Ultra-Processed Food Consumption Patterns as an Early Risk Factor for Obesity and Cardiovascular Disease in Today's Adolescents

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ABSTRACT

Modern dietary shifts have increased ultra-processed food (UPF) consumption, particularly among adolescents, raising concerns about obesity and cardiovascular disease (CVD) risk. This review analyzes the relationship between UPF intake and obesity and CVD risk in adolescents based on evidence from observational and cohort studies conducted in Korea, Brazil, Canada, and Indonesia. Key parameters included UPF contribution to total energy intake, body mass index (BMI), waist circumference, and blood pressure. The analysis found that UPF accounts for up to 40% of daily energy intake in adolescents. High UPF consumption significantly increased the risk of central adiposity (OR: 1.9) and high cardiovascular risk (OR: 3.77). Consistent associations were observed across countries for increased risk of obesity, hypertension, and diabetes. In Indonesia, over 80% of adolescents regularly consume UPF, with 29% experiencing overnutrition. In conclusion, high UPF consumption is strongly associated with increased obesity and cardiovascular risk from adolescence. Targeted nutritional interventions and public health policies to restrict UPF intake are urgently needed to mitigate long-term health impacts.

Keyword : cardiovascular disease; body mass index; obesity; total energy intake; Ultra-pocessed food.

Introduction

Obesity is a global health problem that continues to increase in various age groups, including children and adolescents. According to the World Health Organization (WHO), more than 650 million adults worldwide are obese, and this number has increased sharply in recent decades as people's consumption patterns have shifted towards convenient but nutritionally poor foods. This trend is not only occurring in adults, but also in children and adolescents, who are now showing a

significant increase in the prevalence of obesity and risk factors for cardiovascular disease. National data from Indonesia also shows a similar trend, with an increase in overweight and obesity among adolescents in the last five years, largely influenced by changes in consumption patterns towards fast food and processed products[8].

One of the main causes of this increase is the shift in consumption patterns towards ultra-processed foods (UPF). Based on the NOVA classification, UPF are ready-to-eat industrial products that are manufactured through various processing methods with the addition of food additives such as sugar, salt, fat, and synthetic additives that enhance the taste, color, and shelf life of the product (11). These types of foods are high in energy, low in fiber and micronutrients, but are often consumed in large portions due to their easy availability and relatively low price, especially among adolescents in urban areas[6,7]. Various global studies show a strong association between UPF consumption and an increased risk of obesity, abdominal adiposity, and metabolic disorders. In the Korean adult population, UPF consumption accounts for an average of 17.9% of total daily energy, and individuals with the highest consumption have a 1.24 times greater risk of obesity compared to the group with the lowest consumption[1]. Similar results were found in the adult population in Canada, where the group with the highest UPF consumption had a 31% higher risk of obesity, 37% higher risk of diabetes, and 60% higher risk of hypertension after adjusting for socio-demographic factors[2].

The evidence in children and adolescents is also growing stronger. A study of 232 children and adolescents with congenital heart disease showed that UPF consumption accounted for approximately 40.7% of total daily energy intake. Each 10% increase in the proportion of UPF consumption increased the risk of central adiposity by 1.9 times and the risk of being classified as high cardiovascular risk by 3.77 times, after controlling for confounding factors[3]. Other studies have shown that high UPF consumption in children and adolescents is associated with an increased risk of obesity, dyslipidemia, and high blood pressure[6]. Meta-analytic analysis also shows that increased UPF consumption is associated with an increased risk of overweight (OR 1.36), obesity (OR 1.55), and abdominal obesity (OR 1.41) in a dose-response relationship pattern[5]. In Indonesia, various studies show similar patterns. More than 80% of students in urban areas consume UPF regularly[7], while a study in Semarang found that 29% of school children are overweight and 76% of snacks consumed are classified as UPF[9]. National data also indicates an increase in the consumption of fast food and sweetened beverages among adolescents[8]. This phenomenon shows that lifestyle changes and easy access to processed foods are accelerating dietary transitions among adolescents.

