Health Problems of Civilization
eISSN: 2354-0265, ISSN: 2353-6942

REVIEW PAPER

Food environment transformation and ultra-processed food availability as determinants of obesity in post-transition Central and Eastern European countries: a narrative review

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Podwiak F. Food environment transformation and ultra-processed food availability as determinants of obesity in post-transition Central and Eastern European countries: a narrative review. Health Prob Civil. https://doi.org/10.29316/hpc/236241

Tables: 2
Figures: 1
References: 43
Submitted: 2026 May 14
Accepted: 2026 Sep 9

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Abstract

The countries of Central and Eastern Europe (CEE) underwent profound socioeconomic transformation following the collapse of communist regimes in the late 1980s and early 1990s. These transitions were accompanied by rapid liberalization of food markets, the entry of multinational food corporations, and fundamental restructuring of food environments. Concurrently, the region has experienced a marked rise in overweight and obesity prevalence, with several CEE countries now ranking among the highest in Europe. Ultra-processed foods (UPFs), as defined by the NOVA classification system, are industrially manufactured formulations that are energy-dense, nutrient-poor, and increasingly prevalent in post-transition food environments. The specific context of CEE countries remains underrepresented in English-language literature. This narrative review synthesizes available evidence on food environment transformation in CEE since 1990, documents trends in UPF availability and consumption, examines biological mechanisms linking UPF intake to obesity, and evaluates the current policy landscape. Evidence suggests that post-communist market liberalization created conditions favorable to UPF market expansion, contributing to dietary shifts that may help explain rising obesity rates. Public health responses in CEE have lagged behind those in both Western Europe and Latin America, creating a critical gap that requires urgent policy attention.

Keywords: processed food, nutrition policy, Eastern Europe, obesity, nutrition

Introduction

The World Health Organization (WHO) defines health as a state of complete physical, mental, and social well-being [1]. It recognizes obesity as one of the most serious threats to this ideal in the 21st century [2]. Globally, the prevalence of obesity has more than doubled since 1990, with approximately 1 in 8 adults now classified as living with obesity worldwide [2]. Europe has not been immune to this trajectory, and countries in Central and Eastern Europe (CEE) have experienced particularly steep increases in obesity rates since their political and economic transitions in the late 1980s and early 1990s [3,4].

The CEE region encompasses countries formerly part of or politically aligned with the Soviet Union, including Poland, the Czech Republic, Slovakia, Hungary, Romania, Bulgaria, and the Baltic states. Following the collapse of communist governance structures, these nations underwent rapid transitions to market economies, including the liberalization of trade, the privatization of state enterprises, and integration into global supply chains [5]. Among the

many consequences of this transformation, changes to food systems and food environments were profound and far-reaching.

The concept of the food environment, encompassing the physical, economic, political, and sociocultural contexts in which food choices are made, has gained increasing recognition as a structural determinant of dietary behavior and obesity risk [6]. In post-communist CEE countries, the food environment shifted dramatically within a very short period: state-controlled food distribution networks gave way to competitive retail markets, multinational fast-food chains established a rapid presence, and the supply of packaged, industrially processed foods expanded enormously [7].

Ultra-processed foods (UPFs), classified under the NOVA system as industrial food and drink formulations made mostly or entirely from substances derived from foods together with additives, have been identified as a central feature of contemporary obesogenic food environments [8,9]. The energy share contributed by UPFs to total dietary intake has been rising across European countries, with CEE nations showing particularly rapid upward trends compared to Western Europe in recent decades [10].

Despite the significance of this regional pattern, CEE-specific evidence on the relationship between food environment transformation, UPF availability, and obesity remains scarce and fragmented in English-language scientific literature. Most large-scale reviews and policy analyses have focused on Western European, North American, or Latin American contexts, leaving the post-communist dietary transition inadequately synthesized. This review addresses that gap.

