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Association between jewelry-wearing practices and female hormone levels

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ABSTRACT

Background. *Exposure to metals through everyday consumer products, including jewelry, may influence endocrine function, but evidence regarding female hormone levels is limited.*

Methods. *This cross-sectional study included 125 women aged 17–45 years from Basrah, Iraq, categorized into four groups: women who did not wear jewelry (G1, n = 50), women who wore fake (nickel-containing) jewelry daily (G2, n = 27), women who wore gold jewelry irregularly (G3, n = 26), and women who wore gold jewelry daily (G4, n = 22). Blood samples were collected during the mid-cycle phase. Serum levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen (E2), progesterone, serotonin (5-HT), and oxytocin were measured using ELISA. Statistical analysis was performed using SPSS.*

Results. *No statistically significant differences were observed among groups for FSH, LH, or oxytocin levels ($p > 0.05$). Estrogen levels differed significantly between the control group and women wearing gold jewelry irregularly ($p = 0.000$) or regularly ($p = 0.005$), as well as between the fake jewelry group and both gold jewelry groups ($p = 0.001$ and $p = 0.010$, respectively). Progesterone levels showed a significant difference only between the control group and the fake jewelry group ($p = 0.045$). Serotonin levels were significantly higher in women wearing jewelry compared with controls, including comparisons between G1 and G2 ($p = 0.007$), G1 and G3 ($p = 0.000$), and G1 and G4 ($p = 0.000$), while no difference was observed between irregular and regular gold jewelry wearers ($p = 0.374$).*

Conclusion. *Wearing gold jewelry was associated with modest but statistically significant variations in estrogen and serotonin levels, whereas no consistent effects were observed for FSH, LH, progesterone, or oxytocin. These findings should be interpreted cautiously given the cross-sectional design and exploratory nature of the study. Further longitudinal studies with refined exposure assessment are warranted.*

Keywords: gold, jewelry, serotonin, oxytocin, heavy metals

INTRODUCTION

Metals are a part of everyday life, found in everything from kitchen utensils to electronics. While many metals are harmless, some can have effects on human health, especially with long-term exposure [1]. One area of growing interest is how metals might act as endocrine disruptors, meaning they can interfere with the body's hormonal systems [2]. This is particularly relevant for women, who often have prolonged contact with metal-containing products like cosmetics and jewelry. Jewelry is a significant and often overlooked source of dermal metal exposure. Unlike other sources, jewelry is in direct and continuous contact with the skin, which can lead to the absorption of metal ions [3]. This is especially true for fake jewelry, which is often made from a mix of metals including nickel, a known allergen and potential endocrine disruptor [4]. Gold jewelry, while generally considered safer, can also contain other metals in its alloys. Given how common jewelry is, we believe it's important to understand whether this type of exposure could have any systemic effects. We chose to focus on gold and nickel for several reasons. Nickel is a well-known skin sensitizer and has been shown in some

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studies to have effects on the endocrine system [5]. Gold, on the other hand, is often thought of as inert, but it is also a metal that can be absorbed through the skin, and its long-term effects on hormonal balance are not well understood [6]. By comparing women who wear gold jewelry, fake (nickel-containing) jewelry, and no jewelry, we can start to untangle the potential effects of these specific metals.

While the exact mechanisms are still being worked out, it's thought that metal ions absorbed through the skin can interfere with hormone production, transport, and signaling [7]. For example, some metals can bind to hormone receptors, mimicking or blocking the action of natural hormones. Others might interfere with the enzymes that are needed to produce hormones in the first place [8]. This is why we decided to look at a range of hormones that are important for female reproductive health. We measured several key hormones to get a broad picture of the potential effects. Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) are the master regulators of the menstrual cycle, while estrogen and progesterone are the main female sex hormones [9]. We also looked at serotonin and oxytocin, which are not just reproductive hormones but also play important roles in mood and social behavior, and could be affected by metal exposure [10].

To our knowledge, no studies have specifically looked at the association between wearing different types of jewelry and changes in these specific hormone levels. Most research on metal exposure has focused on environmental or occupational sources, not on the common practice of wearing jewelry [11]. This study was designed to address that gap. Therefore, the objective of this study was to investigate the association between wearing gold and fake (nickel-containing) jewelry and serum levels of FSH, LH, estrogen, progesterone, serotonin, and oxytocin in a cohort of healthy women.

