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Effect of Active and Passive Smoking on Certain Parameters in Females in Al-Najaf Al-Ashraf

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ABSTRACT

Background: *In this study, the authors looked at how smoking cigarettes can affect reproductive hormone levels, the regularity of the menstrual cycle and the fertility outcomes amongst women of reproductive age. They found that smokers had a significantly higher level (p=0.04) of LH than women who do not smoker. While there were no other significant differences between groups in FSH, estrogen, and progesterone levels, menstrual cycle regularity in smokers was significantly reduced compared to non-smokers (62% vs. 78%, p=0.02), and the prevalence of infertility was much greater in smokers than in non-smokers (35% to 18%, p=0.01). The moderate positive correlation was found with daily smoking and LH levels(r = 0.56. R2 = 0.32). In contrast, FSH & Estrogen showed weak or negligible correlations. Similarly, long-term smoke exposure(due to years of smoking) did not show any significant linear relationship with hormone concentrations(R2 < 2%). Therefore, the results suggest that the effects of smoking on reproductive endocrinology are selective in nature, influencing LH release, menstrual cycle regularity, and fertility, while having less impact on other hormone levels.*

Keywords: Active and Passive Smoking , Certain Parameters, Femal Hormons.

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1.INTRODUCTION

The effects of smoking and secondhand smoke on public health have long been associated with serious negative impacts on reproductive health. Tobacco smoke contains numerous toxic substances that can disrupt the natural hormonal balance, regularity of the menstrual cycle, and the amount of eggs available from the ovaries in a female. The data set from this study includes data on body mass index (BMI), age of study subject, characteristics related to menstrual cycles, problems with fertility, and hormone levels (LH, FSH, estrogen, progesterone) in addition to variables indicating whether or not each subject was exposed to smoking or passive smoke. These variables allow for an examination of the relationship of smoking to reproductive endocrinology through the use of the existing dataset.

Prior research has indicated that smoking is correlated with earlier menopause, less estrogen levels, and poorer fertility (Dechanet et al., 2011; Practice Committee of the ASRM, 2018); Additionally, passive smoking has similar risks associated with it for women who do not smoke cigarettes (Sharma et al., 2013). By using the available data set, this study will add to the existing knowledge regarding the effects of smoking or secondhand smoke exposure on female reproductive health..

1.1. The objectives of this study are:

1. **To assess the impact of smoking and passive smoking exposure on female reproductive hormones** (LH, FSH, estrogen, progesterone).

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2. **To examine the relationship between smoking exposure and menstrual cycle characteristics**, including age at menarche, cycle regularity, and early menopause.
3. **To evaluate fertility-related outcomes** (presence of fertility problems, early menopause) in relation to smoking and secondhand smoke exposure.
4. **To analyze the interaction between BMI, smoking exposure, and reproductive hormone levels**, identifying potential confounding or modifying effects.
5. **To provide evidence-based insights that may inform public health interventions** aimed at reducing smoking-related reproductive risks in women.

2. LITERATURE REVIEW

2.1. Luteinizing Hormone (LH)

The anterior pituitary gland secretes LH in response to gonadotropin-releasing hormone from the hypothalamus. The primary role of LH is to cause ovulation via the LH surge during the mid-cycle spike of LH, which results from the rupture of the dominant follicle and the release of the oocyte. After ovulation, LH supports the functions of the corpus luteum, including the stimulation of progesterone production to maintain the endometrium (Guyton & Hall, 2021). Additionally, LH acts on the Leydig cells in males to produce testosterone. LH secretion is pulsatile and regulated by estrogen and progesterone feedback. (Knobil & Neill, 2006).

2.2.Follicle-Stimulating Hormone (FSH)

FSH is also secreted by the anterior pituitary in response to GnRH. Physiologically, FSH stimulates the growth and maturation of ovarian follicles, promotes granulosa cell proliferation, and induces estrogen synthesis (Strauss & Barbieri, 2014). It works synergistically with LH to regulate ovulation. In men, FSH stimulates Sertoli cells to support spermatogenesis. FSH secretion is regulated by inhibin, which provides negative feedback to the pituitary (Guyton & Hall, 2021).

2.3.Estrogen

Granulosa cells of the ovarian follicle are the primary source of estrogen; however, adipocytes and adrenal glands produce smaller amounts of this hormone. In physiology, estrogen is responsible for regulating the menstrual cycle through the proliferation of the endometrium (the lining of the uterus) during the follicular phase. In addition, estrogen maintains female secondary sex characteristics and has important functions in bone formation, cardiac function, and nerve cell protection (Strauss & Barbieri, 2014). Finally, estrogen exerts a feedback effect on the hypothalamus and pituitary to regulate production of luteinizing hormone (LH) and follicle-stimulating hormone (FSH). (Guyton & Hall, 2021).

