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The Effects of Viscosity on Blood Glucose Level of Some People in Mosul City

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Abstract

Background: Blood viscosity reflects blood viscosity. It is a measure of the blood's ability to flow through blood vessels. Excessive viscosity is a strong indicator of cardiovascular diseases as it can impede blood flow and/or oxygen supply to body tissues.

Objectives: This study was conducted to investigate the effect of viscosity on blood sugar levels.

Materials and Methods: Seventy-two random blood samples were collected from healthy individuals without diabetes from qualified medical laboratories in the city of Mosul. The blood samples were divided into three groups based on packed cell volume (PCV) results. The first group had a PCV reading below the normal range. The second group had a PCV reading within the normal range. The third group had a PCV reading above the normal range and included both male and female participants aged between 22 and 60 years.

Results: The study results showed that an elevated PCV level in the third group led to a decrease in glucose levels compared to the first and second groups. In males, blood sugar levels in the second group were significantly lower than those in the first group. In females, the second group also showed a significant decrease in glucose levels compared to the first group.

Conclusion: Increased viscosity due to proteins affects the function of glucose-carrying proteins and results in lower blood glucose levels.

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تأثير اللزوجة على مستوى سكر الدم لدى بعض سكان مدينة الموصل

خلاصة

الخلفية: لزوجة الدم تعكس لزوجة الدم. وهو مقياس لقدرة الدم على المرور عبر الأوعية الدموية. تعتبر اللزوجة المفرطة مؤشرا قويا لأمراض القلب والأوعية الدموية لأنها يمكن أن تعيق تدفق الدم و/أو إمدادات الأكسجين إلى أنسجة الجسم.

الأهداف: أجريت هذه الدراسة لمعرفة تأثير اللزوجة على مستويات السكر في الدم.

المواد والطرق: تم جمع اثنين وسبعين عينة دم عشوائية من أشخاص أصحاء وغير مصابين بالسكري من مختبرين طبيين مؤهلين ومتخصصين في مدينة الموصل. تم تقسيم عينات الدم إلى ثلاث مجموعات على أساس نتائج حجم الخلايا المعبأة (PCV). المجموعة الأولى التي كانت فيها قراءة PCV أقل من المعدل الطبيعي. المجموعة الثانية حيث كانت قراءة PCV ضمن المعدل الطبيعي. المجموعة الثالثة حيث كانت قراءة PCV أعلى من المعدل الطبيعي وتضم فئتين ذكور وإناث تتراوح أعمارهم بين (٢٢ –٦٠) سنة.

النتائج: أظهرت نتائج الدراسة أن ارتفاع مستوى PCV في المجموعة الثالثة يؤدي إلى انخفاض مستوى الجلوكوز في التعاطف مع المجموعتين الأولى والثانية. في الذكور، كانت مستويات السكر في الدم في المجموعة الثانية أقل بشكل ملحوظ مما كانت عليه في المجموعة الأولى. أما المجموعة الثانية من الإناث فقد انخفض مستوى الجلوكوز بفارق معنوي عن المجموعة الأولى.

الاستنتاج: إن زيادة اللزوجة بفعل البروتينات يؤثر على وظيفة البروتينات الحاملة للجلوكوز وانخفاض نسبة الجلوكوز في الدم.

Introduction

Blood is a red viscid fluid flowing regularly inside blood vessels of the body. It consists of two parts, cellular part (red blood cells, white blood cells and platelets), and fluid part which contain vitamins particles, hormones, electrolytes, as well as proteins which give the blood its viscous property [1]. Viscosity is an important property of the fluid that have internal friction for the terraced fluid layers that slide over each other[2,3,4]. Viscosity is working independently from fluid velocity, i.e., it doesn't change with the blood velocity, but it can effect on the speed of the flowing blood [5]. Plasma proteins can do their effects on augmenting viscosity either directly under physiologic and pathologic conditions and that what is the globulin do, or indirectly, through aggregation of deformed red blood cells, and that is what fibrinogen do [6, 7].

