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EVALUATION OF THE INFLUENCE OF PHYTOSTEROLS ON CLIMACTERIC. FEMALE HORMONE REGULATION: AN INTEGRATIVE REVIEW

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ABSTRACT

Introduction: Female hormone regulation is closely linked to food intake, and this fact has been the subject of recent investigation. Studies on energy restriction in women show a decrease in leptin, insulin, testosterone, and thyroid hormones, in addition to an increase in ghrelin and cortisol. Phytosterols (phytoestrogens) have the ability to alleviate postmenopausal symptoms. Carbohydrates, proteins, and fats, in addition to their basic functions, also have endocrine effects on different hypothalamic axes, modulating insulin, leptin, gastrointestinal hormones, sex hormones, among others. Objectives: To prove the influence of diet on female hormone regulation as a whole and the effects of phytosterols on postmenopausal symptoms. Methodology: This is a literature review using the descriptors "dietary management", "hormonal regulation", "macronutrients", "phytosterols" and "menopause" in newspapers, books, articles and magazines published in the last ten years. As inclusion criteria, studies published within the mentioned time period and revisional articles will be considered; As exclusion criteria, duplicate studies or those that do not fit the most recent literature will be disregarded. The databases used will be Lilacs, Scielo, PubMed and Efdeportes.

Keywords: Food intake, Hormone regulation, Macronutrients, Phytosterols, Menopause.

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Revista ARACÊ
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INTRODUCTION

Hormonal regulation plays a key role in the functioning of the body, influencing not only reproductive aspects, but also metabolism, mood, and overall health. Among the various factors that can impact hormonal balance, diet plays a significant role, since the nutrients provided by food are essential for the synthesis and regulation of hormones (Ternus, D.L. et al., 2019).

In this context, understanding the relationship between female hormone regulation and diet becomes crucial to promote the health and well-being of women at different stages of life. From puberty to menopause, hormonal fluctuations can directly affect physical and emotional health, and proper nutrition can be a powerful tool for mitigating these effects and promoting a healthy hormonal balance (Yulia; Khusun; Fahmida, 2016).

Menopause is a transitional period in a woman's life, marked by the interruption of menstruation and the decrease in hormone production by the ovaries. This natural process can be associated with a series of uncomfortable symptoms, such as hot flashes, mood swings, insomnia, vaginal dryness, among others, which significantly impact quality of life (Sousa; Lima, 2019).

In this scenario, phytosterols have aroused growing interest due to their potential to alleviate menopausal symptoms. Phytosterols are plant-based compounds that are structurally similar to human sterols, such as estrogen. They are present in a variety of foods, such as whole grains, fruits, vegetables, nuts, and seeds, and have been studied for their potential health benefits, including modulating menopausal symptoms (Melo, 2023).

There is a complex interaction between female hormone regulation and diet, relating how different nutrients and dietary patterns can influence the production, activity, and metabolism of female hormones. In addition, to assess the specific impacts of diet on reproductive health, pregnancy, menopause, and common hormonal conditions such as polycystic ovary syndrome (PCOS) and thyroid disorders. (Sousa; Lima, 2019).

Through a comprehensive review of the scientific literature, this work aims to provide valuable insights on how diet can be used as a therapeutic and preventive tool to optimize female hormonal health, as well as the mechanism of action of phytosterols incorporated into the diet as a complementary strategy to deal with menopausal symptoms. Understanding the therapeutic potential of these natural compounds may offer women additional options for managing this transitional phase in their lives, thereby promoting a better quality of life and overall well-being. By better understanding the underlying

Revista ARACÊ
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mechanisms and specific dietary recommendations, women can make informed decisions about their diet and lifestyle to achieve optimal hormonal balance and full health throughout life.

METHODOLOGY

RESEARCH DESIGN

A systematic review was carried out, elaborated with a careful selection of scientific articles. The research aimed to analyze the influence of diet on female hormone regulation, more precisely, the role of phytosterols in alleviating menopausal symptoms.

CONSTRUCTION AND DELIMITATION OF THE STUDY

The study used the PIOT strategy, an acronym that observed the P: population analyzed, being adult women aged between 30 and 59 years; I: intervention or exposure, such as menopause; O: outcomes/outcome, verifying the role of food in hormonal regulation; and T: type of study, with randomized clinical trials and cross-sectional studies carried out in humans. These elements were fundamental for the answer to the following central question: "Is diet crucial in female hormonal regulation and are phytosterols capable of alleviating the symptoms of menopause?".

