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ORIGINAL ARTICLE

Evaluation of Trace Elements in Patients with Senile Cataract

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ABSTRACT

Background: Senile cataract is a common cause of blindness among older people. The problem is common among adults of age 40 and older. There are various factors that cause senile cataracts among adults. These factors include protein and lipid variations, genetic role, and the existence of trace elements like magnesium, zinc and copper.

Aim and objectives: To evaluate the level of zinc and relationship between copper, and magnesium in patients with senile cataract by comparing with healthy subjects.

Material and Methods: This study has a key focus on examining the effect of trace elements on senile cataract patients. We conducted experiments when 100 people (50 patients and 50 non-patients). Absorption spectrometry was used to examine the blood samples of the people who took part in the research.

Results: It was noted during the results that most of the patients developed senile cataracts after crossing the age of 50. It was also noted from the results that the concentration of copper and zinc was higher in the patients as compared to the non-patients, while the concentration of magnesium was lower in the patients as compared to the non-patients. Based on these results, it can be stated that an increase in the concentration of copper and zinc increases the chances of senile cataracts. The decline in the concentration of magnesium increases the chances of senile cataracts. Also, out of these patients, a majority of them were females. Therefore, there are chances of biased results in this study that can be improved in future studies with the number of patients and an equal number of males and females.

Conclusion: The concentrations of copper and zinc were significantly higher in patients than in the non-patients, whereas the concentration of magnesium was lower in the patients than in the non-patients. Based on these findings, it may be concluded that an increase in copper and zinc concentrations increases the risk of senile cataracts.

Keywords: zinc, copper, magnesium, senile cataract, healthy subjects.

INTRODUCTION

A cataract is one of the most common causes of vision loss across the world. It handles roughly 47.8% of all blindness globally. Cataract handles roughly 51 percent of blindness in the Southeast Asia area, which includes Pakistan. An intraocular crystalline lens focuses light entering the eye onto the retina.[1] The opacification of this natural intraocular crystalline lens is known as a cataract. Because the clouding of the lens occurs gradually and without discomfort, it might cause a loss of eyesight. If not treated promptly, this can cause vision loss and have a negative impact on one's life, even if one is unaware of it. If not treated promptly, this can lead to blindness. 3Capillary development is often triggered by physical aging; however, several situations may cause it to occur early. Pre-senile cataract is defined as the incidence of cataracts from early adulthood to the age of 60. Pre-senile cataract is thought to be secondary to some underlying ocular/systemic/environmental condition that causes the lens opacification at such a young age. 6 Systemic disorders, ocular diseases, drugs, refractive error (high myopia), and trauma (including mechanical, chemical, thermal, and radiation) are some of the risk factors connected to the early development of cataracts.[2]

Around the world, cataract is a common cause of blindness. Its genesis has been linked to several factors. Genetic variables, diabetes, smoking, nutrition, the cumulative influence of X-rays, UV irradiation, and changes in endocrine and enzymatic balance are only a few of them.[3] There is powerful evidence that free radicals such as H_2O_2 can cause lens opacities, and it has been discovered that the activity of Na–K ATPase decreases with age, increasing membrane permeability. Many authors have looked into the involvement of trace elements in the cataract development process. Because considerable changes in the concentrations of trace elements, including Zn, Cu, K, Ca, and Mg in cataractous lenses have been discovered, it is assumed that these elements play a role in cataractogenesis. The amounts of Ca and Na in cataractous lenses increase while the concentration of K declines, according to experimental findings.[4] On the other hand, it has been discovered that Zn concentrations in cataractous lenses, in particular, rise. As a result, inorganic ions may play a part in the cataractogenesis process. The image below shows different phases of senile cataract:

Several studies have looked at the inorganic ion composition of clear and cataractous lenses, with the potassium, sodium, and calcium ions being particularly studied. A few studies have looked at the trace element composition of lenses, and alterations in their concentrations in cataractous lenses have been discovered.[5]

Senile cataract is one of the common causes of blindness in various parts of the world, especially in Pakistan. One of the critical factors that have been identified in the previous studies is trace elements that further increase the chances of senile cataracts among adults. However, it is important to note that the studies in the past were unable to present unambiguous results regarding the impact of trace elements on senile cataracts. Therefore, the major motive behind this study is to examine the impact of trace elements like copper, zinc, and magnesium as important factors for senile cataracts. It is important to note that there are very few studies in Pakistan that have been conducted on patients with senile cataracts. Because of this, there is a major gap in the literature that can provide valid and reliable results regarding trace elements in patients with senile cataracts. Hence, this study is very significant to provide quantitative results that are reliable and accurate. Thus, by using the results, knowledge can be gained about how trace elements can lead to the development of senile cataracts among adults. Also, the results are very beneficial for the medical and environmental experts to ensure that efforts can be taken to protect the people from this medical implication.

