

Ultra-Processed Food Consumption and Its Role in Obesity and Metabolic Syndrome Development

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Abstract: This article examined the relationship between the consumption of ultra-processed foods (UPF) and obesity, as well as metabolic syndrome, through a systematic review approach. UPFs were known to contain salt, sugar, oils, fats, and other additives mimicking natural foods' sensory qualities. Research indicated that diets high in UPF were nutritionally unbalanced and promoted excessive consumption, which was detrimental to health. Data from various studies showed that increased UPF consumption was linked to a higher risk of obesity and related diseases, such as type 2 diabetes. Cross-sectional studies indicated that UPF consumption correlated with a higher risk of overweight in men compared to women. This research utilized diverse data sources that used methods such as semi-quantitative food frequency questionnaires and prospective analysis to evaluate this relationship. Results showed that high UPF consumption significantly contributed to obesity and metabolic disorders, affecting metabolic profiles and overall diet quality, highlighting the need for better dietary policies to mitigate the adverse impacts of ultra-processed foods.

1 INTRODUCTION

Obesity is a primary public health concern worldwide. More than 12.0% of the adult population (≥ 20 years old) suffers from obesity, and this figure is projected to continue rising, affecting 19.5% of the global adult population by 2025 (Lea Nash Castro et al., 2021). Obesity is categorized both as a disease and a risk factor for other non-communicable diseases (NCDs), such as cardiovascular diseases, diabetes, and several types of cancer (Haslam & James, 2005). In 2016, NCDs accounted for 71.0% of all deaths worldwide (Naghavi et al., 2017).

Ultra-processed foods (UPF) are industrial formulations that, in addition to containing salt, sugar, oils, and fats, also include substances (especially additives) used to mimic the sensory qualities of minimally processed foods and culinary preparations (Elizabeth et al., 2020). Diets high in UPF content tend to be nutritionally unbalanced, promoting passive and excessive consumption of food and beverages, thus detrimental to health (Martinez-Perez et al., 2021). The consumption of ultra-processed food products worldwide has

drastically increased. Based on data from the National Food Survey, UPF contributes between 25% to 60% of total daily energy intake (Pagliai et al., 2021).

Dependency on UPF as a substantial part of daily calorie intake can reduce the consumption of fresh and minimally processed foods, which indirectly may jeopardize health (Martinez-Perez et al., 2021). UPF consumption has a substantial impact on nutrient intake and overall diet quality, playing a crucial role in increasing the risk of weight gain and health conditions such as obesity (Monteles Nascimento et al., 2023). In a cross-sectional study, there is evidence indicating a gender-specific relationship between UPF intake and overweight conditions. The study suggests that UPF consumption may be associated with an increased risk of being overweight in men with higher body mass index (BMI), waist circumference (WC), and abdominal obesity, while no similar relationship was found in women (Marrón-Ponce et al., 2018). Furthermore, UPF is associated with a decrease in muscle mass markers, corrected arm muscle area, and arm circumference (Monteles

Nascimento et al., 2023). Additionally, in a sample of adults representing the entire country, food insecurity was found to be associated with increased UPF consumption (Leung et al., 2019). Based on these descriptions, this research aims to investigate how ultra-processed food consumption influences obesity and metabolic syndrome through a systematic review method. A better understanding of this relationship is expected to assist in the development of more effective policies and interventions to address obesity and metabolic health issues in the community.

2 METHODS

Research Type

This study employed a literature review method. This method was utilized to identify, evaluate, and interpret findings from research relevant to a specific topic or phenomenon that was the focus of the study.

