Journal of Libyan Academy Bani Walid 2025
مجلة الأكاديمية الليبية بني وليد
e-ISSN: 3104-3860
Volume 1, Issue 3 (Part 2), 2025, Pages: 144-152

Determine the relationship between some biochemical elements and estradiol hormone for women in the reproductive and menopausal stages

Munira Abdulwahed Nwirat*
Biology Department, Faculty of Arts and Sciences, University of EL-MergIb, City. Msallata- Libya
*Email (for reference researcher): muniranwirat@gmail.com

تحديد العلاقة بين بعض العناصر البيوكيميائية وهرمون الإستراديول لدى النساء في مرحلتي الإنجاب وانقطاع الطمث

منيرة عبد الواحد محمد نويرات *
قسم الأحياء، كلية الآداب والعلوم، جامعة المرقب، مسلاتة – ليبيا

Received: 10-07-2025; Accepted: 14-09-2025; Published: 29-09-2025

الملخص
أُجريت هذه الدراسة لتقدير تركيز كل من المغنيسيوم والكالسيوم في المصل وهرمون الإستراديول، وبيان تأثير نقصها لدى النساء في مرحلة انقطاع الطمث مقارنةً بالنساء في مرحلة الخصوبة، وكذلك لتحديد العلاقة بين الفئات العمرية لكل مجموعة مع مستويات المغنيسيوم والكالسيوم والإستراديول.
تم جمع (60) عينة قُسِّمت إلى مجموعتين: الأولى لنساء في سن الإنجاب (30 عينة من فئات عمرية مختلفة)، والثانية لنساء في مرحلة انقطاع الطمث (30 عينة من فئات عمرية مختلفة)، من النساء المراجعات لمختبر الدقة ومختبر الجزيرة ومستشفى مسلاتة.
استُخدم البرنامج الإحصائي SPSS (Statistical Package for Social Sciences) لتحليل البيانات، حيث تم حساب المتوسط الحسابي والانحراف المعياري للمتغيرات قيد الدراسة، كما استُخدمت الطرق الوصفية والتحليلية عبر اختبار T-test لمقارنة المجموعتين (العينات المستقلة) واختبار Levene's test لتحديد التجانس داخل مجتمع الدراسة، بهدف معرفة الفروق بين مجموعتي الخصوبة وانقطاع الطمث، والتحقق من فروض الدراسة عند مستوى دلالة.($P > 0.05$)
أظهرت النتائج وجود فروق ذات دلالة إحصائية بين مجموعتي الخصوبة وانقطاع الطمث في كل من المغنيسيوم والكالسيوم، وكانت لصالح مجموعة الخصوبة. كما وُجدت فروق معنوية في مستوى هرمون الإستراديول بين المجموعتين أيضًا لصالح مجموعة الخصوبة.
ومن خلال هذه النتائج تبين أن كلًّا من المغنيسيوم والكالسيوم والإستراديول تكون مستوياتها ضمن المعدلات الطبيعية لدى النساء في سن الإنجاب، بينما تنخفض بشكل ملحوظ لدى النساء في مرحلة انقطاع الطمث.

الكلمات المفتاحية: الكالسيوم، المغنيسيوم، الإستراديول، الخصوبة، انقطاع الطمث.

Abstract:
This study was conducted to estimate the concentration of magnesium, serum calcium and estradiol and to explain the effect of their deficiency on the menopausal group and the reproductive group and to compare the two groups, and to determine the relationship between the age groups of the study groups and both magnesium calcium and estradiol, where (60) samples were collected and divided into two groups, a group, the first was women of fertile age, with (30) samples from different age groups and 30 samples from menopausal women of different age groups, from women who frequented the precision laboratory, Al-Jazeera Laboratory and Msallata hospital. Using the statistical program, Statistical Package for Social Sciences (SPSS) Statistical Package for Science, where the arithmetic mean and the variables under consideration were analyzed standard deviation. The data were also generated by descriptive and analytical methods using the (T test) test after analyzing the two groups to match the T test for independent samples and entering them together in this analysis and the (Levene's test) to determine

homogeneity within the study community in order to compare the samples to know the differences between the fertility groups and the age of menopause (hope) in order to answer the questions of the study or control its hypothesis at a significant level.(0.05>P) , where this study showed that there are statistically significant differences in magnesium and calcium between the reproductive and menopause groups in favor of the reproductive group, and that there are statistically significant differences in estradiol between the two groups in favor of the reproductive group as well, and from these results we found that both magnesium, calcium and estradiol have normal values in the reproductive group while they have low rates in the menopause group.

