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The Link Between Inflammation, Obesity, and Protein Growth Factors: Understanding the Basics and Their Health Impacts

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Abstract— *Obesity is a multifaceted metabolic disorder associated with chronic low-grade inflammation, leading to insulin resistance, metabolic dysfunction, and organ damage. Growth factors such as fibroblast growth factors (FGFs), epidermal growth factor receptor (EGFR), plasminogen activator inhibitor type 1 (PAI-1), and placental growth factor (PlGF) play pivotal roles in modulating inflammation and metabolic processes. While FGF1 demonstrates protective effects by improving insulin sensitivity and reducing pro-inflammatory cytokines, FGF2 exacerbates adipose tissue inflammation via NLRP3 inflammasome activation. EGFR activation has been linked to obesity-related renal injury, while PAI-1 contributes to chronic inflammation in obesity-induced diabetes by inhibiting hepatocyte growth factor (HGF). Additionally, PlGF has been implicated in the regulation of immune cell differentiation in adipose tissue, further promoting systemic metabolic dysfunction. Understanding these molecular pathways is essential for developing targeted interventions to mitigate obesity-related complications. This review highlights the critical interplay between growth factors and obesity-related inflammation.*

Keywords— *Obesity, inflammation, growth factors, health.*

I. INTRODUCTION

Obesity, defined by an excessive accumulation of adipose tissue, has become a significant public health concern due to its association with various chronic diseases. Beyond its implications for energy storage and metabolism, obesity is now recognized as a major driver of chronic low-grade inflammation, a condition that predisposes individuals to metabolic disorders, cardiovascular diseases, and certain cancers (Gregor & Hotamisligil, 2018). The systemic inflammation observed in obesity originates primarily from adipose tissue, which functions as an active endocrine organ. This tissue secretes numerous pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6), alongside adipokines like leptin and adiponectin, which are integral to the regulation of metabolic homeostasis (Lee et al., 2020).

In recent years, protein growth factors, including insulin-like growth factors (IGFs) and vascular endothelial growth factor (VEGF), have emerged as critical components in the complex network linking inflammation and obesity. These growth factors are essential for cellular proliferation, differentiation, and repair and play a dual role in modulating inflammation and tissue remodeling. For instance, IGFs are involved in insulin signaling and metabolic regulation, while VEGF promotes angiogenesis, a process critical for expanding adipose tissue in obesity (Singh et al., 2019). However, the dysregulation of these growth factors in the context of obesity can exacerbate inflammatory pathways, contributing to systemic metabolic imbalances.

The interplay between obesity-induced inflammation and protein growth factors has significant implications for health. Chronic low-grade inflammation can disrupt the delicate balance of pro- and anti-inflammatory signals, further exacerbating metabolic dysfunction. Meanwhile, growth factors act as both mediators and regulators within this dynamic, influencing processes such as adipose tissue expansion, immune cell infiltration, and vascular development (Zhao et al., 2021). The intricate relationship between these elements underscores the complexity of obesity as a multifaceted condition with systemic consequences.

Understanding the mechanisms linking inflammation, obesity, and protein growth factors is vital for developing novel therapeutic interventions. By targeting specific pathways influenced by growth factors, researchers may identify strategies to mitigate obesity-associated inflammation and its complications. This review aims to elucidate the fundamental connections between these factors, providing insights into their roles and potential implications for disease prevention and management.

II. METHODS

This study conducted a literature review and article search using the PubMed database. The search utilized specific keywords [obesity-induced inflammation and metabolic disorders and growth factors]. The article selection process followed the guidelines set by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. The process involved removing duplicate articles and further refining the selection to include studies published between 2015 and 2025, and those published in English. Book sections, studies involving animals, review articles, and conference proceedings were excluded. Data extraction encompassed a range of variables such as author names, article titles, publication years, study designs.