MATERIALS AND METHODS

Study groups

This cross-sectional study included 125 women recruited from the general population in Basrah city, Iraq, between September 2024 and January 2025. Participants were enrolled on a voluntary basis through interviews and were not restricted to a specific recruitment site. Based on self-reported jewelry-wearing habits, participants were classified into four groups: group 1 (G1, control group): 50 women who did not wear any type of jewelry, group 2 (G2, nickel-containing jewelry group), 27 women who wore fake (nickel-containing) jewelry on a daily basis, group 3 (G3, irregular gold jewelry group): 26 women who wore gold jewelry irregularly (e.g., on a weekly basis), and group 4 (G4, regular gold jewelry group): 22 women who wore gold jewelry daily.

All participants completed a detailed jewelry exposure assessment questionnaire that captured the following information: (1) hours per day of jewelry wear; (2) years of continuous jewelry wear; (3) whether jewelry was worn continuously or removed during certain activities (e.g., sleep, showering, exercise); and (4) frequency of jewelry removal and cleaning. This standardized questionnaire ensured that exposure duration and intensity were quantified consistently across all participants.

All blood samples were collected during the mid-cycle phase of the menstrual cycle, Mid-cycle phase was operationally defined as days 12–16 of a regular 28-day menstrual cycle, determined based on the first day of the last menstrual period. Only participants with regular cycles (26–32 days) were included to ensure comparability using Calendar estimation and during daytime hours (between 9:00 a.m. and 1:00 p.m.) to minimize hormonal variability related to circadian rhythm and cycle phase.

Prior to participation, all women received a detailed explanation of the study and provided informed consent. Participant identities were anonymized using coded identifiers throughout data collection and analysis. The study was conducted in accordance with ethical guidelines and approved by the relevant institutional ethics committees.

Selection bias

We acknowledge that participants self-selected into groups based on their existing jewelry-wearing habits, which introduces the potential for selection bias. Certain demographic or lifestyle characteristics may be associated with jewelry-wearing preferences, and these characteristics could confound the relationship between jewelry exposure and hormone levels.

Inclusion and exclusion criteria

Inclusion criteria

Women aged 17-45 years were eligible for inclusion in the study if they met the following criteria: regular menstrual cycles during the preceding six months; normal or near-normal body mass index (BMI); not pregnant or breastfeeding at the time of the study; absence of known hormonal disorders; and willingness to participate and provide informed consent. This was a cross-sectional observational study with no intervention. Participants were classified into groups based on their existing, self-reported jewelry-wearing habits, not on study-assigned protocols.

Exclusion criteria

Women were excluded from the study if they met any of the following conditions: use of hormonal con-

traceptives or other hormonal therapies; diagnosis of polycystic ovary syndrome (PCOS); thyroid, adrenal, or pituitary disorders; menopause; irregular menstrual cycles; pregnancy or breastfeeding; chronic diseases known to affect hormonal balance (including diabetes, liver, or kidney disease); regular smoking or heavy alcohol consumption; use of medications or supplements known to influence hormone levels (e.g., steroids or phytohormones); known allergies or hypersensitivity to metals (including nickel or gold); presence of implanted metal devices; or refusal to provide informed consent.

Sample collection and preparation

Venous blood samples (5 mL) were collected from each participant using standard aseptic techniques. Blood was drawn into serum separator tubes (SST) and allowed to clot at room temperature. Samples were then centrifuged at 1,500 rpm for 5 minutes to separate the serum.

The resulting serum was carefully aliquoted and stored in freeze until hormone analysis. All samples were processed under identical conditions to minimize pre-analytical variability.

Measuring hormone levels

Serum concentrations of follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen (E2), progesterone, serotonin (5-HT), and oxytocin were measured using commercially available enzyme-linked immunosorbent assay (ELISA) kits, according to the manufacturers' instructions. Hormone levels were quantified using a BioTek 800 Ts microplate reader (BioTek Instruments, USA).