3 RESULTS and DISCUSSIONS

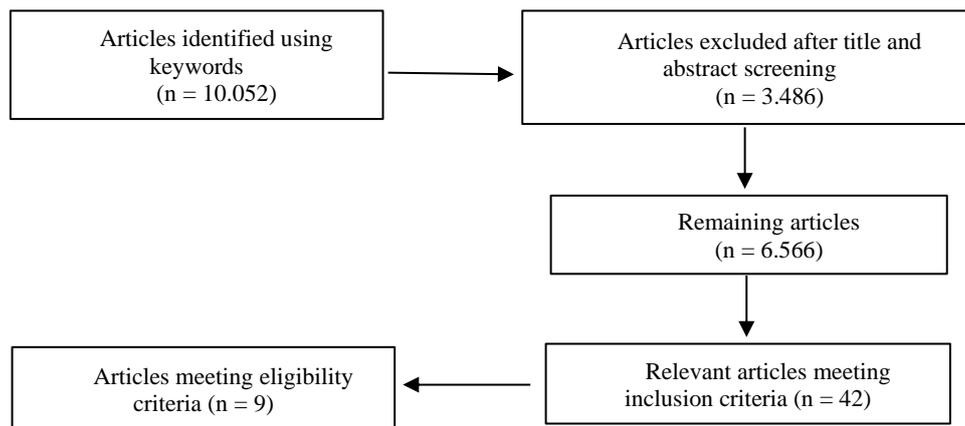


Figure 1: Article Selection Process

The search of articles in the designated databases yielded a total of 10,052 articles. Subsequently, a screening process based on titles and abstracts was conducted, resulting in the elimination of 3,486 articles and leaving 6,566 articles for further consideration. From these articles, those deemed relevant according to the established inclusion criteria and suitable for both qualitative and quantitative synthesis were selected, amounting to 42 articles. Following this, the full texts of the 42 relevant articles were carefully examined, leading to the identification

This process involved systematically and systematically reviewing scholarly articles

Keywords for Article Search

The selection of articles for this research involved the use of specific keywords and Boolean operators (AND). This search was carried out in May 2024, utilizing various databases such as Pubmed.gov, Wiley Online Library, Cochrane Library, ProQuest, and ScienceDirect. Furthermore, articles were also sought through the Google search engine. The scope of the search encompassed publications from 2020 to 2024, with inclusion criteria limited to literature reporting research outcomes. The literature search process employed a combination of keywords including ultra-processed food, ultra-processed food and obesity, ultra-processed food and its metabolic implications, ultra-processed food consumption, and ultra-processed food and metabolic syndrome.

of 9 articles that met the criteria for relevance and acceptability. The process of article selection, from initial identification to the determination of the final chosen articles, is depicted in Figure 1.

Based on the literature review in this article, eligible articles are original research articles that are not literature reviews, with a study period within the last 5 years, specifically from 2020 to 2024. From the literature review, it was found that the consumption of ultra-processed food is associated with weight gain leading to obesity. Furthermore, several studies

related to ultra-processed food consumption are known to increase the risk of metabolic syndrome and its severity. A summary description of the data from the included studies can be seen in Table 1.