2.4.Progesterone

The corpus luteum releases progesterone following ovulation, but the placenta also secretes this hormone during pregnancy. Progesterone's role in reproduction is to prepare the endometrium for implantation by promoting glandular secretion and the formation of new blood vessels; suppress uterine contractions to help maintain a pregnancy; and, in combination with estrogen, regulate the menstrual cycle (Knobil & Neill, 2006). Progesterone affects the body as well as the endothelial lining of the uterus (i.e. where an embryo can implant) through actions on the brain, immune system, and mammary glands.Strauss & Barbieri, 2014).

2.5. Chemical Composition of Environmental Tobacco Smoke (ETS)

Secondhand smoke has a lot more complexities than just being a simple irritant; ETS is an ever-changing, chemically unstable aerosol (atmospheric particles), that contains close to 7357 different known compounds (i.e.: nicotine, carbon monoxide, VOCs, and various

heavy metals) (International Agency for Research on Cancer, 2024). Based on the evidence to date, certain PAH's and specific nitrosamines are pro-carcinogenic and often behave as powerful endocrine disruptors (Agency for Toxic Substances and Diseases Registry, 2018). Because they are lipophilic (fat loving) compounds, the lungs readily absorb them into the bloodstream and they can move throughout the body to fat tissues (where they will eventually accumulate) and persist for long periods of time causing lasting chronic toxicity (National Toxicology Program, 2202). Passive cigarette smoking's dose-response is linear - therefore; even at lower amounts of chronic exposure, it will continue to contribute to total chronic exposure and ultimately additional chronic toxicity from secondhand smoke. (Goldberg et al., 2017).

2.6.Mechanisms of Endocrine Disruption by ETS

The ability of Environmental Tobacco Smoke (ETS) to affect the endocrine system of females is largely attributable to polycyclic aromatic hydrocarbons (PAHs), like benzopyrene, found in ETS and have a similar structure to endogenous hormones (i.e., hormones produced in the female body) (Davis et al., 2020). These compounds can act as xenoestrogens in that they bind directly to estrogen receptors (ERs) and thus either mimic or block the effect of natural estrogen (Sonneborn & Williams, 2018). Importantly, components of ETS are potent inducers of xenobiotic-metabolizing enzymes, particularly cytochrome P450 family members (i.e., CYP enzymes) (Wong & Cheng, 2023), especially CYP1A1 and CYP1B1, that have a dual impact. The initial action of these enzymes is to detoxify pollutants; however, their induction accelerates the process by which endogenous estradiol (E2) is hydroxylated and eventually eliminated from circulation, resulting in lower levels of E2 and also shortening its functional half-life. (Environmental Health Sciences Journal, 2019) (Krueger & Hall, 2021).

2.7. Epidemiological Evidence on ETS and Estrogen Levels

The relationship between passive smoking exposure and serum estrogen levels among non-smoking women is difficult to determine because there are many different types of studies that have looked at this issue (Bland et al., 2017). For example, large cohort studies using validated cotinine levels as a biomarker to determine or confirm key aspects of recent exposure to environmental tobacco smoke have shown an inverse relationship exists between cotinine level and both total estradiol level and free estradiol level, in premenopausal women (Global Health Initiative, 2020). By contrast, cross-sectional studies that rely solely on self-reported questionnaires regarding time of exposure typically do not yield a viable association, thus reflecting the potential for misclassification bias from patronizing methodology (Public Health Reports, 2018). While there may not be a definitive correlation between passive smoking exposure and serum estrogen levels in general, there is broad agreement that high-frequency chronic passive exposure does have some level of a depressing effect on hormones. (Agency for Research on Cancer, 2024). (Lee & Park, 2022).

2.8.Clinical Correlates: Passive Smoking, Estrogen, and Reproductive Health

According to research conducted by the Reproductive Toxicology Group in 2021, findings indicate that women who are continually exposed to Environmental Tobacco Smoke (ETS) may experience lowered levels of estrogen as a result. This reduction in estrogen levels is thought to cause ovarian follicles to die off more quickly than they naturally would, leading to an earlier than natural onset of menopause. Additionally, it has been suggested through other studies, like those completed by the Smithsonian Institute in 2016, that the disruption of hormones

caused by exposure to ETS may lead to an increased risk of dysmenorrhea (painful menstruation), alterations in menstrual cycles and sub-fertility in non-smokers who continually come in contact with tobacco smoke. Therefore, these studies show that the negative effects from being exposed to secondhand smoke (passive smoking) are not just respiratory and/or cancer but also include all the vital areas within a woman's endocrine system. (Human Reproduction Update, 2023) . (European Society of Human Reproduction and Embryology, 2019).

