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The Impact of Protein Intake on Insulin-Like Growth Factor-1 (IGF-1) Levels and Its Implications for Metabolic Health and Aging Processes - a literature review

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ABSTRACT

Introduction

Insulin-Like Growth Factor-1 (IGF-1) is a key hormone involved in cellular growth, metabolism, and aging. Its levels are influenced by various factors, including dietary protein intake. While IGF-1 plays a crucial role in muscle maintenance, tissue repair, and overall metabolic function, elevated levels have been associated with an increased risk of certain diseases, including cancer and metabolic disorders. Conversely, lower IGF-1 levels have been linked to longevity and reduced aging-related diseases. In particular, concerns have been raised about whey protein's potential impact on acne flare-ups.[1]

Aim of the study

The primary aim of this study is to examine the relationship between dietary protein intake and Insulin-Like Growth Factor-1 (IGF-1) levels, assessing its potential implications for metabolic health and aging. This includes examining physiological mechanisms, identifying types of protein linked to acne flare-ups, and analyzing clinical studies to better understand their impact on skin health.

Materials and Methods

This review is based on a literature search conducted on PubMed. The following keywords were used: acne, protein supplementation, whey protein, and Insulin-like Growth Factor 1 (IGF-1), plant-based products.

Conclusions

Protein supplements, particularly those containing whey protein, may contribute to acne development through hormonal mechanisms such as increased IGF-1 levels and androgen production. While not everyone will experience acne from protein supplementation, individuals with a sensitivity to dairy or those who consume excessive amounts of protein may be more likely to notice acne flare-ups. Insulin-Like Growth Factor-1 (IGF-1) plays a critical role in growth, metabolism, and aging, with its levels being significantly influenced by dietary protein intake.

Keywords

Acne, protein supplementation, whey protein, insulin-like growth factor 1 (IGF-1), plant-based products, aging processes.

INRODUCTION

1. Understanding Acne Pathogenesis

1.1 Overview of Acne Vulgaris

Acne vulgaris is a common skin condition that typically affects adolescents but can also persist into adulthood. It primarily affects areas of the skin with the highest concentration of sebaceous (oil) glands, such as the face, back, and chest. Acne vulgaris is characterized by the formation

of *comedones* (clogged pores), *papules* (small red bumps), *pustules* (pus-filled lesions), and, in more severe cases, *cysts* (deep, painful lumps).[1] [2]

The pathogenesis of acne involves multiple factors working together, leading to the blockage and inflammation of hair follicles. The key contributors to the development of acne are:

1. Excess Sebum Production
Sebum is an oily substance produced by the sebaceous glands in the skin, which helps to keep the skin moisturized and protect it from external factors. However, in acne vulgaris, these sebaceous glands become overactive and produce excessive sebum. This is often influenced by hormonal changes (e.g., during puberty, menstruation, or pregnancy), androgens (male hormones that are present in both men and women), or genetic factors. Excess sebum can clog hair follicles, creating an environment where acne can develop. [3]

2. Follicular Hyperkeratinization
Under normal circumstances, skin cells (keratinocytes) in the hair follicle shed regularly and are replaced by newer cells. However, in individuals with acne vulgaris, this process of shedding is abnormal, leading to *follicular hyperkeratinization*. This means that the skin cells within the hair follicle accumulate too rapidly and form a plug, or *comedone*. The clogged follicle may eventually form a whitehead (closed comedone) or a blackhead (open comedone), depending on whether the pore is open or closed.[4][5]

3. Bacterial Colonization (Propionibacterium acnes
The bacterium *Propionibacterium acnes* (P. acnes) is a naturally occurring microorganism found on the skin, particularly in the sebaceous follicles. In acne, the blocked follicles create an anaerobic (low-oxygen) environment that encourages the growth and proliferation of P. acnes. This bacterium can trigger an inflammatory response by releasing enzymes and other substances that break down sebum, resulting in the release of free fatty acids that irritate the skin. The bacterial colonization contributes to the formation of pustules and inflammatory acne lesions.[6][7]

