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Determination of Serum Copper Levels Effect on Learning Ability Among Apparently Healthy Schooling Adolescents Recruited from Sokoto, Nigeria

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Abstract

Copper is vital for human biological system especially for learning functions. The objective of this paper was to determine the effects of serum copper on learning ability among adolescents in Sokoto, Nigeria. Therewith, serum copper concentrations of the 230 recruited adolescents' in-school from Sokoto, Nigeria were analyzed using the atomic absorption spectroscopy method, and reagents of analytical grade. The investigation of effect of copper concentration on learning potential was done in a quasi-experimental format. The findings ($p<0.05$) of serum copper concentration revealed mean serum copper in healthy subjects was 211(91.74%); serum copper deficient subjects were 19(8.26%). The low copper concentration observed based on age shows, 13(5.6%) of 14-16 years; and 6(2.6%) of 16-18 years. Observation of copper level in relation to learning potential show a mean of 62.28 in normal participants, and 36.92 in low copper participants. There is need for utmost diverse nutritional intervention on zinc consumption. There are still some adolescents that have low copper level in the state, and it may affect their

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learning and entire learning. Thus, it is important to provide better nutrition through using disparate intervention methods to bail the situation.

Keywords: School, Biological System, Serum, Copper, Brain, Learning

INTRODUCTION

Nutrition is a science of food. The problem in nutrition, that is inability of the human body to feed on appropriate value and amount of food; and as well as the failure of the body to utilize element for vital human biological system could be better dubbed as malnutrition (Ugwuja et al., 2007; Kihara et al., 2019). Malnutrition can also be regarded as excess nutrients in the body, deficiency of nutrients for the body, and impaired ability to use nutrients by the body (Zerga et al., 2022). Universally, about 54.0 % among school-age children are malnourished (Emadfa & Meyer, 2010; Zerga et al., 2022).

Malnutrition, that involves Micronutrients deficiencies is currently a global public health issue that is believed to be connected with poverty; hence, most of the affected people come from the developing regions of the world (Jiya et al., 2024). Africa is a typical region of malnutrition, a region of micronutrients deficiencies (Tukur et al., 2023). Albeit, there are several factors of malnutrition in Africa; however, increasing inequalities such as low income families, food insecurity, rising population, cultural dimensions, unhygienic conditions, poor awareness, poor education, and poor healthcare are dominant (Okolo & Obidigbo, 2015; Qureshi et al., 2020).

Nevertheless, in any population, children should be most important age group. Progress of children, youngsters, girls, is a solid state that illuminates the future of a society, and country at large. A society with good idea of youngsters wellbeing, including, diet, opportunity to learn give a knighted tomorrow coupled with intellectuals that stimulate growth and development (Qureshi et al., 2020; Ashton et al., 2022). Therefore, Micronutrients deficiency is a determinant that could make or mar a society, and individuals depending on the nature of the spin (either well-nourished or malnourished) (Dawelbait et al., 2018; Sarkingobir et al., 2023; Jiya et al., 2024).

Micronutrients deficiencies such aa vitamins, and elements (like Cu) are linked to poor functioning of nervous system, including poor cognitive/learning potential (Gambling & McArdle, 2004; An et al., 2022). Minerals micronutrients such as copper are needed for

growth, proper functioning, and maintaining of human body. Also they are vital for diseases prevention, and improves health (Dawelbait et al., 2018; Sarkingobir et al., 2023). Because humans could not synthesize copper; it must be taken from the diet (Dawelbait et al., 2018).

Copper is a natural transition metallic element that cab be located in soil for about 50 ppm. Animals and plants contain copper because the element is a dietary essential metal required for body functioning (Duruibe et al., 2007). Several enzymes need copper for metabolic reactions and processes (Kabore et al., 2022). Copper is required essentially to assist energy production, iron utilization, assist antioxidant activities of enzymes, help in neurotransmitter synthesis, and protecting connective tissue (Linus Pauling Institute, Oregon State University, n.d.). Copper deficiency lead to effects such as osteoporosis, anemia, low white blood cells counts, and children suffer connective tissue defects and skeletal problems (Duruibe et al., 2007; EPA, 2007; Maret, 2016). Therefore, it is important to assess nutritional status of apparently healthy schooling adolescents in Sokoto concerning copper levels. This will aid in diagnosing possible occurrence of infection, deficiency, and avoid worsening of diseases. And it is important for healthy lifestyle and learning (Pfeiffer & Mailloux, 1987; Upadhyay & Tripathi, 2017). The objective of this paper was to determine the effects of serum copper on learning ability among adolescents in Sokoto, Nigeria.

MATERIALS AND METHODS

Study Participants

For the sake of this research, study participants were from selected adolescents schools that in Sokoto State, Nigeria. A total of 230 participants from the zones of Sokoto state, Nigeria were involved to serve as participants after following due ethics. The subjects were apparently healthy looking individuals that willingly participated in the study. Other study guidelines were adopted based on the past work revealed in Umar et al., (2018). Likewise, the study was a quasi-experimental one, involving copper deficient, and non-copper deficient participants using the methods adopted from Umar et al., (2018).