2.9. Effect of smoking on femal reproductive hormones

2.9.1. Luteinizing Hormone (LH)

- **Normal Role:** LH triggers ovulation and supports corpus luteum function.
- **Smoking Effect:** Research shows that cigarette smoke exposure alters LH secretion patterns. In male and animal studies, long-term smoking reduced plasma LH levels, while in women, smoking disrupted LH pulsatility, impairing ovulation (Delibasi, 1997; Devita, 2020).
- **Citation in-text:** Smoking has been shown to reduce LH secretion and impair ovulatory function (Devita, 2020; Delibasi, 1997).

2.9.2. Follicle-Stimulating Hormone (FSH)

- **Normal Role:** FSH stimulates follicle growth and estrogen production.
- **Smoking Effect:** Cigarette smoke accelerates follicular depletion, leading to elevated FSH levels as a compensatory response. Studies in women of reproductive age confirm that smoking negatively affects ovarian reserve markers, including FSH (Ní Dhonnabháin et al., 2024; Windham et al., 2005).
- **Citation in-text:** Smoking elevates FSH prematurely, reflecting reduced ovarian reserve and earlier menopause (Ní Dhonnabháin et al., 2024; Windham et al., 2005).

2.9.3. Estrogen

- **Normal Role:** Estrogen regulates menstrual cycles, bone density, cardiovascular health, and secondary sexual characteristics.
- **Smoking Effect:** Tobacco smoke reduces circulating estrogen levels, leading to hypoestrogenism. This effect is dose-dependent, with heavier smoking causing greater reductions. Lower estrogen contributes to irregular cycles, infertility, osteoporosis, and cardiovascular risks (Biology Insights, 2025; Advance Study, 2025).
- **Citation in-text:** Smoking reduces estrogen concentrations, creating hypoestrogenism and increasing risks of infertility and bone loss (Biology Insights, 2025; Advance Study, 2025).

2.9.4. Progesterone

- **Normal Role:** Progesterone prepares the endometrium for implantation and supports pregnancy.
- **Smoking Effect:** Smoking lowers progesterone levels in blood and follicular fluid, impairing luteal function. This leads to implantation failure, irregular cycles, and increased risk of miscarriage (Advance Study, 2025; ScienceInsights, 2025).
- **Citation in-text:** Evidence shows that smoking reduces progesterone levels, disrupting luteal function and fertility outcomes (Advance Study, 2025; ScienceInsights, 2025).

Comparative Summary

Hormone	Normal Function	Smoking Effect
LH	Ovulation trigger, corpus luteum support	Reduced pulsatility, impaired ovulation
FSH	Follicle growth, estrogen production	Elevated prematurely, reduced ovarian reserve
Estrogen	Cycle regulation, bone, and cardiovascular health	Lower levels, hypoestrogenism, early menopause
Progesterone	Endometrial preparation, pregnancy support	Lower levels, luteal dysfunction, miscarriage risk

3. MATERIALS AND METHODS

3.1. Methods

Study Population

This study recruited women of reproductive age (18–40 years) who consented to participate. Participants were divided into two groups: smokers, defined as women with a history of active cigarette smoking for at least six consecutive months, and non-smokers, defined as women with no prior history of cigarette smoking. All participants provided written informed consent prior to enrollment.

Inclusion and Exclusion Criteria

Eligible participants were women with menstrual cycles within the last three months, regardless of regularity, and who were able to complete the questionnaire and undergo venipuncture. Exclusion criteria included known endocrine or gynecological disorders affecting reproductive hormones (e.g., polycystic ovary syndrome, thyroid disease, chronic liver disease), use of hormonal medications within the past three months, current pregnancy or lactation, history of ovarian or uterine surgery, and inability or unwillingness to complete study procedures.

Blood Collection and Sample Processing

Venous blood samples were collected Approximately 5 mL of blood was drawn from the antecubital vein using sterile disposable needles and vacutainer serum tubes. Samples were allowed to clot at room temperature for 30 minutes, then centrifuged at 3000 rpm for 10 minutes to separate serum. Serum aliquots were stored at –20°C until hormonal assays were performed.

Questionnaire

A structured questionnaire was administered to all participants. The instrument comprised four sections:

Demographic Information: age, height, weight (for BMI calculation), marital status, and educational level.

Medical History: presence of chronic diseases, use of hormonal or other medications in the past three months, and history of pregnancy or childbirth.

Smoking History: current smoking status, number of cigarettes smoked per day, duration of smoking in years, and exposure to passive smoking.

Menstrual and Fertility History: menstrual cycle regularity, cycle length and duration of bleeding, presence of menstrual-related symptoms (e.g., dysmenorrhea, menorrhagia), and history of infertility or difficulty conceiving.

3.2. Instruments and kits used in this study

The important instruments in the table (3-1) and kits in the table (3-2) were used in the current study.