Keywords: calcium, magnesium, estradiol, reproductive, menopausal.

1. Introduction:

Menopause is one of the stages of normal physiological development that all women must go through when they reach a certain age, and it occurs after the ovaries stop producing eggs. It is also known as the last blood flow in the last menstrual cycle in the sense of complete menopause and occurs after the ovaries stop producing eggs (Abdulaziz *et al*., 2016), in which women are subjected to a severe decrease in the level of female sex hormones (Female Sex Hermone). This physiological condition occurs when the female reaches the age of 45-50 years (Omran and Ajeel, 2016), during which women suffer from many physiological disorders, including hot flashes, night sweats, psychological disorders and skeletal densities, which in turn lead to osteoporosis (, Indumatieti et al.,2007), (Omran and Ajeel, 2016), which is one of the diseases closely associated with age progress in both sexes [(Bonte et al., 2000) ; (Omran and Ajeel, 2016)].

The levels of sex hormones such as progesterone and estrogen are reduced to the loss of follicular vesicles, which in turn form menstruation. Progesterone is one of the steroid hormones officially produced by the ovaries, and its composition and secretion are mainly regulated by the luteinizing hormone during the menstrual cycle through the human chorionic gonadotropin (HCG) (Al Qamaty, 2005), while estrogen is secreted from the ovary by the yellow body and casing cells. It is also secreted from the placenta and its function is to stimulate the growth of the ovaries, vesicles and smooth muscles and reduce FSH secretion (Mazouz et al., 2020). In addition to its direct effect on calcium, an important element for bone formation, as well as affecting various minerals and electrolytes such as magnesium, zinc, copper, sodium and potassium [(Bednarek et al., 2010); (, Omran and Al-Ajeel, 2016)]. Postmenopausal women also tend to be prone to primary osteoporosis due to its association with estrogen deficiency. (Bolaji and Marlena, 2020), which in turn is directly related to their calcium deficiency compared to women of fertile age.

Calcium (Ca) is mainly associated with bone formation and metabolism in the circulatory system, extracellular fluids, muscles, and other tissues. Calcium plays a vital role in regulating the contraction and expansion of blood vessels, muscle function, transmission of nerve signals, intracellular signals, and hormonal secretion [(Sokoll and Dawson, 1989); (Wood, 1994); (Nagata et al., 1998); (Strause et al., 1994); (Mahdavi-Roshan, 2015); Tomasz et al., 2023)]. Calcium deficiency can also lead to weak bones and increase their fragility, increasing the risk of falls. A study of calcium intake and menopause in Japanese women showed that higher calcium consumption was associated with an increased likelihood of early menopause (Nagata et al., 1998). Calcium deficiency and osteoporosis are common problems among postmenopausal women.Magnesium (Mg), a divalent intracellular cation, has been identified as a cofactor for more than 300 metabolic reactions in the body. Magnesium plays an important role in maintaining normal nerve and muscle function, blood pressure, bone integrity, heart health, and glucose and insulin metabolism. [(Mendola, 2008); (Tomasz et al., 2023)] Magnesium deficiency has been associated with a number of chronic diseases, including migraines and high blood pressure. Due to high levels of ferritin in menopausal women compared to younger women, magnesium concentrations in the blood are lower in women at this age. However, there are no studies that determine the effect of magnesium on the timing of menopause (Lee and Kim, 2012)].; (Tomasz et al., 2023)]

2. The aim of the Work:

1. Estimation of serum estradiol concentration for both study groups

2 Estimate the concentration of serum magnesium and calcium and explain the effect of their deficiency on the menopausal and reproductive groups.