Aim of the work

This narrative review aims to synthesize and critically examine the available evidence on the relationships among post-communist food environment transformation, UPF availability and consumption, and obesity prevalence in CEE countries. Specifically, this review seeks to:

1. document the nature and scale of food environment changes in CEE countries since 1990;
2. describe trends in UPF availability and consumption in the region;
3. outline the biological mechanisms through which UPF intake promotes obesity;
4. examine socioeconomic and cultural factors mediating UPF consumption in post-transition CEE populations;

5. assess the current public health and regulatory policy landscape in CEE in relation to UPFs;
6. identify research gaps and propose directions for future investigation.

Methods

This review was conducted as a narrative review of peer-reviewed literature and relevant gray literature sources. A search of electronic databases was performed, including PubMed/MEDLINE, Scopus, and Web of Science. The following key terms and their combinations were used: "ultra-processed food", "NOVA classification", "food environment", "obesity", "Central Europe", "Eastern Europe", "post-communist", "dietary transition", "food market liberalization", and "non-communicable diseases". Additional searches were conducted using Google Scholar to capture gray literature, reports from international organizations (WHO, Food and Agriculture Organization (FAO), European Food Safety Authority (EFSA), Eurostat), and publications not indexed in primary databases. This review aimed to synthesize representative and recent evidence rather than conduct an exhaustive systematic search. A narrative approach was chosen because the evidence base is heterogeneous, spanning dietary surveys, sales data, ecological studies, policy documents, and gray literature from multiple CEE countries, and does not lend itself to formal meta-analytic synthesis.

Inclusion criteria encompassed: peer-reviewed original research articles, systematic reviews, meta-analyses, and narrative reviews published in the English language; publications focused on UPF consumption, food environment characteristics, or obesity epidemiology in European populations, with at least partial coverage of CEE countries; publications from 2000 to 2025, with priority given to literature published in the last three years; reports from authoritative international organizations with data relevant to the CEE context. Older foundational sources were retained where necessary to document the historical context of the post-communist food system transition, for which no recent equivalents exist. Exclusion criteria included studies focused exclusively on non-European populations without comparative European data, studies limited to pediatric populations without adult or population-level data, and publications for which the full text was unavailable.

Given the narrative nature of the review, no formal quality scoring, meta-analytic synthesis, or PRISMA-based screening protocol was performed, thus exact per-database record and exclusion counts and stage-specific reasons for exclusion are not reported. Literature identification and selection were performed by a single author, without independent dual-

reviewer screening, so no inter-rater agreement statistics or disagreement-resolution procedure apply. Critical appraisal of sources followed principles of the Scale for the Assessment of Narrative Review Articles (SANRA). Priority was given to: (I) study design and sample representativeness, with population-based or nationally representative data favored over convenience samples; (II) methodological transparency regarding UPF/NOVA classification; (III) recency, with studies published within the last three years prioritized where comparable evidence was available; (IV) direct relevance to the CEE context, with non-CEE evidence retained only where it provided mechanistic or comparative value.

A total of 43 sources were included in the final review. Given the breadth of the search strategy employed, the literature selection process is presented schematically in Figure 1 to enhance methodological transparency.