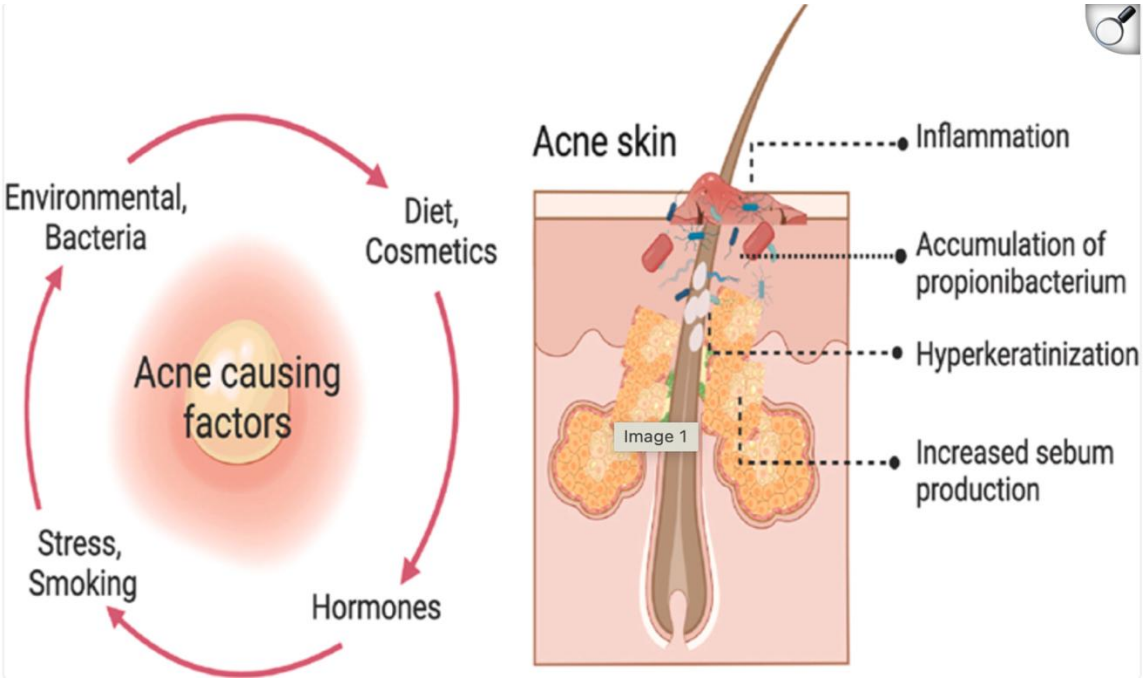
4. Inflammation
Inflammation plays a crucial role in the development and worsening of acne. When the follicle becomes clogged, the immune system reacts to the bacterial colonization and the buildup of sebum. This immune response leads to redness, swelling, and pus formation. Inflammatory acne lesions, such as papules, pustules, and cysts, are the result of this inflammatory cascade. In some cases, the inflammation can become so severe that it leads to scarring. [7][8]
Factors Influencing the Development of Acne:

I. **Hormonal Factors:** Androgens, such as testosterone, increase the size and activity of sebaceous glands. This is one of the main reasons acne can worsen during puberty, menstrual cycles, and pregnancy, when androgen levels fluctuate.[9][10]
II. **Dietary Factors:** Although not fully understood, there is some evidence that high-glycemic foods (such as sugar and refined carbohydrates) and dairy products may worsen acne in certain individuals. These foods can affect insulin levels and inflammatory pathways, potentially influencing sebum production and inflammation.[11]
III. **Genetic Predisposition:** Family history plays a significant role in the development of acne. If a person's parents had acne, they are more likely to develop the condition themselves. [12]
IV. **Environmental and Lifestyle Factors:** Exposure to environmental pollutants, oily cosmetic products, stress, and even certain medications can contribute to the development or exacerbation of acne. For example, medications like corticosteroids or lithium can induce acne flare-ups. [13][14]