3. Determine the relationship between magnesium, calcium and estradiol in the menopause and reproduction groups and compare them

4. The relationship between the age groups of the study groups and both magnesium, calcium and estradiol.

3. Material and Methods

The samples were taken from the precision laboratory and the Al-Jazeera laboratory and with the help of some of the cases frequented by Al-Salam International Hospital, where (60) samples were collected, divided into two

groups, the first group was women of fertile age and it was with (30) samples from different age groups and 30 samples from menopausal women who had gone through the menstrual cycle and from different age groups, and this was done by performing the following steps:

First: To conduct the magnesium and calcium analyzes, the sample is withdrawn from the patient: After making sure that the patient does not have health problems that may affect the levels of magnesium and calcium in the blood, by asking her directly, as drugs such as diuretics and mineral supplements can affect the results, where 5 ml was withdrawn for each sample for calcium, magnesium and estradiol analyzes.

Specimen type and preparation: - The blood sample was of the serum type in the precision and island laboratories, after placing the blood in a special tube called(plant tube) , free of (EDTA) material, and placing the samples in the centrifuge for 10 minutes to clot the samples , after placing the sample name, type of analysis, and sample number or code. This is done on all study samples.

1- Preparing a device(Mindray 230 BS-) to conduct calcium and magnesium analysis:

To turn on the device: We have ensured that the Mindray 230 BS- is ready to use. The general condition of the device, and any software updates to it, which is a device imported from the Medical Atlas Company to import medical equipment, was examined, then the chemical strips were inserted: and the chemical strips for the analysis of magnesium and calcium were correctly installed in the place designated for them.

Sample entry: - The sample was placed after taking the serum from a sample from the centrifuge by a special pipette (Pipit) at a rate of (500 µ) and placed in a special (cup) and placed in the place designated for it in the device after making sure to put the names of samples and sample numbers for each group and then give the order to the device to take the results after choosing the analyzes of calcium and magnesium for each sample of the two groups from the list of the device and then take the results and print them after a period of 10-20 minutes from the start of reading the results.

Automated analysis: The Mindray 230 uses spectroscopic techniques to measure the level of magnesium in the blood using chemical components whose reaction is based on the concentration of magnesium in the sample. Once the analysis is completed, the device will process the data and display the level of magnesium in standard units (usually mg/dL or micromol/L).

Confirm the results. If they are within the normal range of magnesium (1.6-2.2 mg/dL or 0.70-0.95 µmol/L), they are considered normal. If they are lower than this percentage, the woman suffers from magnesium deficiency. If magnesium levels are high, she is prone to hypermagnesemia or hypermagnesemia.

As for calcium, the normal rate is from .58-10 mg/dL. If the results are within this rate, the woman is normal. Less than this, the woman suffers from calcium deficiency. The more calcium deficiency, the more susceptible she is to osteoporosis. The higher the percentage than normal, the more susceptible she is to hypercalcium disease or hypercalcemia.

2- Preparing a device (Mindray CL-900i) to conduct estradiol analysis:

This device is prepared and imported from the Atlas Medical Company to import medical equipment. The rest of the serum taken from both samples of the two groups was placed after taking them, numbered and placed in this device after calibration. Bare code and ID were selected and filled. We choose the type of analysis, which is estradiol from the device after selecting it from the list and turning on the start button. We leave the device for 35 minutes to take the results and print them. If the estradiol rate is normal, it is as follows: If the woman is of fertile age, it ranges between 30-400 pg / ml, while in menopausal, it ranges from 0-30 pg/ml. This hormone is higher than normal levels, which indicates the presence of a tumor in the ovaries, adrenal gland, or early puberty for girls. If it is lower than normal, it indicates primary ovarian insufficiency (menopause) , Turner syndrome or ovarian cystic syndrome.