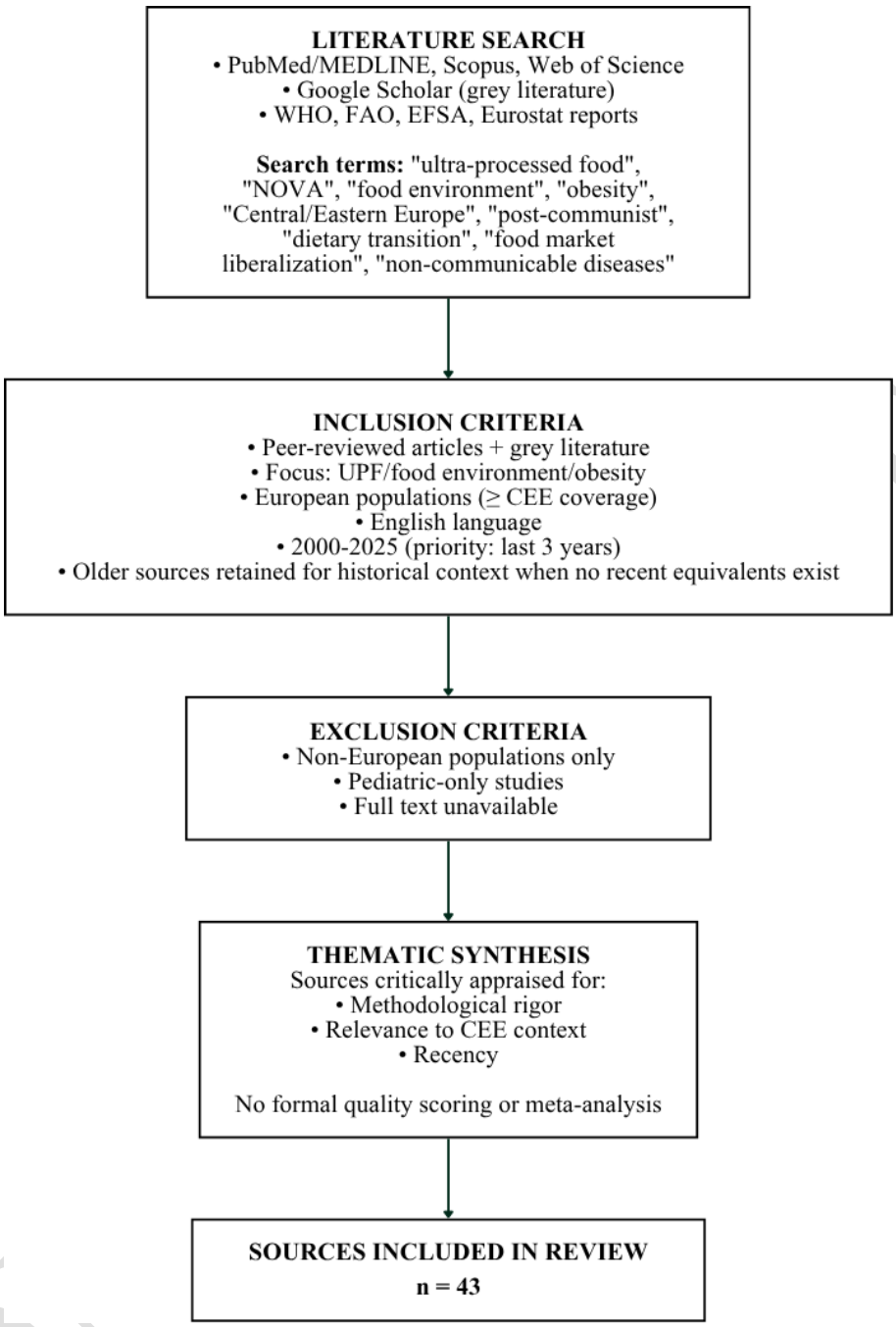

Figure 1. Literature search and selection strategy

Literature review results

Post-communist food environment transition in CEE countries

The transition from centrally planned to market economies in CEE countries from approximately 1989 to 1995 constituted one of the most rapid socioeconomic transformations in modern history. The consequences for food systems were immediate and substantial. State-

owned food enterprises were privatized or dissolved, import restrictions were lifted, and foreign direct investment in the food retail and manufacturing sectors surged [11]. Transnational food corporations, whose global expansion had been enabled by trade liberalization since the 1980s, rapidly entered CEE markets, establishing retail chains, fast-food restaurants, and food manufacturing facilities [12].

In the communist period, food distribution in CEE was characterized by state control, limited product variety, and a dietary pattern based largely on unprocessed staple foods, including grains, potatoes, root vegetables, legumes, and locally produced meats and dairy products [3]. While this diet had notable nutritional limitations, particularly in terms of fruit and vegetable variety, it was, by definition, low in UPFs simply because the industrial food production infrastructure did not exist on a larger scale [7].