Hypoalbuminemia might lead to increase viscosity due to increase in fibrinogen and finally leads to aggregation of disfigured red blood cells [8]. After knowing the most important causes of high blood viscosity, we should know the bad consequences of it as a result of increased percentages of plasma proteins and slowdown of blood flow, with possible cardiovascular problems in the form of heart attack, cardiomegaly, blood vessels fibrosis, and impairment of renal function and function of other systems in the body due to ischemic changes [9]. The blood has many functions, the most important of which is transportation of oxygen necessary for the cellular respiration, in addition to that, it will deal with metabolic waste products like Co2 and solid products and excrete them through specialized excretory system, transport hormones from endocrine glands to target organs, in addition to that, the blood keeps the body temperature fixed and defends against microorganism. The blood also transports the food particles which has been absorbed in the intestine and delivered to the cells and tissues. The increasing rate of blood viscosity will be affect directly or indirectly on the function of the blood [10], and this may change the normal rate of blood components [11],.

Blood glucose is regarded as the main source of energy in the body and it is the corner stone in most of the metabolic process inside the cells in order to proceed in their life cycle [12]. After absorption of glucose by intestinal mucosa, it will enter the blood and then move to the cells through proteins which is present on the cytoplasmic membrane of cells which includes **(GLUT 1 – 4)**. Each type of cells having a specific type of protein present on its cytoplasmic membrane, for example, **GLUT -1** is present on the red blood cell membrane [13], **GLUT- 2** is present on the cytoplasmic membrane of epithelial cells of intestine ,liver and pancreas [14]. **GLUT -3** a protein carrier for sugar is present on the cytoplasmic membrane of nervous cells , while the **GLUT - 4** protein is present in the fat cells and striated muscles [15,16]. All these proteins help glucose to enter the cells where cytoplasmic membrane separates the intracellular fluid from extracellular fluid. The protein on the plasma membrane binds to the glucose and introduces it into the cell by selective method [17]. The function of these proteins is affected by osmotic pressure [18]. The levels of glucose and lipids also vary with a decrease in the proportion of albumin due to the high proportion of fibrinogen, which increases blood viscosity. When the blood protein is increased, it may increase

the concentration of glucose transporting proteins and thus directly proportional to the process of entering glucose into the cells, so that the concentration of glucose inside the cell become more than outside it [19,20].

The aim of this experimental study is to find out the effects of high blood viscosity (as a result of increased plasma proteins) on blood glucose levels.

Materials and Methods

The samples used in the study included 72 random samples of people without diabetes. Samples were collected from two specialized laboratories for the period from November 5th ,2019 to October 20th ,2020 in the city of Mosul /Iraq, with ages ranging between (22-60) years, males and females. The samples were kept in special test tubes after taking the sample and under ideal laboratory conditions, using sterilized equipments.

The samples were divided according to the sex into male and females and as follow :

1. **Male samples:**

Group (1) included samples of people whose PCV test results were less than normal ranges (38%).

Group (2) included samples of people whose PCV test results were within normal ranges (38-44%).

Group (3) included samples of people whose PCV test results were above normal ranges (44%).

2. **Female samples:**

Group (1) included samples of women whose PCV test results were less than normal ranges

Group (2) included samples of women whose PCV test results were within normal ranges

Group (3) included samples of women whose PCV test results were above normal ranges.

Laboratory tests

1. Hematology tests:

The PCV of all samples was measured using Micro –Hematocrit centrifuge, a German origin apparatus [21].

2. Biochemistry tests:

The glucose level of the samples was measured by the enzymatic method using Spectrophotometer ,721- 2000, a Chinese –origin device at a wavelength 500nm ·

The statistical analysis: Analysis of variance ANOVA ONE WAY was used and the factors were tested using Duncan, a multi-range test to show the significant differences.