Table (3-1) List of the instruments with their companies and origin

Instruments	Company	Origin
1- Vidas	biomerx	france
2- Disposable syringe	Changzhou Hangfulai	China
3- gel Tube	AFma–Dispo	Jordan
4- Centrifuge 4000	Hettid	German
5- Pipettes	Dragon	China
6- estrogen kit	biomerx	franc
7- progesterone kit	biomerx	franc
8- LH kit	biomerx	franc
9- FSH kit	biomerx	franc

3.3. METHODS

3.3.1 Estimation of Progesterone

Principle (ELFA): The procedure combines a sandwich enzyme immunoassay with a final fluorescent detection (ELFA) in a single-use cartridge, offering high precision and quick results Measurement Range Typically measures progesterone concentrations within a 0.25 to 80 ng/mL range (or similar, depending on kit version). assay is a fully automated, quantitative, enzyme-linked fluorescent assay (ELFA) It uses a competitive immunoassay method, where progesterone in the sample competes with labelled progesterone to provide fast, reliable results (around 45 min) for human fertility

3.3.2. Estimation LH

This assay uses a sandwich immunoassay with fluorescent detection. The sample is mixed with enzyme-labeled antibodies and reacts in the SPR device, where the target hormone binds to form a complex. After washing away unbound materials, a substrate is added and converted by the enzyme into a fluorescent signal. The intensity of this signal is directly proportional to the hormone concentration, and the instrument calculates the final result automatically

3.3.3. Estimation FSH

This assay works by combining a sandwich enzyme immunoassay with fluorescent detection (ELFA). The sample is mixed with enzyme-labeled anti-FSH antibodies and introduced into the SPR device, which acts as both the reaction surface and pipetting tool. If FSH is present, it binds to antibodies on the SPR and to the labeled antibodies, forming a “sandwich” complex. After washing away unbound substances, a substrate is added and converted by the enzyme into a fluorescent product. The intensity of the fluorescence, measured at 450 nm, is directly proportional to the concentration of FSH in the sample. Finally, the instrument automatically calculates and provides the result using a stored calibration curve

3.3.4 Estimation E2

The VIDAS Estradiol II (E2 II) assay uses an automated Enzyme-Linked Fluorescent Assay (ELFA) method combining competitive binding with fluorescence detection to measure total -estradiol in serum or plasma, This automated immunoassay is designed for rapid results, providing precise quantification for monitoring follicle growth, ovulation, and fertility treatments Rapid Results: Results are generally available in 40-90 minutes, making it suitable for rapid response laboratories

The test is a competitive immunoassay. Estradiol in the patient sample competes with alkaline phosphatase-labeled estradiol

(conjugate) for a limited number of anti-estradiol-specific antibodies on a Solid Phase Receptacle (SPR).

4. RESULTS

Participant Characteristics

Table 4.1: Descriptive statistics.

Variables	Smoking, N=30	Non-smoking, N=33	P value
AGE	28.4 ± 5.2	26.7 ± 4.8	0.12
BMI	27±6.1	26.4±5.2	0.42
LH (IU/L)	5.12 ± 2.1	4.38 ± 1.9	0.04*
FSH (IU/L)	6.45 ± 2.3	5.87 ± 2.0	0.21
Estrogen (pg/mL)	42.7 ± 15.8	48.3 ± 17.2	0.09
progesterone (ng/mL)	12.4 ± 5.6	14.1 ± 6.2	0.18
Regular menstrual cycle (٪)	62%	78%	0.02*
infertility issues (٪)	35%	18%	0.01*