In addition, UPF consumption plays an important role in increasing the risk of cardiovascular disease through chronic inflammation, dyslipidemia, and insulin resistance caused by high levels of saturated fat, sodium, and added sugar in processed products[4,10]. Excessive UPF consumption during adolescence also has long-term effects on increasing the risk of coronary heart disease and metabolic syndrome in adulthood[3,5,10]. However, there are several significant research gaps in the Indonesian context. There has been no comprehensive review that specifically analyzes and synthesizes the

relationship between UPF consumption and obesity and cardiovascular risk in the Indonesian adolescent population. Most of the evidence still comes from small-scale studies in certain regions, which do not provide a comprehensive picture of the national situation. In addition, analysis of the dominant types of UPF, socio-cultural factors, and environmental influences on consumption behavior is still limited. Therefore, more in-depth and contextual research is needed to support the formulation of effective nutrition policies and interventions for Indonesian adolescents[12].

Material and Methods

The method used was a literature search from various scientific sources discussing the relationship between ultra-processed food (UPF) consumption patterns and the risk of obesity and cardiovascular disease (CVD) in today's adolescents. The search process was conducted using the PICO (Population, Intervention, Comparison, Outcome) framework approach to facilitate the search for relevant sources. The PICO framework used in this study is as follows:

- Population (P): Adolescents aged 10–19 years
- Intervention (I): Consumption of ultra-processed foods
- Comparison (C): Diet based on natural or minimally processed foods
- Outcome (O): Increased risk of obesity and cardiovascular disease

Literature searches were conducted through PubMed, Scopus, Web of Science, Google Scholar, and ResearchGate, using the following English keywords: (“Ultra-processed food” OR ‘UPF’) AND (Obesity OR “Cardiovascular disease” OR “Non-communicable disease”) AND (Adolescents OR Teenagers OR Youth). The keyword combinations were arranged using the Boolean Operator method to broaden and narrow the search results as needed. The publication time limit was set between 2020 and 2025 to ensure the latest data updates. The types of publications selected included scientific research articles (original research), observational studies (cross-sectional, cohort, or longitudinal), as well as systematic and narrative reviews relevant to the research topic.

Inclusion criteria include: Articles in English or Indonesian, Open access, Population of children or adolescents, Analysis assessing the relationship between UPF consumption and obesity or cardiovascular risk factors. Exclusion criteria included: Non-research articles (such as editorials, letters, or comments), Studies with adult populations without adolescent groups, Studies that did not use the NOVA food classification, Journals with limited access. The search yielded 15 scientific articles, which were then selected based on the inclusion and exclusion criteria, leaving 5 main articles used in the analysis and discussion. These articles covered studies from various countries, such as Brazil, Korea, Canada, Iran, and Indonesia, which consistently reported a significant relationship between ultra-processed food consumption and an increased risk of obesity and cardiovascular disease in adolescents.

