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Research Article

Serum Protein Evaluation and Electrophoretic Patterns of Post-Menopausal Women in Ekpoma, Edo State

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Abstract

Menopause is the permanent cessation of menstruation resulting from loss of ovarian follicular function, leading to reduced production of estradiol and other ovarian hormones. This hormonal decline, particularly in estrogen, is known to influence several metabolic and biochemical processes. This study aimed to evaluate serum total protein, albumin, calculated globulin, and the electrophoretic patterns of serum proteins in post-menopausal women in Ekpoma, Edo State, Nigeria. A total of 120 women were recruited, comprising 70 post-menopausal women (test group) and 50 pre-menopausal women (control group). Venous blood was collected into plain tubes, allowed to clot, and centrifuged to obtain serum for analysis. Serum total protein and albumin were determined using standard colorimetric methods (biuret and bromocresol green methods, respectively). Serum globulin was derived by subtracting albumin from total protein, and serum protein electrophoresis was performed using cellulose acetate paper. Post-menopausal women showed significantly higher ($p < 0.05$) serum total protein, albumin, and globulin concentrations compared with pre-menopausal controls. The mean total serum protein increased from 7.64 ± 0.83 g/dL in pre-menopausal women to 8.34 ± 1.15 g/dL in post-menopausal women. Similarly, serum albumin increased from 4.52 ± 0.54 g/dL in controls to 4.85 ± 0.97 g/dL in the post-menopausal group. Calculated globulin was also higher in post-menopausal women (3.46 ± 1.37 g/dL) than in pre-menopausal women (3.12 ± 1.37 g/dL). The albumin-to-globulin ratio, however, was lower in post-menopausal women (1.77 ± 1.28) compared with controls (1.95 ± 1.28), indicating a relative increase in globulin fractions. Electrophoretic analysis further revealed alterations in specific protein fractions among post-menopausal women: albumin band variation was observed in 33 (46.57%) subjects, α_1 and α_2 globulin differences in 10 (14.28%), β_1/β_2 globulin variation in 19 (27%), and γ-globulin variation in 43 (67%) of post-menopausal subjects compared with controls. These findings suggest that menopause is associated with measurable changes in serum protein concentrations and electrophoretic patterns, possibly reflecting hormonal withdrawal, low-grade inflammation, or altered protein synthesis in post-menopausal women. Routine evaluation of serum proteins in this population may therefore provide useful supportive information in monitoring health status after menopause.

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1. Introduction

Menopause is the permanent cessation of the female reproductive cycle and is characterized by a marked decline in ovarian follicular function, leading to a reduction of estrogen and other ovarian hormones [1, 2]. It typically occurs between 45 and 55 years of age and is often accompanied by vasomotor symptoms such as hot flashes and night sweats, as well as a range of psychological and physiological changes. Because estrogen has wide systemic effects, its decline during menopause can influence several organ systems, including the liver. The liver performs essential metabolic, synthetic, and detoxification functions, and liver function tests (LFTs) remain useful tools for detecting subclinical hepatic impairment [3]. Menopause is a unique, individualized transition that marks the end of a woman's reproductive years. The fall in ovarian estrogen production has been associated with changes in energy balance, bone metabolism, cardiovascular function, cognition, and urogenital health [4]. Lifestyle factors such as adequate nutrition, weight management, and regular physical activity can help mitigate some of these changes and promote healthy aging through and beyond the menopausal period.

Serum proteins, particularly albumin and globulins, are important indicators of nutritional status, liver synthetic capacity, and systemic inflammation. Total serum protein reflects the combined concentrations of albumin and globulin [5]. Albumin, which is synthesized exclusively by the liver, plays key roles in maintaining plasma oncotic pressure and transporting endogenous and exogenous substances. Plasma globulins comprise a broad group of proteins with diverse functions, including transport, enzyme inhibition, coagulation, and immune defense [6]. Because many of these proteins are synthesized or regulated by the liver, alterations in liver function, hormonal status, or inflammatory state as may occur in menopause can be reflected in serum protein levels.

