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Cancer Antigen 125 (CA-125) Levels Among The Female General Population Of Muzaffarabad City Of Azad Jammu And Kashmir State, Pakistan: A Retrospective Study

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Abstract

Background: CA-125 is a widely used biomarker for evaluating various conditions, including malignancies and chronic diseases. Unfortunately, there is a lack of published data on CA-125 levels in the state of Azad Jammu and Kashmir, Pakistan. This study aimed to assess CA-125 levels in women from Muzaffarabad, providing a foundation for future research in this region.
Methods: In this retrospective study, data of 103 women were collected from two labs. Their recorded CA-125 levels were categorized as either normal (0.0 to 35.0 IU/mL) or abnormal. Statistical analysis included least squares linear regression to assess the association between age and CA-125 levels, with additional temporal analysis from 2021 to 2024 and geographical distribution between Muzaffarabad, AJ&K and Hazara, KPK. The residuals were tested for normality using Anderson-Darling, D'Agostino-Pearson omnibus test, Shapiro-Wilk and Kolmogorov-Smirnov test.
Results: The mean CA-125 level among participants was 54.84 ± 10.01 IU/mL, with 32.04% exhibiting abnormal levels. The analysis showed a statistically significant positive association between age and CA 125 levels ($p = 0.0020$). The regression model indicated that for each additional year of age, CA 125 levels increased by an estimated 2.456 IU/mL. Temporal analysis revealed variable CA-125 levels across different years, with a notable increase in 2024. Geographical comparison showed higher CA-125 levels in Hazara, KPK, compared to Muzaffarabad, AJ&K.
Conclusion: The study's findings align with some literature suggesting a positive correlation between CA-125 levels and age, although the variability in CA-125 levels across age groups and locations highlights the need for further investigation. The significant association of CA-125 levels with age and geographical differences highlights the importance of considering these factors in future research.

Keywords: **CA-125; correlation of CA 125 with age; distribution of abnormal CA 125 in Azad Kashmir; temporal trends of CA 125; Prevalence of CA 125 positivity.**

1. Introduction

Cancer antigen 125 (CA 125) is a tumor marker primarily associated with epithelial ovarian tumors. It is also found in the cells lining various organs, including the endometrium, fallopian tubes, pleura, peritoneum, and pericardium [1, 2]. A specific epitope on the CA 125 molecule, which is present in the amnion, its derivatives from fetal coelomic epithelia, and various adult tissues is the target of the murine monoclonal antibody OC 125. The normal endometrium also produces CA 125, which causes the blood to contain increased level of this antigen during menstruation [3].

CA 125 is frequently used as a blood test to monitor patients with confirmed epithelial ovarian cancer as well as to assist in the diagnosis of suspected ovarian tumors [2, 4]. It plays a critical role in the preoperative assessment of patients who have an adnexal mass and are suspected to have ovarian cancer [5]. Unfortunately, the CA 125 test has limited effectiveness in identifying early-stage ovarian cancer due to its low sensitivity. This limitation is especially noticeable in premenopausal women, where its specificity is reduced while it became more reliable in postmenopausal women [6].

Serum or plasma tests are the conventional methods for determining CA 125 levels. Serum should be removed from the clot and kept at −30°C for long-term storage or at 4°C for short-term use to preserve the specimen [7]. Two assays are available for evaluating CA 125 levels: the first is a radioimmunoassay that uses the OC 125 monoclonal antibody to identify antigenic sites on the CA 125 glycoprotein, and the second-generation test increases accuracy by utilizing both the OC 125 and M 11 antibodies [8]. The potential of CA 125 in screening for early-stage ovarian cancer is currently under investigation. Recent studies suggest that serum CA 125 measurements could also serve as a prognostic marker in endometrial cancer and indicate disease progression in advanced endometriosis [9]. CA 125 levels can reflect tumor status. Typically, patients with CA 125 levels above 35 U/mL are likely to experience disease recurrence during second-look surgery. In contrast,

levels below 35 U/mL generally suggest minimal residual disease, as seen in approximately half of the cases [10].

In the largest ovarian cancer screening trial conducted in the general population, the UK Collaborative Trial of Ovarian Cancer Screening observed a stage shift when using annual multimodal screening, which involved the longitudinal CA125 Risk of Ovarian Cancer Algorithm. However, no such shift was noted with annual transvaginal ultrasound screening. Neither screening approach resulted in a clear reduction in mortality compared to no screening [11]. A study conducted by Bast et al. [10] found that elevated serum CA125 levels (>35 U/mL) were detected in 82% of patients with epithelial ovarian cancer, 28.5% of those with non-gynecological cancers, and 6% of patients with benign conditions like ovarian cysts [12].