ELISA kits from Reed Biotech Ltd. were used for the measurement of FSH, LH, progesterone, serotonin, and oxytocin, while estrogen levels were determined using kits from ELK Biotechnology. The analytical detection ranges provided by the manufacturers were as follows: FSH 0.16-10 mIU/mL, LH 0.16-10 mIU/mL, estrogen 15.6-1000 pg/mL, progesterone 0.0781-5 ng/mL, serotonin 14.1-900 ng/mL, and oxytocin 15.6-1000 pg/mL. All assays were performed under identical laboratory conditions to minimize inter-assay variability. In addition to hormonal assays, baseline hematological parameters, including white blood cell count (WBC), hemoglobin (Hb), and platelet count (PLT), were measured from the same blood samples using an automated hematology analyzer. These parameters were included for exploratory correlation analysis.

Statistical analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS), version 20 (IBM Corp., Armonk, NY, USA). Data distribution was assessed prior to analysis. Continuous variables were expressed as mean ± standard deviation (SD). Comparisons among the four study groups were conducted using one-way analysis of variance (ANOVA) for normally distributed data, followed by least significant difference (LSD) post hoc tests when overall significance was detected. For data that did not meet normality assumptions, non-parametric tests were applied, including the Kruskal-Wallis test for multiple-group comparisons and the Mann-Whitney U test for pairwise analyses. Correlation analyses were performed using Spearman's rank correlation coefficient to assess monotonic relationships between variables. Given the exploratory nature of this analysis within each subgroup, no correction for multiple testing was applied. A p-value ≤ 0.05 was considered statistically significant.

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. respectively, also in G2 with G3r and G4 respectively, and in G3 with G4. As for BMI, the results also showed no statistical significance difference when comparison of G1 with G2, G3, G4 groups, respectively. in G2 with G3 and G4, as well as in G3 and G4.

The Table 2 results of the present study had shown no statistically significant difference in FSH hormone in comparing of G1 with G2, G3, G4 respectively, also G2 with G3, G4 respectively, and in G3 with G4. As for LH when comparing hormone level in G1 with G2 , G3, G4 respectively, also in G2 with G3, G4) respectively, as well as G3 with G4. However, regarding results of estrogen in the data, it showed statistically significant difference in estrogen hormone level when comparing G1 with G3, G4 (p-value = 0.000, 0.005) respectively, also G2 with G3, G4 (p-value= 0.001, 0.010) respectively,

TABLE 1. *Socio-demographic parameters of the study groups*

Parameter	G1 (Control, n = 50)	G2 (Fake jewelry, n = 27)	G3 (Irregular gold, n = 26)	G4 (Daily gold, n = 22)	p-value*
Age (years)	29.48 ± 8.92	29.85 ± 8.75	31.45 ± 8.99	30.81 ± 9.21	0.796
BMI (kg/m²)	28.06 ± 4.72	27.64 ± 6.12	27.15 ± 4.06	28.05 ± 5.34	0.839

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

and G1 with G2 (p-value = 0.936), on the other hand, the data showed no statistically significant difference in G3 with G4. The results shown no statistically significant difference in progesterone level when comparing G1with G3, G4 respectively, in G2 with G3, G4, in addition to G3 with G4. Nevertheless, results were significant statistically in progesterone level when comparing G1 with G2 (p-value = 0.045) in as shown in Table 2.

The data in Table 5 showed statistically significant difference in serotonin level in comparing G1 with G2, G3, G4 (p-value = 0.007, 0.000, 0.013) respectively, also G2 with G3 and G4 (p-value = 0.013, 0.049) respectively, while there was no significant different shown in serotonin level in comparing G3 with G4. While in oxytocin there was no significant difference when comparing G1 with G2, G3, G4 (p-value = 0.070, 0.098, 0.056) respectively, showed no significance in G2 with G3 and G4 respectively, and when comparing G3 with G4.

As shown in Table 7 there was direct positive correlation in age and BMI (p-value = 0.009), in BMI and oxytocin (p-value = 0.042), in estrogen and progesterone (p-value = 0.031), also in estrogen and serotonin (p-value = 0.006), in progesterone and serotonin (p-value = 0.041), as well as in serotonin and oxytocin (p-value = 0.009). However, the results also shown negative correlation between age and progesterone (p-value = 0.020).

The following tables present the statistically significant correlations found within each group. These analyses were exploratory and were not adjusted for multiple comparisons.