Results

The results of the analysis of statistical variance for the mean of the three male samples showed a significant difference in the levels of the PCV test and its effect on glucose level , as shown in table –1

parameters	Groups	means	Sig.
P.C.V	Group 1	38.51 (a)	**1.000**
	Group 2	47.53 (b)	**1.000**
	Group 3	53.07 (c)	**1.000**
Glucose	Group 1	90.98 (d)	**.077**
	Group 2	90.41 (e)	**.077**
	Group 3	86.20 (f)	**.077**

Table -1- shows the mean differences between the three groups of the variables for males (PCV, glucose) .

Similar letters are not significantly different from each other at the 0.05 probability level .

To clarify the difference between the results of the three groups, a letter code was given for each result, and that the similarity in letters means that there is no significant difference between the groups. We note the results of PCV test of the first group (a), the second group (b) and the third group (c) , where there was a significant difference at the significant degree of 1.000 , while the glucose results for the first group (d) and the second group (e) ,and the third group (f) at the significant degree .077, it also gave a significant difference between the groups.

After completing the analysis of variance for the results of (PCV) and glucose for the groups, and from following the tables and figures, it's clear that there is an inverse relation between the levels of PCV and glucose level. When a comparison is made between figure (1) and (2) , we note that the first group is the lowest in terms of PCV than the second group and the third group with discrepancy between the means . The first group represented 38.51 while the mean of the second group were 47.53 and the third 53.07. As for the level of glucose for the three groups (first, second and the third), the mean degree of glucose in the first group was 90.98, and for the second and third, they were 90.41and 86.20 respectively.

Parameters	**groups**	**means**	**Sig.**
P.C.V	Group 1	33.36 (a)	**1.000**
	Group 2	40.36 (b)	**1.000**
	Group 3	46.75 (c)	**1.000**
	Group 1	166.10 (d)	**.239**

Glucose	Group 2	96.70 (e)	**.239**
	Group 3	90.00 (f)	**.239**

Table -2- shows the mean differences between the three groups of variables (PCV, glucose) in female.

Similar letters are not significantly different from each other at the probability level 0.05.

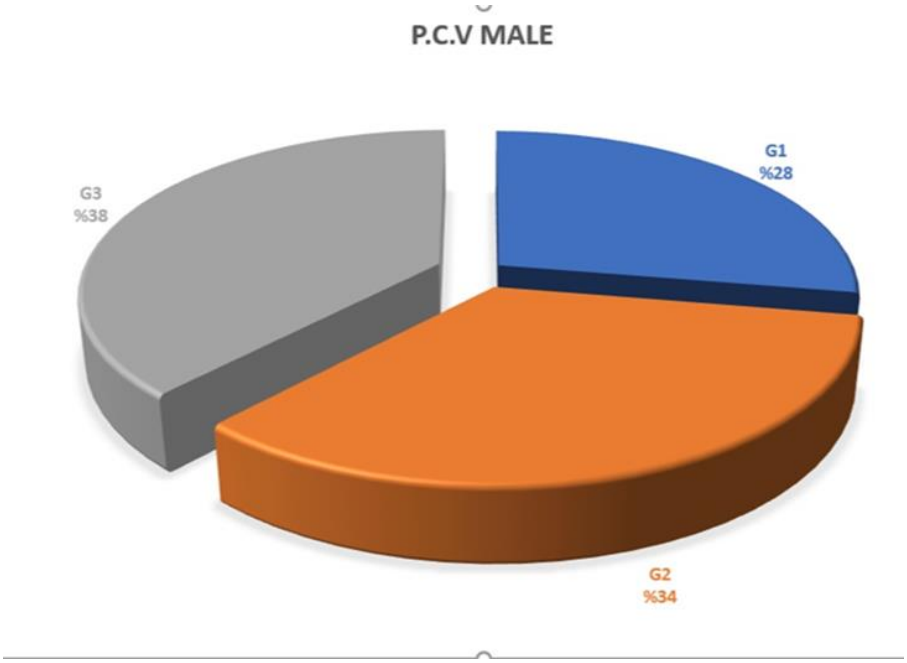
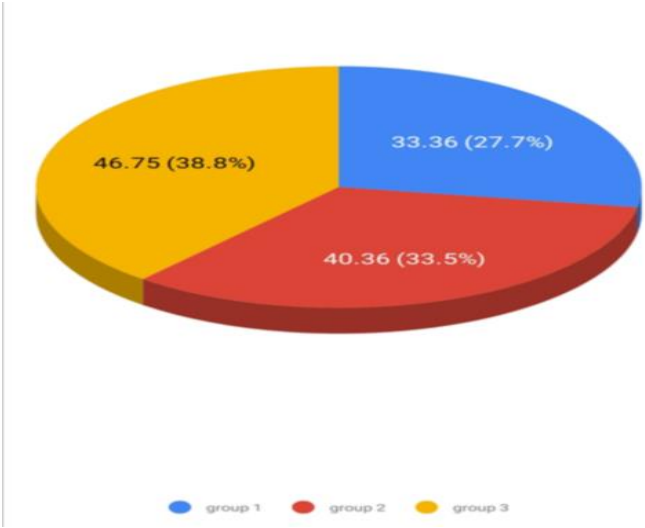


