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Research Article

Chromium's Hidden Role in Insulin Resistance, Metabolic Syndrome, and Diabetes

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ABSTRACT

In this study, we developed a spectrophotometric method to explore the association of nutrient composition, particularly of chromium, and insulin resistance. Forty volunteers were used for tissue concentrations by using the Oligo-Check spectrophotometer to determine chromium, zinc, and selenium measurements. Subjects were divided into low chromium (n=18) and normal chromium level (n=22) groups. Serum insulin and fasting blood glucose were determined by Roche Cobas systems, and HOMA-IR was calculated according to the formula. Findings showed that insulin resistance was significantly higher in the low chromium group, concluding that; "depleted chromium leads to insulin resistance., The implications of the study emphasize the need of watchfulness and regulation of chromium in patients with insulin resistance.

Bullet points:

- Spectrophotometric Analysis: Chromium, zinc, and selenium levels were measured in 40 volunteers using the Oligo-Check spectrophotometer.
- Group Comparison: Participants were divided into low-chromium (n = 18) and normal-chromium (n = 22) groups; insulin and fasting glucose were analyzed using Roche Cobas systems.
- Key Finding: The low-chromium group showed significantly higher HOMA-IR values, indicating that reduced chromium levels contribute to insulin resistance.

1. INTRODUCTION

When cells become insulin resistant, the hormone is unable to control how they absorb and store glucose. It begins with high levels of insulin in the blood and then progresses to glucose intolerance, which can lead to type 2 diabetes, as well as high cholesterol, high blood pressure, obesity and heart disease. A number of factors are involved in the creation of these disorders, but one mineral, chromium, is implicated in each [1,2]. Glucose tolerance factor (GTF) is dependent on chromium and is important for healthy glucose metabolism. When the amount of chrome decreases as, for example, by too low dietary intake or malabsorption, cravings for sugar arise2. It also metabolizes proteins, fats and carbohydrates. There is a supposition that the hormone insulin might work more effectively leading to better control of sugar levels in the blood as a result [3]. thought to enhance insulin sensitivity so the body can use that hormone more effectively. This can help to prevent blood sugar levels from spiking, and might even be useful in the management of a condition known as type 2 diabetes [4]. We need zinc for our immune systems to function, to make a variety of hormones and to carry out loads of enzymatic reactions in our bodies. Symptoms of deficiency include lethargy, increased fat mass and hormonal perturbations [5,6]. Mineral testing shows low chromium and iodine, high copper and zinc 'block' levels, fatigue patients with hormonal imbalance or excess weight etc. It is this combination of causes that leads to insulin resistance and the diseases which follow like a terrestrial gravity.

We chose the study model insulin resistance among our research program since this is the simplest organ to confirm or exclude diabetic mellitus. On the contrary, several studies observe an increasing prevalence of diabetes mellitus, particularly among young people and children. We hope to address with the study whether or not there are factors that

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have to do with both absolute levels of micronutrients and the ratios between them (Coming Soon – Solving Insulin Riddle) that promote insulin resistance. This sort of disorder may give rise to metabolic disturbances owing to overabundance or deficiency of modifiers, and eventually lead to onset of the diabetes mellitus.

- The aim: - The following study is of a model nature, whose purpose is to determine the suitability of the Oligo Check spectrophotometric method to search for significant interdependencies of chromium and insulin resistance in blood within the human body.

2. MATERIAL AND METHODES

2. 1 Subjects

The study involved 40 healthy volunteers, comprising an equal number of women and men (20 women and 20 men). All participants were carefully selected to ensure they did not exhibit any symptoms of illness or suffer from chronic diseases. The age range of the participants was between 35 and 55, ensuring a balanced representation within this specific age group.

2. 2 Study groups

The participants were subsequently categorized into two primary groups according to their chromium levels. The first group consisted of 18 individuals, comprising 11 women and 7 men, who were identified as having low chromium levels. In contrast, the second group included 22.