After the transition, the food retail landscape changed remarkably within a single decade. Supermarket and hypermarket chains expanded aggressively, and by the mid-2000s, modern retail formats dominated food purchasing in urban and peri-urban CEE areas [13]. Large retail chains, through their supply chain relationships with multinational food manufacturers, systematically promote packaged and ultra-processed products, often at competitive prices compared to fresh alternatives [14].

Fast-food restaurant chains similarly expanded rapidly throughout the region. The symbolic and material significance of Western fast-food brands in post-communist CEE was notable: access to international fast-food chains represented, for many citizens, a clear sign of the new market economy and improved material standards of living [15]. This cultural dimension facilitated the rapid normalization of fast-food consumption habits, particularly among younger generations who came of age during the transition period.

Urbanization trends accelerated alongside economic transition. Rural-to-urban migration increased the proportion of the population dependent on purchased, rather than home-produced, food. Urban food environments, with their higher density of fast-food establishments and supermarkets relative to fresh-food markets, are widely recognized as more obesogenic than rural environments, particularly in post-communist urban structures characterized by large, prefabricated housing estates with limited walkability and limited access to healthy food options [16].

Trends in UPF availability and consumption in CEE

Quantifying UPF consumption in CEE populations is methodologically complex, as many national dietary surveys were not originally designed with NOVA classification in mind [8]. Nevertheless, several European-level studies provide important evidence. Analysis using data from the EFSA Comprehensive European Food Consumption Database, with NOVA classification applied to dietary records and 24-hour recalls across 22 European countries, found that the energy share from UPFs varied markedly across the continent, ranging from approximately 14% in Italy and Romania to 44% in the United Kingdom and Sweden [10].

Sales data from 2002 to 2016 indicate that UPF sales decreased slightly on average in Western Europe, while increasing substantially across CEE countries, reflecting a progressive shift in dietary patterns toward more processed foods following market liberalization [10]. More recent evidence reinforces this divergence: a 2025 global analysis of retail food environments across 97 countries from 2009 to 2023 found consistent increases in chain outlet density, grocery sales from chain retailers, and unhealthy food sales per capita, with these changes positively correlated with rising obesity prevalence – a pattern particularly relevant to CEE, where the modernization of retail food environments accelerated during this period [14]. Current NOVA-classified dietary survey data covering the post-2016 period in CEE remain limited, creating a methodological gap that constrains the precise quantification of recent consumption trends. A landmark ecological cross-sectional study of 19 European countries demonstrated that each percentage-point increase in household availability of UPFs was associated with a 0.25 percentage-point increase in obesity prevalence, after adjustment for national income, physical inactivity, smoking prevalence, and a time lag between estimates [17]. It is important to note that ecological study designs cannot establish individual-level causation, and residual confounding by unmeasured country-level variables, including physical activity infrastructure, healthcare access, and historical dietary patterns, cannot be excluded. These limitations mean that associations observed at the population level should be interpreted as hypothesis-generating rather than confirmatory evidence.

Analyses of the EU survey data for 2022 indicate that CEE countries bear a disproportionate burden of overweight. When the combined prevalence of overweight and obesity is considered, Romania and Poland lead among men at approximately 76%, followed by Croatia and Slovakia at 74% [4]. For obesity alone, the NCD Risk Factor Collaboration's pooled analysis of global trends places several CEE countries, including Hungary, the Czech Republic, and the Baltic states, among the highest-burden countries in Europe [4]. The

temporal correspondence between UPF market expansion and rising overweight/obesity prevalence in CEE since the 1990s constitutes an epidemiological signal warranting deeper investigation. However, it falls short of demonstrating causation given the ecological design of available data.