In postmenopausal women without ovarian cancer, CA-125 levels are influenced by several factors, including racial and ethnic background, age, whether they have had a hysterectomy, smoking history, and obesity [13]. Postmenopausal women with elevated CA-125 levels, but without ovarian cancer, face a higher risk of early mortality [14].

Understanding the prevalence of abnormal CA-125 levels among women in Muzaffarabad, Azad Jammu and Kashmir, is challenging due to a lack of existing data. The region covers 13,297 km² and includes 10 districts and 33 tehsils, with a population of about 4.045 million, more than half of whom are female. The capital district, Muzaffarabad, spans 1,642 km² and has around 650,370 residents. The present study analysed the data of women who had their CA-125 levels checked at the Healthcare Diagnostic & Research Centre and New Medicare Laboratory in Muzaffarabad. This retrospective study aimed to assess CA-125 levels in women from Muzaffarabad, providing a foundation for future research in this region.

2.1. Methodology

2.1. Study Design

This is a retrospective study to understand the prevalence of abnormal CA-125 levels among women in Muzaffarabad, Azad Jammu and Kashmir, Pakistan. The present study was designed to review the data from two diagnostic centres to establish a baseline for future research and to increase awareness about CA-125 levels and health-related risk factors.

2.2. Selection criteria of participants

Data from 103 female patients was examined who had CA-125 tests at the Muzaffarabad's Healthcare Diagnostic & Research Centre and New Medicare Laboratory. In order to be included, participants had to be current residents of Muzaffarabad city and have access to their CA-125 test results. Women who were originally from adjacent villages in Azad Jammu and Kashmir or from the Hazara region in Pakistan's KPK province were included. The test results obtained between 2021 and 2024 were considered. Participants who had incomplete or missing CA-125 test results and were not current residents of Muzaffarabad city, its surrounding villages, or the Hazara region were excluded from the study. To avoid redundancy, duplicate entries were eliminated. Moreover, to ensure the study was only focused on female subjects, male participants or those with unclear sex were excluded. To maintain the accuracy and relevance of the data analysis, these exclusion criteria were applied.

2.3. Data Collection

Information was collected from female's medical records who had CA-125 levels tested between 2021 and 2024. The findings of the CA-125 test results were divided into normal (0.0 to 35.0 IU/mL) and abnormal (>35.0 IU/mL) categories. Moreover, demographic information, including age and geographical location, was also noted.

2.4. Data Analysis

The percentage of participants with normal and abnormal levels of CA-125 were calculated. These findings were summarized by using descriptive statistics. Participants were categorized into age groups (15-24, 25-34, 35-44, 45-54, and 55 and above). Trends were identified by analysing the prevalence of abnormal CA-125 levels in each age group. The levels of CA-125 were examined from 2021 to 2024. Mean levels and percentages of aberrant results for each year were computed for temporal trends detection. Data between participants from Muzaffarabad and Hazara regions were compared. To identify geographical variations, the mean CA-125 levels and the percentages of normal versus abnormal results were analysed.

2.5. Statistical Methods

To summarize the data descriptive statistics, including means, standard deviations, and percentages were used. Trends between age groups and years were evaluated to identify significant patterns. Comparisons between geographical regions were made to evaluate the variation in CA-125 levels. Data analysis was performed using GraphPad Prism Version 9.0. A least squares linear regression model was also used to investigate the relationship between age and CA 125 levels among the participants. To evaluate the significance of this relationship, an F-test was used. Moreover, several normality tests on the residuals were conducted, including the Anderson-Darling, D'Agostino-Pearson omnibus, Shapiro-Wilk, and Kolmogorov-Smirnov tests, to assess the distribution of residuals.

2.6. Ethical Considerations

As a retrospective study, it involved the review of existing medical records. All data were anonymized to ensure participant confidentiality.

3. RESULTS

3.1. Overall levels of CA 125 in the studied population

In our study, the total number of participants was 103, and all participants (100%) were female. The normal range for CA 125 levels is considered to be 0.0 to 35.0 IU/mL. The mean CA 125 level among the participants was found to be 54.84 ± 10.01 IU/mL. Out of the total 103 participants, 70 (67.96%) had CA 125 levels within the normal range, while 33 (32.04%) participants exhibited CA 125 levels outside this range.

