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The Effect of Wearing Jewellery on Iron and Trace Elements (Zinc, Copper) Levels in Women from Basrah, Iraq

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ABSTRACT

Background: *Trace elements (e.g., Fe, Zn, Cu) are essential for human health but become toxic at elevated levels. Heavy metals from industrial activities and everyday items, such as jewellery, pose health risks through oxidative stress and metabolic interference.* ***Objective****: To investigate the impact of jewellery (fake and gold) on serum trace element levels (Fe, Zn, Cu) and hematological parameters (WBC, Hb, PLT) in women.* ***Methods:*** *A cross-sectional study (September 2024–January 2025) included 125 healthy women (17–45 years) in Basrah, Iraq, categorized into four groups: no jewellery (G1, n = 50), daily fake/nickel jewellery (G2, n = 27), irregular gold jewellery (G3, n = 26), and daily gold jewellery (G4, n = 22). Serum Fe, Zn, and Cu were quantified spectrophotometrically (Mindray BS-240 analyzer), while hematological parameters (WBC, Hb, PLT) were analyzed using an automated Nipigon NP-21H system.* ***Results:*** *No significant differences occurred in trace elements (Fe, Zn, Cu) across groups ($p > 0.05$). However, hemoglobin (Hb) was significantly reduced in fake jewellery wearers (G2: 10.64 ± 1.95 g/dL) and daily gold wearers (G4: 10.70 ± 1.62 g/dL) versus non-wearers (G1: 11.74 ± 1.45 g/dL; $p = 0.007$ and $p = 0.011$, respectively). Positive Fe-Hb correlations emerged in jewellery-wearing groups (G2–G4; $p < 0.05$), while WBC and PLT remained unchanged ($p > 0.05$).* ***Conclusion:*** *Wearing jewellery (fake or gold) did not alter trace element levels but significantly reduced hemoglobin concentrations, suggesting heavy metals (e.g., nickel) may compete with iron in hematopoiesis. This highlights jewellery as a potential risk factor for subclinical anemia in women.*

Keywords: Sickle Cell Anemia, Iron Overload, Renal Function Tests, Ferritin.

Article Information

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INTRODUCTION

Trace elements are of great importance to the human body, also are dietary components that are present in minute amounts in human body. Some are significant components of enzymes where they attract substrate molecules and facilitate their conversion to specific end products. Some give or accept electrons in (reactions) of oxidation and reduction, which results in the generation of metabolic energy (1). Both the level and effect of trace element is strongly relying on one another. That's why, high intakes of zinc or copper interfere with the utilization and tissue storage of iron (2). These elements are beneficial in certain concentrations, when crossing the normal value limit, might cause toxicity, leading to heavy metal poisoning. Heavy metals mix with soil, they reduce the nutritive value, and also heavy metals pose harmful effects on human beings (3). The metal ions toxicity to mammalians systems is because of chemical reactivity of the ions with cells structural proteins, enzymes,

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and membrane contents. The target organs of specific metal toxicities are usually those organs that have high accumulate concentrations of the metal. This is often depending on the route of exposure and the chemical compound of the metal for example, lipid solubility (4). The process of trace mineral poisoning is basically the production of reactive oxygen species (ROS), thus causes oxidative damage and has a negative impact on human health (5) . Dealing with devices , items and pollution that contains these metals in our everyday life may cause changes in our trace element level , some of these items are in contact with our digestive system used in kitchen equipment (utensils) and dental implants , some are in direct contact with our skin such as piercings, jewellery and makeup (6).

Iron (Fe) is an abundant element on earth and biologically important for living organisms. Its concentration in tissues, due to the ability to form free radicals, must be constantly regulated so it will not cause tissue damage resulting from excessive amounts, the amount of iron absorbed from the amount ingested is typically low, but may range depending on circumstances and type of iron (7) .As for storage, Ferritin concentration together with that of hemosiderin reflects the body iron stores. They store iron in an insoluble form and are present primarily in the liver, spleen, and bone marrow, While Transferrin is the protein responsible for transporting Iron in the blood. Iron can be taken by food, Heme iron, whose main source is red meat, is easily absorbed by the human body. In addition, heme iron, which is mainly found in myoglobin in meat, contributes to the desirable bright red color and to the most undesirable brown color of meat. Both (Heme) and (nonheme) iron are catalysts of lipid oxidation in meat (8).