4. Statistical Analysis 4

The data were entered into the computer after coding, to perform the statistical operations necessary to analyze the data using the statistical program, Statistical Package for Science (SPSS) Statistical Package for Science, where the arithmetic mean and standard deviation of the variables under study were calculated. The data were also generated by descriptive and analytical methods using the (T test) test after analyzing the two groups to match the T test for independent samples and entering them together in this analysis and the (Levene's test) to determine homogeneity within the study population in order to compare the samples to find out the differences between the fertility and despair (hope) groups in order to answer the questions of the study or control its hypothesis at a significant level.(0.05>P).

Reselts:

First: The differences in magnesium between the reproductive group and the hope group

Table 1. The results of the T-test for the differences in magnesium between the reproductive group and the hope group

Age Groups	Number	Arithmetic	Standard deviation (Maths.)	differences	Statistical significance
Reproduction group 17-39	30	1	0.554080	4276	0.008
Hope Age Group 45-51	30	1	0.638640		

Calculated T-value = 2.77 degrees of freedom 58 Tabular T-value= 2

From Table No. (1), it is clear that the average magnesium at the reproductive group was (1.9973), while the average magnesium at the age of hope group was (1.5697), and the value of the difference was (0.4276), and to determine whether this difference is statistically significant, the calculated value of T was (2.77), which is greater than its tabular value (2), and this indicates the significance of this difference, and this enhances the value of the statistical significance (0.008), which is less than (0.05) and indicates that there are statistically significant differences in magnesium between the two groups in favor of the reproductive group .In the Fig (1).

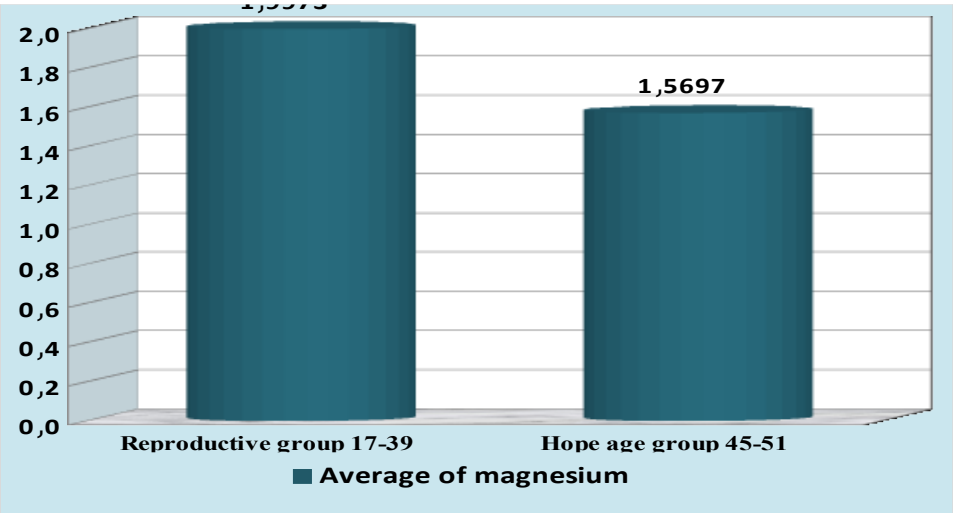

Figure (1) shows the average magnesium in the two groups .

Second: Differences in calcium between the reproductive group and the hope group

Table 2. the results of the T-test for the differences in calcium between the reproductive group and the hope group

Age Groups	Quantity	Arithmetic	Standard deviation (Maths.)	differences	Statistical significance
Reproduction group 17-39	30	897	1.07407	1.373	0.000
Hope Age Group 45-51	30	.524	1.06219		

Calculated T-value =4.978 degrees of freedom 58 Tabular T-value= 2

From Table No. (2), it is clear that the average calcium at the reproductive group was (8.897), while the average calcium at the age of hope group was (7.524), and the value of the difference was (1.373), and to determine whether this difference is statistically significant, the calculated T-value was (4.978), which is greater than its tabular value (2), and this indicates the significance of this difference, and this enhances the value of statistical

significance (0.000), which is less than (0.05) and indicates the existence of statistically significant differences in calcium between the two groups in favor of the reproductive group.is as in Fig (2).