Serum protein electrophoresis (SPEP) is a simple and informative screening method for separating serum proteins into major fractions albumin, α_1-globulin, α_2-globulin, β-globulin, and γ-globulin based on their electrophoretic mobility [7]. Each of these regions may contain multiple proteins under separate metabolic control [8]. Electrophoretic analysis is therefore useful not only in detecting paraproteinemias such as multiple myeloma [9, 10], but also in identifying more subtle shifts in protein fractions that occur in response to inflammation, tissue injury, malignancy, or hormonal changes [11]. Because menopause is associated with endocrine changes that may affect protein synthesis, turnover, and body composition, evaluating electrophoretic patterns in post-menopausal women may provide insight into subclinical metabolic or inflammatory alterations.

Aging itself is accompanied by changes in protein metabolism, although reports are not entirely consistent: some studies describe reduced protein turnover with age, while others report increased requirements to maintain nitrogen balance [12]. Loss of metabolically active tissue, especially muscle, lowers basal energy expenditure and may influence circulating protein levels. Elevated serum protein concentrations may result from hemoconcentration (dehydration) or from increased production of specific proteins. Since hormonal withdrawal in menopause can interact with age-related metabolic changes, it becomes relevant to characterize serum protein profiles in this population.

In view of these considerations, the present study was designed to assess total serum protein, albumin, calculated globulin, and serum protein electrophoretic patterns in pre-menopausal and post-menopausal women residing in Ekpoma. The overarching goal was to determine whether menopause is associated with measurable shifts in serum protein concentrations and their electrophoretic distribution, which could have clinical or physiological significance in women after the reproductive years.

2. Materials and Methods

2.1. Research Design

Participants for this cross-sectional study were recruited from women residing in Ekpoma, Edo State, Nigeria. The study compared post-menopausal women with age-matched pre-menopausal (control) women to evaluate the effect of menopausal status on serum protein levels and electrophoretic patterns. Specifically, the study assessed total serum protein, serum albumin, calculated globulin, and serum protein fractions obtained by cellulose acetate electrophoresis. Data collection was carried out during the study period, and all participants were screened to ensure they were apparently healthy.

2.2. Study Population

The study population comprised one hundred and twenty (120) women residing in Ekpoma, Edo State, Nigeria, recruited into two groups: seventy (70) age-matched post-menopausal women and fifty (50) apparently healthy pre-menopausal women who served as the control group. Participants were drawn from the same community to ensure comparability. Informed consent was obtained from all participants prior to sample collection, and ethical approval was obtained from the Ambrose Alli University Ethics Review Committee. Each subject was informed about the purpose of the study, and only those who voluntarily consented were enrolled. Only women aged 45 years and above who were post-menopausal, non-pregnant, and without sickle cell anaemia were included in the post-menopausal group. Women younger than 45 years (i.e. pre-menopausal), those with a history of haematological co-morbidities, sickle cell anaemia, or pregnancy were excluded from the study. These criteria were applied to ensure that the observed biochemical changes reflected menopausal status rather than underlying disease conditions.

2.3. Sample Collection

Blood samples were obtained by venipuncture from the antecubital vein and dispensed into properly labeled plain (non–anticoagulated) tubes. The samples were allowed to clot at room temperature for about 1 hour, after which they were centrifuged at 3,000 rpm for 10 minutes to separate the serum. The clear serum was then transferred into clean, dry, correspondingly labeled tubes and stored at -20°C until analysis.

2.4. Biochemical Assays

Serum total protein was determined by the biuret colorimetric method as described by [13]. In this method, peptide bonds of proteins in an alkaline medium react with cupric ions to form a violet-coloured complex, and the absorbance was measured at 546 nm; the absorbance

obtained was compared with that of a protein standard to derive the total protein concentration. Serum albumin was measured using the bromocresol green (BCG) dye-binding method of [14], in which albumin forms a colour complex with BCG that absorbs maximally at 578 nm, and the absorbance was compared with an albumin standard to determine the albumin concentration. Serum globulin was obtained indirectly by subtracting the serum albumin value from the total serum protein value, and the albumin–globulin (A/G) ratio was calculated accordingly.

Serum protein electrophoresis was performed on cellulose acetate paper. Proteins were separated into albumin, α_1-, α_1-, β-, and γ-globulin fractions under an electric field, stained with an appropriate protein dye, and the band intensities were evaluated to assess relative protein distribution.