SEARCH STRATEGY

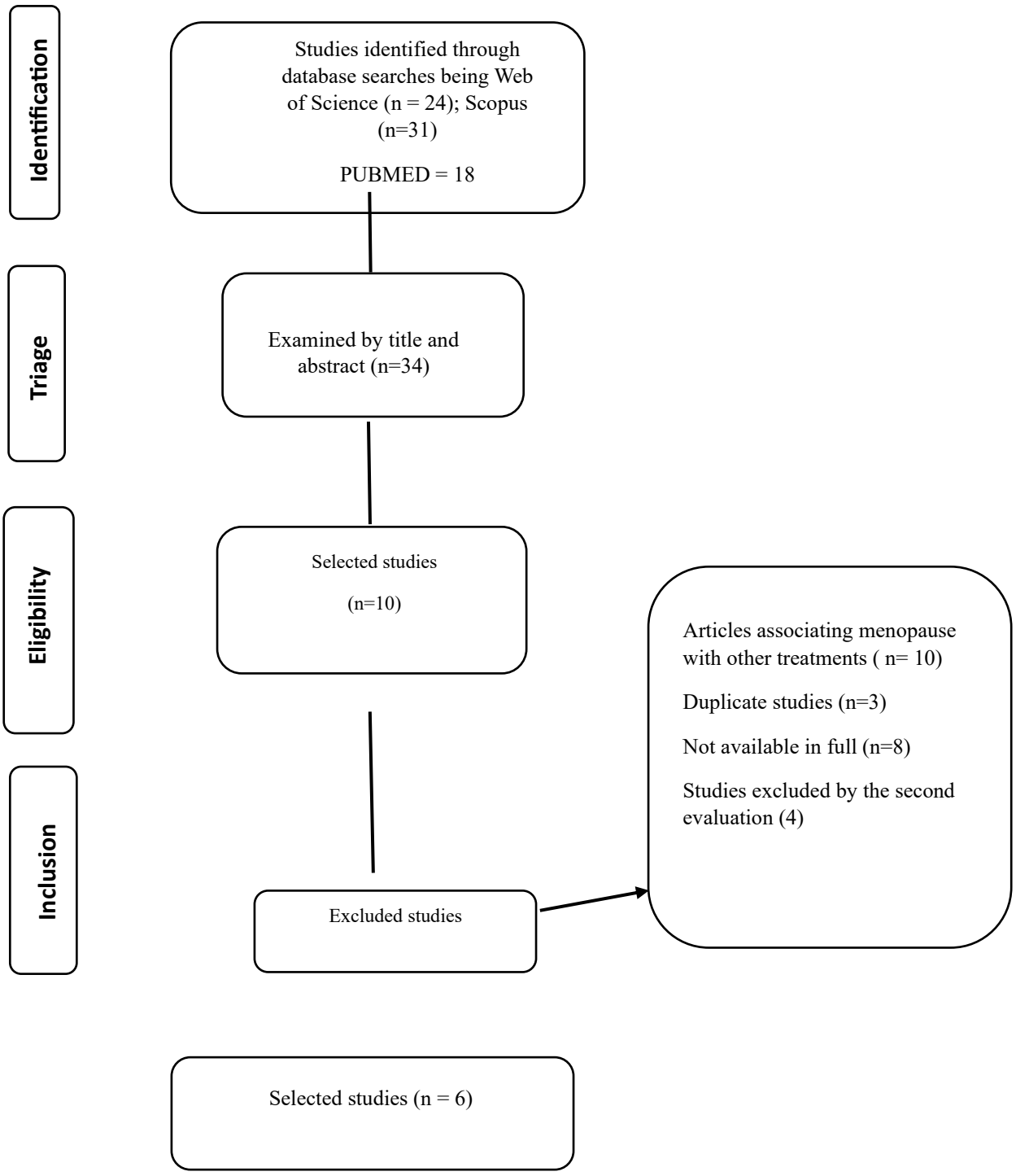
The search was carried out using the descriptors "hormonal regulation"; "phytosterols"; " menopause" that were submitted to *the Web of Science, Pubmed, and Scopus databases*. The Boolean operator "AND" was used to establish the relationship between the descriptors. On the Scopus platform, 31 articles were found, of which 6 reach the theme according to the eligibility criteria. In the Web of Science, 26 articles were identified, of which 4 meet all the eligibility criteria.