MATERIAL AND METHODS

This Comparative case-control study was conducted on 100 samples (50 patients and 50 controls) at the Department of Biochemistry, LUMHS in collaboration with the Institute of Ophthalmology, affiliated with Liaquat University of Medical and

Health Sciences, Jamshoro and High Tech Central Resource Laboratory located in University of Sindh, Jamshoro from June 1, 2021 to November 30, 2021.

All diagnosed cases with senile cataract patients within the range of 40-70 years of age were included in this study. While patients with cataracts due to secondary causes, and diabetic mellitus were excluded from the study:

The study collected specimens from different patients with senile cataracts using the technique of flame atomic absorption spectrometry. In this regard, an instrument named Perkin Elmer Analyst AA 800 was used. This instrument uses a liquid sample that is examined to find out the proportion of Zinc, Magnesium, and Copper.

Samples from cataract patients were collected from the Outpatients Department (OPD) of Institute of Ophthalmology at LUMHS. The collection of data is considered a critical research part that is one of the noticeable steps to aid the research for gathering data or information of the targeted topic, which could be utilized later for addressing the problem of the study as well as findings that are reliable and generalizable.[6] The data for conducting research is possible to be collected by using different sources. The data sources of the study are required to be credible in order to conduct effective research and gather reliable as well as accurate information for extracting findings from that. In such a realm, there are two sources that the researcher has, which are secondary and primary sources. The sources of primary data are mostly denoted as first-hand information, which is directly gathered from the respondents (subject under focus).[7,8] In contrast to that, the sources of secondary data are defined as the evaluations of the third party, which are conducted upon the primary collection of data. These sources are usually presented within new bulletins, organizational reports, institutional sets of data, and other private as well as public records.

This research is based upon primary sources of data collection, in which the researcher needs to directly extend towards the respondents for examining the problem of the research. In comparison with a collection of secondary data, primary data is preferred because it is helpful for the researcher towards gaining more control over the data. In addition to that, not every time is it possible to collect secondary data as most of the businesses keep their data confidential, which is not in excess of the researchers. That is why most researchers give preference to gathering primary data. McCrea et al.[7] further discussed that primary data usually have specific nature, are authentic, and provide up-to-date information, which makes them more reliable for the researchers. In this research, experimental data is collected through the use of medical equipment based on absorption spectrometry.

Data Analysis: The analysis of data is viewed as an essential step by which the researcher becomes able towards addressing the objectives as well as aims of the research. Numerous tools of quantitative analysis of data have been employed by the researcher, for example, descriptive analysis, frequency analysis, etc. Correlational and regression analysis was applied in order to analyze the relationship between magnesium, copper and zinc with senile cataracts. All the data was analyzed in SPSS version 23.0

Ethical considerations: The study was conducted strictly under the ethical rules after the formal approval by the ethical review committee of the Liaquat University of Medical and health sciences Jamshoro. The procedures used were strictly performed considering the Helsinki Declaration on human experimentation guidelines. These protocols were carefully explained to each research participant before the study and written informed written consent was taken from all participants.

RESULTS

A total of 100 samples were included in the study (50 were patients and 50 were control). The blood samples of these patients were collected and examined through absorption spectrometry. It was noted during this study that most of the patients that had senile cataracts were above the age of 50. This is a significant finding as it shows that the chances of developing senile cataract increase with age, and people are most likely to develop the disease as they cross 50 years of age. These findings can be noted in table 1 below.

Another important aspect to consider when examining the result is that a hundred people participated in this research. Besides this, 74 out of these people were females, while only 26 were males. **Table 1** below shows this observation.

After examining the age and gender of the participants, let's move towards the date of concentration of zinc, copper and magnesium of blood sample of these hundred people.

It can be noted from **Table 2** that the minimum value of the zinc concentration among the participants was 4.4 mg/dL, while the highest value was recorded to be 12.6 mg/dL. In addition to this, the minimum value of the copper concentration among the participants was 0.11 mg/dL, while the highest value was recorded to be 2.65 mg/dL. Besides this, the minimum value of the magnesium concentration among the participants was 1.10 mg/dL, while the highest value was recorded to be 2.40 mg/dL.

The **table 2** shows the individual minimum and maximum value for senile patients and control group. It can be noted that the concentration of zinc and copper is higher in senile patients, while that of magnesium is lower than that of the control group.

individual minimum and maximum value for senile patients and control group

Regression tests are also run on the data collected in this study to determine the relationship between the independent variables and dependent variable (existence of senile cataract).