2.5. Statistical Analysis

The mean and standard deviation (SD) of all measured parameters were calculated. Differences between post-menopausal and pre-menopausal women were assessed using Student's t-test in SPSS software (version 21; IBM Corp.). A p-value of less than 0.05 was considered statistically significant.

3. Results

Table 1 presents the concentrations of total serum protein (TSP), serum albumin (SA), and total serum globulin (TSG) in post-menopausal women compared with apparently healthy pre-menopausal women. TSP, SA, and TSG were all significantly higher in the post-menopausal group ($p < 0.05$). The mean TSP concentration increased from 7.64 ± 0.83 g/dL in pre-menopausal women to 8.34 ± 1.15 g/dL in post-menopausal women. Similarly, serum albumin rose from 4.52 ± 0.54 g/dL in the control group to 4.85 ± 0.97 g/dL in the post-menopausal group ($p < 0.05$). Total serum globulin also showed a significant increase, from 3.12 ± 0.81 g/dL in pre-menopausal women to 3.46 ± 1.37 g/dL in post-menopausal women ($p < 0.05$). In contrast, the albumin-to-globulin (A/G) ratio was lower in post-menopausal women (1.77 ± 1.28) than in pre-menopausal women (1.95 ± 2.13), although this difference was not statistically significant ($p > 0.05$).

Table 1: Total serum protein, albumin, globulin and albumin/globulin ratio of premenopausal women (control) and post-menopausal women (test)

Parameters	Control (50)	Test (70)	t-value	p-value
Total Serum Protein	7.64±0.83	8.34±1.15	13.395	0.000(s)
Serum Albumin	4.52±0.54	4.85±0.97	4.765	0.031(s)
Serum Globulin	3.12±0.81	3.46±1.37	2.585	0.011(s)
Albumin: Globulin	1.95±2.13	1.77±1.28	0.278	0.599(ns)

Key: s-Significant (p-value < 0.05), ns-Non-significant (p-value > 0.05)

Figure 1 presents the serum protein electrophoretogram on cellulose acetate. In this figure, the albumin fraction was elevated in one post-menopausal sample but was reduced in two other test samples when compared with the pre-menopausal control pattern. The α_1- and α_2-globulin fractions remained essentially unchanged relative to the control. The β_1- and β_2-globulin fractions were increased in two test samples, and no reduction was observed in this region. The γ-globulin fraction showed the greatest variability, with increases observed in three test samples, while one sample showed a decrease compared with the control.

