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Исторические перспективы и современное понимание науки о питании: от влияния промышленности до понимания метаболизма

Original article

Historical Perspectives and Current Understanding of Nutritional Science: From Industry Influence to Metabolic Insights

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ABSTRACT

In recent years, the scientific and academic community has witnessed both groundbreaking discoveries and significant controversies. These developments underscore the profound impact of historical practices, technological innovation, and emerging research on societal and scientific paradigms. This review delves into notable cases, such as the controversial 2006 Alzheimer's study published in Nature, which raised concerns about research integrity, and the sugar industry's historical influence on dietary guidelines. The discussion also explores the rise of industrial seed oils and their implications for human health, particularly regarding the roles of omega-3 and omega-6 fatty acids in inflammation and disease. Advances in cellular biology, including the critical mechanism of vesicular fusion, are examined for their implications in health and disease. Furthermore, the review highlights the intricate relationship between peroxisomal metabolism, fatty acids, and retinal health, particularly in conditions like diabetic retinopathy and age-related macular degeneration. These insights illuminate the need for rigorous scientific methodologies, ethical research practices, and interdisciplinary collaboration to address contemporary health challenges and foster progress.
Key words: *metabolism, age-related macular degeneration, diabetic retinopathy, retinas, bile*

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Научная статья

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РЕФЕРАТ

В последние годы научное сообщество стало свидетелем как революционных открытий, так и серьезных противоречий. Эти события подчеркивают важное влияние исторических практик, технологических инноваций и новых исследований на общественные и научные парадигмы. В этом обзоре рассматриваются значимые кейсы, такие как противоречивое исследование болезни Альцгеймера, опубликованное в журнале Nature в 2006 г., которое вызвало обеспокоенность по поводу целостности исследования, а также историческое влияние сахарной промышленности на рекомендации диетологов. Также обсуждается рост использования промышленных масел из семян и их влияние на здоровье человека, в частности, в отношении роли омега-3 и омега-6 жирных кислот в воспалении и развитии заболеваний. Достижения в области клеточной биологии, включая важнейший механизм слияния везикул, рассматриваются на предмет их влияния на здоровье и болезни. Кроме того, в обзоре подчеркивается сложная взаимосвязь между пероксисомным метаболизмом, жирными кислотами и здоровьем сетчатки, особенно при таких состояниях, как диабетическая ретинопатия и возрастная макулярная дегенерация. Эти выводы указывают на необходимость применения строгих научных методологий, этических методов проведения исследований и междисциплинарного сотрудничества для решения современных проблем здравоохранения и содействия прогрессу.

Ключевые слова: *метаболизм, возрастная макулярная дегенерация, диабетическая ретинопатия, сетчатка, желчь*

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INTRODUCTION

Scientific research serves as the cornerstone of societal and technological progress. However, the credibility of research has, at times, been undermined by instances of bias, manipulation, or flawed methodologies. One notable case is the disputed 2006 Alzheimer's study published in Nature, where allegations of falsified data prompted a re-evaluation of critical findings on amyloid plaques [1]. Similarly, historical scrutiny has revealed that the sugar industry, in the 1960s, funded studies to downplay sugar's role in cardiovascular disease, shifting the focus to saturated fats [2]. Such revelations have had lasting impacts on public health policies and societal perceptions of nutrition.

This review explores the evolving understanding of industrial seed oils and their integration into human diets, examining their biochemical and physiological impacts [3, 4]. Additionally, it investigates key cellular processes, such as vesicular fusion, which underpins critical biological functions [5]. Finally, the role of omega-3 fatty acids and peroxisomal metabolism in retinal health is analyzed, with a focus on their implications for diseases like diabetic retinopathy and age-related macular degeneration [6, 7]. Together, these topics provide a comprehensive overview of the challenges and opportunities within contemporary scientific research.

Historical Scientific Controversies

The retraction of the 2006 Alzheimer's study due to alleged data manipulation underscored the critical need for stringent peer-review processes and research validation [1]. The study's findings on amyloid plaques as a therapeutic target influenced years of research investment, highlighting the cascading effects of flawed science. Similarly, the sugar industry's strategic funding of research in the mid-20th century manipulated public health narratives by deflecting attention from sugar's role in cardiovascular health [2]. This manipulation not only misinformed dietary guidelines but also fostered decades of misguided public health strategies, as highlighted in recent evaluations of cardiovascular risk factors [8].

These controversies emphasize the ethical responsibility of researchers, institutions, and policymakers to uphold transparency and prioritize public welfare over corporate or personal interests. They also highlight the importance of integrating retrospective analyses into policy-making to counteract the lingering effects of flawed historical research [9].

Evolution of Industrial Seed Oils

Industrial seed oils, derived from crops like cottonseed, sunflower, and soy, gained prominence during the 19th century as a cost-effective alternative to animal fats. Advances in hydrogenation and refining processes facilitated the production of consumable products, such as margarine and shortening, from what were once industrial byproducts [3].