Table 1. Overview of CA 125 Levels in the Studied Population

Total participants	CA 125 normal range	Mean CA 125 Level of the participants	Participants within normal range	Participants with abnormal range
103	0.0 to 35.0 IU/mL	54.84 ± 10.01	70	33

3.2. Trends in abnormal CA 125 levels across different age groups

Table 2 presents the distribution of participants with abnormal CA 125 levels across different age groups. In the 15-24 age group, 57.89% (11 out of 19) participants had abnormal CA 125 levels, with a mean age of 20.16 ± 0.7061 years and a standard deviation of 3.078. In the 25-34 age group, 22.22% (8 out of 36) participants had abnormal CA 125 levels, with a mean age of 29.36 ± 0.4750 years and a standard deviation of 2.850. For the 35-44 age group, 26.32% (5 out of 19) participants had abnormal CA 125 levels, with a mean age of 38.58 ± 0.6367 years and a standard deviation of 2.775. In the 45-54 age group, 25% (5 out of 20) participants exhibited abnormal CA 125 levels, with a mean age of 49.40 ± 0.6898 years and a standard deviation of 3.085. In the 55 and above age group, 44.44% (4 out of 9) participants had abnormal CA 125 levels, with a mean age of 59.44 ± 0.9296 years and a standard deviation of 2.789. Overall, the total participant group had a mean age of 35.88 ± 1.228 years and a standard deviation of 12.47, with 32.04% (33 participants) showing abnormal CA 125 levels.

The analysis of abnormal CA 125 levels across different age groups showed important trends. In the youngest age group (15-24 years), a significant 57.89% of participants were abnormal for CA 125 levels, suggesting a higher prevalence of elevated levels among younger women. This percentage decreases markedly in the 25-34 age group, where only 22.22% of participants had abnormal levels. A slight increase is observed in the 35-44 age group with 26.32% showing abnormal levels. The trend continues with 25% of participants in the 45-54 age group having elevated CA 125 levels. Surprisingly, in the oldest age group (55 and above), the prevalence of abnormal CA 125 levels rises again to 44.44%. These trends indicate that while younger and older women in the study tend to have higher rates of abnormal CA 125 levels, middle-aged women (25-54 years) show comparatively lower percentages, suggesting possible age-related physiological or pathological differences affecting CA 125 levels.

Table 2. Distribution of participants and trends of abnormal CA 125 levels across different age groups

Age Group	Total Participants	Mean Age ± Standard Error of Mean	Std. Deviation	Participants with Abnormal CA 125 Levels
15-24	19	20.16 ± 0.7061	3.078	11
25-34	36	29.36 ± 0.4750	2.850	8
35-44	19	38.58 ± 0.6367	2.775	5
45-54	20	49.40 ± 0.6898	3.085	5
55andAbove	9	59.44 ± 0.9296	2.789	4
Total	103	35.88 ± 1.228	12.47	33

A least squares linear regression analysis was also conducted to investigate the relationship between age and CA 125 levels among 103 participants. The analysis revealed a statistically significant positive association between age and CA 125 levels, with a p-value of 0.0020. The regression model indicated that for each additional year of age, CA 125 levels increased by an estimated 2.456 IU/mL, though the intercept was not statistically significant ($p = 0.2596$). The model accounted for approximately 9% of the variance in CA 125 levels ($R^2 = 0.09083$). Despite this, the residuals did not pass the normality tests, suggesting that the relationship may be more complex than captured by the model.

3.3. Temporal trends in CA 125 levels over 2021-2024

Table 3 presents the trends in CA 125 levels across the years 2021 to 2024. In 2021, a total of 67 participants were tested, with a mean CA 125 level of 49.36 ± 8.438 (standard deviation: 69.07). Of these, 46 participants (68.7%) had normal CA 125 levels, while 21 participants (31.3%) had abnormal levels. Unfortunately, the data for 2022 were not available with unknown reasons. In 2023, the sample size decreased to 8 participants, showing a mean CA 125 level of 45.92 ± 21.06 (standard deviation: 59.57). Among these, 6 participants (75%) had normal levels and 2 participants (25%) had abnormal levels. By 2024, the number of participants increased to 28, with a mean CA 125 level rising to 70.49 ± 30.50 (standard deviation: 161.4). This year, 18 participants (64.3%) had normal CA 125 levels and 10 participants (35.7%) had abnormal levels.