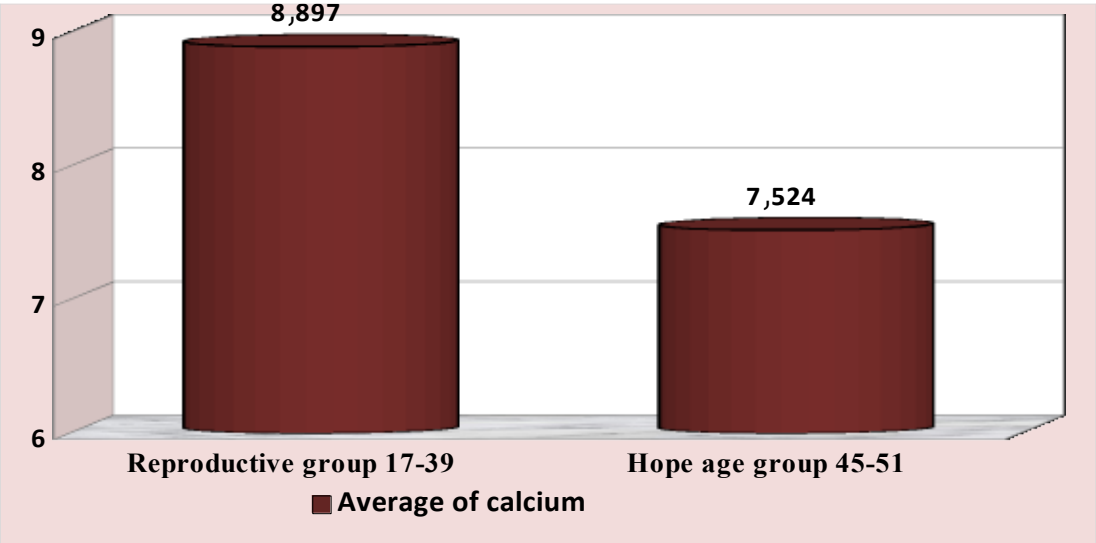

Figure (2) shows the average calcium in the two groups

Third: Differences in estradiol between the reproductive group and the hope group

Table No. (3) shows the results of the (T-test) test for the differences in estradiol hormone between the reproductive group and the hope group

Age Groups	Quantity	Arithmetic	Standard deviation (Maths.)	differences	Statistical significance
Reproduction group 17-39	30	598	71.35985	103	0.000
Hope Age Group 45-51	30	19	8.84889		

Calculated T-value = 7.85 degrees of freedom 58 Tabular T-value = 2

From Table No. (3), it is clear that the average estradiol hormone at the reproductive group was (122.598), while the average estradiol hormone at the maternal age group was (19.5387), and the value of the difference was (103.0593), and to determine whether this difference is statistically significant, the calculated T-value was (7.85) , which is greater than its tabular value (2), and this indicates the significance of this difference, and this is reinforced by the value of the statistical significance (0.000), which is less than 0.05)) and indicates that there are statistically significant differences in the estradiol hormone between the two groups in favor of the reproductive group.As in Figure (3).