Table 3 below shows the R-value of regression, which is closer to 1. This means that the model is strong with minimal error. Also, this shows that the relationship between the independent variables and the dependent variable is strong.

Table 3 presents the results of regression, where zinc, copper and magnesium are independent variables, while the existence of senile cataract is the dependent variable. It can be noted that the significance for each of the three dependent variables is <0.05. This means that the null hypothesis is accepted for all three of them, and alternate hypotheses are rejected.

In addition to this, the results show the same behavior as the initially framed hypotheses. The regression coefficients are positive for copper and zinc while negative for magnesium, which means that the existence of senile cataract has a positive relationship with copper and zinc concentration, while a negative relationship exists with the concentration of magnesium **(Table 3).**

It can be noted that the value of the Pearson correlation between zinc and senile cataract is 0.885, which is very close to 1. This shows a very strong relationship. Also, the value has a positive sign, which means that the increase in zinc concentration will lead to an increase in the chances of the existence of senile cataract. Therefore, based on this, H1 for this study is validated.

Moreover, it can be noted that the value of the Pearson correlation between copper and senile cataract is 0.941, which is again very close to 1. This shows a very strong relationship. Also, the value has a positive sign, which means that the increase in copper concentration will lead to an increase in the chances of the existence of senile cataract. Therefore, based on this, H2 for this study is validated **(Table 4).**

Table 1: Distribution of patients according to gender and age groups (n = 100)

Age Group	Number	Percentage
41 – 45	2	2%
46 – 50	4	4%
51 – 55	22	22%
56 – 60	34	34%
61 – 65	26	26%
66 – 70	12	22%
Gender		
Male	26	26%
Female	74	74%

Furthermore, it can be noted that the value of the Pearson correlation between magnesium and senile cataract is 0.842, which is very close to 1. This shows a very strong relationship. Also, the value has a negative sign, which means that the decrease in zinc concentration will lead to an increase in the chances of the existence of senile cataract. Therefore, based on this, H3 for this study is validated **(Table 4).**

Table 2: Minimum and maximum value for senile patients and control group

Senile Patients		Min	Max	Mean
	Zinc	7.6	12.6	10.819
	Copper	1.25	2.65	1.7894
	Magnesium	1.1	1.8	1.4842
Control Group		Min	Max	Mean
	Zinc	4.4	7.3	5.953
	Copper	0.11	0.14	0.1246
	Magnesium	1.8	2.4	2.0922

Table 3: Regression Model

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.960[a]	0.923	0.920	0.142
a. Predictors: (Constant), Magnesium Conc. (mg/dL), Zinc Conc. (mg/dL), Copper Conc. (mg/dL)				

Table 4: Pearson's correlation

Correlations					
		Senile Cataract Exists	Zinc Conc. (mg/dL)	Copper Conc. (mg/dL)	Magnesium Conc. (mg/dL)
Senile Cataract Exists	Pearson Correlation	1	.885**	.941**	-.842**
	Sig. (2-tailed)		0.000	0.000	0.000
	N	100	100	100	100
Zinc Conc. (mg/dL)	Pearson Correlation	0.885**	1	.870**	-.726**
	Sig. (2-tailed)	0.000		0.000	0.000
	N	100	100	100	100
Copper Conc. (mg/dL)	Pearson Correlation	.941**	.870**	1	-.800**
	Sig. (2-tailed)	0.000	0.000		0.000
	N	100	100	100	100
Magnesium Conc. (mg/dL)	Pearson Correlation	-.842**	-.726**	-.800**	1
	Sig. (2-tailed)	0.000	0.000	0.000	
	N	100	100	100	100
**. Correlation is significant at the 0.01 level (2-tailed).					

DISCUSSION

The results of the study show that the concentration of zinc was higher in patients with senile cataract as compared to normal people. It was noted that the normal range for zinc concentration in blood samples of normal people was found to be less than 7.5 mg/dL. The value of this concentration was higher in patients with senile cataract.

In the presence of Zn (2+), the stability of α-crystalline is enhanced. The Zn (2+) binding residues in αAcrystallin are H79, H107, and H115, whereas, in B-crystalline, they are H104, H111, and H119.[9,10] The absence of copper-zinc superoxide dismutase, an antioxidant enzyme, was linked to the development of lens opacities. Mineral and antioxidant defense have a strong relationship. Cu/Zn- and MnSOD activity, as well as Cu/Zn-SOD transcript, were lower in cataractous lenses. In cataractous lenses, reduced superoxide dismutase activity was linked to lower levels of mRNA transcripts and protein expression. Because of this, an increase in zinc concentration is observed in the patients with senile cataract.[9–16]

The results of the study show that the concentration of copper was higher in patients with senile cataract as compared to normal people.[17] It was noted that the normal range for zinc concentration in blood samples of normal people was found to be less than 1.1 mg/dL.[18] The value of this concentration was higher in patients with senile cataract. It was also noted during the literature review that the patients with senile cataract had higher levels of copper in their blood.[19] The mammalian lens contains α-crystallin, a member of the tiny heat shock protein family.