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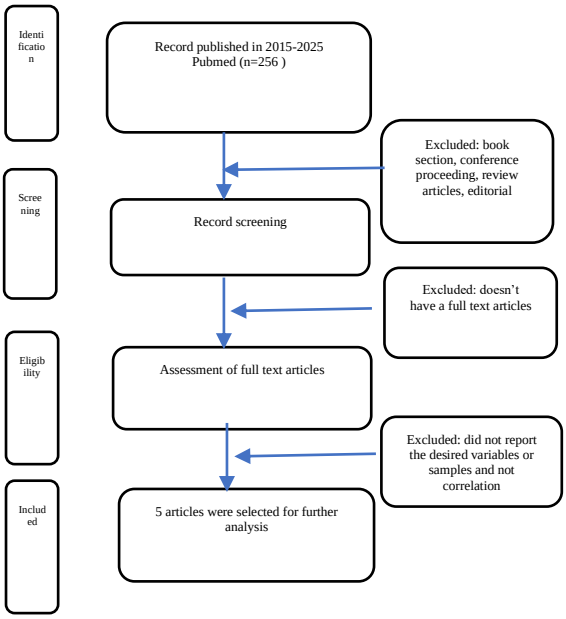

Figure 1. The article selection process flow diagram

III. Result and Discussion

The article selection process is outlined in Figure 1. a total of 256 articles were initially identified through the designated keywords in PubMed from 2015-2025. After meticulous removal of duplicate articles and application of the inclusion and exclusion criteria, 5 articles met the study's eligibility criteria. Table 1 provides a summary of the extracted data from the selected studies.

Extraction of the data shows in table 1. Growth factors contribute to obesity indication. Obesity is a complex metabolic disorder characterized by chronic low-grade inflammation, which contributes to insulin resistance, metabolic dysfunction, and organ damage (Hotamisligil, 2017). Growth factors, such as fibroblast growth factors (FGFs), epidermal growth factor receptor (EGFR), plasminogen activator inhibitor type 1 (PAI-1), and placental growth factor (PlGF), play crucial roles in regulating inflammation and metabolic processes in obesity.

Recent studies have further elucidated the complex role of growth factors in obesity-related inflammation and metabolic dysfunction. For instance, fibroblast growth factor 23 (FGF23) has been implicated in the development of obesity. Research indicates that elevated levels of FGF23 contribute to metabolic disturbances, suggesting that targeting FGF23 could be a potential therapeutic strategy for obesity management (Han et al., 2020). Fibroblast growth factors (FGFs) exhibit differential effects on obesity and inflammation. While FGF1 has been shown to improve insulin sensitivity and reduce pro-inflammatory cytokine levels (Zhao et al., 2020), FGF2 exacerbates adipose tissue inflammation through NLRP3 inflammasome activation, leading to worsened metabolic outcomes (ZhuGe et al., 2020). These findings suggest that modulating specific FGFs could serve as a therapeutic strategy for obesity-related metabolic dysfunction.