Table 3. CA 125 level trends across years (2021-2024)

Testing Year	Total participants	Mean CA-125 levels ± Standard Error of Mean	Standard deviation	Participants with normal CA-125 levels	Participants with abnormal CA-125 levels
2021	67	49.36 ± 8.438	69.07	46	21
2022	0	-	-	-	-
2023	8	45.92 ± 21.06	59.57	6	2
2024	28	70.49 ± 30.50	161.4	18	10

3.4. Geographical distribution of CA 125 levels among participants

Table 4 shows the geographical distribution of CA 125 levels among participants from Muzaffarabad, AJ&K, and Hazara, KPK. In Muzaffarabad, out of 88 participants, the mean CA 125 level was 45.67 ± 6.583, with a standard deviation of 61.75. Among these participants, 54 (61.4%) had normal CA 125 levels, while 34 (38.6%) had abnormal levels. In Hazara, 15 participants were tested, and they had a significantly higher mean CA 125 level of 108.6 ± 56.49, with a large standard deviation of 218.8, indicating greater variability. Of these participants, 11 (73.3%) had normal CA 125 levels, and 4 (26.7%) had abnormal levels. Geographically, participants from Hazara, KPK, exhibited much higher and more variable CA 125 levels compared to those from Muzaffarabad, AJ&K.

Table 4. Geographical distribution of CA 125 levels

Geographical areas	Total participants	Mean CA-125 levels ± Standard Error of Mean	Standard deviation	Participants with normal CA-125 levels	Participants with abnormal CA-125 levels
Muzaffarabad, AJ&K	88	45.67 ± 6.583	61.75	54	34
Hazara, KPK	15	108.6 ± 56.49	218.8	11	4

4. Discussion

The results of this study provide critical insights on the prevalence and patterns of CA-125 levels in women residing in Muzaffarabad and the Hazara region of KPK province, Pakistan. Through analysing data from a heterogenous cohort collected over multiple years, this research highlights significant differences in CA-125 levels between age groups and geographical areas. The higher amounts observed in certain age groups—especially in younger and older women that highlight the need for further research into the fundamental causes of these variations. The statistical analysis revealed a significant (p=0.0020) positive correlation between age and CA-125 levels. The regression model showed that CA-125 levels increased by an estimated 2.456 IU/mL for each additional year of age, although the intercept was not statistically significant (p=0.2596). Furthermore, the geographical variations in CA-125 levels suggest potential environmental or genetic influences that need further examination. These findings not only contribute to our understanding of CA-125 as a biomarker in this population but also lay the groundwork for future studies aimed at enhancing the early diagnosis and treatment of conditions linked to abnormal CA-125 levels in these areas.

Ulgu et al. [15] found that CA-125 testing was most commonly performed for women in the 18-64 age group and reported an overall positive rate of 13.31%. This is in line with our study, where we also focused exclusively on female participants and observed that 32.04% of the participants had CA-125 levels outside the normal range. However, our study reveals a higher mean CA-125 level of 54.84 ± 10.01 IU/mL compared to the positive rate reported by Ulgu et al. This suggests a broader range of CA-125 levels in our sample population. Ulgu et al.'s finding that females had a slightly lower positive rate (13.18%) compared to males (14.07%) contrasts with our results, where we observed a significantly higher percentage of abnormal CA-125 levels among younger and older age groups. Specifically, we found that 57.89% of participants in the 15-24 age group and 44.44% in the 55 and above age group had abnormal levels, indicating that our sample might be influenced by age-related factors affecting CA-125 levels differently from Ulgu et al.'s study.

While Cooper et al. [16] reported a median CA-125 value of 582 U/mL with a wide range of 7 to 52,930 U/mL. This median value is substantially higher than the mean CA-125 levels observed in our study (54.84 IU/mL). Additionally, Cooper et al. did not find a significant correlation between preoperative CA-125 levels and age ($P = 0.40$), which contrasts with our findings of a statistically significant positive association between age and CA-125 levels ($p = 0.0020$). This discrepancy might be attributed to differences in study design, participant demographics, or the specific conditions under which CA-125 levels were measured.

In our study, we observed a significant positive association between age and CA-125 levels, with CA-125 levels increasing by 2.456 IU/mL for each additional year of age ($p = 0.0020$). This result is in contrasts with Tang et al. [17], who revealed a negative correlation between age and CA-125 levels which showed that CA-125 levels tended to decrease as age increased.