Country-level data reveal substantial heterogeneity within the region (Table 1). Romania reports among the lowest UPF energy shares in available European dietary surveys (approximately 14% of dietary energy) yet ranks among the highest in adult overweight prevalence [4,10]. Several explanations have been proposed. First, Romania's national dietary surveys rely on instruments not designed for NOVA classification [10], and the substantial informal and home-prepared component of the Romanian diet may be misclassified as "minimally processed" even when key ingredients are industrial inputs [8]. Second, the high overweight burden in Romania may reflect total energy intake from traditional energy-dense foods rather than NOVA-defined UPF intake specifically – a pattern consistent with ecological evidence showing dietary energy availability, rather than UPF share per se, as more strongly associated with obesity across Eastern Europe [18]. Third, large urban-rural gradients in food environments mean that population-average UPF shares mask divergent exposures across subpopulations [16,19]. The Romanian case is therefore a reminder that NOVA-applied dietary data with full national representativeness remains a research priority for the region. By contrast, countries with more advanced retail sector development and higher urbanization rates, such as Hungary, show higher UPF energy shares in available survey data [10]. In contrast, the Baltic states show intermediate consumption levels [10]. This intra-regional variation underscores the importance of country-specific analyses rather than treating CEE as a monolithic entity.

Table 1. Country-level UPF energy share and overweight/obesity burden in CEE [4,10,17]

Country group	UPF energy share (dietary energy)	Overweight/obesity prevalence indicator	Key note
Romania	~14% (lowest reported in region)	~76% combined overweight+obesity, men	"Romanian paradox" – low UPF share, high overweight; likely reflects NOVA misclassification and/or total energy intake from traditional foods
Poland	Not separately quantified in reviewed surveys	~76% combined overweight+obesity, men	-

Croatia	Not quantified	~74% combined overweight+obesity, men	-
Slovakia	Not quantified	~74% combined overweight+obesity, men	-
Hungary	Higher UPF energy share than Baltic states (no absolute % reported)	Among highest-burden countries for obesity (NCD-RisC pooled analysis)	Reflects more advanced retail sector development and higher urbanization
Baltic States	Intermediate UPF consumption level	Among highest-burden countries for obesity (NCD-RisC pooled analysis)	-
Czech Republic	Not quantified	Among highest-burden countries for obesity (NCD-RisC pooled analysis)	-

Notes: "Not quantified" indicates the reviewed sources did not report a country-specific UPF energy share figure, not that consumption is assumed to be zero or negligible.

Biological mechanisms linking UPF intake to obesity

Multiple biological mechanisms have been proposed to explain why UPF consumption promotes weight gain and obesity, operating at the levels of food composition, appetite regulation, digestive physiology, and gut microbial ecology [8].

Energy density and macronutrient profile represent the most straightforward mechanistic pathway. UPFs are typically high in free sugars, saturated fats, and refined starches, while being low in dietary fiber and protein [8]. This combination promotes positive energy balance by elevating energy intake and impairing satiety signaling. A 2024 randomized crossover study demonstrated that UPF consumption led to weight gain and increased ad libitum energy intake compared with non-UPF diets, partly through reduced chewing frequency, which accelerated eating rate and impaired appetite suppression [20].

Hyperpalatability – the engineering of foods to exceed natural palatability thresholds through combinations of sugar, fat, salt, and flavor additives – is a defining characteristic of UPFs and a central mechanism driving overconsumption [9]. The sensory properties of UPFs are deliberately optimized through industrial processing to stimulate hedonic eating behavior

independent of physiological hunger signals, undermining the normal homeostatic regulation of food intake [18].

Gut microbiome disruption represents an emerging mechanistic pathway of considerable importance. UPFs consist largely of acellular nutrients derived from substances extracted from foods rather than intact food matrices, which lack the fibrous cell walls that normally slow nutrient absorption and provide substrates for beneficial fiber-degrading gut microbiota [21]. UPF consumption has been shown to reduce gut microbiota diversity and increase intestinal permeability, thereby promoting systemic low-grade inflammation associated with obesity and metabolic syndrome [22].

The effects of food additives represent a further area of active investigation. Emulsifiers, artificial sweeteners, colorings, and preservatives are increasingly recognized as potentially disruptive to gut microbiome composition and intestinal barrier integrity. However, the direct contribution of specific additives to obesity, as distinct from the broader dietary pattern, remains difficult to isolate methodologically [23,24]. Residual confounding and classification limitations inherent to the NOVA system, which groups nutritionally heterogeneous products under the same UPF label, should be acknowledged when interpreting mechanism-specific evidence [25].