ELIGIBILITY CRITERIA

The inclusion criteria established were articles published from 2015 to 2024; in Portuguese, English or Spanish; with females and aged 35 to 59 years. As exclusion criteria, repeated articles that do not represent the theme of female hormone regulation through diet and review articles.

Revista ARACÊ
ISSN: 2358-2472

Flow chart 1. Characterization of the stages of data collection.



Source: Survey data (2024)

RESULTS

For data analysis and interpretation, an information table was prepared with the following categories: title, author, year of publication, type of study, objective and results.

Revista ARACÊ
ISSN: 2358-2472

Chart 1 - Presentation of scientific articles involved in the narrative review

TITLE	AUTHOR/YEAR	DESIGN OF STUDY	OBJECTIVES	RESULT
The effects of phytosterols on the climacteric: a narrative review.	Melo, *et al.,* 2023	Narrative Review	To evaluate the relationship between the effects of phytosterol and the symptomatological aspects of climacteric.	Positive responses were observed in relation to libido and psychological aspects, reverberating in the quality of life, from the consumption of soy and derivatives, and the use of some medicinal plants that are sources of phytoestrogens.
Phytoestrogens in the climacteric: Proposal of a menu rich in phytoestrogens for climacteric women	Machado, 2021.	Randomized controlled trial	Develop a food menu based on foods that are sources of phytoestrogens	In the present study, a food menu was elaborated for 5 days/week, based on the traditional Brazilian diet, in which foods that are sources of phytoestrogens (isoflavones, ecoumestane lignans) were included. In the end, there was a significant reduction in vasomotor symptoms, insomnia, vertigo, and paresthesias
Phytosterols: From preclinical evidence to potential clinical applications	Salehi, 2021.	Systematic review	To provide in-depth data on the therapeutic potential of phytosterols for human health, also emphasizing their preclinical effects and bioavailability-related issues.	It was concluded that the bioavailability of phytosterol is a limiting aspect that can be affected by multiple factors, such as the type, source, processing, preparation, method of administration, food matrix, dose, time of administration in the body and genetic factors, and there is an intercorrelation between low absorption rates and its chemical structure.
Soy isoflavones as an alternative treatment for menopausal/climacteric symptoms: a literature review	Gibowski, 2023.	Literature review	To evaluate the efficacy and benefits of soy isoflavone on menopausal and climacteric symptoms	Isoflavones have many benefits in the menopausal and climacteric phase, due to the similarity of their chemical structure with the hormone estrogen, reducing the rate of hot flashes, night sweats and helping to prevent the loss of bone mineral density, providing

Revista ARACÊ
ISSN: 2358-2472

				improvement in quality of life
Menopause, a nutritional approach to minimize signs and symptoms	Veloso, 2022.	Descriptive bibliographic research	Develop an educational newsletter focused on nutritional guidance, with the objective of improving the quality of life for women in the menopause phase.	Individual nutritional strategies that can be guided by a nutritionist, such as intake of isoflavones from soy, flaxseed, blackberry, rosea stretcher, fennel, red clover, maca, evening primrose oil, fearful cimicifuge and female ginseng, have been shown to be effective in addition to supplementation of dietary calcium and vitamin D, which are essential to reduce increased risks of osteoporosis and prevent overweight and obesity, in addition to association with Chronic Non-Communicable Diseases (NCDs) and with a focus on minimizing symptoms, promoting well-being and quality of life for women.
Nutrition in the climacteric: what are the benefits?	Santos, 2023.	Integrative review	Describe the possible nutrition-related benefits during the climacteric	Nutritional intervention in the climacteric resulted in significant benefits, including weight loss, reduction of menopausal symptoms, improved cardiovascular health, decreased BMI, and relief of depression-related symptoms. These results highlight the importance of nutrition as an effective approach to improving women's quality of life in this transition phase.

DISCUSSION

It is highly recognized in the health sciences literature that dietary and lifestyle aspects are directly related to climacteric symptoms. Particularities such as the consumption of phytosterols, either through diet or supplements, and the adoption of a healthy diet, rich in fresh foods, such as fruits, legumes, oilseeds, and minimally processed products, can play an important role in controlling and reducing the most common

Revista ARACÊ
ISSN: 2358-2472

symptoms of this phase.

