Linking Dietary Quality and Overall Health: The Role of Ultra-Processed Foods in Adult Chronic Diseases

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ABSTRACT

Chronic diseases such as cardiovascular disease (CVD), type 2 diabetes (T2D), obesity, and cancer are among the leading causes of mortality in the world, according to the CDC. While many different factors participate in development and progression of these diseases, increasing evidence suggests diet, especially diet high in ultra-processed foods (UPFs), is a major contributor to the development of these chronic diseases. This review synthesizes findings from randomized controlled trials (RCTs), meta-analyses, and large-scale cohort studies to evaluate the association between UPF consumption, chronic inflammation, and the prevalence of disease in adult and adolescent populations. Inflammation acts as a common-ground which links UPFs to chronic diseases; elevated levels of inflammatory biomarkers, including C-reactive protein (CRP) and interleukin- 6 (IL-6) are found in individuals with a higher UPF intake, and are also commonly associated with increased risks of CVD, T2D, and other chronic-disease related complications. In contrast, diets with a lower UPF consumption, such as the Mediterranean Diet (MD), have been found to have lower levels of CRP and IL-6, as well as being associated with lower rates of chronic disease.

KEYWORDS

Ultra-processed foods, diet, chronic disease, inflammation

INTRODUCTION

Lifestyle factors have been shown to influence organismal health in multiple species, including humans (1–4). Diet, for example, can have profoundly positive or negative impacts on various metrics of health, depending on the content and structure of the diet (5). Indeed, evidence from human and animal studies indicate that diet can influence lifespan, disease risk, body mass index, and more (5–7). A large and growing body of clinical studies support the idea that dietary habits can mitigate or exacerbate risk of chronic disease, which are health conditions that persist for longer than 3 months (8). The most common chronic diseases in the world include heart disease, type 2 diabetes, cancer, and obesity, which are common causes for illness and death (9,10). Here, we review diet patterns, with specific focus on the consumption of ultra-processed foods (UPFs), and how these diets are associated with the prevalence of chronic diseases in adult and adolescent humans.

It has been established that certain foods can influence the levels of inflammation in our bodies (11), and increased chronic inflammation is a common-ground for many chronic diseases to arise from—which is why different kinds of diets may be beneficial for certain people. Diets that are low in UPFs, like the Mediterranean Diet, are found to have positive health benefits (12), while diets high in UPFs are found to have the opposite effect (13). Evidence from various randomized controlled trials and clinical trials show that diets high in ultra-processed foods are

associated with higher levels of inflammation and a greater prevalence of chronic diseases (13). However, on the other hand, diets without as much ultra-processed foods seem to have positive health benefits and lower the prevalence of certain chronic diseases (12). This article goes over the importance of specializing your diet and potentially minimizing ultra-processed food consumption, while focusing more on whole-food dietary patterns to help mitigate the prevalence of chronic diseases.

OVERVIEW OF INFLAMMATION, DIET, AND UPFS

Many chronic diseases are associated with elevated levels of inflammation in the body. Inflammation is a major component of the body's natural defense system, activating in response to an injury occurring to the body. While this inflammation plays a protective role in the healing process, chronic inflammation can be detrimental and lead to the development of autoimmune disorders (14,15). Chronic inflammation is also known to be linked to the development of chronic disease; a meta-analysis study has shown that higher levels of inflammatory biomarkers, substances which can be measured to determine the presence or severity of inflammation within the body(16). Biomarkers such as C-reactive protein (CRP), Interleukin-6 (IL-6), fibrinogen (FIB), and galectin-3 (Gal-3) are linked to the increased incidence of cardiovascular disease (CVD), one of the major chronic diseases in the world (11,15).

Many lifestyle factors can influence chronic inflammation, and diet is one of the major ones. A meta-analysis done on randomized controlled trials (RCTs) shows that following a Mediterranean diet (MD) or similar diets can significantly lower inflammatory biomarkers such as IL-6, IL-1β, CRP, IL-8, and TNF-α, giving the MD anti-inflammatory properties (11). Consistent with this research, diet is also one of the factors that can influence chronic diseases as well; In a cross-sectional study done through the NHANES in which they used the Dietary Inflammatory Index (DII), it was found that diets with a higher DII correlated with 28% higher odds of having CVD, 17% higher odds of diabetes, and 19% higher odds of hypertension (17).