Clinical Manifestations of Acne

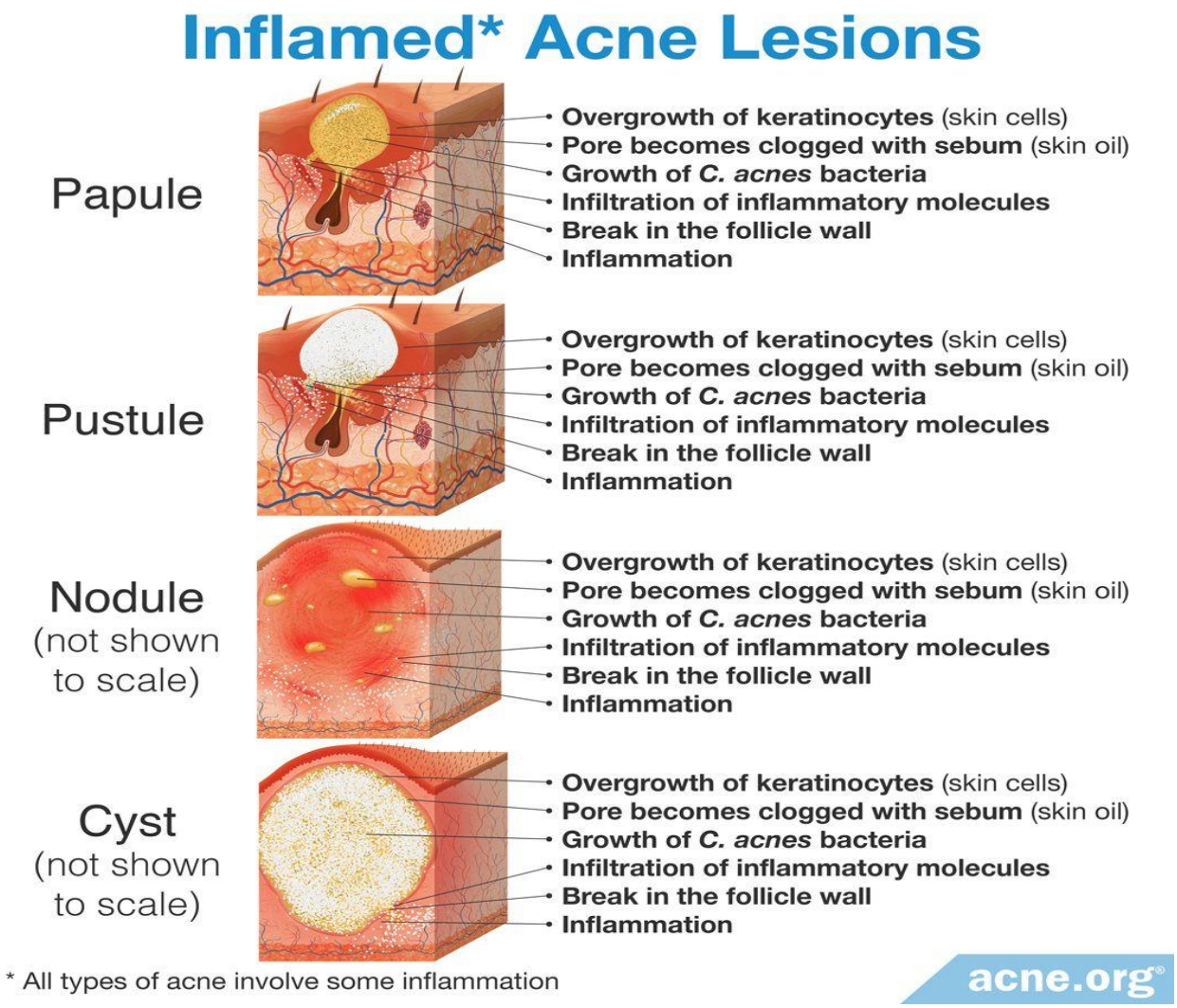
- **Comedones:** The initial lesion of acne is the comedone, which is formed when a hair follicle becomes clogged with excess sebum and dead skin cells. Comedones can be either:
    - **Closed comedones (whiteheads):** These occur when the follicle is completely blocked and the plug is not exposed to air. As a result, the plug remains a pale, flesh-colored or white bump under the skin's surface. These lesions are typically small, round, and do not usually cause significant inflammation, although they can progress into more inflamed lesions like papules or pustules if they remain untreated or become infected.

    - **Open comedones (blackheads):** When the plug partially opens to the surface, the sebum becomes oxidized, turning black in color. Despite the black appearance, blackheads are not caused by dirt but rather by the oxidation process that occurs when the contents of the pore are exposed to air. [15][16]



Picture 1. Acne causing factors
Vasam, M., Korutla, S., & Bohara, R. A. (2023). Acne vulgaris: A review of the pathophysiology, treatment, and recent nanotechnology based advances. *Biochemistry and biophysics reports*, *36*, 101578. https://doi.org/10.1016/j.bbrep.2023.101578

- **Inflammatory Lesions:** If a comedone becomes infected or irritated, it can lead to the formation of:
    - **Papules:** Small, red, raised bumps on the skin.
    - **Pustules:** Larger, pus-filled lesions, often with a yellow or white center.
    - **Nodules:** Larger, deeper, more painful bumps that are often firm and may persist for a longer time.
    - **Cysts:** Deep, painful, fluid-filled lumps that can cause scarring.[8]