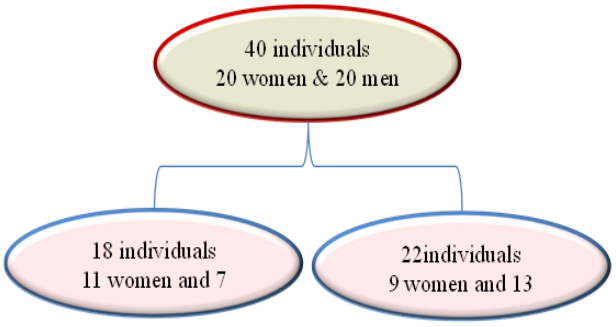

Fig. 1. Schematic representation of participant selection and gender distribution.

participants, 9 women and 13 men, who exhibited normal chromium levels. This classification allowed for a more detailed analysis of the impact of chromium levels across the two distinct groups.

2. 3 Sample Collection and processing

Blood samples were collected from all volunteers in 12-h fasting state after the last meal, with individual 2.5-ml samples. Blood samples were centrifuged at 5000rpm to obtain blood serum. The isolated serum was then utilized for insulin and glucose analysis. Insulin was measured by using Roche Cobas e411 and fasting blood sugar was measured by using Roche Cobas C311. The Homa-IR due to insulin resistance was calculated by the equation Homa-IR = (Glu × Insu) ÷ 405.

The concentration of all tissue (chromium, selenium, and zinc) for all persons was determined by Oligo-Chek contact spectrophotometer, that concentration, which was processed by devices based on complex test algorithms.

Results were marked using color graphs and percentages, by the device software. In accordance with the producer for the organization database assigned the percentage: 0 ± 25 % green zone, satisfactory. On fasting blood sugar and insulin level a blood was taken.

2. 4 Description of testing process

Quantitative analysis by spectrophotometry depends on measuring absorbance in the target tissue at a designated wavelength, by the Lambert-Beer law. If the evaluated system complies with the linearity concept established by the Lambert-Beer law, it is feasible to ascertain the quantitative properties of the analyzed components.

The OligoCheck system is engineered to accurately evaluate the bioavailability of minerals, trace elements, and heavy metals in biological tissues. The measurement procedure is performed on the palm's skin utilizing a spectrophotometer (Figure 2). The procedure is rapid and effective, yielding outcomes in only seconds.

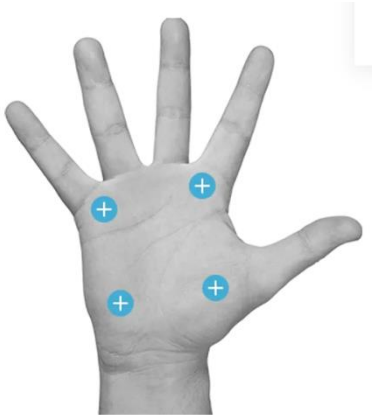

Fig. 2. OligoCheck test apply in the hand.

The OligoCheck test uses a sensor unit (figure 3), which is connected to a computer, and the software developed by the manufacturer via an internet connection. The software must first be loaded with patient information such as sex, age, weight, height and blood type before test execution. We take four consecutive spectral measurements of the subject's palm. They relay the readings via an internet connection to remote servers, where processing is performed, and a results report is generated in seconds.

Fig. 3. OligoCheck spectrophotometric sensor.

Oligo Check is a spectrophotometric method that works using a laser beam that offers several advantages, such as non-invasiveness, speed, and cost-effectiveness. So, they enhance patient adherence to some dimensions and so they also ease the getting consent for participation. In addition, the small foot print of the sensor unit minimizes lengthy set-up procedures ensuring high portability and ease of use.

2. 5 Statistical analysis

To achieve a thorough description of the data, means and standard error values of the quantifiable variables were calculated. Normally distributed variables were compared between groups using a paired one-way analysis of variance (ANOVA). This study aimed at examining glycemic and insulinemic responses (plasma glucose and insulin levels, and the insulin resistance index) according to the values of chromium in basal blood, calculated as the means ± standard deviations (SD) to characterize patients with below-average and above-average levels of chromium in plasma. SPSS version 24.0 for Windows (IBM Corp., Armonk, NY, USA) was used for statistical analyses. Statistical significance was defined as a p-value of < 0.05, since this method yields the best and most reliable results interpretation.