A 2024 umbrella review of meta-analyses confirmed consistent associations between higher UPF consumption and a broad range of negative health outcomes across multiple disease categories [26]. A 2024 meta-analysis published in The BMJ, examining 32 prospective studies, identified a 17% increased risk of cardiovascular disease and a 15% increased all-cause mortality risk among those with the highest UPF intake [21]. A 2023 systematic review of prospective studies confirmed that UPF consumption is associated with increased incidence of general and abdominal obesity, as well as elevated risk of hypertension, type 2 diabetes, and dyslipidemia [27].

Socioeconomic and cultural dimensions in CEE

The relationship between UPF consumption and obesity in CEE cannot be fully understood without accounting for the socioeconomic and cultural factors that mediate food choice in the region. The post-communist transition generated significant social inequality, with segments of the population experiencing sharp declines in purchasing power, while others benefited from economic growth [5]. UPFs, being typically cheaper per calorie than fresh,

minimally processed alternatives, became an important component of food security strategies for lower-income households [9].

Educational and health literacy gradients in UPF consumption are evident across Europe, where sociodemographic characteristics, including age, urbanization, income, and education, show varying but consistent associations with UPF intake [19]. Food marketing targeting children and adolescents has been identified as a major driver of UPF consumption normalization across the lifespan, and marketing restrictions in CEE countries remain among the least developed in Europe [28].

Cultural attitudes toward food processing and convenience have also shifted substantially during the post-communist period. Traditional food preparation skills, which, in the communist period, were often a practical necessity rather than a lifestyle choice, have eroded as working hours increased, female labor force participation rose, and time for domestic food preparation declined [29]. These structural shifts increased demand for convenient, ready-to-eat, and ready-to-heat foods, which are predominantly classified as UPFs under the NOVA system.

Several inconsistencies in the evidence reviewed above deserve clear critical discussion rather than simple summary. The most notable example is the Romanian paradox, where despite a low reported UPF share, one of the highest overweight rates in the region is observed. None of the explanations offered here fully resolve this pattern. Possible reasons such as: NOVA misclassification of home-prepared foods, high intake of traditional energy-dense dishes, or urban-rural averages hiding differences between population groups, are all plausible; however, current CEE dietary data cannot distinguish between them. This reflects a real evidence gap rather than a settled conclusion.

More broadly, the contrast between Hungary's relatively high UPF share and Romania's low one, despite both countries having high overweight prevalence, shows that UPF share alone is not a complete predictor of national obesity levels. Country-specific factors, including retail sector development, urbanization, dietary survey methods, and the wider societal changes discussed below, likely shape how UPF availability affects obesity. This variation suggests that CEE should not be treated as a single, uniform obesogenic environment. Instead, future research should prioritize country-specific, comparative analyses.

Concurrent societal changes as competing and interacting explanations

The post-communist transition involved far more than food system change. Several concurrent shifts plausibly contributed to rising obesity independently of, or alongside, UPF availability. Occupational and leisure-time physical activity declined sharply as economies deindustrialized and private car ownership expanded rapidly, reducing routine active transport [3]. Urbanization and retail modernization further reshaped activity patterns, resulting in men in transitional North-East European cities gaining significantly more BMI and waist circumference over comparable follow-up than men in non-transitional Mediterranean and North-Western European cities [30]. Rapid demographic aging, driven by falling fertility, rising life expectancy, and emigration of younger cohorts [31], has altered the population age structure in ways that interact with obesity trends independently of dietary change. Socioeconomic restructuring, including shifts in income per capita and trade openness, has shaped CEE health transitions in strongly country-specific ways [32], while alcohol-related mortality shows among the largest socioeconomic inequalities in Europe within CEE [33], reflecting a further confounding pathway across socioeconomic gradients in metabolic health. Given this multiplicity of concurrent changes, UPF expansion is best understood as one contributing strand within a broader, only partially disentangled web of post-transition societal change rather than a standalone explanation for the region's obesity trend.