Picture 2. Inflamed Acne Lesions
https://www.acne.org/what-is-the-difference-between-inflamed-and-non-inflamed-acne

2. Protein Supplements and Hormonal Regulation

2.1 Protein and Insulin-Like Growth Factor 1 (IGF-1)

The relationship between protein supplementation and acne is often mediated through hormonal mechanisms. **Insulin-like Growth Factor 1 (IGF-1)** is a key hormone implicated in acne development. IGF-1 is similar in structure to insulin and plays a crucial role in growth and development, particularly in cellular proliferation and differentiation.[17]

Whey protein has been shown to increase IGF-1 levels, which in turn may stimulate sebaceous glands to produce more sebum. This increased sebum production can clog pores and lead to acne.[18]

IGF-1 and Androgens: Elevated IGF-1 levels may also stimulate the production of androgens, further exacerbating acne by increasing sebum secretion.[10]

2.2 Whey Protein and Its Bioactive Components

Whey protein contains a variety of bioactive compounds that play a role in the body's immune response and metabolic processes. These include:

- **Lactoferrin**: A glycoprotein that has antimicrobial and anti-inflammatory properties.
- **Immunoglobulins**: Antibodies that contribute to the immune system's ability to fight infections.
- **Peptides**: Short chains of amino acids that may have various effects on hormone regulation and immune response.[19]

These components contribute to the overall health benefits of whey protein, but they can also affect **hormonal regulation**, which is a crucial factor in the development of acne.

2.3. Mechanisms by Which Whey Protein Increases IGF-1

Several mechanisms help explain how whey protein can lead to increased IGF-1 levels:

- **Insulin Response**: Whey protein has a high **insulinotropic** effect, meaning it stimulates insulin release after consumption. Insulin, in turn, can increase IGF-1 levels because insulin is a potent stimulator of the growth hormone axis.[20] Elevated insulin levels can activate the **mTOR (mechanistic target of rapamycin)** pathway, which enhances IGF-1 production in the liver.[21]
- **Amino Acid Composition**: Whey protein is rich in essential amino acids, particularly **leucine**, which plays a critical role in stimulating the mTOR pathway. Leucine is one of the most potent amino acids in terms of its ability to promote muscle protein synthesis, but it can also trigger hormonal responses that lead to increased IGF-1 production.[22]
- **Rapid Digestion and Absorption**: Whey protein is rapidly digested and absorbed in the body, leading to a quick spike in amino acid levels in the blood. This rapid elevation in amino acids can trigger a significant insulin and IGF-1 response. This rapid hormonal surge may be one reason why individuals who consume large amounts of whey protein on a regular basis may experience acne outbreaks.[23]

3. The Role of Whey Protein in Individuals with Acne-Prone Skin

While not all individuals who consume whey protein will develop acne, those who are genetically predisposed or have sensitive skin may be more susceptible to the effects of increased IGF-1 levels. In particular, people who have a family history of acne, or those who experience hormonal fluctuations (e.g., teenagers, women during menstruation or pregnancy), may find that whey protein exacerbates their skin issues.[24]

4. Managing Acne While Using Whey Protein

For individuals who wish to continue using whey protein but are concerned about acne, several strategies can help mitigate the risk of flare-ups:

- **Switching to plant-based protein**: For those who are particularly sensitive to the hormonal effects of dairy, switching to **plant-based protein powders** such as pea protein, rice protein, or hemp protein may be beneficial. These plant-based options do not contain dairy-derived IGF-1 and are less likely to affect sebum production or exacerbate acne.[25][26]
- **Lowering protein intake**: Instead of high doses of whey protein, consider **moderating the intake** of protein supplements and obtaining more protein from whole food sources like lean meats, legumes, nuts, and seeds. This approach helps to avoid large, rapid surges in amino acids that can trigger an insulin and IGF-1 response.[26]
- **Using skincare to manage acne**: For those who continue using whey protein, maintaining a good skincare regimen is essential. Using non-comedogenic skincare products and ensuring proper hydration can help minimize the risk of acne formation.[27]
- **Consulting a healthcare provider**: If acne persists or worsens despite dietary changes, it is advisable to consult with a dermatologist or a nutritionist. They can help determine whether protein supplementation is contributing to acne and offer personalized recommendations.[28]

4. The Role of Dairy in Acne Development

4.1 Dairy and Acne

Dairy products have long been suspected of exacerbating acne, possibly due to their hormonal content. **Milk, especially cow's milk**, contains natural hormones, including IGF-1, which can be absorbed into the bloodstream and potentially influence acne development.