Figure (1) shows the comparison between the mean PCV test for males.

Figure (1) represents the significant differences between the three groups of PCV test, and c was the highest compared with b and a.

Figure (2) showing the comparison between the mean glucose test for males

Figure -2- shows that there are differences in blood glucose level for the three groups, as (d) is the highest in glucose level compared with (e) and (f) .



The results of the statistical analysis of the tests of female samples of three groups show significant differences for the PCV test with a significant degree of 1.000 Figure (3), as well as blood glucose test with a significant degree of 239 as in table -2.

The same applies to female samples as well as to the male, as the PCV mean of the first group was 33.36 compared to second group 40.36 and the third 46.75. As for glucose level, the female samples of the first group were the highest with a mean of 166.10, compared with the mean of the second and third groups which were 96.70 and 90.00 respectively.

Fig -3- shows the difference in pcv ratios between the three groups in females, and we notice the difference between group number (1) and the control group (3). While the difference between group (2) and (3) was the smallest ratio

Fig -4- gives the indicators of the difference in the concentration of glucose in the three groups, where the third group was the lowest compared to the first and second groups, and the relationship of the increase in PCV was inverse with concentration of glucose, just as in the male samples. We noticed an intersection between the results of the study with other studies [10,15,20], where these studies showed that high glucose is a major cause of high viscosity and this intersection may be due to several reasons, including the environmental level or nutrition or a difference in some living habits such as daily physical activity.

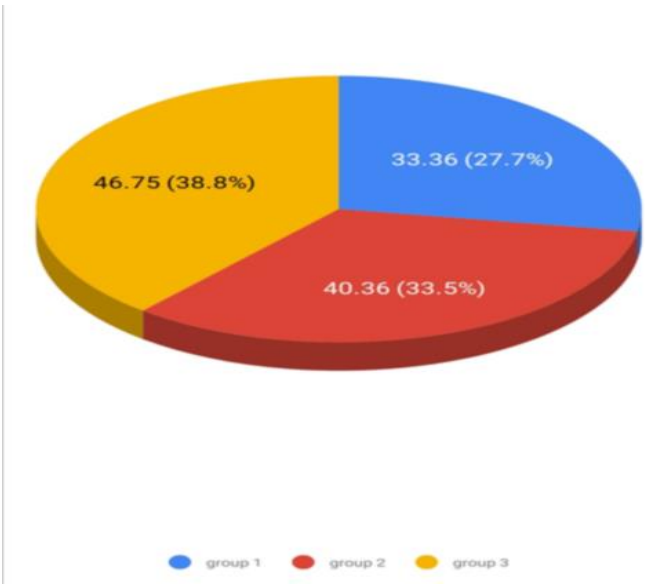


Fig .-3- Shows the comparison between the mean of the PCV test for females

Fig -3- shows the difference between the three groups, as the third group is the highest in PCV compared to the first and second group.