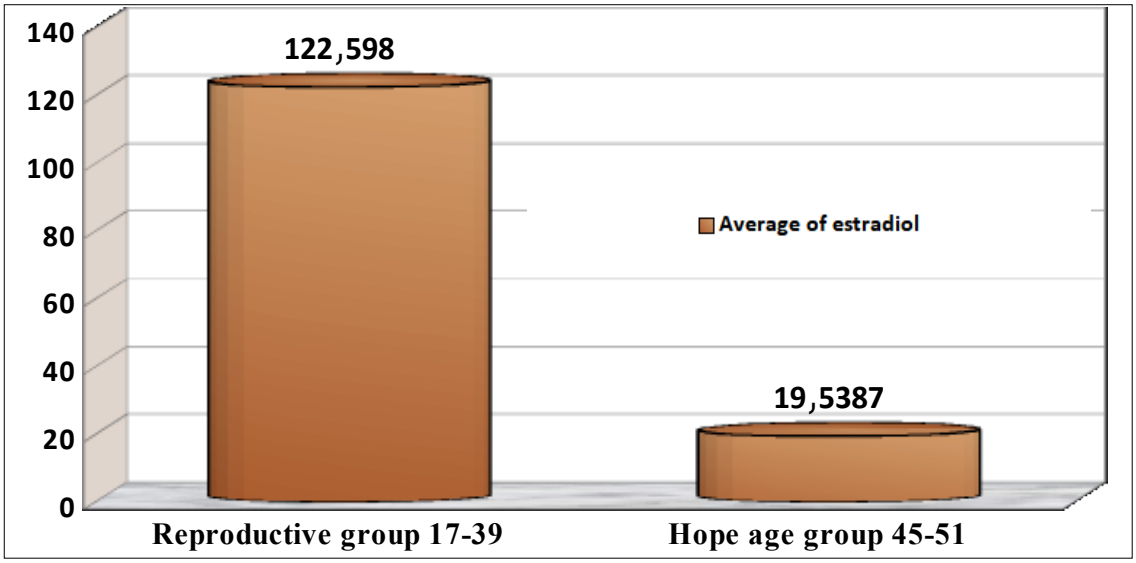

Figure (3) shows the average estradiol hormone in the two groups

5.Conclusion:

1. There are significant significant differences in magnesium between the reproductive and hope groups in favor of the reproductive group
2. There are statistically significant significant differences in calcium between the two groups in favor of the reproductive group
3. There are statistically significant differences in estradiol between the two groups in favor of the reproductive group as well. From these results, we found that magnesium, calcium and estradiol all have normal values in the reproductive group while they were at low rates in the hope group. That is, women in this group suffer from low rates of calcium, magnesium and estradiol, which also results in health problems.

6.Discussion:

Postmenopausal women are at greater risk of biochemical changes in serum and possible nutritional disorders, especially with regard to rare minerals. The risk of age-related diseases is very high during this period. These harmful changes in serum trace minerals must be taken into account for early diagnosis and prevention of menopausal-related diseases. Dietary supplements may be necessary during the stages of fertility and menopause, especially when levels are significantly low. In this study, the results showed that there are statistically significant differences of less than (0.05> P) In estradiol between the two groups (menopause and reproductive age group) in favor of the reproductive group, and this corresponded with a study (Omran and Ajeel, 2016) in which they indicated a significant decrease (0.05>p) in the level of Estradiol in postmenopausal women for all age groups when compared with premenopausal women (control group), and where there was a severe decrease in the level of sex hormones in the menopausal group in both studies, and menopause is known to be the final stage of ovarian function in Women, which represents the time of transition from reproductive life and the stage of fertilization to the life of menopause or menopause, which in turn led to the complete depletion of the ovarian vesicles and thus the loss of function in menopause (*et al.*, 2021 Santoro), (Tomasz *et al.,* 2023)]

This study showed that there are significant differences and a positive relationship of magnesium between the two groups in favor of the reproductive group, and this is what contradicted with the study of (Omran and Ajeel, 2016) In which they indicated that the concentration of magnesium in the same study (a non-significant rise) in the age group of (46-50 years) while there was a non-significant decline (05.0>P) in the level of serum magnesium in postmenopausal women from the age groups of (51-55 years) and (56-60years) and from (61-65 years) when compared with the control group.

Some studies, such as a study of (2002, Worthley and Baker), found that magnesium has a key role in regulating the secretion of PTH Parathyroid Hormone in cooperation with calcium, as Odabasi et al., 2000). Their study showed a significant decrease in the level of serum magnesium in females with osteoporosis (after menopause, and this was explained by an increase in the mechanism of introducing magnesium into cells.

The study of Riggs et al., 1998) noted a decrease in renal function on the reabsorption of calcium, magnesium, zinc, and copper as well as a decrease in intestinal function on the absorption of the mentioned minerals in elderly females .