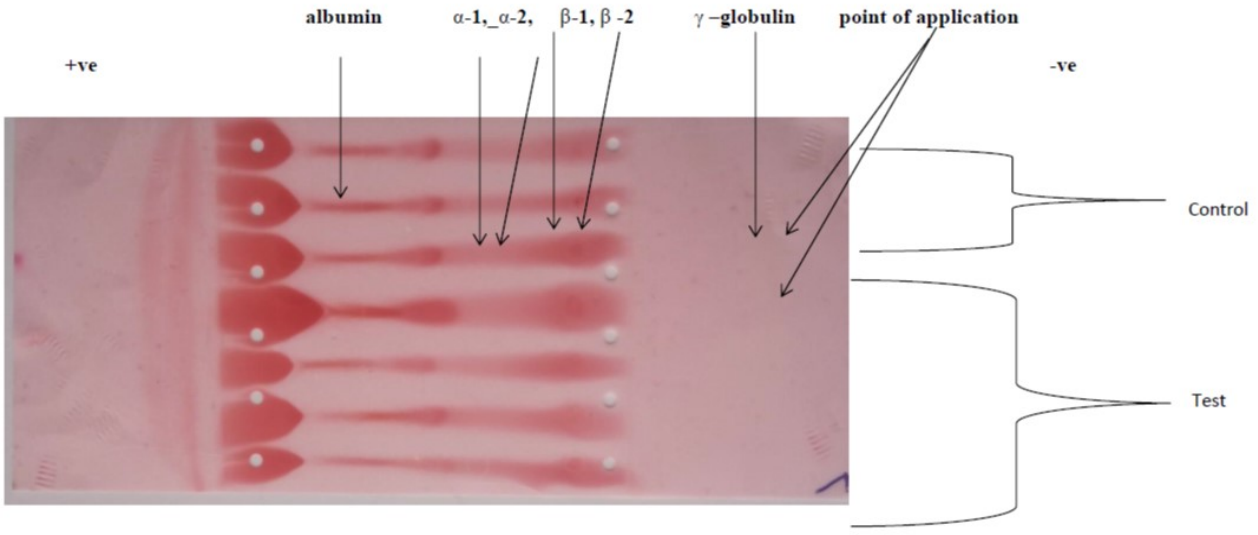

Figure 1: Showing electrophoretic patterns of Control (pre-menopausal women) and test (post-menopausal women.) **Key:** Normal controls are the first two on the strip, different types of Electrophoretic patterns as indicated by the arrows.

Figure 2 shows another electrophoretic profile in which albumin was increased in one test sample and decreased in another relative to the control. The α_1- and α_2-globulin fractions were increased in one test sample, with no corresponding decreases. The β_1- and β_2-globulin

fractions showed bidirectional changes, with one sample each exhibiting an increase and a decrease when compared with the control. The γ-globulin fraction was increased in three test samples, whereas one sample showed a decrease.

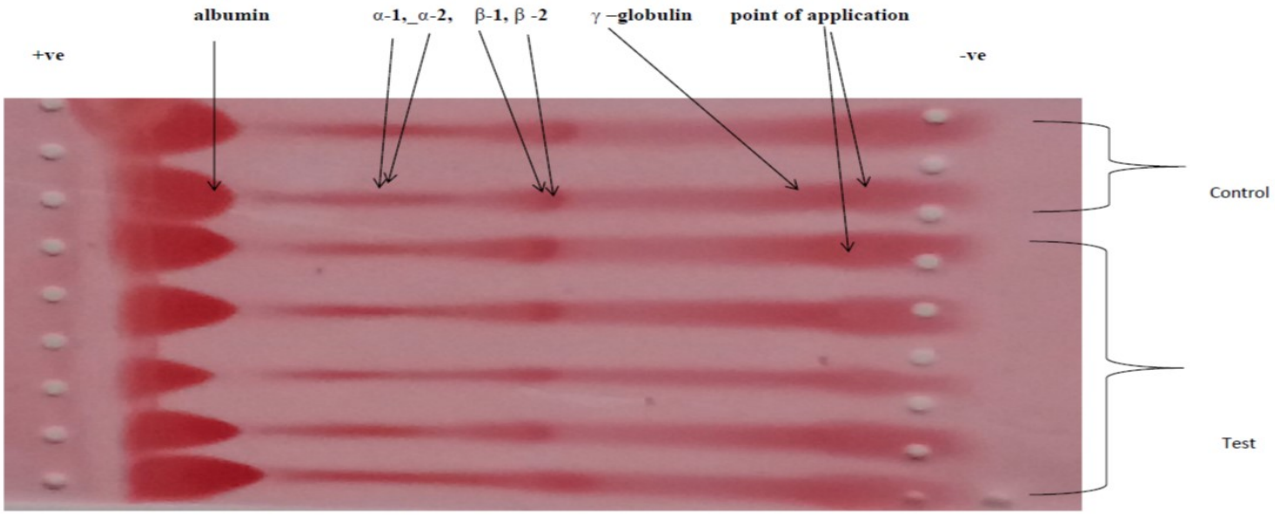

Figure 2: Showing electrophoretic patterns of Control (pre-menopausal women) and test (post-menopausal women). **Key:** Normal controls are the first two on the strip, different types of Electrophoretic patterns as indicated by the arrows.

Figure 3 demonstrates a profile in which albumin was increased in two test samples, with no decrease observed relative to the control. The α_1-, α_2-, β_1-, and β_2-globulin fractions all appeared within normal limits when compared with the control pattern. The γ-globulin fraction, however, was increased in two test samples, with no sample showing a decrease.