3. RESULTS

Table I illustrates Mineral testing with the Oligoscan. It reveals anomalies in mineral levels, helping us understand the nutritional causes of insulin resistance.

TABLE I. THE DEMOGRAPHIC THE MINERAL IN STUDY GROUPS

Parameters	Normal range	Normal chromium		Low chromium		ANOVA P-value
		Mean	Standard Error	Mean	Standard Error	
Chromium	25-1+25	1.66	0.32	-65.60	8.17	0.000
Zinc		3.60	0.74	44.00	4.80	0.000
Selenium		5.20	0.37	6.20	1.15	0.435

Table II illustrates the mean blood sugar, insulin, and insulin resistance in people with normal chromium (85.00 ± 5.03 mg/l, 56.90 ± 9.59 U/ml, and 1.70 ± 0.05, respectively) and in people with low chromium (118.93 ± 14.39 mg/l, 60.91 ± 48.02U/ml, and 5.33 ± 0.05, respectively).

TABLE II. THE DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF ALL INDUVIAL OF STUDY

Parameters	**Normal chromium**	**Low chromium**
	Mean ± Standard Error	**Mean ± Standard Error**
Fasting blood sugar mg/dl	85.00 ± 5.03	118.93 ± 14.39 **NS**
Insulin U/ml	56.90 ± 9.59	60.91 ± 48.02 **NS**
Insulin resistance	1.70 ± 0.05	5.33 ± 0.05 **S**

The statistical analysis revealed a significant increase in insulin resistance among individuals with low chromium levels compared to those with normal (p-value < 0.05, df = 1). In contrast, no significant differences were observed between the groups in fasting blood sugar or insulin levels (p-value > 0.05, df = 1; Table III).

TABLE III. COMPARISON BETWEEN THE CLINICAL FEATURES OF ALL INDUVIAL OF STUDY

Parameters	**df between groups**	**df within groups**	**f**	**sig**
Blood sugar mg/dl	1	7	1.268	0.297
Insulin U/ml			0.016	0.902
Insulin resistance			6.688	0.036

4. DISCUSSION

In the current study, it was observed that patients with low chromium level have insulin resistance, despite reasonable moralities of insulin and glucose. This finding is consistent with the idea that in insulin resistance in early stages decreased cellular sensitivity is compensated for by pancreatic production of enough insulin to keep blood sugar within normal range. But as insulin resistance increases and chromium deficiency may make this worse over time, pancreatic beta cells can be pushed to their limit. This inability to maintain sufficient insulin secretion is a pathway toward hyperglycemia and progression to type 2 diabetes. These data indicate a possible protective effect of chromium on insulin sensitivity and the development of glucoregulatory defects. [7.8]. Chromium is important in the metabolism of carbohydrates, lipids, and proteins [9]. Several hypotheses have been put forward to explain the role of chromium for glucose and insulin metabolism. Chromium might have an effect on glucose transport, especially the major glucose transporter, GLUT- [10]. Low chromium levels have also been linked with insulin resistance, where body cells stop responding to insulin and instead cause blood sugar levels to rise [11]. Chromium enhances insulin activity by increasing the insulin receptors located on cellular surfaces and it enables a greater amount of insulin to bind site, facilitating glucose entry into the cells [12]. Inadequate Cr begins this process to become distorted and culminates in insulin resistance. Deficiency in Chromium may raise blood sugar levels by reducing the absorption of glucose and its state and tissue storage in the body. Moreover, the ability of our body to maintain levels of blood sugar decreases when a deficiency of chromium affects insulin signaling pathways. Insufficient concentrations of chromium (Cr) have been observed to affect insulin action in the blood [13, 14], possibly through perturbation of insulin signaling pathways resulting from insufficient Cr. Recent research indicates that consuming an appropriate amount of chromium is crucial for preventing insulin resistance and maintaining a healthy metabolism. Evidence for chromium to assist those with diabetes in decreasing blood sugar and increasing insulin appears to be inconclusive at this time, and more research is needed before conclusions can be made [15 – 17].