Table 1: Summary of Data Description from Included Studies

| No | Titles | Researcher / Year | Methods | Results |
|----|---|----------------------------------|--|---|
| 1 | Increase ultra-processed food consumption is associated with worsening of cardiometabolic risk factors in adults with metabolic syndrome: Longitudinal analysis from a randomized trial | (González-Palacios et al., 2023) | The research method employed was prospective, involving the collection of data for 12 months with a total of 618 participants aged 60-75 years old, without a history of cardiovascular disease at the beginning of the study, and with at least 3 metabolic syndrome risk factors. Information regarding dietary intake was obtained using the FFQ method at the beginning of the study, at 6 months, and 12 months during the follow-up period. | There is a correlation between changes in UPF consumption levels (according to quartiles in g/day) and Cardiometabolic Risk Factors from the beginning of the study to 6 and 12 months of follow-up. Compared to the lowest quartile, the highest quartile of UPF consumption is positively associated with body weight, BMI, waist circumference, diastolic blood pressure, fasting blood glucose, HbA1c, plasma triglycerides, and TyG index in multivariate analysis. All associations indicate a significant dose-response relationship (p-trend <0.05). No statistically significant relationship was found between the highest UPF consumption and systolic blood pressure as well as all types of cholesterol (total cholesterol, HDL, and LDL cholesterol). This study concludes that when adults with metabolic syndrome consume large amounts of ultra-processed foods (UPF), factors that can lead to heart and metabolic problems (CMR) tend to worsen after 12 months. |
| 2 | Ultra-processed Food Intake and Risk of Type 2 Diabetes in Korean Adults | (Cho et al., 2024) | The research method utilized in this study was experimental, with subjects obtained from the Ansang-Ansung Cohort, Korean Genome and Epidemiology Study (KoGES). The study included a total of 7,438 adult participants aged 40-69 years old who met the following inclusion criteria: diagnosed with type 2 diabetes mellitus (DM), taking diabetes medication, having fasting blood glucose concentration measured ≥ 126 mg/dL, or HbA1c concentration $\geq 6.5\%$ at the beginning of the study. Dietary intake over the previous 12 months was assessed at the beginning of the study using a 103-item semi-quantitative food frequency questionnaire (FFQ). | During the study period from 2001 to 2019, which lasted on average for 15 years, there were 1,187 cases of type 2 diabetes recorded in the cohort study. The analysis results indicate that individuals who consumed the highest amounts of ultra-processed foods had a significantly higher risk of developing type 2 diabetes compared to those who consumed them in smaller quantities [risk ratio (HR) = 1.34, with a 95% confidence interval between 1.13 and 1.59, P-trend = 0.002]. This correlation remained significant even after adjusting for confounding factors such as dietary quality and body mass index (BMI). Further analysis of specific ultra-processed food consumption showed that a higher intake of foods such as ham/sausages, instant noodles, ice cream, and carbonated drinks was associated with a higher risk of type 2 diabetes. However, higher consumption of candy/chocolate was associated with a lower risk factor for type 2 diabetes. |
| 3 | The influence of ultra-processed food consumption on | (Rego et al., 2023) | The main objective of this study is to determine the influence of ultra-processed food (UPF) consumption on brain activity | The results of this study indicate that the diet chosen by participants on average consisted of 50% carbohydrates, 35% fat, and 15% protein (10% animal-based/5% |

| No | Titles | Researcher / Year | Methods | Results |
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| | reward processing and energy intake: Background, design, and methods of a controlled feeding trial in adolescents and young adults | | measured by Blood Oxygen Level-Dependent (BOLD) response, increased ad libitum energy intake, and negative effects on executive function (EF) and delay discounting in individuals aged 18–25 years. This study employs a crossover design with controlled feeding periods of 14 days each, followed by a four-week washout period. Participants will undergo two diet conditions in random order: a high-UPF diet (81% of calories from UPF) and a non-UPF diet (0% of calories from UPF). | plant-based), adjusted in terms of fiber, added sugars, saturated and unsaturated fats, sodium, glycemic index, and overall dietary quality. Some of the most commonly selected ultra-processed food groups included: 1) Buffet meal tray comprising Nature’s Path Corn Flakes, Lucky Charms, Del Monte canned peaches in syrup, Pop Tart, Sunny Delight orange juice drink, Kroger whole milk yogurt with vanilla flavoring; 2) Snack tray consisting of Cape Cod chips, Pringles, Keebler sugar cookie, Welch’s fruit snacks. These ultra-processed food types were chosen due to their palatability and texture preferences among the study subjects. The findings of this research suggest that ultra-processed food (UPF) consumption influences various physiological and behavioral aspects related to diet and health. UPF consumption is associated with increased ad libitum energy intake and changes in brain reward responses, as well as having negative impacts on executive function and cognitive control. These findings could aid in developing healthier dietary strategies and better nutrition policies. |
| 4 | Metabolic profiles of ultra-processed food consumption and their role in obesity risk in British children | (Handakas et al., 2022) | This study aims to understand the relationship between ultra-processed food (UPF) consumption and obesity risk in children in the UK, focusing on the underlying metabolic mechanisms for analysis. Data were obtained from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort. A cross-sectional research design was employed to investigate the relationship between UPF consumption and metabolic profiles at the age of 7 years, with a total of 4,528 children included in the study. Prospective testing was conducted to examine the relationship between UPF consumption at the age of 13 years and metabolic profiles at the age of 17 years, involving a total of 3,086 children in the study. | Metabolic characteristics influenced by UPF reveal that at the age of 7, UPF consumption is associated with 115 different metabolic characteristics. Significant changes include a decrease in branched-chain amino acids (BCAA) and aromatic amino acids, as well as an increase in citrate, glutamine, and monounsaturated fatty acids (MUFA). Furthermore, the association between UPF consumption and obesity involves identified metabolites (such as increased citrate and glutamine) associated with increased fat mass accumulation, indicating potential mechanisms by which UPF contributes to childhood obesity. Nutrient intake also mediates most of the relationships between UPF and metabolites, except for citrate. The effect of UPF intake on cardiometabolic risk is mediated by overall dietary quality, as poor dietary quality exacerbates the negative effects of UPF. In general, this study concludes that UPF consumption disrupts various metabolic pathways, significantly contributing to the risk of obesity in children. |
| 5 | The interaction between ultra-processed foods and genetic risk | (Gholami et al., 2024) | The research method employed in this study was cross-sectional. The study involved 376 female participants who were overweight | The study results comprised: 1) Descriptive characteristics of participants involving 376 women categorized as overweight or obese. The mean age of participants was |