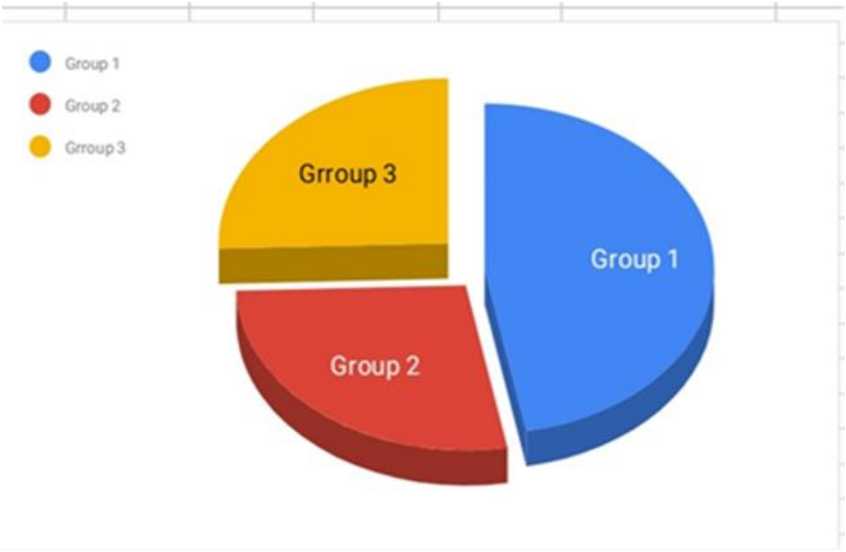


Fig -4- shows the comparison between the mean glucose test for females

DISCUSSION

This discrepancy and the inverse relationship between the levels of PCVs and glucose is due to the fact that the viscosity occurred due to increase in blood proteins and that the increase in the blood proteins was the reason for the increase in the level of activity of glucose transporting proteins across the cell membranes **GLUT 1- 4** and this is consistent with the study [17,22]. in increasing the activity of glucose transporting proteins through the cell membrane. The balanced flow of glucose through the narrow orifice represented by GLUT -2 increases the vestibular tension of the extracellular fluid, which in turn raises the hydrostatic pressure, so that water, glucose and salt enter, and the flowing water prevents the glucose from leaving with ferritin and thus works to restore the activity of vestibular tension again [23].

The inverse relationship between PCV and glucose levels explain that an increase in blood protein increases osmotic pressure and thus an increase in the activity of glucose transporting proteins [24,25] and high levels of protein in the blood led to a decrease in glucose levels and this what was stated in the study, although the increase in PCV of the samples was within the normal limits, but with significant differences between groups and the difference in glucose concentration ,which is also within the normal ranges with the differences between groups ,but this decrease in the normal levels of glucose may result in

long term complications for both the circulatory system and the brain ,which affects the individual in doing sports activities or make sleep difficulties [26,27].

CONCLUSION

The increase in viscosity by the action of proteins (under physiological and biological factors) affects the function of glucose – carrying proteins and decrease in blood glucose, this may result in major health complications.

ETHICAL DECLARATIONS

Acknowledgements

Ethics Approval and Consent to Participate

Before embarking on the research, the approval of the College Council was obtained under approval reference no. 103065, and then it was presented to the Scientific Committee, Finally we have got approval**.**

I agree with the above statements and declare that this submission as outlined in the Guide for Authors and in the Ethical Statement.

All blood samples were drawn from humans. We obtained their consent to conduct this research.

Availability of Material

1) This material is the authors' own original work, which has not been previously published elsewhere.

2) The paper is not currently being considered for publication elsewhere.

3) The paper reflects the authors' own research and analysis in a truthful and complete manner.

4) The paper properly credits the meaningful contributions of co-authors and co-researchers.

5) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.

Authors' Contributions

All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

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