Although there are many different factors in diet that can influence both inflammation and chronic disease, a major constituent is ultra-processed foods (UPFs). In a cross-sectional study done by (18), it was found that individuals with diets heavy in UPFs also had higher levels of the C-reactive Protein (CRP), an inflammatory biomarker, indicating higher levels of inflammation. Furthermore, it's established that UPFs are also linked to chronic disease as well; a meta-analysis study shows Class I evidence of exposure to UPFs being associated with a higher risk of dying from CVD (risk ratio 1.50), and type 2 diabetes (dose-response risk ratio 1.12), (13). Together, this evidence highlights diet—and particularly UPF consumption—as a critical factor that shapes inflammation and long-term disease risk.

DISEASE OVERVIEW

Heart Disease

Heart disease, also known as Cardiovascular disease (CVD), is the leading cause of death worldwide according to the World Health Organization (19,20). It refers to several conditions that affect how the heart functions and its structure— it can be used to refer to heart failure, irregular heartbeats, congenital heart defects, and more. However, although heart disease can be used as an umbrella term for a variety of disorders, it is most commonly used to describe coronary artery disease (CAD), a condition where there is reduced blood flow to the heart due to

insufficient movement of blood passing through the coronary arteries (21). This reduction in blood flow to the heart often arises from buildup in the arteries of fats and cholesterol, which blocks blood flow, which is called Atherosclerotic Disease.

Beyond this, it has been proven that inflammation highly contributes to the occurrence of heart disease; double-blind randomized controlled trial (RCT) containing 10,061 participants study aimed to reduce inflammation by blocking cytokine pathways and then study the incident rate of CVD. In this specific study, the cytokine pathway of IL-1β was blocked by the drug Canakinumab, which resulted in a decrease of 6-17% of hsCRP and IL-6. This led to a reduction in the CVD incidence of non-fatal myocardial infarction (heart attack), nonfatal strokes, or CVD; the 150 mg dose of Canakinumab, which produced one of the largest hs-CRP decreases, was associated with a statistically significant 15% relative reduction in the primary endpoint of major adverse cardiovascular events (HR 0.85; 95% CI, 0.74–0.98; P=0.021) when compared with the placebo (20). Diet is a well-established risk factor for heart disease, and growing evidence suggests that the proportion of ultra-processed foods (UPFs) in the diet may substantially influence cardiovascular risk. A longitudinal study in Brazil which followed participants—civil servants aged 35-74 years— for 4 years revealed that the participants who had a high UPF consumption (measured by the Food Frequency Questionnaire) showed a 23% greater risk of developing hypertension than individuals who did not consume as many UPFs (5). On the other hand, diets with low UPFs and anti-inflammatory purposes are reported to have positive impacts on the development of heart disease. One randomized controlled trial showed that adherence to a Mediterranean Diet was linked to a lower risk of major cardiovascular events, with a 30% relative difference when compared to the low-fat control group. The control group diet consisted of grains, potatoes, vegetables and fruits, lean fish and seafood, making it quite different from the standard Western Diet, which contains a large amount of UPFs (12). This presents a limitation on these findings, because there could be a third variable influencing the perceived relationship between UPFs and chronic disease. Indeed, there is a comprehensive body of supporting literature that is consistent with the idea that diet influences cardiac health.