| No | Titles | Researcher / Year | Methods | Results |
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| | score on body adiposity index (BAI), appendicular skeletal muscle mass index (ASM), and lipid profile in overweight and obese women | | or obese, recruited from 21 healthcare centers in Tehran, Iran, using a multi-stage random sampling method. The study took place from April 2023 to February 2024. The recruited participants were healthy women with a BMI between 25-40 kg/m ² and aged over 18 years. The data observed included: 1) Biochemical parameter measurements, including fasting venous blood samples to measure total cholesterol as well as LDL and HDL cholesterol levels; 2) Anthropometric measurements and body composition assessment; 3) Assessment of dietary intake using FFQ and NOVA questionnaires; 4) Assessment of physical activity using the IPAQ questionnaire; 5) Genotyping and GRS testing by DNA extraction from blood using the salting-out method and PCR technique. Statistical tests included normality tests for quantitative variables using the Kolmogorov-Smirnov test. Categorical data were presented as absolute and relative frequencies, while quantitative data were presented as mean and standard deviation. ANOVA and chi-square tests were used to assess mean differences and distribution of categorical variables across UPF tertiles. Analysis of covariance (ANCOVA) was used to adjust for confounding factors. The analysis was conducted using SPSS v.26 software, with a significance level of $p < 0.05$ and a marginal significance level of $p < 0.07$. General linear regression models were used to analyze the interaction between GRS and UPFs, with adjustments for age, BMI, energy intake, physical activity, and education. | 36.68 ± 9.23 years, with a weight of 80.59 ± 11.27 kg, height of 161.21 ± 5.78 cm, BMI of 31.02 ± 3.86 kg/m ² , and waist circumference of 99.21 ± 9.58 cm. 48.5% of participants had a bachelor's degree or higher, and the majority (71.7%) were married. The mean physical activity of participants was 993.26 (1098.67) MET/min/week; 2) Mean differences in variables based on NOVA score: Age: Participants in higher NOVA score tertiles were younger, with significant differences between tertile 3 (T3) and tertile 1 (T1) ($p = 0.03$), Weight: The mean weight was lower in participants with the lowest NOVA tertile. Significant differences were observed between T3 and tertile 2 (T2) ($p = 0.02$), Body Fat Percentage (BF %) was higher in participants in NOVA T3, indicating marginal significant variation ($p = 0.06$), Waist Circumference (WC): Significant differences between T3 and T2 in adjusted models; 3) Mean differences in variables based on GRS group: Height: Participants with GRS < 3 had higher height with significant differences in both crude ($p = 0.02$) and adjusted models ($p = 0.03$), BMI: Significant difference in crude model ($p = 0.01$) and remained marginally significant after adjustment ($p = 0.07$), Body Roundness Index (BRI): Higher in participants in GRS > 3 with significant difference in crude ($p = 0.01$) and adjusted models ($p = 0.02$), Skeletal Muscle Index (SMI): Significant difference in crude and adjusted models ($p = 0.02$). Participants in GRS > 3 groups had lower SMI compared to other GRS groups; 4) Food intake based on UPF consumption tertile: Non-Dairy Beverages, Cakes, Dairy Beverages, Potato Chips, Processed Meats, Oils & Sauces, and Sweets Intake: All showed significant variations among UPF consumption tertiles ($p = 0.00$), Energy Intake: Also showed significant differences among UPF consumption tertiles ($p = 0.00$). The conclusion of this study indicates that individuals with a higher genetic predisposition to obesity, as indicated by their genetic risk score (GRS), may be more vulnerable to the negative effects of ultra-processed food (UPF) consumption on skeletal muscle mass. |
| 6 | Consumption of a variety of plant foods, ultra-processed foods, and risk for | (Mitra et al., 2024) | This study was an experimental diet study using a quasi-experimental method over 18 weeks to analyze the impact of increased plant-based food intake | All 19 participants in this study were females. The average age of the participants was 28 years (± 11.8). One participant had lactose intolerance, and another had a peanut allergy. Five |