Whereas, Pouraghaei et al. [18] studied a cohort with a mean age of 31.65 ± 12.9 years and found that the mean age was similar between the adenomyosis (AA) and non-AA groups, with no significant difference ($p = 0.59$). They also observed a gender-specific link where CA-125 levels were significantly lower ($p = 0.012$) in females with AA compared to those with non-AA (20.7 ± 26.7 U/mL vs. 34.23 ± 39 U/mL). This gender-specific result contrasts to our findings, where age was positively correlated with CA-125 levels without any significant gender-specific differences observed.

In the study conducted by Ashi et al. [19], a significant age-related correlation was observed in males where CA-125 levels were found to have an abnormal increase with age. In comparison our study found a statistically significant positive association between age and CA-125 levels, with a rise of 2.456 IU/mL for each year of age. These findings indicate that age is a significant factor in CA-125 levels, though they suggest distinct patterns based on the population and gender.

Serum CA-125 levels were significantly elevated in patients with coronary heart disease (CHD) compared to control subjects ($P < 0.001$), even after accounting for factors like age, gender, and lifestyle [20]. According to

the study, the odds ratio between individuals in the highest quartile of CA-125 levels and those in the lowest quartile was 2.10 (95% CI: 1.69-2.60) indicating a significantly higher risk of CHD ($P < 0.001$). Furthermore, people over 60 years of age (OR: 2.19, 95% CI: 1.75-2.73), as well as those who currently smoke, drink, and have hypertension had higher CA-125 levels and a greater risk of CHD. By comparing this with our research, which demonstrated a significant positive association between age and CA-125 levels, both investigations highlight the importance of CA-125 as an age-related biomarker. However, our study concentrated on the overall correlation between age and CA-125 levels in a broader population whereas Li et al. [20] focused on significance of CA-125 in predicting CHD risk among older individuals and its relationship with lifestyle factors. This comparison highlights the potential of CA-125 as a marker of disease risk and its age-related variation in different health contexts.

Conclusion

This study highlights the importance of CA-125 as a biomarker, revealing a significant positive correlation between CA-125 levels and age among women in Muzaffarabad and its surrounding areas. The observed variability in CA-125 levels across different age groups and geographical locations suggests that age and region may play crucial roles in influencing CA-125 levels. Furthermore, the temporal analysis highlighted a notable increase in CA-125 levels in 2024, emphasizing the need for ongoing monitoring and research. The findings provide a solid foundation for future studies on CA-125, particularly in understanding its association with age, regional differences, and potential implications in clinical practice. This study serves as a baseline for further research on CA-125 levels and related topics.

DECLARATIONS

Author contributions

The contributions of the authors are as follows: S.A.K. was responsible for conceptualization, methodology, statistical analysis, writing the original draft, and supervision. A.R. and M.Z.L. focused on formal analysis and validation. B.S. contributed through literature review, writing the original draft, and validation. T.A. played a key role in reviewing and editing the manuscript and ensuring validation. M.Z.A. and R.S. were involved in validation, resources, and also contributed to reviewing and editing the manuscript. H.A. and N.F. was involved in methodology and data collection. Z.A. managed software, data analysis, and took part in reviewing and editing the manuscript. M.T. assisted in reviewing and editing the manuscript, performed the literature review, and was involved in data collection. S.F. and J.A. contributed to reviewing and editing the manuscript. All authors have read and approved the final version of the manuscript.

Ethical approval

As a retrospective study, it involved the review of existing medical records. All data were anonymized to ensure participant confidentiality.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Date availability

The data is available and will be provided to the journal on suitable demand.