Zinc (Zn) is an essential trace elements that has biochemical roles shows its involvement in a wide range of enzymes or as a (stabilizer) of the molecular structure of subcellular molecules and membranes , it also plays a role in the production and destruction of carbohydrates, lipids, proteins, and nucleic acids (9). Zinc has a strong effect on growth and development. One of the main reasons for this positive effect is involving of zinc in the bone, for most located in the bones (29%) and in the skeletal muscles by (57%) also plays a role as a cofactor for more than 300 enzymes (10). It plays huge role in growth The concentration of zinc, in comparison to other tissues, in the bones is higher. Zinc increases the production of some proteins in osteoblast that stop producing osteoclasts. And also zinc is vehicle D vitamin’s affects in bone tissue (11). However, taking zinc in high doses from contaminated food and acute zinc poisoning has been associated with gastrointestinal symptoms such as abdominal pain, diarrhoea, nausea, and vomiting, Long term taking and exposure to high zinc levels have shown interfering with the metabolism of other trace elements such as copper (12).

Copper (Cu) is significant for the function of many cellular enzymes , in all living organisms in the bound and unbound (free) state (2), This element has a role as a cofactor of many enzymes involved in biological processes, mostly related to energy metabolism (e.g., cytochrome c oxidase), the oxidation–reduction system (e.g., superoxide dismutase) and iron turnover (hephaestin and ceruloplasmin) (13). Copper ranks third right after iron and Zinc, in the liver and its concentration is lower in the brain, heart, kidneys and muscles. when its rate is higher than the normal limit, more than (140) µg/dl, it will lead to Copper poisoning, causing vomiting and diarrhoea, and leading to kidney damage, including acute kidney failure, decreased urine production (14). An increase or decrease in the blood, both of which affect the work of the brain, and these imbalances have been associated with Alzheimer's and Wilson’s

diseases (15). The largest sources of copper releases in environment include the mining, refining and smelting of copper, industries producing products from copper such as pipes, wire and sheet metal, and fossil fuel combustion. Water pipes are (often) made of copper and bath faucets may be made from brass and bronze 'alloys' that may contain copper. The principal source of copper in drinking water comes from the leaching of copper from pipes and bath faucets because of acidic water, other releases of copper to the environment include pesticides that contain copper and different form of salts (16), (17). To systematically investigate the potential health implications of jewelry wearing in women by comparing serum levels of trace metals (Iron, Zinc, Copper) and key haematological indices (WBC, Hb, PLT) between those who wear jewelry (including fake jewelry), those who do not wear any jewelry, and analyzing the relationship to metal exposure.

MATERIALS AND METHODS

A cross-sectional study was conducted in Basra city, Iraq, from September 2024 to January 2025. Participants comprised 125 women aged 17-45 years, stratified into four groups based on jewelry-wearing habits: A Control group (G1, n=50) reporting no jewelry use; a Nickel group (G2, n=27) reporting daily wear of fake jewelry; an Irregular Gold group (G3, n=26) reporting non-daily wear of gold jewelry; and a Regular Gold group (G4, n=22) reporting daily wear of gold jewelry. All participants were confirmed healthy with no history of endocrine disease, polycystic ovary syndrome (PCOS), or irregular menstrual cycles. Participants were recruited from the general population without restriction to specific locations. Data collection involved structured interviews, and written informed consent was obtained from all participants prior to enrollment. Participant identities were anonymized throughout the study using unique codes.