We also found that patients who are chromium-deficient are often deficient in zinc as well. This co- deficiency may act synergistically during the process of ER stress, insulin resistance and progression. It is well established that zinc plays critical roles as an essential trace element in many biological processes such as insulin synthesis, secretion and signaling. Deficiency of zinc may adversely affect these systems, thereby impairing the body's ability to control glucose homeostasis. In addition, there is a link between zinc deficiency, oxidative stress and chronic inflammation that are key contributors to insulin resistance. Zinc is also needed to make insulin, thyroid hormones, and sex hormones, including testosterone and estrogen. These hormones govern major systems, such as those related to metabolism, reproductive health and overall energy levels [18,19]. Elevated zinc levels in the body can induce insulin resistance, although it is complex and context-dependent. Insulin production, secretion and action is also affected by zinc - a critical trace element [20]. Yet elevated zinc intake or accumulation can also be maladaptive and have negative metabolic consequences, and it is important to consider zinc homeostasis as low or excess levels of this mineral negatively impact on metabolic health.

5. CONCLUSIONS

Chromium and zinc deficits may coexist and together inhibit metabolic pathways, thereby increasing the risk of insulin resistance and subsequent complications such as type 2 diabetes. Addressing these gaps is critical for identifying the populations at risk and for developing effective prevention or treatment strategies. More studies are needed to clarify the

complex interplays between these micronutrients and their role in maintaining systemic insulin sensitivity and metabolic health.

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Conflicts of Interest:

The authors declare no conflicts of interest.

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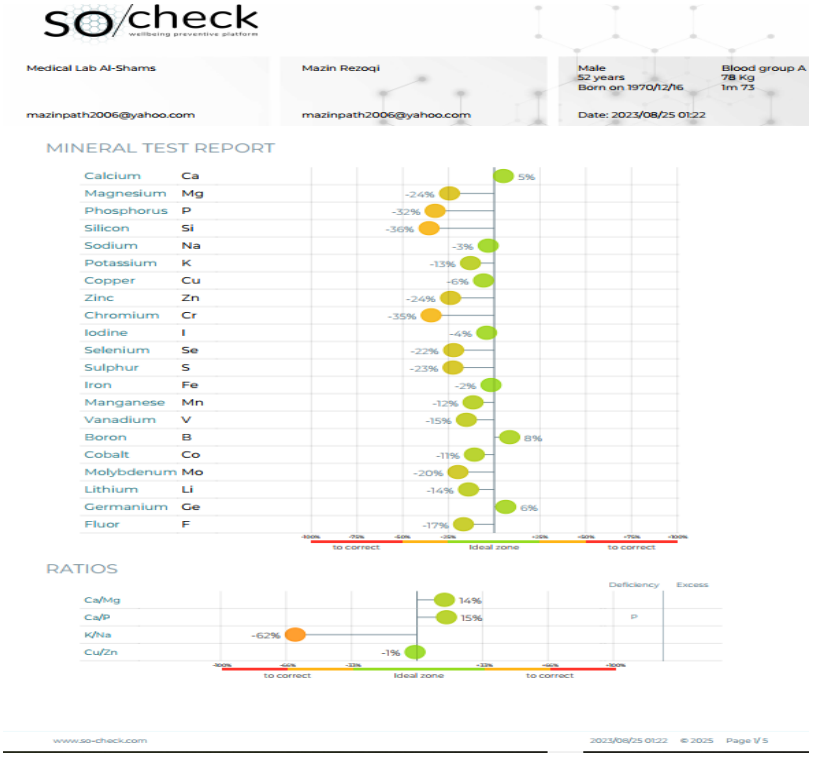
Appendix:

Appendix. 1. The result of the voluntary participant showed a decrease in both chromium and zinc levels, measured using the OligoCheck technique.



Appendix. 2. The result of the voluntary participant showed a normal in both chromium and zinc levels, measured using the OligoCheck technique.