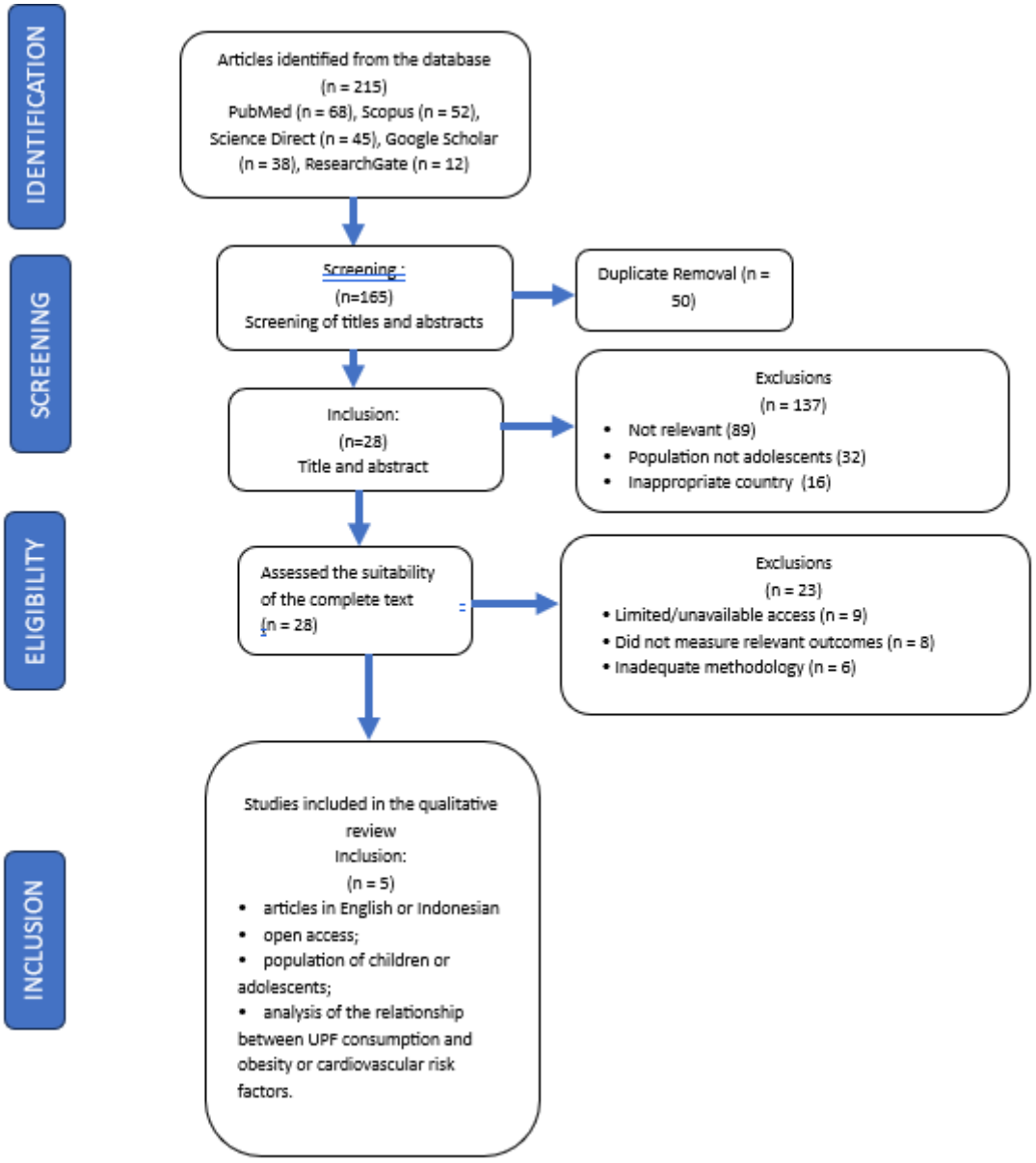

Figure 1. PRISMA Chart Flow

Result and Discussion

Tabel 1. Literature Tabel

TITLE	AUTHOR & YEAR	METHOD	RESULT
Ultra-processed food intake is associated with children and adolescents with congenital heart disease clustered by high cardiovascular risk factors DOI :	Michele Honicky, *et al* (2023)	Design: Cross-sectional study Population & Sample: 232 children and adolescents aged 5–18 years with congenital	Average UPF intake: 40.69% of total daily energy. Most common UPF groups: • Fast food (22.2%)