TABLE 2. *Serum sex hormone levels in the study groups*

Parameter	G1 (Control, n = 50)	G2 (Fake jewelry, n = 27)	G3 (Irregular gold, n = 26)	G4 (Daily gold, n = 22)	p-value*
FSH (mIU/mL)	7.21 ± 6.21	8.37 ± 8.63	6.60 ± 7.66	5.41 ± 3.69	0.486
LH (mIU/mL)	5.25 ± 2.92	5.27 ± 3.35	5.04 ± 2.93	4.21 ± 2.22	0.390
Estrogen (pg/mL)	233.69 ± 63.31	234.75 ± 56.46	182.04 ± 47.07	195.11 ± 42.18	0.000
Progesterone ng/mL	4142.38 ± 3728.19	4644.13 ± 2992.44	4099.15 ± 3359.78	3956.73 ± 3324.03	0.045

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

TABLE 3. *Estrogen levels comparison in study groups*

Comparison	Mean difference	p-value	Significant (Yes/No)	95% CI
G1 vs G2	1.0590	0.9998	No	-33.36 to 35.48
G1 vs G3	-38.5840	0.0237	Yes	-73.43 to -3.74
G1 vs G4	-51.6541	0.0022	Yes	-88.53 to -14.78
G2 vs G3	-39.6430	0.0497	Yes	-79.25 to -0.04
G2 vs G4	-52.7131	0.0065	Yes	-94.11 to -11.32
G3 vs G4	-13.0701	0.8470	No	-54.82 to 28.68

*Tukey's HSD (Honestly Significant Difference) test for post-hoc comparisons

TABLE 4. *Progesterone level comparison in study groups*

Comparison	Mean difference	p-value	Significant (Yes/No)	95% CI
G1 vs G2	1.1603	0.8862	No	-2.99 to 5.32
G1 vs G3	-1.8019	0.6811	No	-6.01 to 2.41
G1 vs G4	-0.6129	0.9842	No	-5.07 to 3.84
G2 vs G3	-2.9622	0.3753	No	-7.75 to 1.82
G2 vs G4	-1.7732	0.7923	No	-6.77 to 3.23
G3 vs G4	1.1890	0.9274	No	-3.86 to 6.23

*Tukey's HSD (Honestly Significant Difference) test for post-hoc comparisons

TABLE 5. *Serum mood-related hormone levels in the study groups*

Parameter	G1 (Control, n = 50)	G2 (Fake jewelry, n = 27)	G3 (Irregular gold, n = 26)	G4 (Daily gold, n = 22)	p-value*
Serotonin (ng/mL)	433.07 ± 181.91	550.83 ± 187.91	683.44 ± 171.31	619.33 ± 193.32	0.000
Oxytocin (pg/mL)	68.59 ± 42.81	78.04 ± 36.47	81.62 ± 39.26	99.43 ± 65.30	0.070