| No | Titles | Researcher / Year | Methods | Results |
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| | chronic disease: A dietary intervention | | on the consumption of ultra-processed food (UPF) and chronic disease risk factors. The study consisted of a four-week control period followed by an eight-week diet intervention, during which participants were asked to increase their intake of unprocessed plant-based foods to 30 varieties per week. Follow-up was conducted six weeks after the intervention ended. Diet intake was assessed using the Automated Self-Administered 24-Hour Dietary Assessment Tool (ASA24). Participants completed a 24-hour recall once during the control and intervention periods, as well as a three-day diet record. Consumption of ultra-processed food was assessed from ASA24 data by calculating the amount of ultra-processed food consumed in each 24 hours. Participants also recorded the number of unprocessed plant-based food varieties consumed each week. Chronic disease risk was assessed through anthropometric and laboratory data. Paired t-tests were used to test the difference in mean plant-based food consumption between the control and intervention periods, as well as the difference in education assessment scores before and after the intervention. Differences in overall and individual HEI scores were assessed with the T-test. Laboratory data were analyzed using repeated measures ANOVA and Bonferroni post-hoc tests. | participants (26.3%) reported having chronic diseases: hypertension (n = 1), polycystic ovary syndrome (n = 1), diabetes (n = 1), Crohn's disease (n = 1), and thyroid disease (n = 1). All participants who completed the survey on determinants of ultra-processed food consumption (n = 18) reported consuming ultra-processed food. The three most common individual determinants were "I enjoy it," "It tastes good," "I am familiar with it," and "It is easy to prepare." The most common categories of determinants were habit, pleasure, and taste. The average number of plant-based food varieties per week was higher during the intervention period compared to the control period (34.7 ± 10.8 vs 23.1 ± 12.1; p < 0.001). The average amount of ultra-processed food consumed per day was significantly lower during the intervention period compared to the control period (5.32 ± 1.65 vs 6.54 ± 2.04; p < 0.05). There was no difference in mean HEI scores between the control and intervention periods. However, there was a significant increase in the total fruit consumption score. Anthropometric measurements mostly remained unchanged at the four-time points except for diastolic blood pressure. There was a significant difference in diastolic blood pressure at the four different time points; F(3,14) = 3.70, p < 0.05. Post-hoc analysis showed a significant difference in diastolic blood pressure between baseline (time point 1) and early intervention (time point 2). Diastolic blood pressure was significantly lower at time point 2 compared to time point 1 (t = 3.95, df = 14, p < 0.01). The percentage of blood pressure measurements in the normal category was higher after the intervention compared to before, but not statistically significant. |
| 7 | Association of normal weight obesity with lifestyle and dietary habits in young Thai women: A cross-sectional study | (Kobayashi et al., 2023) | The experimental method utilized in this study was cross-sectional. Data were obtained between 2017 and 2020, with the study subjects consisting of 507 female university students in Thailand residing around Thaniyaburi and Chiang Mai. A total of 113 underweight women (BMI <18.5 kg/m ²) and 144 overweight women (BMI ≥ 25.0 kg/m ²) were excluded from the analysis. The remaining 250 women fell within | A total of 46.8% of study participants with normal body type (BMI, 18.5–25.0 kg/m ²) were detected to have Normal Weight Obesity (NOW). There were no differences in age or height between the NO-NWO and NWO groups. Weight, BMI, and BFR in the NWO group were significantly higher than those in the NO-NWO group (all p < 0.001). Muscle mass in the NWO group was lower than in the NO-NWO group, but this difference was not statistically significant (p = 0.084). There was no difference in basal metabolic rate between |