Analytical Methods

Serum levels of iron (Fe), zinc (Zn), and copper (Cu) were quantified using a Mindray BS-240 chemistry analyser (United States of America). Zinc determination employed the 5-Br-PAPS (5-Bromo-Pyridylazo-P-N, N-Dimethylaniline Sulfonate) reagent, with absorbance measured at 550–570 nm. Copper analysis utilized either Bathocuproine or DiBr-PAESA reagent to form a colored complex, and absorbance was read at 580–600 nm. Iron was assayed using the Ferrozine method, where Fe^{2+} forms a purple complex measured at 560–580 nm. A complete blood count (CBC), including white blood cell count (WBC), hemoglobin (Hb), and platelet count (PLT), was performed on whole blood samples using an automated Nipigon NP-21H analyzer (Nipigon Health Corp, Canada).

Sample collection and separation

Five millilitres were drawn from each participant by vein puncture, 2ml were put in PST ethylene diamine-tetra-acetic acid (EDTA) tube for haematological tests, whole blood samples test was carried out within 5 hours after collection, and 3ml of blood sample were put in SST (Gel tube) was left to coagulate at room temperature in a gel vacuum tube to coagulate, the tubes were centrifugalized at (1500rpm) for 5 minutes. Serum was collected and kept in freeze for later use.

Statistical analysis

Statistical package for social science (SPSS) V26.0 was performed. Analysing differences in trace elements level between the groups were compared by using ANOVA for variables, while the Kruskal-Wallis test (NPAR) was applied for data as well. Post hoc comparisons were conducted following significant ANOVA results. In addition to using the Spearman correlation test to assess the relationship between variables.

RESULTS

As shown in **Table 1** the results of current study were shown No statistical significance difference in both Age and BMI, regarding **Age** when comparing G1 with G2, G3 and G4 groups. (P-value = .839, .385, .525) respectively, also in G2 with G3r and G4 (P-value =.546, .735) respectively, and in G3 with G4 (P-value =.796). As for **BMI**, the results also showed No statistical significance difference when comparison of G1 with G2, G3, G4 groups. (P-value = .730, .489, .992) respectively, in G2 with G3 and G4 (P-value =.742, .770) respectively, as well as in G3 and G4 (P-value =.547).

Table 1: Socio-demographic parameters (Age, BMI) comparison among including study groups (G1, G2, G3, G4). Value was expressed as (mean ± SD).

Parameter	Groups		P-value
Age (yrs)	**G1/mean ± SD**	**G2/mean ± SD**	
	29.48 ± 8.924	**29.85 ± 8.752**	**.839**
		G3/mean ± SD	
		31.45 ± 8.996	**.385**
		G4/mean ± SD	
		30.81 ±9.217	**.525**
	G2/mean ± SD	**G3/mean ± SD**	
	29.85 ± 8.752	**31.45 ± 8.996**	**.546**
		G4/ mean ± SD	
		30.81 ±9.217	**.735**
	G3/ mean ± SD	**G4/mean ± SD**	
	31.45 ± 8.996	**30.81 ±9.217**	**.796**
BMI (Kg/m2)			
	Groups		**P-value**
	G1/mean ± SD	**G2/mean ± SD**	
	28.0620±4.72357	**27.6411±6.12697**	**.730**
		G3/mean ± SD	
		27.1591±4.06669	**.489**
		G4/mean ± SD	
		28.0500±5.34987	**.992**
	G2/mean ± SD	**G3/mean ± SD**	
	27.6411±6.12697	**27.1591±4.06669**	**.742**
		G4/mean ± SD	
		28.0500±5.34987	**.770**
	G3/mean ± SD	**G4/mean ± SD**	
	27.1591±4.06669	**28.0500±5.34987**	**.547**

**** Kruskal-Wallis Test.***

****p-value significant at ≤ 0.05 .***

Results regarding trace elements showed that there was no statistically significant difference in comparing of trace elements (Fe, Zn, Cu) in groups, according to iron (Fe) when comparing G1 with G2, G3, G4 (P-value= .367, .310, .852) respectively, also in G2 with G3, G4 (P-value= .904, .266) respectively, and in G3 with G4 (P-value= 301). according to zinc (Zn) when comparing G1 with G2 (P-value= .802) and according to copper (Cu) G1 with G2 (P-value= .375) as shown in **Table 2.**

Table 2: comparison among included study groups (G1, G2, G3, G4) according to trace elements (Fe, Zn, Cu). Value was expressed as (mean ± SD).