There was no statistically significant association between serum Cu levels and cataract risk in Jacques et al[20] study. Similar results were reported by Andakyol et al,[21] and Manoj B, et al.[22] According to a recent study by K.N. Sulochana et al,[23] there is no significant difference between patients with cataracts and controls regarding blood copper concentrations and ceruloplasmin levels. As compared to controls, serum samples from cataract patients had lower levels of copper, according to Bhat et al.[24]

The zinc-copper ratio has been reported to be 1.07 by Monaj B et al.,[22] based on data from several studies. The ratio remains normal in cataract cases, which is like ours. The smaller size of the group may explain the slightly higher ratio in the present study.

Another study showed that although the levels of copper and zinc in the cortex and nucleus of normal lenses did not differ significantly, they were found to be significantly higher in the cortex and nucleus of cataractous lenses. Zinc metabolism in the eye is still fragmentary and difficult to understand in 1982, according to Karcioglu.[25] Although there is some controversy regarding the status of these trace elements in serum, as well as in aqueous humor and the lens, as well as the possible role they may play in senile cataracts, we still think it is an appropriate statement to make at this point.

It has been reported that Akyol[21] found no significant difference in serum Zn concentrations in cataract patients between the normal range (80-140 g/dl). The levels of Zn and Cu in plasma of patients were lower than those of controls in the study by Bhat[24], but a larger study by Mohan and his colleagues could not show such a link.[22] The serum zinc levels of cataractous patients were also found to be lower than those of controls by IssaNourmohammadi et al.[26] The serum zinc levels of cataract patients have been found to be lower than those of controls by Indranilchakraborthy et al.[27] These findings are like those of Akyol et al[21] and Monaj B, et al,[22] who both found no significance in zinc levels between cataract patients and controls. Zinc levels in cataract patients and controls were also not significantly different in a study by K. N. Sulochana. R. Punitham, and S Ramakrishnan.[23] Zinc levels differ significantly between smokers and nonsmokers with cataracts. Such patients may benefit from zinc supplementation. SOD (superoxide dismutase) is an enzyme that stores zinc as an intracellular metal in various proteins and enzymes. Zinc levels in plasma and serum indicate human zinc deficiency, but they do not always reflect zinc levels throughout the body.

It was noted during the literature review that Magnesium is one of the most important components in lens function regulation. It supports the operation of over 350 enzymes by managing the body's ATPase's intracellular ionic environment. Its deficit resulted in ATPase dysfunction, which resulted in a significant rise in intracellular calcium and sodium concentrations and a reduction in intracellular potassium concentration, as well as the formation of cataracts. As a result, magnesium shortage has been linked to an increase in oxidative stress and inducible NOS activation, which can lead to cataracts, glaucoma, and diabetic retinopathy.[9–16]

The results found that the concentration of magnesium was lower in patients with senile cataract as compared to normal people. It was noted that the normal range for magnesium concentration in blood samples of normal people was found to be more than 1.8 mg/dL. The value of this concentration was lower in the patients with senile cataract. It was also noted during the literature review that the patients with senile cataract had lower levels of magnesium in their blood. Another study noted that magnesium ions are essential for lens homeostasis. As a result, magnesium deficit promotes ATPase failure, which leads to the

denaturation of lens crystalline protein, the soluble lens protein essential to keep the eye lens transparent. Magnesium shortage also increase lenticular oxidative stress by increasing free radical generation and depleting antioxidant defenses, which can promote cataract development. Therefore, these findings support that the decrease in magnesium can enhance the chances of developing a senile cataract. The regression results of the study noted that the concentration of magnesium was found to be lower in the patients with senile cataract. The significance for the variable is less than 0.05. This means that the null hypothesis is accepted for magnesium, and the alternate hypothesis is rejected.

CONCLUSION

The concentrations of copper and zinc were significantly higher in patients than in the non-patients, whereas the concentration of magnesium was lower in the patients than in the non-patients. Based on these findings, it may be concluded that an increase in copper and zinc concentrations increases the risk of senile cataracts. On the other hand, a decrease in magnesium content raises the risk of senile cataracts. More research and studies are needed to get more precise results.

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