| No | Titles | Researcher / Year | Methods | Results |
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| | | | <p>the normal BMI range, as classified by the World Health Organization ($18.5 \leq \text{BMI} < 25.0$ kg/m²). Height was measured using In Lab 550 (In Body Japan Inc., Tokyo, Japan), while weight, body fat ratio (BFR), basal metabolic rate, and muscle mass were measured using ACCUNIQ BC300 (Toyo Medic Co., Ltd., Tokyo, Japan), and BMI calculation was also performed. Surveys on lifestyle and dietary habits were conducted using self-administered questionnaires. Participants in this cross-sectional study were classified into NONWO and NWO groups (normal weight obesity), and physical measurements, lifestyle, and dietary habits were compared between the two groups. Qualitative variables were analyzed using the chi-square test or Fisher's exact test, and quantitative variables were analyzed using the Student's t-test.</p> | <p>the NWO and NO-NWO groups. The NWO group had a higher percentage of irregular menstrual cycles than the NO-NWO group, but this difference was not significant ($p = 0.079$). There were no differences in exercise habits, type of residence, duration of sleep, or smoking habits. Participants in the NWO group walked fewer steps per day than those in the NONWO group, but this difference was not significant ($p = 0.291$). Young Thai women in the NWO group were less likely than those in the NONWO group to answer "almost every day" to the item "eating oily foods" ($p = 0.047$). The NWO group was more likely than the NO-NWO group to answer "almost every day" to the item "eating UPF" ($p = 0.036$). Additionally, the NWO group was more likely than the NO-NWO group to answer "almost every day" to the item "drinking sugary drinks"; however, this difference was not significant ($p = 0.073$). Logistic analysis showed that frequent consumption of UPF was positively associated with NWO. The results of the multivariate analysis indicated similar patterns for physical activity, menstrual cycle, and typical stool softness, with a 2.04-fold higher risk for NWO in participants who consumed UPF "almost every day" compared to those who consumed it "rarely" ($p = 0.014$). The frequency of drinking additional sugary drinks was also associated with NWO.</p> |
| 8 | Consumption of ultra-processed foods associated with weight gain and obesity in adults: A multi-national cohort study | (Cordova et al., 2023) | <p>This study was a prospective cohort study conducted in 10 European countries: Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, and the United Kingdom (UK). Between 1992 and 2000, a total of 521,448 men and women were recruited as study subjects. Anthropometric measurements, including weight and height, were taken at the beginning of the study and after a median follow-up time of 5 years. Individual dietary patterns were assessed using validated diet questionnaires in each country. Consumption of ultra-processed foods (UPF) was estimated by integrating the NOVA food classification system into the EPIC database. Data on factors such as education level, physical activity, alcohol intake,</p> | <p>Participants in the highest quintile showed a greater increase in weight, were younger, and consumed more sugar/sweets and biscuits. Additionally, those in the highest quintile consumed more soft drinks and less alcohol compared to those in the lowest quintile. Observing weight between the start of the study and the second assessment about five years later, the average weight gain in the study population was 2.1 kg with significant variation among participants (SD 5.0 kg). The results of this study indicate that changes in weight over 5 years based on UPF consumption show that higher UPF consumption is associated with greater weight gain. Analysis by quintile of UPF consumption confirms these findings, with participants in the highest quintile experiencing more weight gain than those in the lowest quintile. Participants with normal weight initially in the highest quintile of UPF consumption had a 15%</p> |