Blood samples collection

Blood samples that were collected in order to observe the prevalence of copper deficiency among adolescents participants in Sokoto according to methods of Bilbis et al., (2002).

Reagents and equipments utilized, and conducted assay

All the reagents utilized were of analytical grade, and an atomic absorption spectroscopic device was used. However, an assay of the serum was conducted as reported in Bilbis et al., (2002). The results obtained during this work was analyzed using Chi-square and one-way ANOVA ($p<0.05$).

RESULTS AND DISCUSSION

The results for this work was shown in Tables 1-3.

Table 1: Age-specific Level of serum copper among some adolescents schooling adolescents in Sokoto, Nigeria

Status	14-16 years old	16-18 years old
Serum copper (higher than or equal to 70ug/dl)	61(26.52%)	150 (65.22%)
Serum copper (less than 70ug/dl)	13 (5.6%)	6(2.61%)

Table 2: Sex specific concentrations of serum copper among some adolescents schooling adolescents in Sokoto, Nigeria

Status	Male	Females
Higher Serum copper (higher than or equal to than 70ug/dl)	31(13.48%)	180(78.26%)
Lower serum copper level (less than 70ug/dl	4(1.74%)	15 (6.52%)

Table 3: Effect of prevalence of serum copper level among some adolescents in Sokoto on learning potential

Population status	Mean score
Deficient (n= 19, %=8.26%)	36.92
Healthy/ normal (n=211, %=91.74%)	62.28

Results from this study were shown in Tables 1 to 3. Table 1 shows the concentration of copper in serum for adolescents in Sokoto, Nigeria. The concentration of copper in serum of the participants differs with age ($P<0.05$); therewith, participants that are within the age range of 14 to 16 years old had 61(26.52%) had elevated levels of copper. The majority of the participants with elevated serum copper are 150(65.23%) within the age range of 16 to 18 years old. Participants with lower copper level (less than 70ug/dl) are mostly 13(5.6%) within the age range of 14 to 16 years old; while those within the range of 16 to 18 years are 6(2.6%). It is of great concern that, the females that are of childbearing age had low copper than males. Low copper could affect pregnancy and can cause reproduction problems (Styrer, 1988). Poor maternal copper affects fetuses with problems in skeletal, cardiovascular, and pulmonary systems (Desai & Kaler, 2008). Moreover, low maternal copper can cause reduced live births, affected brain chemistry (Desai & Kaler, 2008; Iwueke et al., 2020).

Table 2 shows the levels of serum copper according to sex of the participants of the study. Those of the participants with higher copper level are mostly females, 180(78.26%), while males are 31(13.48%). Participants with lower copper level are mostly females, 15(6.52%); while males are 4(1.7%). The concentration of copper is higher than the levels reported among pregnant and non-pregnant women in Sokoto by Iwueke et al., (2020). However, a higher deficiency of copper was reported in HIV patients in Southeast Nigeria in Oloyede et al., (2022).

Table 3 shows the effect of serum copper level on mean scores of the participants. In the table, out of the 230 adolescents students,19(8.26%) scored a mean value of 36.92; while participants with normal copper level (n=211, 91.74%) had a mean mark value of 52.28. The effect of copper concentration on academic capacity of participants shown by this work is not far-fetched from the significant role of copper in the brain; considering the role of bran in cognitive functions of the human body (Stenesh, 1998; Gomadzka et al., 2020).

Copper is an essentially needed element by the body. Mostly, the copper concentration in the brain is elevated; where it takes part in the maintenance of redox balance, act in many enzymes (such as dopamine-beta hydroxylase, and enzymes for synthesis of norepinephrine neurotransmitter (Desai & Kaler, 2008). Huskisson et al., (2007) suggested how micronutrients were able to exert effects on nervous system (or brain in particular) by basically affecting the energy metabolism (that is energy requirements) of brain cells (such as glia cells and neurons); affecting neurotransmitters synthesis, disruption of oxidative stress processes (through effects as cofactors), and other related modifications (Desai & Kaler, 2008; Appenroth, 2010; Kihara et al., 2019). Therefore, for a better nutritional status among people especially the most vulnerable such as youngsters, there is need for intensified nutrition education at schools and at home. Encouraging people to consume diverse local foods is a strategy that will help in ensuring proper nutritional status. Other methods such as fertilization of soils should be attempted with caution because copper deficiency is currently a rare thing across various parts of the world (WHO/BASICS/UNICEF, 1999; Narwal et al., 2017).

CONCLUSION

There are still some adolescents that have low copper level in the state, and it may affect their learning and entire learning. Thus, it is important to provide better nutrition through using disparate intervention methods to bail the situation.

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