- **Milk and IGF-1**: Cow's milk contains significant amounts of IGF-1, which may increase the circulating levels of this hormone in the body, stimulating sebaceous glands.[3]
- **Whey Protein as a Dairy Derivative**: As whey is a milk derivative, it shares many of these hormonal effects. This may explain why individuals sensitive to dairy may experience more frequent or severe acne flare-ups with whey protein supplementation.[29]

4.2 Dairy-Free Alternatives

For individuals concerned about acne, **plant-based protein powders** (e.g., pea protein, rice protein) may offer a suitable alternative. These proteins do not contain dairy hormones and are less likely to affect IGF-1 levels. Research suggests that **plant-based proteins** have a lower likelihood of exacerbating acne compared to whey protein.[30]

5. Managing Acne While Using Protein Supplements

5.1 Choosing the Right Type of Protein

For those concerned about acne, switching to **plant-based protein powders** may be a more skin-friendly option. Proteins from peas, rice, or hemp are less likely to influence IGF-1 levels or contribute to acne flare-ups.[30]

5.2 Moderating Protein Intake

Ensuring that protein intake is within recommended levels is important for overall health and skin health. Excessive protein consumption can overwhelm the body's metabolic systems and potentially affect skin clarity.[31]

5.3 Hydration and Skincare

Proper hydration and maintaining a consistent skincare routine are essential for managing acne. Drinking plenty of water and using non-comedogenic skincare products can help manage acne while using protein supplements.[32]

6. Aging Processes

6.1 IGF-1 and Cellular Senescence

IGF-1 is involved in regulating cell growth, proliferation, and apoptosis. Studies have demonstrated that reduced IGF-1 signaling can delay cellular senescence, a key hallmark of aging. In various organisms, including humans, low IGF-1 levels are associated with increased stress resistance and lifespan extension. However, studies also suggest that while a decrease in IGF-1 levels may reduce aging-related cellular damage, it could lead to an increased susceptibility to age-related diseases such as osteoporosis and sarcopenia.[33]

6.2 IGF-1 and Longevity

In animal models, including rodents and primates, reduced IGF-1 signaling is associated with extended lifespan. This is supported by studies showing that genetic mutations that lower IGF-1 levels or block its receptor are linked to increased longevity. However, the effect of IGF-1 on human longevity remains more complex. Some human populations with lower IGF-1 levels have been found to live longer, but this association is not universal. Further longitudinal studies are necessary to better understand the precise relationship between IGF-1 and human lifespan.[34]

6.3 IGF-1 and Age-Related Diseases

The reduction of IGF-1 levels with age has been linked to various age-related diseases, including:

- **Cardiovascular Diseases**: Low IGF-1 levels have been associated with an increased risk of cardiovascular diseases, including heart failure and atherosclerosis.[35]
- **Neurodegeneration**: In the brain, IGF-1 plays a protective role by promoting neurogenesis and preventing neuronal damage. Reduced IGF-1 levels have been linked to age-related neurodegenerative diseases like Alzheimer's and Parkinson's.[36]
- **Metabolic Disorders**: Lower IGF-1 levels have been correlated with insulin resistance and type 2 diabetes in aging individuals, suggesting a complex relationship between IGF-1 and metabolic health.[37]

6.4 IGF-1 Regulation

IGF-1 levels are regulated by various factors, including growth hormone (GH), nutritional intake, and genetic factors. Growth hormone therapy has been explored as a potential method to increase IGF-1 levels and mitigate age-related decline. However, while growth hormone replacement may improve some aspects of physical function, it has not been consistently shown to extend lifespan, and it may carry risks such as promoting cancer growth.[38]

Conclusion

Protein supplements, particularly those containing whey protein, may contribute to acne development through hormonal mechanisms such as increased IGF-1 levels and androgen production. While not everyone will experience acne from protein supplementation, individuals with a sensitivity to dairy or those who consume excessive amounts of protein may be more likely to notice acne flare-ups. For those concerned about acne, plant-based protein powders and moderation in protein intake may help mitigate the risk. Insulin-Like Growth Factor-1 (IGF-1) plays a critical role in growth, metabolism, and aging, with its levels being significantly influenced by dietary protein intake. This literature review has highlighted the complex relationship between protein consumption and IGF-1 regulation, emphasizing both its beneficial and potentially harmful effects.

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