| No | Titles | Researcher / Year | Methods | Results |
|----|--|-----------------------------|---|---|
| | | | and smoking history were collected through validated questionnaires at the start of the study. The relationship between UPF consumption and weight changes was analyzed using multilevel mixed linear regression with centers as random effects and UPF consumption and confounding factors as fixed effects. Potential interactions between UPF consumption and factors such as age, gender, and BMI category were also tested. | higher risk of becoming overweight or obese during the follow-up period. Similarly, overweight participants initially had a 16% higher risk of becoming obese (P trend <0.001) compared to the lowest quintile of UPF consumption. The conclusion of this prospective study of adults from 9 European countries representing a population with a heterogeneous diet provides additional evidence that a higher proportion of UPF in the diet is associated with greater weight gain and a higher risk of developing overweight or obesity. |
| 9 | High Consumption of Ultra-Processed Food is Associated with Incident Dyslipidemia: A Prospective Study of Older Adults | (Donat-Vargas et al., 2021) | <p>This study was a cohort study utilizing data from the Seniors-Study on Nutrition and Cardiovascular Risk in Spain (ENRICA) Cohort in Spain, the methods of which have been previously reported. This cohort was established between 2008 and 2010 with non-institutionalized individuals aged ≥ 60 years. Participants were followed up until 2015 when additional data collection was conducted. With a response rate of 72%, the cohort consisted of 1821 participants.</p> <p>Dietary assessment and UPF consumption: To measure participants' habitual food consumption, a validated computerized dietary history (DH-ENRICA) was used. This dietary history comprised a structured questionnaire administered by trained interviewers regarding the foods consumed at each mealtime, from breakfast to bedtime. All foods were recorded and classified according to the NOVA classification, which organizes foods into 4 groups based on the extent and purpose of industrial processing.</p> <p>The association between the percentage of energy from UPF in the diet and the incidence of hypertriglyceridemia, low HDL cholesterol, and high LDL cholesterol were obtained using logistic regression.</p> | <p>From 1082 participants, the average age was 68 years (± 6 years), with 52% being women. The mean percentage of energy from UPF was 18.7% ($\pm 11.2\%$). The UPF groups contributing the most to the total UPF consumed were: cookies and pastries (31.2%), processed meat and meat products (15.7%), breakfast cereals and breads (11.1%), and sweets (10.9%). The baseline concentrations of triglycerides, HDL cholesterol, and LDL cholesterol were 91.4 mg/dL (± 26.5 mg/dL), 58.7 mg/dL (± 12.1 mg/dL), and 109 mg/dL (± 16.3 mg/dL) respectively. During the 5–7 year follow-up period, the average concentrations of triglycerides, HDL cholesterol, and LDL cholesterol were 95.2 mg/dL (± 36.9 mg/dL), 56.8 mg/dL (± 13.1 mg/dL), and 102 mg/dL (± 23.9 mg/dL) respectively.</p> <p>Regarding the incidence of dyslipidemia during follow-up, 60 participants (out of 895) experienced hypertriglyceridemia (≥ 150 mg/dL), 112 (out of 878) had low HDL cholesterol (<40 in men or <50 mg/dL in women), and 54 (out of 472) had high LDL cholesterol (>129 mg/dL). After adjusting for potential confounders, those in the highest tertile compared to the lowest tertile of UPF energy percentage had more than double the odds of developing hypertriglyceridemia or low HDL cholesterol.</p> <p>This study concludes that UPF consumption is associated with an increased risk of dyslipidemia risk factors such as hypertriglyceridemia and low HDL cholesterol. However, no association was found between UPF consumption and high LDL cholesterol.</p> |