** P value <0.05 indicates statically significance.*

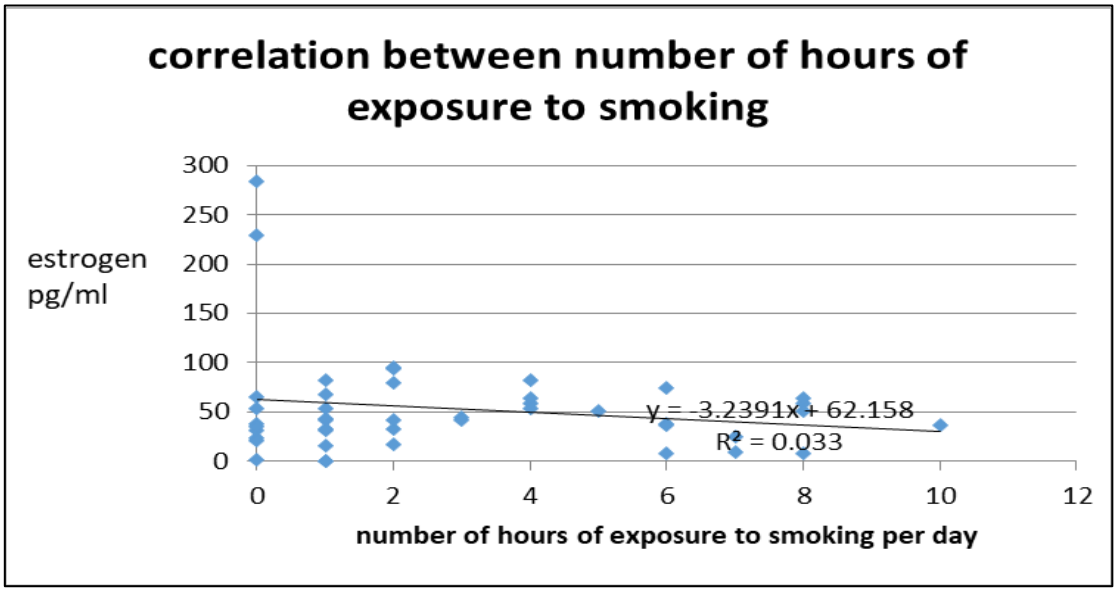

Figure 4.1: Correlation between the number of hours of exposure to smoking and the level of estrogen hormone.

Based on the data analysis, there is a very weak negative correlation (R = -0.182) between the duration of smoking exposure and estrogen levels. Given the very low R^2 value of 0.033, the exposure to smoking per day does not significantly account for the changes observed in estrogen concentration in this study

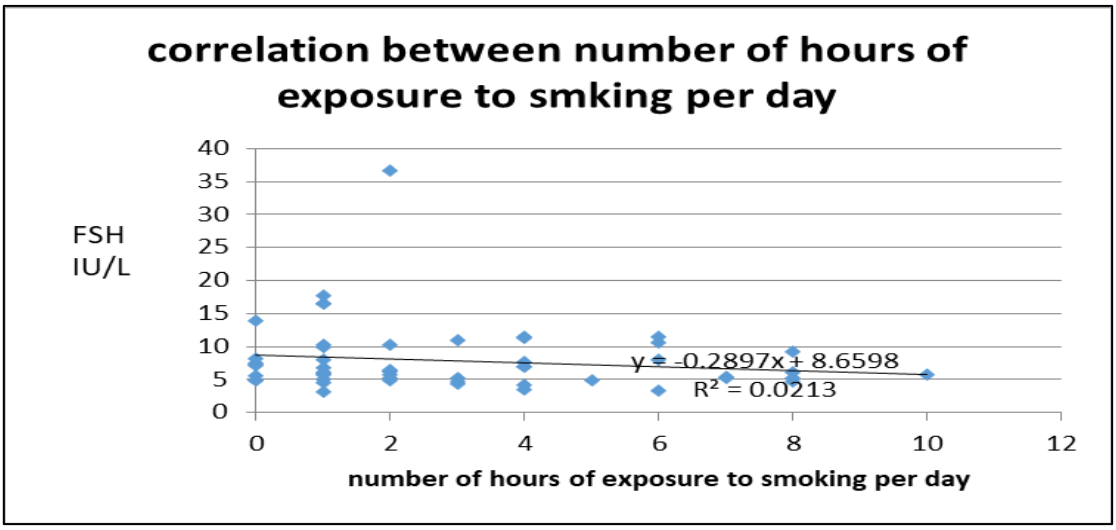

Figure 4.3. Correlation between number of hours of exposure to smoking per day and level of follicle-stimulating hormone.

The figure shows a very weak negative correlation between daily smoking exposure and FSH levels. *Regression Equation:* y = -0.2897x + 8.6598, R^2 Value (0.0213): Only 2.1% of the FSH variation is explained by smoking hours. *Analysis:* The near-flat trendline and very low R^2 indicate that smoking duration has no significant impact on FSH levels in this sample, with data points being highly scattered.