https://doi.org/10.1017/S0007114522002240		heart disease (CHD) Patients underwent surgery or cardiac catheterization and were undergoing outpatient treatment at two referral hospitals in southern Brazil Data Collection: Dietary intake was assessed using three 24-hour dietary recalls (two weekdays, one weekend) Food classification used the NOVA classification, separating ultra-processed foods (UPF) Cardiovascular risk factors measured: Central adiposity (waist circumference ≥ 75th percentile) hs-CRP (≥ 3 mg/L) Subclinical atherosclerosis (carotid intima-media thickness ≥ top third) Participants were grouped into high- and low-risk clusters using two-stage cluster analysis Statistical analysis with SPSS v23 and multivariate logistic regression, adjusting for confounding factors	• Sweeteners (17.7%) • Sweet cereals & biscuits (9.8%) Risk factors found: • Central adiposity: 24.6% • High hs-CRP: 12.5% • Subclinical atherosclerosis: 33.2% • 22.3% of children/adolescents with CHD were included in the high cardiovascular risk cluster Main results of logistic regression: • Every 10% increase in UPF intake → increases the risk of central obesity (OR = 1.90; 95% CI: 1.01–3.58) • A 10% increase in UPF intake → increases the likelihood of being included in the high cardiovascular risk cluster (OR = 3.77; 95% CI: 1.80–7.87) • The relationship is particularly significant in adolescents (OR = 4.66 for central obesity)
Ultra-Processed Foods and Cardiovascular Disease: Where Do We Go From Here? DOI: https://doi.org/10.1016/j.	Robert J. Ostfeld, MD, MSc (Division of Cardiology, Montefiore Health System, New York, USA),*et al* (2021)	**Framingham Offspring Cohort Study:** • n = 3,003 adults without initial CVD • Average follow-up: 20.2 years	**Key findings from Juul et al. (2021):** • Average UPF consumption: 7.5 servings/day • Each 1-serving/day

jacc.2021.02.003		• Diet assessment: Food Frequency Questionnaire (FFQ) • UPF categorized using the NOVA classification	increase in UPF was associated with: • ↑ Total CVD event risk: 7% • ↑ Coronary heart disease risk: 9% • ↑ CVD mortality risk: 9% • No significant association was found between UPF and total mortality (HR 1.01; 95% CI 0.99–1.04) Sub-analysis: • Only ultra-processed bread, ultra-processed meat, and ultra-processed low-calorie beverages were significantly associated with poor CVD outcomes. • Breakfast cereals were associated with better CVD outcomes (possibly due to fortification effects).
Ultra-Processed Food Consumption and Risk of Overweight and Obesity: the University of Navarra Follow-Up (SUN) Cohort" **DOI:** https://doi.org/10.1007/s13679-020-00429-3	Miguel A. Martínez-González,*et al* (2020)	Design: Prospective cohort study Population: 8,451 participants from the SUN Project (University of Navarra, Spain) Follow-up duration: 9 years (median follow-up 8.9 years) Instruments: Validated Food Frequency Questionnaire (FFQ) to measure Ultra-Processed Food (UPF)	Positive relationship between UPF consumption and obesity risk. Participants with the highest UPF consumption had a 26% higher risk of being overweight or obese compared to those with the lowest consumption. (HR = 1.26, 95%

		consumption based on the NOVA classification system. Analysis: Cox proportional hazard models were used to calculate the relative risk (hazard ratio) of overweight/obesity due to UPF consumption. Controlled variables: age, gender, physical activity, total energy intake, smoking, and sociodemographic factors.	CI: 1.12–1.41, $p < 0.001$). Cumulative effect on body weight. Each 5% increase in energy intake from UPF was associated with a 0.12 kg/m² increase in average BMI during follow-up. The effect remained significant after multivariate adjustment. Dietary patterns influenced the results. Those who consumed more UPF tended to have low fiber intake, high saturated fat intake, and low adherence to the Mediterranean diet. Biological explanation: UPF are high in energy, low in micronutrients, and affect the regulation of hunger hormones (ghrelin, leptin). Additives, added sugars, and soft textures increase palatability, thereby increasing calorie intake.
Ultra-Processed Food Consumption and Obesity in Korean Adults **DOI:** https://doi.org/10.4093/d	Seung-Hwan Lee,*et al* (2022)	Design: Prospective cohort study Data source: Korean Genome and Epidemiology Study	UPF consumption is significantly associated with an increased risk of type 2 diabetes.