Dependent Variable	Groups		P value
Iron (Fe) (mcg/dL)	G1/mean ± SD	G2/mean ± SD	
	123.260± 45.4469	132.037± 38.7323	.367
		G3/mean ± SD	
		132.455± 44.5117	.310
		G4/mean ± SD	
		118.465±40.7480	.852
	G2/mean ± SD	G3/mean ± SD	
	132.037± 38.7323	132.455± 44.5117	.904
		G4/mean ± SD	
		118.465±40.7480	.266
	G3/mean ± SD	G4/mean ± SD	
	132.455± 44.5117	118.465±40.7480	.301
Zinc (Zn) (mcg/dL)	Groups		
	G1/mean ± SD	G2/mean ± SD	
	99.133±14.9694	102.778±18.7250	.802
Copper (Cu) (mcg/dL)	Groups		
	G1/mean ± SD	G2 /mean ± SD	
	102.88±26.222	107.48±26.401	.375

NPar Tests, Kruskal-Wallis Test, p-value significant at ≤ 0.05

Results of current study regarding Haematological test were shown no statistical significant difference according to (WBC, Hb, PLT), regarding WBC in comparing G1 with G2, G3, G4 (P-value= .064, .828, .185) respectively, also G2 with G3, G4 (P-value=.177, .652) respectively, and in G3 with G4 (P-value= .360). Regarding Hb comparing G1 with G3 (P-value= .064), and in G2 with G3, G4 (P-value= .168, .905) respectively, in G3 with G4 (P-value= .210). On the other hand, there was statistical significant difference when comparing G1 with G2 (P-value= .007) and G1 with G4 (P-value= .011). According to PLT in comparing G1 with G2, G3, G4 (P-value= .119, .426,.408) respectively, in G2 with G3, G4 (P-value= .552, .526) respectively, in G3 with G4 (P-value= .991) as shown in **Table 3**.

Table 3: comparison among included study groups (G1, G2, G3, G4) according to Haematology test (WBC, PLT, HB). Value was expressed as (mean ± SD).

Dependent Variable	Groups		P value
WBC	G1/mean ± SD	G2/mean ± SD	
	6.8776± 1.53906	7.5911± 1.53122	.064
		G3/mean ± SD	
		6.9668± 1.22640	.828
		G4/mean ± SD	
		7.3927±2.00981	.185
	G2/mean ± SD	G3/mean ± SD	
	7.5911± 1.53122	6.9668± 1.22640	.177
		G4/mean ± SD	
		7.3927±2.00981	.652
	G3/mean ± SD	G4/mean ± SD	

Dependent Variable	Groups		P value
	6.9668± 1.22640	7.3927±2.00981	.360
Hb (gm/dL)	Groups		
	G1/mean ± SD	G2/mean ± SD	
	11.744±1.4499	10.641±1.9488	.007
		G3/mean ± SD	
		11.305±1.8224	.306
		G4/mean ± SD	
		10.696±1.6175	.011
	G1/mean ± SD	G2/mean ± SD	
	10.641±1.9488	11.305±1.8224	.168
		G4/mean ± SD	
		10.696±1.6175	.905
	G3/mean ± SD	G4/mean ± SD	
	11.305±1.8224	10.696±1.6175	.210
Plt	Groups		
	G1/mean ± SD	G2/mean ± SD	
	238.32±54.326	259.30±49.230	.119
		G3/mean ± SD	
		249.73±57.230	.426
		G4/mean ± SD	
		249.54±63.637	.408
	G1/mean ± SD	G2/mean ± SD	
	259.30±49.230	249.73±57.230	.552
		G4/mean ± SD	
		249.54±63.637	.526
	G3/mean ± SD	G4/mean ± SD	
	249.73±57.230	249.54±63.637	.991

NPar Tests, *Kruskal-Wallis Test, *p-value significant at ≤ 0.05.