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

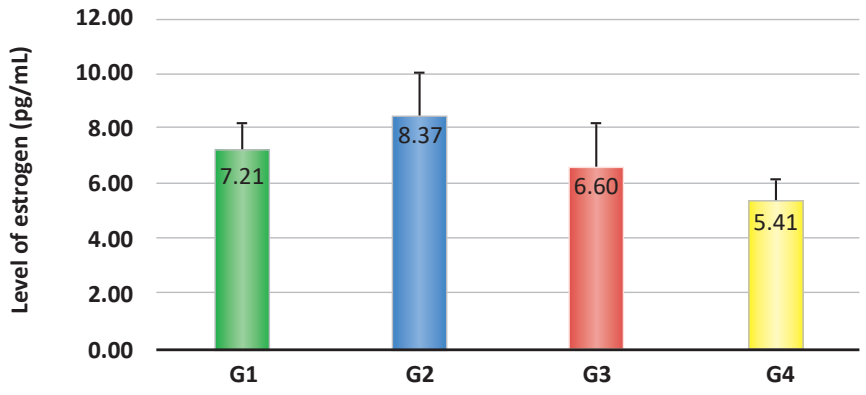

FIGURE 1. *Comparison of estrogen levels across groups (G1-G4)*

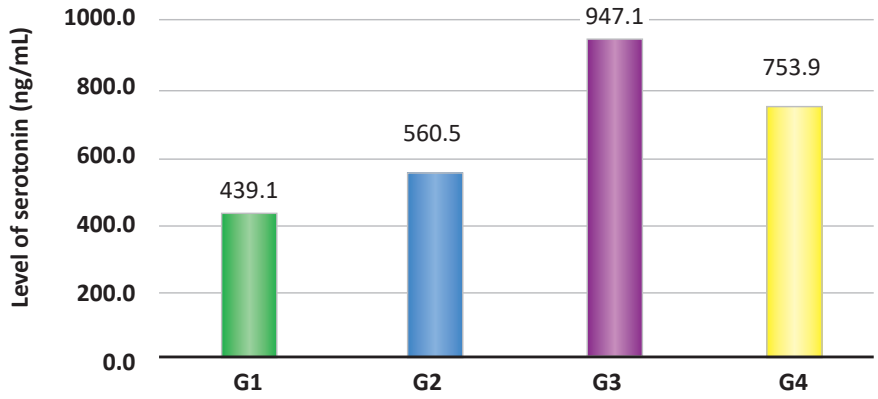

FIGURE 2. *Comparison of serotonin levels across groups (G1-G4)*

TABLE 7. *Significant correlations in (G1) control group for all parameters*

Parameter 1	Parameter 2	p-value	R
Age	BMI	0.009	0.368
Age	Progesterone	0.020	-0.328
Age	PLT	0.010	-0.363
BMI	Oxytocin	0.042	0.289
Estrogen	Progesterone	0.031	0.305
Estrogen	Serotonin	0.006	0.382
Progesterone	Serotonin	0.041	0.290
Serotonin	Oxytocin	0.009	0.364

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

The results were shown in Table 8 direct proportional correlation between age (FSH) (p-value= 0.018), between FSH and (estrogen and LH) (p-value = 0.000, 0.003) respectively, also in WBC and progesterone Hb (p-value = 0.028). Nevertheless, the were inverse significant correlations between age and serotonin (p-value = 0.022), progesterone and (BMI and estrogen) (p-value = 0.033, 0.001) respectively, as well as in LH and oxytocin (p-value = 0.013).

Table 9 results shown the positive correlation among parameters between estrogen and (LH and serotonin) (p-value = 0.034, 0.016) respectively, in progesterone

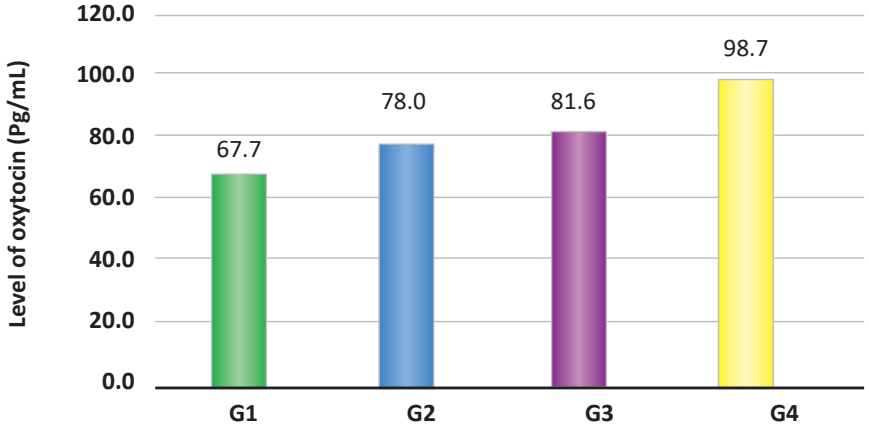

FIGURE 3. *Comparison of oxytocin levels across groups (G1–G4)*

TABLE 8. *Significant correlation in (G2) nickel group for all parameters*

Parameter 1	Parameter 2	p-value	R
Age	FSH	0.018	0.451
Age	Serotonin	0.022	-0.438
BMI	Progesterone	0.033	-0.411
Estrogen	Progesterone	0.001	-0.608
Estrogen	FSH	0.000	0.646
FSH	LH	0.003	0.554
LH	Oxytocin	0.013	-0.470
WBC	Progesterone	0.028	0.423

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

TABLE 9. *Significant correlation in (G3) irregular group among all parameters*

Parameter 1	Parameter 2	p-value	R
Estrogen	LH	0.034	0.455
Estrogen	Serotonin	0.016	0.508
Progesterone	FSH	0.024	0.480
Progesterone	Serotonin	0.043	0.435
FSH	LH	0.003	0.596
FSH	Serotonin	0.023	0.483
FSH	Oxytocin	0.036	0.450
Serotonin	Oxytocin	0.001	0.647

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

and (FSH and serotonin) (p-value = 0.024, 0.043) respectively, also in FSH and (LH, serotonin, and oxytocin) (p-value = 0.003, 0.023, 0.036) respectively, and finally in serotonin and oxytocin (p-value = 0.001).