mj.2022.0026	(KoGES) Number of participants: 113,561 Korean adults aged 40–69 years Follow-up period: 2004–2018 (median follow-up: ±10 years) Diet assessment: Used the Food Frequency Questionnaire (FFQ) to calculate the proportion of energy derived from ultra-processed foods (UPF) based on the NOVA system classification. Statistical analysis: Cox proportional hazard regression was used to calculate the hazard ratio (HR) and 95% confidence interval (CI) of type 2 diabetes incidence. Variable adjustments: age, gender, physical activity, smoking status, alcohol consumption, total energy intake, BMI, and family history of DM.	Participants with the highest UPF consumption had a 39% higher risk of developing type 2 diabetes compared to the lowest group. (HR = 1.39, 95% CI: 1.22–1.58, p < 0.001). Positive dose-response relationship. Each 10% increase in energy from UPF → 12% increase in risk of type 2 diabetes. The correlation remained significant even after adjusting for obesity and other lifestyle factors. Differences by gender and age. The association was stronger in women and younger participants (<50 years). This suggests a higher potential for metabolic vulnerability in this group. Biological mechanisms explained: High UPF intake of sugar, saturated fat, and additives causes oxidative stress, gut microbiota dysbiosis, and low-

			grade chronic inflammation, leading to insulin resistance and impaired pancreatic β-cell function.
Ultra-Processed Foods and Coronary Artery Disease Severity: A Cross-Sectional Study of At-Risk Normal-Weight and Overweight Patients Undergoing Elective Angiography **DOI :** 10.1186/s41043-025-00796-4	Zeinab Ghorbani,*et al* (2025)	• Design: Cross-sectional study. • Location: Nutrition Heshmat Registry (NUTHER), Rasht, Iran. • • Study period: January 2022 – June 2023. • • Number of participants: 1,015 adult patients at risk of heart disease who underwent elective angiography. • Primary measurements: • 1. Food consumption: • o Measured using a 168-item Food Frequency Questionnaire (FFQ). • o Food classification was performed using the NOVA system distinguishing between whole foods, processed foods, and ultra-processed foods (UPF). • Examples of UPF: packaged snacks, sweetened beverages, sausages, burgers, instant noodles, commercial white bread, and	High UPF consumption is associated with a significant increase in CAD severity. Patients with the highest UPF consumption have a much higher risk of severe CAD than those with the lowest consumption. Detailed data: Normal weight group: Highest UPF quartile → 5.01 times higher risk of severe CAD (OR = 5.01; 95% CI: 1.89–13.29; p = 0.002). Overweight/obese group: Highest quartile of UPF → 3.53 times higher risk of severe CAD (OR = 3.53; 95% CI: 2.07–5.99; p < 0.001). Positive dose–response relationship. Each 10% increase in energy from UPF was associated with an approximately 1.6–2.2-fold increase in the risk of severe CAD.

	ready-to-eat meals. • 2. CAD severity: Assessed using the Gensini Score, which evaluates the degree of coronary artery narrowing. • A score ≥60 is considered severe CAD. 3. Data analysis: • Used multivariate logistic regression and restricted cubic spline (RCS) to examine the dose–response relationship. • Adjusted for various confounding factors such as age, gender, physical activity, smoking, blood pressure, cholesterol, and total daily energy intake.	UPF types most contributing to risk: Packaged snacks and sweets, Sugary soft drinks, Ready-to-eat or frozen ready-to-heat meals. Other important findings: The relationship remained significant after accounting for total calories and overall diet quality. The negative effects of UPF are not only due to their high calorie content, but also due to additives, sugar, saturated fat, and lack of micronutrients, which increase inflammation and oxidative stress.

The Relationship Between Ultra-Processed Food Consumption Patterns and Obesity Incidence in Adolescents

The consumption of ultra-processed foods (UPF) has become one of the main characteristics of modern diets among adolescents. Changes in lifestyle, the availability of fast food, and the influence of social media have made this age group a prime target for the processed food industry. A study by Shim et al. shows that UPF consumption accounts for approximately 17.9% of total daily energy intake, with a prevalence of obesity at 35.4% and abdominal obesity at 30.2%. Individuals in the highest quartile of UPF consumption had higher BMI (β=0.36; 95% CI 0.15–0.56) and waist circumference (β=1.03; 95% CI 0.46–1.60) compared to those in the lowest quartile. The risk of obesity increased 1.24 times, while the risk of abdominal obesity increased 1.34 times after controlling for sociodemographic factors, behavior, and family medical history[1].