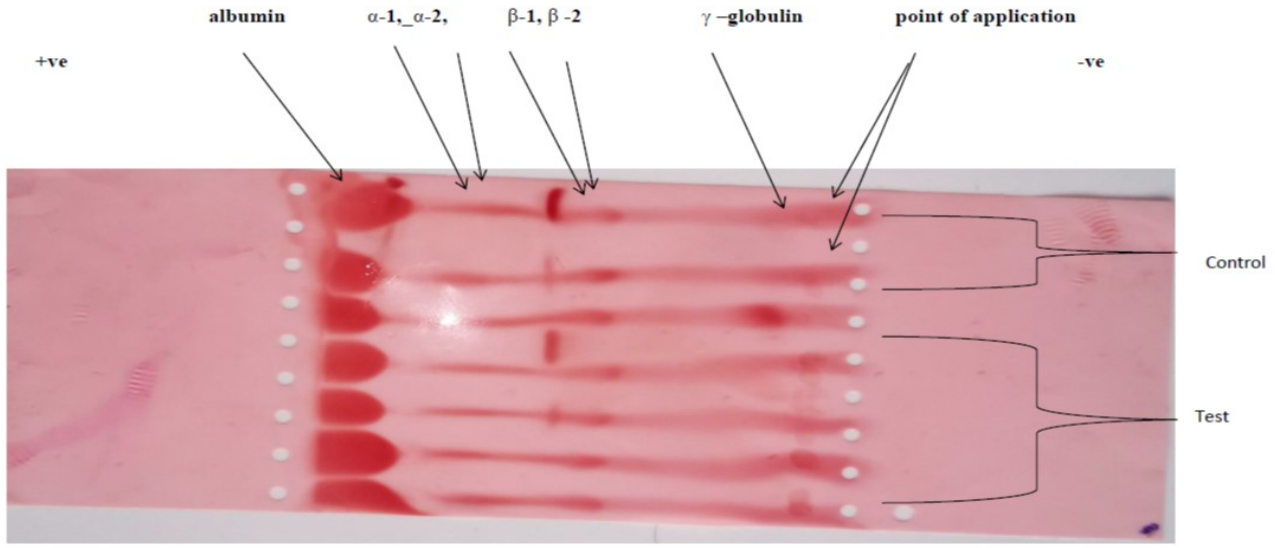

Figure 3: Showing electrophoretic patterns of Control (pre-menopausal women) and test (post-menopausal women). **Key:** Normal controls are the first two on the strip, different types of Electrophoretic patterns as indicated by the arrows.

4. Discussion

Serum proteins are valuable biomarkers in clinical practice because alterations in their concentration or distribution can reflect underlying disease states, nutritional status, hepatic synthetic function, immune activation, or protein-losing conditions. Since the advent of serum protein electrophoresis (SPEP), diagnostic accuracy for a wide range of disorders, particularly dysproteinemias and chronic inflammatory conditions, has improved substantially, owing to the ability of electrophoresis to separate serum proteins into distinct fractions and to detect even subtle shifts in these bands [8]. In this study, electrophoresis proved useful for characterizing protein alterations associated with the post-menopausal state.

In the present work, total serum protein was significantly higher ($p < 0.05$) in post-menopausal women compared with pre-menopausal controls. This agrees with the findings of [15], who also reported increased total protein in recently menopausal women and attributed the rise to age- and menopause-related physiological adjustments. However, Delmas [6] reported lower total protein in post-menopausal women, suggesting that population differences, nutritional status, or the timing of sampling relative to menopause may influence protein levels. Our

finding, therefore, supports the view that menopause can be accompanied by biochemical remodeling and that these changes may not be uniform across populations.

Serum albumin was likewise significantly increased ($p < 0.05$) in post-menopausal women compared with the pre-menopausal group. This parallels the observation of [15], who linked higher albumin to menopausal transition and aging. Albumin is a negative acute-phase protein and a marker of hepatic synthetic capacity; a rise in albumin in an ostensibly healthy post-menopausal population may reflect adequate nutrition and intact liver function. By contrast, Delmas [6] reported a decrease in albumin after menopause, highlighting that hormonal withdrawal, diet, comorbidities, or sample size can produce divergent patterns. These discrepancies underscore the need for locally derived reference ranges for post-menopausal women.

A significant elevation in calculated globulin ($p < 0.05$) was also observed in the post-menopausal group. This is consistent with [15], who suggested that increased globulin may be related to immune activation or subclinical inflammatory processes that become more prevalent with aging and estrogen decline. Globulin fractions particularly α- and γ-globulins often rise in response to infection, tissue injury, or autoimmune activity. In older or post-menopausal women, waning immune regulation may predispose to low-grade, chronic inflammatory states, which can manifest as modest increases in these protein fractions.