Results in Table 10 were shown positive correlation between age and FSH (p-value = 0.002), BMI and (progesterone and serotonin) (p-value = 0.023, 0.048) respectively, in estrogen and (serotonin and oxytocin) (p-value = 0.005, 0.013) respectively, also in progesterone and oxytocin (p-value= 0.001), as well as in Hb and (FSH and WBC) (p-value = 0.043, 0.009) respectively. Furthermore, the study was appeared there is inverse significant correlation between LH and oxytocin (p-value = 0.003).

DISCUSSION

Regarding the sex hormones, the results of the present findings indicate no statistically significant differences in serum FSH and LH levels across all group comparisons. Oxytocin levels also showed no significant variation, suggesting relative hormonal stability.

For serum progesterone, only the comparison between G1 and G2 showed a modest statistical difference (p = 0.045). This trend is partially consistent with Pollack et al., who reported higher progesterone levels among participants with low-level exposure to certain metals [12]. Nevertheless, other studies found no association between metal exposure and progesterone levels [13]. The lack of significance across the remaining group comparisons supports the possibility that progesterone changes may be small and sensitive to uncontrolled factors.

TABLE 10. *Significant correlation in (G4) regular group among all parameters*

Parameter 1	Parameter 2	p-value	R
Age (year)	FSH (mIU/ml)	0.002	0.585
BMI (Kg/m^2)	Progesteron (Pg/ml)	0.023	0.446
BMI (Kg/m^2)	Serotonin (ng/ml)	0.048	0.392
Estrogen (Pg/ml)	Serotonin (ng/ml)	0.005	0.537
Estrogen (Pg/ml)	Oxytocin Pg/ml	0.013	0.478
Progesteron (Pg/ml)	Oxytocin Pg/ml	0.001	0.620
FSH (mIU/ml)	Hb (gm/dL)	0.043	0.400
LH (mIU/ml)	Oxytocin Pg/ml	0.003	-0.560
Serotonin (ng/ml)	Oxytocin Pg/ml	0.002	0.571
WBC	Hb (gm/dL)	0.009	0.504

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

Estrogen (E2) was the hormone that demonstrated the most variation across groups. The control group G1 and fake-jewelry group G2 showed no significant difference (p = 0.936), though with a slight numerical increase. This pattern is in partial agreement with Stoica et al., who described estrogen-mimicking activity of certain metals [14], but contrasts with findings by Wang et al., who reported reduced E2 levels in middle-aged women with metal exposure [15]. The comparison between G1 and G3 yielded the largest difference (p = 0.000). While some literature suggests that metal exposure may influence steroidogenic pathways in granulosa cells [16], these mechanisms were described for nanoparticles, which differ substantially from exposure through jewelry; therefore, extrapolation should be made cautiously. Women who regularly wore gold showed a decrease in E2 compared with controls (p = 0.005), a pattern similar to Larson et al. [17], though again, their findings involved gold nanoparticles rather than typical daily exposure. Additional significant differences were observed between G2 and G3 (p = 0.001) and between G2 and G4 (p = 0.010). The comparison between G3 and G4 did not reach significance (p = 0.416), suggesting limited differences in E2 levels between irregular and regular gold wearers. Overall, these mixed findings may reflect underlying variability related to menstrual cycle timing, lifestyle factors, and the cross-sectional nature of the study, rather than consistent biological effects.

Given its sensitivity to multiple physiological and psychosocial influences, serotonin should be regarded as a non-specific marker in this context, and the ob-

served differences cannot be attributed solely to jewelry-related metal exposure. Serotonin levels showed several statistically significant differences.