The decrease in association strength after adjusting for total energy and diet quality indicates

that UPF consumption contributes to obesity through excess energy and low overall nutritional quality. UPFs are generally high in simple sugars, saturated fats, and sodium, but low in protein, fiber, and micronutrients. This pattern causes chronic energy imbalance that promotes body fat accumulation. In adolescents, the rapid growth phase amplifies these negative effects because high energy needs are often met by calorie-dense but nutrient-poor UPF products. In the long term, UPF consumption can alter the regulation of hunger (ghrelin) and satiety (leptin) hormones, leading to energy homeostasis disorders that exacerbate the risk of obesity[1].

The Impact of UPF Consumption on Children and Adolescents as a Predictor of Early Cardiovascular Risk

Research by Honicky et al. reinforces the view that the impact of UPF is not limited to obesity, but is also directly related to cardiovascular risk factors from childhood and adolescence. In a study involving 232 children and adolescents with congenital heart disease (CHD), UPF consumption reached 40.7% of total daily energy. Each 10% increase in energy from UPF increased the risk of central adiposity (OR=1.90) and the combined risk of cardiovascular risk factors (waist circumference, hs-CRP, and carotid intima-media thickness) by up to 3.77 times[2].

These findings indicate that UPF triggers systemic inflammatory processes and endothelial dysfunction underlying the pathogenesis of atherosclerosis. The trans fat, added sugar, and synthetic additives in UPF increase C-reactive protein (CRP) levels and accelerate plaque formation in the arteries. In the context of adolescents, chronic exposure to these components can accelerate the onset of subclinical atherosclerosis even before clinical symptoms of heart disease appear. Additionally, high UPF consumption patterns are often accompanied by low physical activity, insufficient sleep, and psychological stress, which collectively reinforce the pathophysiological pathways leading to early metabolic and cardiovascular disorders[2]. Thus, early detection and modification of dietary behavior in adolescents are crucial steps to prevent the accumulation of cardiovascular risk from a young age.

Correlation between UPF Consumption and Cardiovascular Disease Incidence

A study by Ostfeld and Allen in the Journal of the American College of Cardiology provides a global perspective on the impact of UPF on cardiovascular disease (CVD). Based on analysis of large cohort data such as the Framingham Offspring Study and NutriNet-Santé, it was found that every 10% increase in UPF consumption was associated with a 9% increase in the risk of coronary heart disease, a 7% increase in the risk of CVD overall, and a 9% increase in the risk of death from CVD[3].

This increased risk mainly stems from types of UPF such as processed bread, processed meat, fast food, and low-calorie drinks. The content of additives such as heterocyclic amines and acrylamide produced by high-temperature heating can cause oxidative stress, DNA damage, and changes in gut microbiota that negatively impact lipid metabolism. Conversely, consumption of whole foods such as fruits, vegetables, and whole grains has been shown to reduce the risk of CVD

through antioxidant effects and increased insulin sensitivity. Therefore, in adolescents who are beginning to form long-term eating patterns, limiting UPF consumption is key to preventing atherosclerosis and hypertension in adulthood[3].

The Relationship between UPF Consumption and Metabolic Disorders in Adolescents

A nationwide study in Canada by Nardocci et al. provides strong evidence of the link between UPF and metabolic disorders. In an analysis of 13,608 respondents, the highest UPF consumption (73% of daily energy) was associated with an increased risk of obesity (OR=1.31), diabetes (OR=1.37), and hypertension (OR=1.60) compared to the lowest consumption group[4]. This association remained significant after controlling for age, gender, education, and lifestyle.