Type 2 Diabetes and Obesity

Type 2 diabetes (T2D) is a metabolic disease in which there's a build-up of sugar in the blood due to insulin resistance. Risk factors of T2D include excess weight, waist size, lack of physical activity, genetics, and more (22). However, it has been shown that there has been a link between inflammation and the development of T2D; a meta-analysis study showed revealed that elevated CRP levels were highly associated with a higher risk of T2D (relative risk 1.26, CI [1.16-1.37] (23). This association can be explained by numerous things, but one large component is through pro-inflammatory cytokines (i.e.: IL-1β) disrupting the insulin pathways, causing insulin resistance (24). Furthermore, diets high in UPFs are shown to cause a higher risk of T2D. In a meta-analysis, each 10% increment in UPF consumption (total) was linked to a 12% increase in T2D risk (25), indicating the negative influence that UPFs have on T2D.

Obesity is often closely linked with T2D. Obesity is an illness where the body has too much fat stored, impairing health. Obesity can significantly increase the risk of having other diseases (like CVD and T2D), and it can be measured using the Body Mass Index (BMI) (26). Obesity is also shown to be associated with inflammation; a meta-analysis showed a Pearson correlation of 0.36 between BMI and CRP (95% confidence interval, 0.30-0.42) (27). Similarly, with T2D and CVD, diets high in UPFs are shown to cause higher risks of obesity. In a randomized controlled

trial, subjects who were assigned to the ultra-processed groups gained weight, and their body fat mass increased by 0.4±0.1 kg (p=0.0015), while the subjects in the unprocessed group lost weight and lost 0.3±0.1 kg (p=0.05) in body fat mass (28).

Cancer

Cancer is the second leading cause in the world. It refers to a number of health conditions that are caused by uncontrolled cell division and create tumors. Cancer can initially occur in different parts of the body, but it can spread (29). Chronic inflammation is one of the factors that is linked to the development and severity of cancer. Inflammation can result in immunosuppression, which makes the body more susceptible to cancer development. Pro-inflammatory cytokines can activate NF-κB (a group of proteins regulating cellular responses that are sometimes linked to tumorigenesis) in cancerous cells, which causes the cells to further develop (30). Not only is inflammation linked to cancer, but diets that are high in UPFs are known to be linked to the development of cancer as well. A population-based cohort study showed that UPF food intake was linked to a higher overall cancer risk, hazard ratio 1.12 (1.06 to 1.18); P for trend<0.001 and breast cancer risk, hazard ratio 1.11 (1.02 to 1.22); P for trend=0.02 (31), showing that a higher UPF intake is associated with higher risks of cancer.

DISCUSSION/CONCLUSION

Ultimately, it has been proven throughout studying multiple chronic diseases and the tracking of biomarkers, that higher inflammation is linked to an increased risk of chronic disease, and this is true across CVD, T2D, Obesity, and Cancer. Furthermore, diet can heavily impact both inflammation and the incidence of chronic disease— specifically, diets containing ultra-processed foods. Diets high in UPFs have a greater risk of the development of hypertension, T2D, obesity, and cancer, proving these foods to be negative towards human health. Diets high in UPFs also show a higher number of biomarkers of inflammation. There is currently minimal current evidence and research regarding how UPFs may alter the mechanisms of the brain pathways; however, there is speculation on how UPFs may possibly be disrupting satiety signaling and are able to produce addictive-like food responses, which if true, could be another factor of why they are negative towards our health. Other evidence suggests that diets low in UPFs, like for example the Mediterranean diet, is effective in lowering the incidence of chronic illnesses. However, there are limitations to using the MD to compare it to diets high in UPFs, because the MD has other components of the diet that are beneficial (for example, whole foods and healthy fats) which could be contributing to the positive health benefits seen when the MD is studied in comparison to a high consumption of UPFs. To counter this limitation, further research in animal studies on UPFs would be helpful. If researchers isolated UPFs to be the only variable being manipulated while the rest of the diet stayed the same for both groups and measured the rate of risk for chronic diseases in the absence of other changing factors, this would greatly help the study in how UPFs affect chronic illnesses. The knowledge that there is a strong correlation between UPF consumption and disease prevalence suggests a way to help prevent chronic diseases from arising; individuals can find ways to improve their diet daily as a preventative measure or can help curb the development of a disease. By populations collectively reducing their UPF consumption, chronic illness would be

reduced across populations, allowing for an overall healthier lifestyle and less suffering within individuals.

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