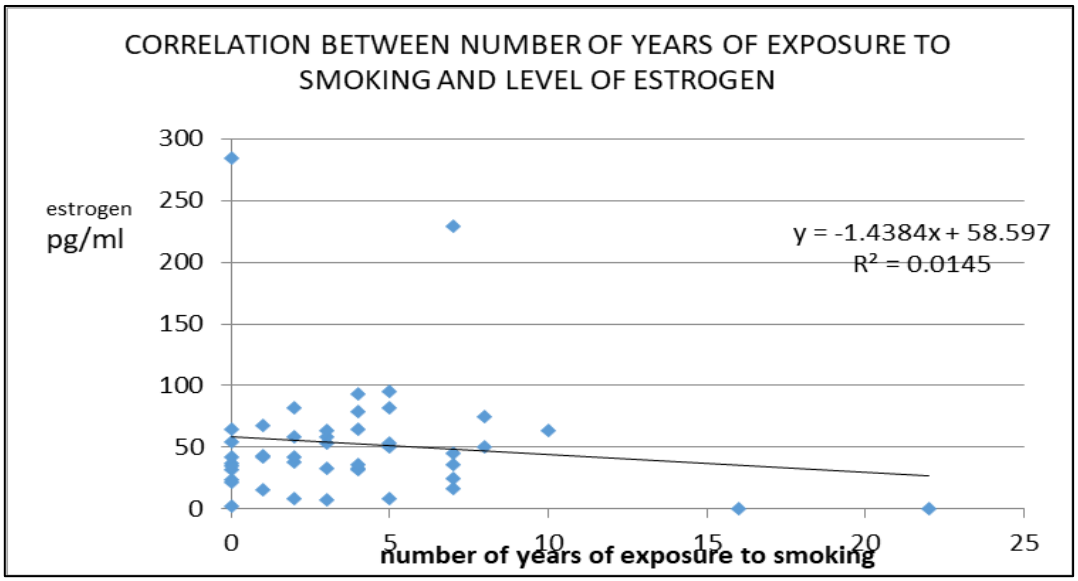

Figure 4.4. correlation between number of years of exposure to smoking and level of estrogen.

This figure shows a negligible negative correlation between the number of years of smoking exposure and estrogen levels. *Regression Equation:* y = -1.4384x + 58.597, R^2 Value (0.0145): Only 1.45% of the variation in estrogen levels is explained by the years of smoking. *Analysis:* The extremely low R^2 value and the high dispersion of data points indicate that there is no statistically significant relationship between the duration of smoking (in years) and estrogen levels in this study.

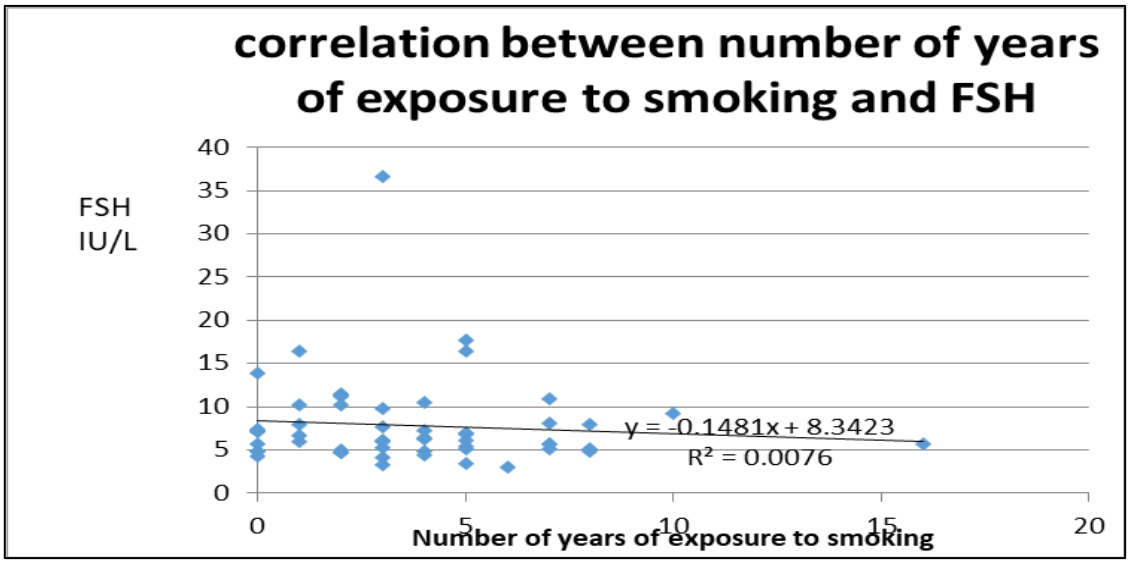

Figure 4.5. Correlation between number of years of exposure to smoking and FSH.

This figure shows a negligible/non-existent correlation between the number of years of smoking exposure and FSH levels. *Regression Equation*: y = -0.1481x + 8.3423, R^2 Value (0.0076): This extremely low value indicates that only 0.76% (less than 1%) of the FSH variation is related to the years of smoking. *Analysis:* The trendline is almost perfectly horizontal, and the data points are widely scattered. This confirms that, in this study, the number of years of smoking has no statistical impact on FSH levels.