In adolescents, a diet high in UPF contributes to the development of metabolic syndrome, which is characterized by increased blood pressure, dyslipidemia, insulin resistance, and elevated triglyceride levels. High intake of simple sugars and sodium from packaged foods causes chronic hyperinsulinemia, which decreases insulin sensitivity and increases visceral fat storage. As a result, the risk of type 2 diabetes and hypertension may appear earlier than in populations consuming natural foods. Therefore, nutrition education and public policies that limit adolescents' access to ultra-processed products are crucial to prevent the transition to chronic diseases in adulthood[4].

The Effect of UPF on the Severity of Coronary Artery Disease as a Continuation of Risk from Adolescence

The results of Ghorbani et al.'s study show a strong association between UPF consumption and the severity of coronary artery disease (CAD). In a study involving 1,015 patients undergoing angiography, individuals with the highest UPF consumption had a 3–5 times higher risk of severe CAD compared to the lowest consumption group. Restricted cubic spline analysis showed a positive dose-response relationship between increased UPF consumption and Gensini scores, even after adjusting for BMI[5].

This suggests that the adverse effects of UPF are not only due to obesity, but also to direct inflammatory, oxidative, and atherogenic mechanisms. High salt content increases blood pressure and arterial stiffness, while saturated fat accelerates the formation of atherosclerotic plaque. In individuals who already have a predisposition to risk since adolescence, high UPF consumption can worsen the progression of coronary artery disease in adulthood. Thus, low-UPF dietary intervention since adolescence not only serves as primary prevention of obesity, but also as secondary prevention against long-term cardiovascular damage[5].

Implications for Public Policy and Adolescent Health Promotion

Various studies show that the increase in UPF consumption among adolescents is not only an individual issue, but also a structural problem that requires a public policy approach and community-based health promotion. The World Health Organization (WHO) and the Pan American Health Organization (PAHO) have recommended restricting advertising of ultra-processed foods to children and adolescents, implementing nutrition warning labels on packaging, and imposing taxes on sugar-

sweetened beverages to reduce consumption among the general public[11].

In the context of adolescents, health promotion should focus on digital nutrition literacy education, as most consumption decisions are influenced by social media and online advertising. School-based programs have also been shown to be effective in reducing UPF consumption by providing healthy foods in school cafeterias and training in simple cooking skills using fresh ingredients[7]. In addition, the government can play a role by regulating a healthier food environment, such as restricting the sale of ultra-processed foods around schools and encouraging family participation in monitoring children's diets.

With the implementation of cross-sectoral policies and sustainable health promotion strategies, it is hoped that the prevalence of adolescent obesity and the burden of chronic heart disease can be significantly reduced in the future[11,12].

Conclusion

The rapid increase in ultra-processed food (UPF) consumption among adolescents, both globally and in Indonesia, represents a significant public health concern. Epidemiological evidence shows that UPF contributes 25–50% of total daily energy intake in many populations, with even higher proportions among adolescents in urban and school settings. Excessive UPF intake is consistently associated with elevated body mass index, increased waist circumference, and higher prevalence of obesity. Moreover, each incremental increase in UPF-derived energy correlates with greater risks of central adiposity, hypertension, dyslipidemia, and other metabolic disturbances that serve as early precursors of cardiovascular disease. During adolescence, high UPF exposure has been demonstrated to contribute to rising blood pressure, visceral fat accumulation, and elevated inflammatory biomarkers, indicating that adverse effects manifest well before adulthood. Physiologically, the hyperpalatability, low fiber content, and high levels of added fats and sugars in UPF disrupt appetite regulation, promote insulin resistance, and induce low-grade chronic inflammation. In Indonesia, high UPF consumption among adolescents, particularly through school snacks and instant products, has become embedded in daily life and is accompanied by rising rates of overnutrition. It can be concluded that high UPF consumption is an early risk factor for obesity and cardiovascular disease in today's adolescents. Without comprehensive prevention strategies and public policies to reduce UPF intake and establish healthy eating habits from school age, long-term exposure to ultra-processed foods will likely impose a substantial future public health burden.

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