing the removal of cholesterol from the peripheral tissue and so reducing the body's cholesterol pool, T2DM was usually associated with a low plasma level of HDL cholesterol, the low-level HDL concentration are often accompanied by elevated triglyceride as in the study and others.[26] The study indicated an association between elevated blood sugar and low concentration of serum HDL, the hyperglycemia progressively increases the transfer of cholesterol ester from HDL to VLDL cholesterol particles.[28] The dense LDL particles acquire a large proportion of HDL ester further diminishing the HDL level in addition HDL cholesterol is a ready substrate for hepatic lipase, which converts to smaller particles that are readily cleared from plasma.[29] The relative insulin dysfunction deficiency that occurs in T2DM loss functions the action of lipoprotein lipase and results in lower HDL levels and high triglycerides.[29]

In the study increased serum spexin in prediabetes individuals when compared with healthy individuals, whereas T2DM patients showed a significant decrease in their serum spexin level. Plasma spexin levels are dysregulated in obesity and diabetes, energy homeostasis is regulated by complex communication pathways between the brain and peripheral organs and disruption of these pathways significantly contributes to chronic metabolic disease.[17] The role of spexin glucose hemostasis is also a major for personal regarding the function of spexin in human pancreatic islets are known to have spexin expression both at the transcript and protein concentration.[17]

That force-reducing serum spexin secretion from the pancreas could not be explained by the study and it was not mentioned in the available source. This is in agreement with a study,[30] which found decreased serum levels of spexin in patients with T2DM.

A study suggests that increased serum spexin levels in prediabetes patients in the study determination spexin in the endocrine pancreas organ with insulin in secretory vesicles that can be secretion jointly with insulin in patients with T2DM serum concentration of spexin has been mentioned to be attenuated by 44%.[30] Insulin resistance leads to increased insulin causing hyperinsulinemia the spexin secreted together with insulin in a beta cell leads to an increase in both spexin and insulin levels this is in agreement[31] found the spexin and insulin secreted by beta cell together.

Conclusion

The rise of serum spexin hormones and decreased serum GLUT4 with the rise of serum insulin in pre-diabetic individuals gives the idea that it could be an indicator or predictor of insulin resistance.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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