Ultra-processed foods (UPF) are designed to have high palatability, easy accessibility, and immediate consumption, which may explain their increased consumption in recent decades in high- and middle-income countries. Based on several studies, the percentage of total energy derived from UPF is 17.0% in Spain, 24.6% in Brazil, 48.6% in the UK, 45.0% in Canada, and 56.1% in the United States. In addition to high and widespread consumption, UPF also has other characteristics that may be related to metabolic disease risk factors (González-Palacios et al., 2023). Fardet et al (2017) found that the higher the level of food processing, the lower its satiating potential, which may lead to increased daily intake. UPF consumption is also associated with poor nutritional intake. Along with the increased consumption of UPF, the total energy content, carbohydrates, free sugars, total fat, and saturated fat in foods have also increased, while the content of protein, fiber, some vitamins, and minerals has decreased. A recent review indicates that the biological mechanisms supporting the relationship between UPF and cardiovascular disease include increased energy intake, changes in satiety signals between the gut and brain, hormonal effects, and changes in the gut microbiome (Martini et al., 2021).

Several mechanisms and factors can explain the positive relationship between ultra-processed food (UPF) consumption and increased mortality rates. Firstly, increased UPF consumption is associated with overall poor diet quality and excessive calorie intake due to the high energy density and low satiety of UPFs, all of which may be linked to increased mortality. Secondly, diets high in UPF content provide large amounts of trans fatty acids, salt, and/or sugar. Thirdly, higher UPF intake is associated with unhealthy behaviors such as smoking or a sedentary lifestyle. Fourthly, some studies have shown a significant relationship between mortality from cardiovascular disease (CVD) and UPF consumption, although UPF-rich diet characteristics such as low-fat quality, low consumption of fresh fruits and vegetables, and high sodium content indicate adverse effects on CVD mortality (Torres-Collado et al., 2024).

The following research results indicate the association between ultra-processed food consumption and metabolic syndrome. Ultra-processed food (UPF) intake increases the risk of hypertension and, consequently, cardiovascular disease (CVD) (Rey-García et al., 2021). Based on a recent meta-analysis by (Pagliai et al., 2021) the risk of developing cardiovascular disease (CVD)

increases with high UPF consumption (RR: 1.29, 95% CI: 1.12-1.48; n = 5). Furthermore, a recent meta-analysis examining the relationship between UPF intake and hypertension risk shows a strong association between high UPF intake and hypertension risk (OR: 1.23; 95% CI: 1.11-1.37; P = 0.034, n = 9) (Cai et al., 2022). Recent dose-response meta-analyses also indicate that a 10% increase in UPF intake raises the risk of type 2 diabetes by 15%. Consistent with these findings, our dose-response meta-analysis results indicate that each additional daily portion of UPF increases the risk of CVD by approximately 6%. Therefore, it is important to address risky eating habits and raise awareness about reducing UPF consumption to mitigate the risk of lifestyle-related diseases (Guo et al., 2023).

The majority of observational studies indicate a positive association between ultra-processed food (UPF) consumption and various anthropometric measures such as BMI, overweight, obesity, and abdominal obesity. Nearly all of these studies use the NOVA classification system to assess UPF consumption. In a large prospective study involving the NutriNet-Santé French cohort (n = 110,260), it was found that UPF intake was associated with increased BMI and the risk of overweight and obesity. All studies examining the relationship between UPF consumption and the risk of type 2 diabetes (T2D) also found a strong and positive association using the NOVA food classification (Grinshpan et al., 2024).

4 CONCLUSIONS

The conclusion drawn from this research indicates a significant association between the consumption of ultra-processed foods (UPF) and an increased risk of obesity, metabolic syndrome, and cardiovascular disease (CVD). Studies demonstrate that high UPF consumption is linked to elevated BMI, overweight, abdominal obesity, and increased risk of hypertension and type 2 diabetes. UPF is also known to diminish overall nutritional quality and escalate calorie, carbohydrate, free sugar, total fat, and saturated fat intake while reducing protein, fiber, vitamin, and mineral intake. Furthermore, UPF consumption often accompanies unhealthy behaviors such as smoking and sedentary lifestyles. Therefore, it is paramount to limit UPF consumption through education and public health policies that promote healthy eating patterns and increased intake of minimally processed fresh foods.

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