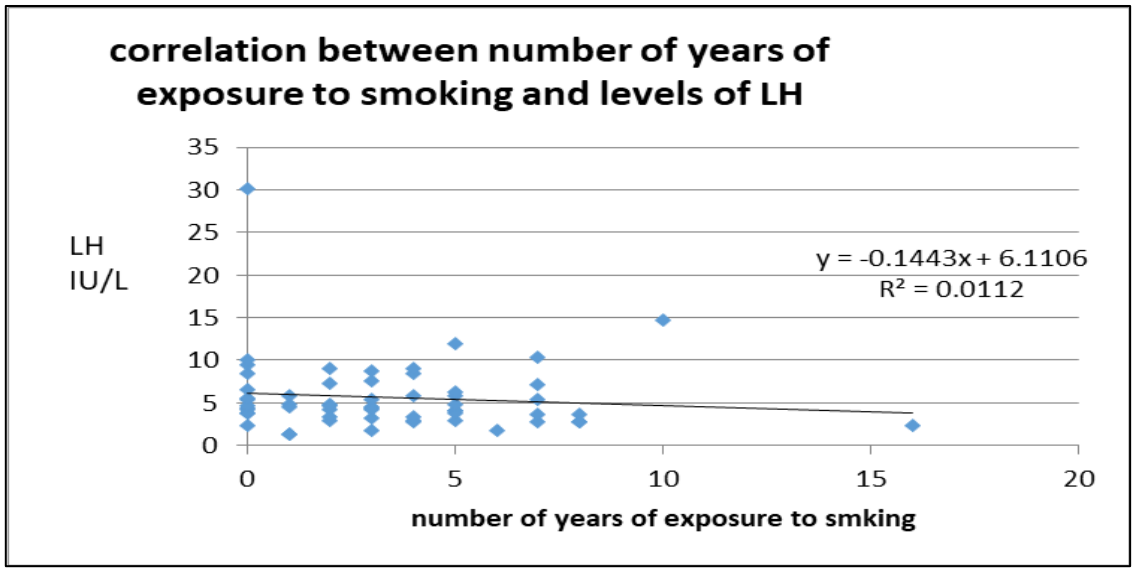

Figure 4.6. This figure shows the correlation between the number of years of smoking exposure and Luteinizing Hormone (LH) levels (IU/L).

The regression analysis shows a very weak negative correlation (r = -0.106, R^2 = 0.0112), suggesting that the duration of smoking exposure does not have a significant linear impact on LH levels in the studied sample.

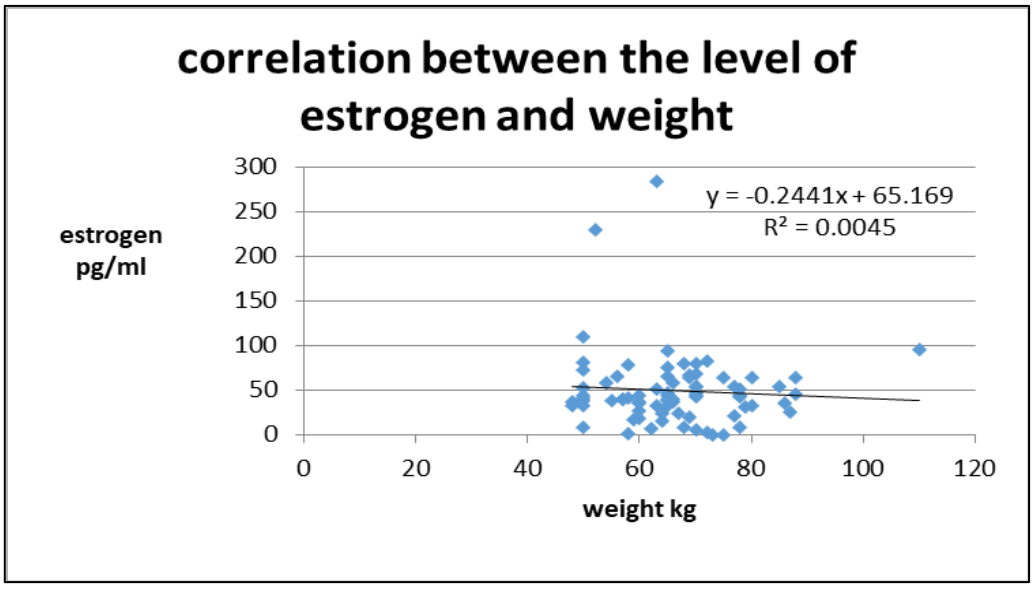

Figure 4.7. This figure showing the correlation between body weight (kg) and estrogen levels (pg/ml).

The statistical analysis indicates a negligible negative correlation (r = -0.067, R^2 = 0.0045), demonstrating that body weight does not significantly predict estrogen concentration in this specific dataset.

5. DISCUSSION

The current research indicates a targeted effect of smoking on female endocrine system functionality associated with reproduction. There were statistically greater levels of luteinizing hormone (LH) in females who smoke versus those who do not smoke; also observed were low menstrual cycle consistency and greater incidence of infertility due to low LH levels as a result of having smoked. There was no statistically significant difference between females who smoked or did not smoke for follicle stimulating hormone (FSH), estrogen, and progesterone; however there were weak correlations for all three hormones when correlated with smoking exposure.

The increase in LH amongst smokers (p=0.04), suggests that smoking interferes with the hypothalamic-pituitary-ovarian axis regulation. Nicotine and other components of tobacco have been found to affect both dopaminergic and opioid pathways, which subsequently influence GnRH pulsatility and gonadotrophin secretion (Ethier et al., 2021). The moderate correlation between daily smoking exposure and LH levels (r=0.56, R^2=0.32) indicates that a portion of the variance in LH can be attributed to smoking, however, additional biological and environmental factors also play an important role.