The term "phytosterols" refers to plant-based sterols and their saturated derivatives, known as plant stanols. These bioactive compounds are found naturally in plant foods and have a chemical structure similar to that of cholesterol, which in turn is only present in animal products. More than 250 phytosterols have been recognized so far. In the diet, the most commonly found phytosterols are beta-sitosterol, campesterol and stigmasterol. As for plant stanols, the most common are beta-sitostanol and campestanol (Gupta; Ahuja, 2011).

The main dietary sources of phytosterols include vegetable oils, especially corn (909 mg/100 mL), sunflower (411 mg/100 mL), soybean (320 mg/100 mL), and olive (300 mg/100 mL); nuts such as almonds (183 mg/100 g); cereals such as wheat germ (344 mg/100 g) and wheat bran (200 mg/100 g); as well as fruits and vegetables such as passion fruit (44 mg/100 g), orange (24 mg/100 g) and cauliflower (40 mg/100 g) (Gylling; Simonen, 2015).

The studies presented investigate the impacts of phytosterols, phytoestrogens and nutritional strategies on improving the quality of life of climacteric women, addressing different methodologies and approaches. Despite the specificities of each study, all converge on the importance of nutrition as a therapeutic tool.

Melo (2023) points out that the means by which phytosterols act by reducing climacteric symptoms is based on their structural similarity to estrogen, as well as their functional ability to replace estradiol in its functions in the female body. Many studies have associated dietary and supplemental consumption of phytoestrogens (or popularly called phytosterols), to help control climacteric symptoms (Salehi, 2021; Gibowski, 2023).

In a more in-depth way, studies that show the effects of phytosterols as an alternative to alleviate and improve the conditions faced during climacteric are highlighted. Phytoestrogens constitute a varied group of bioactive compounds of plant origin, with structures similar to human estrogen (Machado, 2021). The main types of these phytoestrogens, such as isoflavones, prenilflavonoids, coumestans, and lignans, are often found in people's diets (Gibowski, 2023). The mode of action of phytosterols in reducing climacteric symptoms occurs through binding to human estrogen receptors, especially β receptors, which provides a function similar to that of estrogen (Veloso, 2022).

Phytoestrogens are found in several foods, although in quantities that vary according to the type of food. They can be found in herbs, spices, vegetables, grains, fruits, and legumes, in addition to being present in some beverages (Santos, 2023). In view of this, the

Revista ARACÊ
ISSN: 2358-2472

influence that diet exerts on the climacteric is recognized; for this reason, the adoption of new nutritional strategies can improve eating habits, resulting in lower obesity rates, reduced cardiovascular risks, and decreased occurrence of hot flashes, night sweats, and psychological problems (Veloso, 2022).

Machado (2021) describes that phytoestrogens have structures and functions that resemble estradiol. Thus, several studies have shown that phytosterols can have a protective effect on bone health during the climacteric. According to Santos (2023), phytoestrogens can interfere with different pathways in the human body, favoring an anabolic response in the bones, which stimulates the capacity of the cells responsible for bone formation, resulting in an increase in the multiplication and differentiation of osteoblasts.

Based on experimental investigations carried out with animals, among the main results, it is highlighted that the intake of foods rich in phytosterols is linked to the control and decrease of cholesterol levels and their fractions (Salehi, 2021). Likewise, phytosterols have also been shown to be associated with cardiometabolic health, emphasizing that these problems directly affect climacteric women, regardless of the phase they are experiencing (Bacerra-Tomás *et al.* 2019).

For Salehi (2021) there is increasing scientific evidence supporting the idea that phytosterols and their derivatives have multiple pharmacological properties, including abilities to promote human well-being. These health benefits include a great ability to reduce total cholesterol and low-density lipoprotein (LDL) levels, thereby lowering the risk of many diseases (Plat *et al*., 2019).

In addition, phytosterols also modulate inflammation; they have antioxidant, antiulcer, immunomodulatory, antibacterial and antifungal effects; and they also intervene in promoting wound healing and inhibiting platelet aggregation. However, the author came to the conclusion that the bioavailability of phytosterol is a limiting factor influenced by several elements, including the type, source, processing, preparation, administration methodology, food matrix, dosage, time of permanence in the body and genetic aspects. In addition, there is an interrelationship between low absorption rates and the chemical structure of the compound (Salehi, 2021).