As shown in **Table 4** there was direct positive correlation in age and BMI (P-value= 0.009), in Zn and Cu (P-value=0.011), also Zn and Fe (P-value=0.007), finally in Cu and Fe ((P-value=0.027). However, the results also shown negative correlation between Age and (PLT) (P-value=0.010).

Table 4: Significant correlations in (G1) Control group for all parameters.

parameter 1	parameter 2	p-value	(R)
Age	BMI	0.009	.368
Age	PLT	0.010	-.363
Zn	Cu	0.011	.358
Zn	Fe	0.007	.378
Cu	Fe	0.027	.313

R: correlation coefficient.

p-value significant at ≤ 0.05.

The results were shown in **Table 5** direct proportional correlation between Age (Cu) (P-value=0.018), in Fe and Hb (P-value=0.026).

Table 5: significant correlation in (G2) Nickel group for all parameters.

Parameter 1	Parameter 2	p-value	(R)
Age	**Cu**	**0.018**	**.453**
Fe	**Hb**	**0.026**	**.428**

R: correlation coefficient, *p-value significant at ≤ 0.05.

Results in **Table 6** shown the positive correlation among parameters in Fe and Hb (P-value=0.000).

Table 6: significant correlation in (G3) Irregular group among all parameters.

Parameter 1	Parameter 2	p-value	(R)
Fe	**Hb**	**0.000**	**.735**

R: correlation coefficient, *p-value significant at ≤ 0.05.

Results in **Table 7** were shown positive correlation in Hb and (Fe, WBC) (P-value=0.043, 0.009) respectively.

Table 7: significant correlation in (G4) Regular group among all parameters.

Parameter 1	Parameter 2	p-value	(R)
Fe (mcg/dL)	**Hb (gm/dL)**	**0.043**	**0.399**
WBC	**Hb (gm/dL)**	**0.009**	**0.504**

R: correlation coefficient, *p-value significant at ≤ 0.05.

DISCUSSION

Results in trace element tests beginning with Iron Fe show no statistical significance, G1 and G2 results was (P=.367), had a slight increase in iron level in the second group, agree with (18) found that Nickel disrupts iron metabolism by interfering with iron-regulatory proteins, potentially leading to abnormal iron storage and altered distribution within the body, also disagree with (19) whole blood nickel concentrations were significantly higher in anemic women compared to non-anemic counterparts, and with (20) populations that were exposed to heavy metals found with higher levels of certain metals correlated with poorer iron status, result of G1 with G3, G4 (P=.310, P=.852), had slight increase, were statistically not significant, results agree with (21) wrote that in the bloodstream (serum iron levels), there's no evidence yet that gold causes a major change in overall iron concentration in humans. As for G2 with G3 and G4 (P=.904, P=.266) results weren't significant among groups. Finally, in G3 with G4 (P=.301), there also wasn't difference in results, in gold wearing regularly and irregularly. Results of Zinc **Zn** between G1 and G2 (P=.802), there was no change in data level in both groups, agree with (22) found the result did not conclude that nickel exposure directly affects zinc concentrations in the body, disagrees with (23) claiming that Workers in zinc-lead (Zn-Pb) mines have been observed to have elevated blood zinc levels compared to control groups the increase is likely due to direct exposure to zinc in the mining environment, yet agree with (24) mentioned both dietary and environmental zinc exposure are associated with increased zinc levels in the body, as measured in blood or serum. Results of Copper **Cu** in G1 and G2 (P=.375), also reported slight increase in level, yet not significant change, agrees with (25) whom found Copper is absorbed through the gastrointestinal tract and is transported in blood primarily bound to proteins like ceruloplasmin.

When external exposure increases, serum copper levels rise accordingly to maintain homeostasis and prevent toxicity, disagrees with (26) found Lead and cadmium exposure have (particularly) been implicated in reducing copper levels by interfering with its intestinal uptake or enhancing copper excretion. Trace elements were not significantly affected by heavy metals could be due to cultural information among women in the centre of Basrah-city, to take supplement for healthier lifestyle.