TABLE I. Data extracted from included studies

No	Authors/ year	Title	Methods	Result
1	Zhao et al./2020	Fibroblast growth factor 1 ameliorates adipose tissue inflammation and systemic insulin resistance via enhancing adipocyte mTORC2/Rictor signal	Animal experiment, mice were fed on HFD (60% kcal from fat) for 10 weeks. treated with FGF1, while negative treatment control mice were treated with vehicle (PBS)	This study examined the potential effects of FGF1 treatment on adipose tissue and systemic inflammation in obese mice. Using enzyme linked immunosorbent assay (ELISA) kits, we assessed the serum levels of pro-inflammatory cytokines in samples collected from the mice. The results revealed a significant reduction in the plasma levels of TNF-α and IL-6 in db/ db following the administration of FGF1
2	ZhuGe et al./2020	Fibroblast growth factor 2 exacerbates inflammation in adipocytes through NLRP3 inflammasome activation	With cell culture and animal experiment To examine the effect of FGF2 and FGF21 on mature adipocytes, the cells were treated with recombinant FGFs. The mice were fed a high-fat diet	FGF2 levels were increased during adipocyte differentiation and in the adipose tissue of high-fat diet (HFD)-induced obese mice. Recombinant FGF2 treatment upregulated inflammasome markers such as NLRP3, which was further exaggerated by TNF-α treatment. Results from mice confirmed the positive correlation between FGF2 and NLRP3 expression in epididymal and subcutaneous adipose tissue
3	Fang et al./2016	EGFR mediates hyperlipidemia-induced renal injury via regulating inflammation and oxidative stress: the detrimental role and mechanism of EGFR activation	mice were fed with high-fat diet (ApoEHFD) and the control ApoE-/- mice were fed with normal diet (low-fat diet, LFD, n=8) for 16weeks. Using Epithelial rat kidney-derived cell line NRK-52E. Collected the organs for analysis	The effect of EGFR activation is the activation of the NF-κB pathway and the upregulation of key genes involved in the inflammatory response and oxidative stress, contributing to the pathogenesis of obesity-related renal injury. EGFR is deeply involved in the pathogenesis of obesity-related renal injury and provides strong evidence for targeting the EGFR pathway for the treatment of this disease
4	Coudriet et al. 2019	A Noncanonical Role for Plasminogen Activator Inhibitor Type 1 In Obesity-Induced Diabetes	For most experiments, 6- to 8-week–old mice male. Mice were fed either an HFD, consisting of 60% kcal fat and 20% kcal each protein and carbohydrate or standard chow	AI-mediated inhibition of Hepatocyte growth factor (HGF) activation prohibits the resolution of inflammation in the context of obesity-induced type 2 diabetes
5	Kang et al. 2018	Placental Growth Factor (PLGF) is Linked to Inflammation And Metabolic Disorders In Mice With Diet-Induced Obesity	bolic disorders, such as insulin resistance, we fed high-fat diet (HFD) to Tg mice for 16 weeks	Adiposity and glucose intolerance significantly increase in Tg mice fed a HFD (Tg HFD) compared to wild-type (WT) mice fed HFD (WT HFD). PlGF overexpression in T-cells might lead to inflammatory T-cell differentiation and accumulation in adipose tissue (AT) or metabolism-related tissues, contributing to the development of systemic metabolic disorders

Additionally, EGFR activation has been linked to obesity-induced renal injury via the NF-κB pathway, promoting oxidative stress and inflammatory gene expression (Fang et al., 2016). This highlights the potential of EGFR inhibitors as a treatment option for obesity-related kidney damage. Similarly, PAI-1 has been identified as a key player in maintaining chronic inflammation in obesity-induced diabetes by inhibiting hepatocyte growth factor (HGF) activation, preventing the resolution of inflammation (Coudriet et al., 2019).

Another critical factor in obesity-related inflammation is PlGF, which has been found to drive inflammatory T-cell differentiation and accumulation in adipose tissue, exacerbating systemic metabolic disorders (Kang et al., 2018). Targeting PlGF and associated immune pathways could offer novel approaches to mitigating obesity-induced metabolic complications. Additionally, platelet-derived growth factor (PDGF) signaling in pericytes has been shown to promote hypothalamic inflammation, leading to increased susceptibility to obesity. This finding underscores the significance of PDGF in central nervous system regulation of energy balance and its potential as a target for obesity treatment (Cai et al., 2023).

Overall, these studies emphasize the intricate interplay between growth factors, inflammation, and metabolic dysfunction in obesity. Understanding these molecular pathways provides valuable insight into potential therapeutic strategies, emphasizing the need for further research to develop targeted treatments that address obesity-induced complications holistically.

IV. Conclusion

Obesity-induced inflammation is closely intertwined with the dysregulation of various growth factors, which play critical roles in metabolic homeostasis. The reviewed studies underscore the differential effects of FGFs, EGFR, PAI-1, and PlGF in modulating inflammatory pathways and metabolic outcomes. The identification of these pathways provides a foundation for potential therapeutic approaches aimed at targeting growth factor-mediated inflammation in obesity. Future research should focus on elucidating the precise mechanisms by which these growth factors influence metabolic health and exploring targeted interventions to mitigate obesity-associated complications.

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