As for calcium, our current study showed that there are statistically significant significant differences in calcium between the two groups in favor of the reproductive group, and this is what agrees with the study (2007.,Bednarek et al) where they indicated that there is a high level of calcium in postmenopausal women, but the high level of magnesium was immaterial or remained within normal limits.

Another study (Abdulaziz et al., 2016) indicated that the severity of menopausal symptoms was 5.47%. They suffered from moderate symptoms, and one of the most frequent symptoms was mental symptoms, followed by skeletal and muscular symptoms, the least of which were genital and urinary symptoms.

Several research articles from 2001 to 2020 that researched Scopus, Cinahl, and Web of Science also found the relationship between dietary patterns and certain elements of postmenopausal osteoporosis, as nutrients such as calcium, phosphorus, magnesium, and vitamin D were proven to be beneficial and important for bones, especially after menopause. (Bolaji and Marlena, 2020).

There are many scientific publications that indicate that menopause is associated with the occurrence of various diseases such as [osteoporosis. Specific minerals such as lead can lead to fertility disorders, in addition to the fact that their high concentrations in the blood are associated with the onset of menopause (Aneta et al., 2021).Other minerals such as calcium and magnesium are low, and many of the unpleasant symptoms of menopause can be relieved with specific hormone treatments, but women should also pay attention to an appropriate diet that provides adequate levels of vitamins and minerals. [(Tomasz et al., 2023), (Zaneta et al., 2021)].

The impact of minerals on women in the reproductive and menopausal stages is widespread and must remain a topic of research, due to long-term environmental pollution and the use of minerals in many areas of life. Dietary supplements, not only with calcium and magnesium but also with zinc and selenium, are needed in menopausal women to alleviate the clinical symptoms of menopausal women and the toxic effects of minerals on them. (Tomasz et al., 2023).

7.Recommendations:

1. Community awareness for women on the importance of menopause before and after they reach this stage in order to face it in a healthy way and know how to deal with it.
2. Maintaining the ideal weight of women in the stages of reproduction and despair by exercising and avoiding stress, which in turn raises the hormone cortisone, which harms the health of women, especially in menopause.
3. Take supplements, salts and vitamins if they are deficient in the woman's body in both stages with attention to routine and regular analysis.
4. Eat foods rich in vitamins and minerals necessary for women in the stages of reproduction and despair and focus on foods rich in phytoestrogens, especially in menopause, which in turn protect them from the effects of this stage and increase their immunity against cancers, especially breast cancer.
5. Preparing studies and research to include a larger number of women during the two stages and studying other elements and minerals to find out the seriousness of their deficiency on women, especially in menopause.

References:

1. Abdulaziz, H. M. Y., Al-Khudari, L. M. I., & Suleiman, I. R. (2016). *The relationship between the quality of life and the severity of menopausal symptoms.* Department of Economics for My Home, Faculty of Shatibi Agriculture, Alexandria University. *Alexandria Journal of Scientific Exchange, 37*(4).
2. Al-Qamati, A. A.-M. (2005). *Endocrine.* New United Book House, Beirut, Lebanon.
3. Al-Qamati, A. A.-M. (2025). *Endocrine glands.* United New Book House, Beirut, Lebanon.
4. Baker, S. B., & Worthley, L. I. G. (2002). The essentials of calcium, magnesium and phosphate metabolism. *Critical Care and Resuscitation, 4*, 301–306.
5. Bednarek, G. B., Jodkowska, J., & Juchniewicz, J. A. (2010). Zinc, copper, manganese, and selenium status in pre- and postmenopausal women during sex hormone therapy. *Advances in Clinical and Experimental Medicine, 19*, 337–345.
6. Bolaji, L., & Kruger, M. (2020). Nutrient and dietary patterns in relation to the pathogenesis of postmenopausal osteoporosis – A literature review. *Life, 10*, 220. https://doi.org/10.3390/life10090220
7. Bonte, D., Lighezan, R., Sfrijan, F., David, D., & Zosin, I. (2000). Importance of determination of bone alkaline phosphatase in postmenopausal osteoporosis. *Annals of RSCB, 15*, 234–241.