The comparison between G1 and G2 indicated an increase ($p = 0.007$), consistent with Pyatha et al., who suggested that certain exposures may influence enzymes involved in serotonin synthesis and reuptake [18]. However, other studies reported opposite patterns, such as serotonin suppression following exposure to various metals [19,20]. Significant increases were also observed when comparing G1 with G3 and G4 ($p = 0.000$ for both). Differences between G2 and G3 ($p = 0.013$) and between G2 and G4 ($p = 0.049$) further suggest variability across groups. Many non-environmental factors may also contribute to serotonin fluctuations, including diet, physical activity, sunlight exposure, and psychosocial influences [21]. The absence of significant differences between G3 and G4 ($p = 0.374$) suggests that frequency of gold wearing may not strongly differentiate serotonin levels. Serotonin may appear more variable in this sample because it is highly sensitive to multiple physiological and psychosocial factors.

Metal exposure has been proposed to interfere with enzymes involved in neurotransmitter synthesis or to induce oxidative stress, but these mechanisms remain inconsistent across studies. Oxytocin secretion is highly context-dependent and influenced by psychosocial and environmental factors rather than basal gonadal hormone levels, which may explain the lack of consistent differences observed across groups.

Overall, the heterogeneity in the findings across hormones should be interpreted cautiously. The cross-sectional design, absence of menstrual-cycle control, potential variability in unmeasured exposure, and lifestyle differences across groups limit the ability to draw firm conclusions. Differences from previously published studies likely arise from variations in study design, population characteristics, analytical methods, and the type or magnitude of exposure. Future longitudinal or interventional studies with more precise exposure assessment are needed to clarify these preliminary observations.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design does not allow causal inferences to be drawn between jewelry wearing and hormonal changes.

Second, the sample size within each group was relatively small, which may have limited the statistical power to detect subtle differences, particularly for hormones with high biological variability such as oxytocin. In addition, multiple correlation analyses were performed without adjustment for multiple testing; consequently, some statistically significant findings may represent exploratory results and should be interpreted with caution.

Third, potential confounding factors such as dietary habits, psychosocial stress, physical activity, and socioeconomic status were not systematically assessed, although these factors may influence mood-related hormones, particularly serotonin and oxytocin.

Finally, the study population was recruited from a single geographic area, which may limit the generalizability of the findings to other populations with different environmental exposures or lifestyle characteristics. The correlation analyses performed within individual groups were exploratory in nature and should be interpreted cautiously, particularly given the number of tested associations and the absence of correction for multiple comparisons.

Recommendation

In future studies, a few steps are recommended to elevate the work and result quality: taking samples of participants before and after the jewelry wearing (weather gold or fake) to observe the difference in serum level, for more detailed findings, making the third group G3 in series, within same group, as in wearing gold irregularly in (weekly or monthly) basis, and elevating the number or samples in all four groups.

CONCLUSION

This study explored the association between jewelry metal exposure and selected female hormone levels in a cross-sectional sample of women from Basrah, Iraq. Wearing gold jewelry was associated with modest but statistically significant variations in serum estrogen and serotonin levels, whereas no consistent differences were observed for follicle-stimulating hormone, luteinizing hormone, progesterone, or oxytocin across study groups.

These findings suggest that everyday, non-occupational exposure to metals through jewelry may be associated with subtle endocrine changes; however, the observed associations should be interpreted cautiously due to the exploratory nature of the study, the cross-sectional design, and the absence of quantitative exposure assessment.

Further longitudinal studies with standardized exposure characterization and controlled hormonal timing are required to clarify the biological relevance and potential mechanisms underlying these associations.

Ethical approval

The study was conducted with the approval of the Ethics Committee at the University of Basra, in accord-

ance with protocol number EU/24 dated 05-02-2025, and also at the Basra Health Directorate. Verbal consent was obtained from all patients participating in the study.

Conflict of interest

All authors declare that there are no conflicts of interest in this article.

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Author's contributions

Conceptualization, Fatima T. Naji and Hanaa S. Kadhi; methodology, Fatima T. Naji; software, Hanaa S. Kadhi; validation, Hanaa S. Kadhi; formal analysis, Hanaa S. Kadhi; investigation, Hanaa S. Kadhi; resources, Fatima T. Naji; data curation, Fatima T. Naji; writing—original draft preparation, Hanaa S. Kadhi; writing—review and editing, Fatima T. Naji; visualization, Fatima T. Naji; supervision, Hanaa S. Kadhi; project administration, Fatima T. Naji; funding acquisition, Hanaa S. Kadhi.

All authors have read and agreed to the published version of the manuscript.

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