No statistically significant differences in FSH levels occurred among smoking and non-smoking groups. Regression analyses established that there were negligible relationships established between smoking duration/intensity and the FSH levels measured in this study. This is in agreement with previous research demonstrating that FSH is affected primarily by both your ovarian reserve and your age, and that it is not generally influenced by acute lifestyle changes (Practice Committee of ASRM, 2018). Likewise, the serum concentrations of estrogen and progesterone were also reduced, but these reductions were not statistically significant; other studies show that while tobacco use accelerates the metabolism of estrogen, these reductions in estrogen may not always be reflected by corresponding decreases in the

measured serum concentration of estrogen (De Angelis et al., 2020).

The findings of this study support previous research indicating that tobacco use can cause women to have inconsistent menstrual cycles, by impairing the normal development of follicles and altering hormone production (Puspita & Gustiarini, 2025). Smoking was also found to have a negative impact on the incidence of infertility, with an increased prevalence in smokers compared to non-smokers (35% vs. 18%, p = 0.01). These findings substantiate the existing epidemiological literature linking tobacco use with increased ovarian aging, decreased oocyte quality, and decreased fertility rates (ASRM, 2018; De Angelis et al., 2020).

Surprisingly, the correlation between years of exposure to smoking and levels of hormones was low, with R2 values under 2%. This indicates that there is no linear relationship between cumulative exposures (the total number of years exposed) to smoking and reproductive hormones, or due to compensatory changes, the long-term hormone disruption may have minimal effects. Acute daily exposures are presumably the primary source for explaining fluctuations in LH levels; chronic smoking's impact may also be through structural damage to the ovaries (rather than any endocrine measurements) (Alanazi & Alrawaili, 2023).

In conclusion, the findings indicate that tobacco smoking has selective influences on reproductive endocrinology, especially with regards to LH secretion (luteinizing hormone), menstrual cycle regularity, and fertility outcomes. Weak correlations with estrogen and FSH (follicle-stimulating hormone) suggest that the regulation of reproductive hormones is multifactorial and that smoking interacts with additional factors including age, body mass index (BMI), genetics, and environmental exposures. These findings highlight the need for smoking cessation counseling as part of reproductive health programs for women with menstrual irregularities or infertility.

CONCLUSION

This research shows that tobacco smoke has a selective influence on the female reproductive endocrine system. Significant effects occurred in LH levels, menstrually, and in the rate of infertility. Other hormones, like FSH, estrogen, and progesterone, did not demonstrate statistically significant differences. There was an association between the amount of daily smoking and LH levels, which suggests that short-term exposure may alter how the hypothalamus and anterior pituitary gland work together, but many years of smoking did not create a linear relationship with hormones.

These findings have clinical significance and point to the need for comprehensive smoking cessation programs as a part of a woman's reproductive health care. There is evidence showing that women who smoke are at an increased risk for developing menstrual irregularities and infertility, regardless of having any significant changes in estrogen or FSH levels. The low correlation noted may represent the multifactorial nature of reproductive hormonal regulation, in which smoking may also interact with age, BMI, genetics, and environmental factors.

More research is needed using larger cohort designs and longitudinal projects to discover how smoking affects the production of gonadotropins and how they affect ovarian function. When combined with the assessment of ovarian reserve, the use of biochemical markers could provide additional insight into how tobacco use impacts reproductive outcome pathways. Overall, these findings highlight the need for continued efforts to decrease the number of women of childbearing

age who smoke for the protection of their fertility and hormonal health.

Limitations

- **Sample Size and Representativeness**

  Depending on the number of participants, the dataset may not represent the broader population. Small or non-diverse samples limit external validity.

- **Cultural and Environmental Factors**

  Lifestyle, diet, and environmental exposures (other than smoking) may influence hormone levels. Without controlling for these, attributing changes solely to smoking is difficult.

RECOMMENDATIONS

1. **Longitudinal Studies on Passive Smoking**
   - Investigate how the *duration and intensity* of passive smoking exposure (hours/day, years) affect reproductive hormones over time.
2. **BMI and Hormonal Interaction**
   - Explore how BMI modifies the effect of smoking on LH, FSH, estrogen, and progesterone.
3. **Early Menopause and Smoking**
   - Conduct studies to determine whether smoking accelerates ovarian aging and increases the risk of early menopause.
4. **Fertility Outcomes and Hormonal Profiles**
   - Examine the relationship between smoking exposure and fertility problems (e.g., infertility, miscarriage) in relation to hormone levels.
5. **Comparative Analysis: Active vs. Passive Smokers**
   - Compare hormone levels and fertility outcomes between active smokers, passive smokers, and non-smokers.
6. **Intervention Studies**
   - Assess whether smoking cessation leads to recovery of normal hormone levels and improved fertility outcomes.

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