Results of haematological tests starting with **WBC** G1 and G2 results (P=.064) was statistically not significant, with no noticeable elevation, agree with (27) whom concluded analysis revealed no significant association between urinary nickel concentrations and WBC counts ($\beta = 0.005$; $p = 0.929$), suggesting that typical environmental nickel exposure may not markedly influence WBC levels, disagree with (28) whom found participants exposed to heavy metals, including nickel, found a positive correlation between urinary nickel levels and increased red blood cell counts and haematocrit, on the other hand agree with (29) wrote that nickel exposure can impair immune responses, imply potential immunosuppressive effects of nickel. Study also suggests that nickel exposure may influence haematological parameters. In G3 and G4 results (P=.828, P=.185) were statistically not significant, agree with (30) The findings indicated that, at concentrations relevant for drug delivery applications, these gold nanoparticles did not significantly alter WBC counts, however disagree with (31) finding repeated exposure to gold nanorods (AuNRs) can lead to significant increases in total WBC counts. In G2 comparison with G3 and G4 (P=.177, P=.652), due to hot finding difference in WBC between women who wear gold and who wear nickel. As for G3 with G4 (P=.360) suggesting no significance in wearing gold regularly and irregularly. Results of Haemoglobin **Hb** in haematological test in G1 and G2 (P=.007) was statistically significant agreed with (31) found that clinical trial involving patients with systemic nickel allergy and chronic low haemoglobin levels reported that oral hyposensitization therapy with low doses of nickel helped maintain hemoglobin and hematocrit levels, also aligns with (28) whom found that nickel exposure may influence haematological parameters, however disagreed with (32) who wrote the effects of nickel exposure on red blood cell parameters found that nickel exposure was associated with lower hemoglobin levels. Results of G1 with G3 (P=.306) was statistically not significant disagree with (33) concluded gold nanoparticles at a certain doses exhibited notable decreases in hematocrit and RBC counts. While hemoglobin levels also showed a downward trend. G1 with G4 result (P=.011) agree with (34) who found that in primary interaction mechanism , suggesting that the functional integrity of hemoglobin is preserved in the presence of AuNPs. In results of G2 with G3 and G4 (P=.168, P=.905) suggest no difference among results in women who wear fake or real gold. In G3 with G4 (P=.210) also show no difference in Hb level in women who wear gold regularly and irregularly. Results of **Plt** test G1 and G2 (P=.119) showed no statistical significance , yet with slightest increase in number, agree with (35) certain levels of nickel exposure might stimulate hematopoietic activity, resulting in increased platelet production, however with (36) whom found that nickel's impact on platelet counts may be dose-dependent, with higher exposures potentially leading to thrombocytopenia. Results of G3 and G4 (P=.426, P=.408) agree with (37) research indicates that platelet aggregation increases as the size of AuNPs decreases, suggesting a size-dependent response. On the other hand, in G2 with G3 and G4 (P=.552, P=.526) suggest no much difference in women who wear gold or fake

jewellery. Finally, in G3 and G4 (P=.991) show no statistical difference in women who wear gold regularly and irregularly. Hb was the most affected of these haematological results, could be due to Haemoglobin comprises heme groups that contain iron, heavy metals can interfere with enzymes involved in heme biosynthesis, can generate reactive oxygen species (ROS), leading to oxidative stress, this oxidative damage compromises the integrity of RBC membranes, heavy metals compete with essential metals like iron (38).

CONCLUSION

Noticing that there was not much effect of Gold or fake jewellery in trace element parameters, which might suggest that only direct, and strong exposure to these metals effects its levels in blood, not only wearing it on the skin. As for Haematological parameters, Hb was the most affected among the rest of the parameters, the reason might be due to the competitive effect of some heavy metals that might play some changing on Hb level in women.

Ethical approval

Ethical approval was obtained from the Ethics Committee of Faculty of Collage of Science, University of Basra, Iraq.

Conflict of interest

There is no conflict of interest.

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