8. Ciosek, K., Kot, D., Kosik-Bogacka, D., & Łanocha-Arendarczyk, N. (2021). The effects of calcium, magnesium, phosphorus, fluoride, and lead on bone tissue. *Biomolecules, 11*(4), 506. https://doi.org/10.3390/biom11040506
9. Indumati, V., Vidya, S. P., & Jailkhani, R. (2007). Hospital-based preliminary study on osteoporosis in postmenopausal women. *Journal of Clinical Biochemistry, 22*, 96–100.
10. Lee, B.-K., & Kim, Y. (2012). Association between bone mineral density and blood lead level in menopausal women: Analysis of Korean National Health and Nutrition Examination Survey 2008–2009 data. *Environmental Research, 115*, 59–65.
11. Mahdavi-Roshan, M. (2015). Copper, magnesium, zinc and calcium status in osteopenic and osteoporotic post-menopausal women. *Clinical Cases in Mineral and Bone Metabolism, 12*, 18–21. https://doi.org/10.11138/ccmbm/2015.12.1.018
12. Mazouz, A., Toumiat, R., & Lajawi, A. (2020). *Contribution to the study of polycystic ovary syndrome.* University of Larbi Ben M'hidi, Algeria.
13. Mendola, P., Messer, L. C., & Rappazzo, K. (2008). Science linking environmental contaminant exposures with fertility and reproductive health impacts in the adult female. *Fertility and Sterility, 89*, e81–e94. https://doi.org/10.1016/j.fertnstert.2007.12.039
14. Nagata, C., Takatsuka, N., Inaba, S., Kawakami, N., & Shimizu, H. (1998). Association of diet and other lifestyle with onset of menopause in Japanese women. *Maturitas, 29*, 105–113. https://doi.org/10.1016/S0378-5122(98)00007-0
15. Odabasi, E., Turan, M., Aydin, A., Akay, C., & Kutlu, M. (2008). Magnesium, zinc, copper, manganese, and selenium levels in postmenopausal women with osteoporosis: Can magnesium play a key role in osteoporosis? *Annals of the Academy of Medicine Singapore, 37*, 564–567.
16. Omran, I. G., & Ajeel, S. H. (2016). Poise and some rare elements among postmenopausal women. *Babylon University Journal of Pure and Applied Sciences, 24*(1).
17. Riggs, B. L., Khosla, S., & Melton, J. L. (1998). A unitary model for involutional osteoporosis: Estrogen deficiency causes both type I and type II osteoporosis in postmenopausal women and contributes to bone loss in aging men. *Journal of Bone and Mineral Research, 13*, 763–773. https://doi.org/10.1359/jbmr.1998.13.5.763
18. Santoro, N., Roeca, C., Peters, B. A., & Neal-Perry, G. (2021). The menopause transition: Signs, symptoms, and management options. *Journal of Clinical Endocrinology & Metabolism.* https://doi.org/10.1210/clinem/dgaa113
19. Sokoll, L. J., & Dawson-Hughes, B. (1989). Effect of menopause and aging on serum total and ionized calcium and protein concentrations. *Calcified Tissue International, 44*, 181–185. https://doi.org/10.1007/BF02556322
20. Strause, L., Saltman, P., Smith, K. T., Bracker, M., & Andon, M. B. (1994). Spinal bone loss in postmenopausal women supplemented with calcium and trace minerals. *Journal of Nutrition, 124*, 1060–1064. https://doi.org/10.1093/jn/124.7.1060
21. Tomasz, M.-K., Kuć, A., Kubik-Machura, D., Kościelecka, K., & Radko, L. (2023). Interaction of metals, menopause and COVID-19—A review of the literature. *Biology, 12*, 350. https://doi.org/10.3390/biology12030350
22. Wood, R. J. (1994). Potassium bicarbonate supplementation and calcium metabolism in postmenopausal women. *Nutrition Reviews, 52*(1), 278–280. https://doi.org/10.1111/j.1753-4887.1994.tb01333.x