On the other hand, Machado (2021) in his study, showed the full ability to prepare a food menu for 5 days/week, based on the traditional Brazilian diet, in which foods that are sources of phytoestrogens (isoflavones, lignans, and coumestans) were included. In the

Revista ARACÊ
ISSN: 2358-2472

end, there was a significant reduction in vasomotor symptoms, insomnia, vertigo, and paresthesias. In other words, contrary to the study by Salehi (2021), Machado (2021) demonstrates that it is possible to have access to these compounds more easily taking into account the traditional Brazilian diet.

In addition to the menu, the study by Machado (2021) prepared a compact and adapted food replacement list from the Food Guide for the Brazilian Population. The list was composed in greater proportion of foods with relevant levels of phytoestrogens, with emphasis on the group of legumes, oilseeds, fruits, milk and dairy products, where unconventional foods and/or preparations are present in greater numbers, however, common foods of habitual consumption were also included. This highlights the range of foods present in Brazilian cuisine capable of providing these compounds that are so valuable for global and reproductive health.

What was noticed during the construction of this study is that the symptoms associated with the climacteric have a wide variety, implying that both recurrent and atypical signs can be observed among women in this phase (Sousa and Araujo, 2019). However, some symptoms have an occurrence of more than 50%, such as hot flashes and night sweats . A positive aspect of phytosterols is their easy availability and different forms of use, which confirms the conclusions of the study by Machado (2021).

More subjectively, Gibowski (2023) described the importance of soy isoflavones in relieving climacteric symptoms. This component is a chemical compound found in soybeans and other grains, which has a chemical structure similar to human estrogen. Soy isoflavones are considered phytoestrogens as they behave like estrogens but do not cause the same side effects.

Veloso (2022) discussed the variety of essential foods in reducing climacteric symptoms, emphasizing that individual nutritional strategies should be guided by a nutritionist, such as consuming soy isoflavones, flaxseed, blackberry, evening primrose oil, Peruvian maca, ginseng, among others. According to the author, such foods are capable of providing a better quality of life to those who suffer from the symptoms of this very delicate period in women's health.

The study by Santos (2023) corroborates Veloso (2022) when he teaches that nutritional intervention during menopause resulted in significant benefits, including weight loss, reduction of menopausal symptoms, improvement in cardiovascular health, reduction of Body Mass Index (BMI), and relief of symptoms of depression. These results highlight the

Revista ARACÊ
ISSN: 2358-2472

importance of nutrition as an effective approach to improve the quality of life of women in this transition phase.

In summary, studies converge to show that nutritional strategies, whether through phytosterols, phytoestrogens, or broader dietary approaches, play a crucial role in managing climacteric and menopausal symptoms. While some emphasize technical aspects and challenges, such as bioavailability (Salehi, 2021), others offer practical solutions, such as specific menus (Machado, 2021) and educational guidelines (Veloso, 2022).

Phytoestrogens play a multifunctional role in the body, influencing several biological processes through different mechanisms. Among its main forms of action, the ability to bind to estrogen receptors stands out. This interaction makes it possible for these compounds to be similar to estrogens produced by the body itself, mimicking their effects. However, phytoestrogens can also exert antiestrogenic activities by modulating or even inhibiting the typical responses associated with final estrogens (Melo, 2023). In this context, the impact of a balanced diet rich in bioactive compounds such as phytosterols can contribute positively to the improvement of symptoms present in the menopausal period.

FINAL CONSIDERATIONS

This integrative review highlighted important aspects about the effects of phytosterols in relation to common symptoms in climacteric women. These include symptoms ranging from hot flashes and night sweats to improved bone density, as well as psychological symptoms, such as depression, which affect a significant part of women in this phase.

There is substantial evidence that the use of phytosterols — whether through food, supplementation capsules, creams or medicinal plants — can be beneficial in the treatment of climacteric, in its various phases.

In general, the management of climacteric symptoms is carried out by non-pharmacological methods, without the occurrence of side effects, unlike the use of synthetic Hormone Replacement Therapy (HRT). In addition, the combination of phytosterols with lifestyle changes, especially in relation to healthy eating, can enhance the positive effects of this substance. In this scenario, the literature consulted, most of the time, points out that phytosterols can play a promising role in relieving climacteric symptoms, contributing to the well-being of those who are going through this moment.

Revista ARACÊ
ISSN: 2358-2472

However, the use of these compounds should be supervised by a health specialist, ensuring correct doses and preventing any interactions or contraindications. Therefore, a balanced diet, full of phytosterols and phytoestrogens, can play a crucial role in promoting well-being during this transition period.

Revista ARACÊ
ISSN: 2358-2472

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Revista ARACÊ
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