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References

1. Jacobs I, Bast RC. The CA 125 tumour-associated antigen: a review of the literature. Hum Reprod. 1989 Jan;4(1):1-12.

2. Scholler N, Urban N. CA125 in ovarian cancer. Biomark Med. 2007 Dec;1(4):513-23.
3. Bischof P. What do we know about the origin of CA 125? Eur J Obstet Gynecol Reprod Biol. 1993 Apr;49(1-2):93-8.
4. Zhang R, Siu MKY, Ngan HYS, Chan KKL. Molecular Biomarkers for the Early Detection of Ovarian Cancer. Int J Mol Sci. 2022 Oct 10;23(19)
5. Dodge JE, Covens AL, Lacchetti C, Elit LM, Le T, Devries-Aboud M, Fung-Kee-Fung M., Gynecology Cancer Disease Site Group. Preoperative identification of a suspicious adnexal mass: a systematic review and meta-analysis. Gynecol Oncol. 2012 Jul;126(1):157-66.
6. American College of Obstetricians and Gynecologists' Committee on Practice Bulletins—Gynecology. Practice Bulletin No. 174: Evaluation and Management of Adnexal Masses. Obstet Gynecol. 2016 Nov;128(5):e210-e226.
7. Sturgeon CM, Hoffman BR, Chan DW, Ch'ng SL, Hammond E, Hayes DF, Liotta LA, Petricoin EF, Schmitt M, Semmes OJ, Söletormos G, van der Merwe E, Diamandis EP., National Academy of Clinical Biochemistry. National Academy of Clinical Biochemistry Laboratory Medicine Practice Guidelines for use of tumor markers in clinical practice: quality requirements. Clin Chem. 2008 Aug;54(8):e1-e10.
8. Kenemans P, Yedema CA, Bon GG, von Mensdorff-Pouilly S. CA 125 in gynecological pathology--a review. Eur J Obstet Gynecol Reprod Biol. 1993 Apr;49(1-2):115-24.
9. Jacobs I, Bast RC Jr. The CA 125 tumour-associated antigen: a review of the literature. Hum Reprod. 1989 Jan;4(1):1-12.
10. Bast RC, Klug TL, St John E, Jenison E, Niloff JM, Lazarus H, Berkowitz RS, Leavitt T, Griffiths CT, Parker L, Zurawski VR, Knapp RC. A radioimmunoassay using a monoclonal antibody to monitor the course of epithelial ovarian cancer. N Engl J Med. 1983 Oct 13;309(15):883-7.
11. Menon U, Karpinskyj C, Gentry-Maharaj A. Ovarian Cancer Prevention and Screening. Obstet Gynecol. 2018 May;131(5):909-927.
12. Kenemans P, van Kamp GJ, Oehr P, Verstraeten RA. Heterologous double-determinant immunoradiometric assay CA 125 II: reliable second-generation immunoassay for determining CA 125 in serum. Clin Chem. 1993 Dec;39(12):2509-13.
13. Johnson CC, Kessel B, Riley TL, Ragard LR, Williams CR, Xu JL, Buys SS; Prostate, Lung, Colorectal and Ovarian Cancer Project Team. The epidemiology of CA-125 in women without evidence of ovarian cancer in the Prostate, Lung, Colorectal and Ovarian Cancer (PLCO) Screening Trial. Gynecol Oncol. 2008 Sep;110(3):383-9.
14. Terada KY, Elia J, Kim R, Carney M, Ahn HJ. Abnormal CA-125 levels in menopausal women without ovarian cancer. Gynecol Oncol. 2014 Oct;135(1):34-7.
15. Ulgu MM, Birinci S. Exploring the landscape of CA-125 testing: A comprehensive analysis of Ministry of Health data. North Clin Istanb. 2023 Aug 4;10(4):501-506. doi: 10.14744/nci.2023.59908. PMID: 37719262; PMCID: PMC10500244.
16. Cooper BC, Sood AK, Davis CS, Ritchie JM, Sorosky JI, Anderson B, Buller RE. Preoperative CA 125 levels: an independent prognostic factor for epithelial ovarian cancer. Obstet Gynecol. 2002 Jul;100(1):59-64.
17. Tang Y, Wen MB, Xiang RM, Yang MT, Shu B, Xu F, Li J, Hu HQ, Shi Q. Serum CA125 as a biomarker for dysmenorrhea in adenomyosis. Int J Gynaecol Obstet. 2023 Oct;163(1):131-139.
18. Pouraghaei M, Shahsavarinia K, Kakaei F, Gholipour-Khalili S, Mohammadpour B, Moharamzadeh P, Balafar M. Value of CA-125 Glycoprotein in Predicting Acute Appendicitis; a Diagnostic Accuracy Study. Arch Acad Emerg Med. 2019 Apr 6;7(1):e24.
19. Ashi A, Al-Hajeili M, Almaghrabi S, Al-Maghrabi J, Trabulsi N, Alghuraibi S, Alsiary R, Alrayes N. Prevalence of CEA, CA 125, and CA 15-3 serum tumour markers in different regions of Saudi Arabia. Saudi Med J. 2024 Jun;45(6):565-571.
20. Li X, He M, Zhu J, Yao P, Li X, Yuan J, Min X, Lang M, Yang H, Hu FB, Wu T, Wei S. Higher carbohydrate antigen 125 levels are associated with increased risk of coronary heart disease in elderly chinese: a population-based case-control study. PLoS One. 2013 Nov 26;8(11):e81328.