In 1961, the American Heart Association's endorsement of polyunsaturated fats over saturated fats catalyzed a surge in seed oil consumption. While omega-6 fatty acids, abundant in these oils, are essential for physiological processes like immune function and cell signaling, their excessive intake relative to omega-3 fatty acids has been implicated in chronic inflammation, obesity, and cardiovascular diseases [3, 4, 10]. Emerging research suggests that excessive omega-6 consumption may exacerbate systemic inflammation by modulating eicosanoid production pathways, further emphasizing the need for a balanced omega-3 to omega-6 ratio [10, 11].

Vesicular Fusion and Cellular Processes

Vesicular fusion is a fundamental cellular mechanism that mediates the transfer of materials within and between cells. This process is integral to neurotransmitter release, hormone secretion, and immune responses [5]. At the synaptic level, vesicular fusion enables precise neuronal communication, critical for cognitive and motor functions. The mechanisms of vesicular fusion have also been shown to play a key role in lysosomal repair, offering potential therapeutic targets for neurodegenerative diseases like Parkinson's and Alzheimer's [12].

Pathogens often exploit vesicular fusion mechanisms for cellular entry, making it a focal point in the study of infectious diseases [13]. Dysregulation of vesicular fusion has been implicated in conditions such as immune deficiencies and metabolic diseases, emphasizing its dual significance in health and pathology [5, 13].

Retinal Health, Fatty Acids, and Peroxisomal Metabolism

The retina, with its high metabolic activity, is particularly susceptible to oxidative stress and metabolic dysregulation [6]. Omega-3 fatty acids, especially docosahexaenoic acid (DHA), play a pivotal role in maintaining retinal integrity. DHA is integral to photoreceptor function, enhancing membrane fluidity, nutrient transport, and neuroprotection [7, 14]. Its deficiency has been linked to increased risks of retinal disorders, including diabetic retinopathy and age-related macular degeneration [6].

Peroxisomal metabolism contributes to retinal health by generating plasmalogens and bile acids that support cellular integrity [6]. Bile acids, such as cholic acid, also modulate cholesterol homeostasis and protect photoreceptor cells [14]. Emerging therapeutic interventions, such as supplementation with omega-3 fatty acids or bile acid derivatives, show promise in mitigating retinal inflammation and oxidative stress [14, 15]. Additionally, the use of advanced imaging techniques to monitor retinal lipid dynamics offers new avenues for early diagnosis and intervention [15].

DISCUSSION

The interplay between historical biases, industrial advancements, and scientific discovery underscores the complex nature of public health and biomedical research. Historical controversies, such as the sugar industry's manipulation of dietary science, continue to inform modern debates about corporate influence and research integrity

[2, 8]. Similarly, the disputed 2006 Alzheimer's study highlights the ongoing need for rigorous methodological standards and independent validation in scientific research [1].

The evolution of industrial seed oils has highlighted the unintended consequences of large-scale dietary changes. While industrial processes enabled the mass production of polyunsaturated fats, the resulting dietary imbalances have prompted a reevaluation of their health impacts. Current evidence suggests that restoring a balanced intake of omega-3 and omega-6 fatty acids could mitigate inflammation and reduce the prevalence of chronic diseases [3, 4, 10]. Moreover, dietary patterns emphasizing natural sources of omega-3 fatty acids, such as fatty fish and flaxseed, align with broader public health goals [11, 14].

Advancements in cellular biology, particularly in vesicular fusion, have illuminated fundamental processes that underpin health and disease. The dual role of vesicular fusion in both normal cellular function and pathological processes, such as infection and neurodegeneration, underscores its therapeutic potential [5, 12]. Innovative research into vesicular fusion's role in lysosomal repair and immune function holds promise for future treatments [13].

Finally, the intricate relationship between retinal health, peroxisomal metabolism, and fatty acid composition underscores the need for targeted interventions. Omega-3 supplementation, coupled with improved understanding of retinal lipid dynamics, offers new hope for conditions like diabetic retinopathy and age-related macular degeneration [6, 14, 15]. These findings highlight the importance of integrating biochemical research with clinical practice to address unmet medical needs.

CONCLUSION

The interplay between historical practices, industrial advancements, and scientific research continues to shape public health and biomedical progress. Controversies surrounding research integrity, such as the 2006 Alzheimer's study and the sugar industry's influence, serve as cautionary tales, underscoring the necessity of ethical practices and transparency [1, 2]. Concurrently, advancements in understanding the health impacts of industrial seed oils and the physiological roles of omega-3 fatty acids illuminate the potential for targeted dietary interventions in preventing chronic diseases [3, 4].

At the cellular level, insights into vesicular fusion and peroxisomal metabolism offer promising directions for addressing metabolic and neurodegenerative disorders [5, 6, 12]. The pivotal role of omega-3 fatty acids in retinal health exemplifies the broader significance of balanced diets and integrative therapeutic approaches in modern medicine [7, 14]. As science progresses, maintaining integrity and fostering interdisciplinary collaboration will be essential in achieving transformative outcomes [8–15].

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