The albumin-to-globulin (A/G) ratio was lower in post-menopausal women than in controls, although this difference was not statistically significant ($p > 0.05$). A falling A/G ratio typically reflects a relatively greater increase in globulins than in albumin and may point toward chronic inflammation, immune stimulation, or increased production of specific immunoglobulin classes. Our result differs from that of [15], who reported an increased A/G ratio; again, this suggests that menopausal effects on proteins may be modulated by environment, infection burden, or ethnicity.

Electrophoretic profiling provided further insight into these changes. Variation in the albumin band was observed in 33 (46.57%) of the test samples; 19 (25.71%) showed increased albumin and 14 (20%) showed decreased albumin, while 37 (53.43%) remained comparable to controls. Mild albumin elevation in some subjects could be due to hemoconcentration (e.g. transient dehydration at the time of sampling), whereas slight reductions may reflect minor hepatic, nutritional, or inflammatory influences, even in individuals who appear clinically healthy.

Alterations were less frequent in the α_1- and α_2-globulin regions: only 10 (14.28%) of test samples showed variation, with 5 (7.14%) increased and 5 (7.14%) decreased. Increased α-fractions can be seen in acute-phase responses or in conditions associated with tissue injury or stress; reductions, on the other hand, may occur in malnutrition, protein-losing states, or significant liver disease [16]. The fact that 60 (85.72%) of samples were normal in this zone suggests that, for most post-menopausal women in this cohort, acute-phase activation was not prominent.

More noticeable changes occurred in the β_1/β_2 region, where 19 (27%) of test samples differed from controls. Fourteen (20%) showed increased β-globulins, which can be associated with hyperlipidemia, iron deficiency, or nephrotic conditions, while 5 (7%) showed decreases, which may indicate protein malnutrition or impaired synthesis. Nonetheless, the majority 51 (73%) remained within normal limits, indicating that these changes were present only in a subset of the post-menopausal population.

The γ-globulin fraction showed the greatest variability: 47 (67%) of test samples differed from controls, with 37 (53%) showing increased γ-globulins. Elevation of γ-globulin typically reflects polyclonal immunoglobulin production in response to chronic infections, autoimmune conditions, or other sustained antigenic stimulation [11]. Although our subjects were apparently healthy, subclinical or past infections, environmental antigen exposure, or age-related immune shifts may account for these changes. The 10 (14%) samples with decreased γ-globulins could represent individuals with relatively lower immunoglobulin production or subclinical hypogammaglobulinemia. The remaining 23 (33%) had electrophoretic patterns comparable to controls.

Taken together, these findings indicate that menopause is associated with modest but detectable alterations in serum protein concentrations and electrophoretic distribution. The pattern, higher total protein, albumin, and globulin, with variable γ-fraction, suggests an interplay of aging, nutritional status, hormonal withdrawal, and low-grade immune activation. Because some of the observed shifts mimic those seen in chronic inflammatory conditions, future studies with larger samples, inflammatory markers (e.g. CRP, ESR), and hormone profiling would be useful to distinguish menopause-related physiological changes from early pathological processes.

5. Conclusion

In conclusion, this study shows that serum total protein, albumin, and globulin are significantly higher in post-menopausal women than in pre-menopausal controls, indicating that aging and the menopausal transition are accompanied by measurable changes in serum protein profiles. The albumin–globulin ratio, however, did not differ significantly, suggesting a relatively parallel rise in both protein fractions. Electrophoretic analysis further revealed that post-menopausal women exhibit altered serum protein patterns, with the greatest variation occurring in the globulin fractions. These findings suggest that menopause is associated with subtle inflammatory or metabolic adjustments that are reflected in serum proteins. Nonetheless, maintaining an adequate, protein-rich, and balanced diet after menopause remains important to support optimal hepatic protein synthesis, sustain immune competence, and reduce susceptibility to infection and age-related illnesses.

Article Information

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Ethical Permission: Ethical approval was obtained from the University Ethics Committee and also informed consent was sought from the subjects before collection of blood samples.

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Disclaimer (Artificial Intelligence): The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

Competing Interests: Authors have declared that no competing interests exist.

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