Policy landscape and public health responses in CEE

CEE countries have been slow to respond to the growth of UPFs in their food environments. No CEE country has put in place a broad regulatory framework specifically targeting UPFs. Most government efforts so far have focused on nutrition education and public awareness campaigns, which research consistently shows to be insufficient on their own to change eating habits at the population level when cheap, heavily marketed processed foods are widely available [29].

Front-of-pack nutrition labeling (FOPNL) is one of the most promising tools available to governments. Labels such as Nutri-Score and black octagon warning systems have been shown to help consumers make healthier choices and encourage food companies to improve their products [34]. Evidence also shows that mandatory schemes work better than voluntary ones, as voluntary labeling tends to reach fewer people and is unevenly adopted across income groups [35]. Despite this, no CEE country has made any FOPNL system mandatory. The EU-

level policy process has not helped matters. The European Commission committed in 2020 to propose a mandatory harmonized labeling scheme for all member states but failed to deliver. By early 2026, the initiative had been effectively shelved – the Commission's Vision for Agriculture and Food, published in 2025, made no mention of mandatory labeling, and consumer organizations brought legal action against the Commission over its refusal to explain the reversal [36,37]. With no EU mandate in prospect, CEE governments face little external pressure to act, and Nutri-Score adoption across the region remains rare and voluntary [37].

Taxes on unhealthy products have had more traction. Hungary introduced a levy on foods high in sugar, salt, and caffeine as early as 2011 – one of the earliest such measures in Europe – though its long-term effect on obesity has not been fully evaluated [38]. Poland introduced a tiered tax on sugar-sweetened drinks in 2021, with revenue directed to the National Health Fund. Early results suggest some manufacturers reduced the sugar content of their products in response [39], but peer-reviewed evidence of a measurable population health benefit remains limited. Neither country has extended fiscal measures across the full range of UPFs. By contrast, evidence from Chile shows that combining package warning labels with marketing restrictions and school food rules can produce real reductions in purchases of unhealthy products [40]. However, no comparable joined-up policy approach exists in CEE.

Poland is worth examining more closely, given its position as one of the largest food markets in the region and being among the countries with the highest overweight rates. The 2021 beverage levy was a meaningful first step, and school nutrition rules introduced in 2015 restrict the sale of foods high in sugar, salt, and fat on school premises. However, enforcement is inconsistent, and the rules do not cover the full range of products classified as UPFs under NOVA. Analysis of the retail food supply in CEE has found a high share of UPFs on supermarket shelves with very limited voluntary uptake of healthier labeling schemes among manufacturers [41]. The 2025 Lancet Series on UPFs concluded that CEE remains a region where the full set of policies needed to slow UPF expansion – mandatory labeling, restrictions on child-directed marketing, fiscal measures, and improvements to the food environment – is far from being in place [42] (Table 2).

Marketing of UPFs to children is a particular blind spot across CEE. A 2023 review of Europe found that most countries in the European region still rely on voluntary industry commitments rather than legal requirements to restrict child-directed food advertising [38]. Given clear evidence that advertising shapes children's food preferences from an early age, this gap carries long-term consequences. School food policies across the region vary considerably but generally fall short of the WHO and FAO recommendations, and programs to

improve access to fresh food, such as subsidized fruit and vegetable schemes, remain largely absent [36].

Table 2. Policy landscape for UPF regulation in CEE [29-38]

Policy domain	Status across CEE	Country-specific example
Front-of-pack nutrition labeling (FOPNL)	No CEE country has made any FOPNL scheme mandatory; EU-level harmonized mandate stalled as of 2026	-
Fiscal measures (taxes)	Limited; none cover the full range of UPFs	Hungary: levy on sugar/salt/caffeine-rich foods (2011); Poland: tiered sugar-sweetened beverage tax (2021)
Marketing restrictions to children	Predominantly voluntary industry commitments rather than legal requirements	-
School food policy	Generally falls short of the WHO/FAO recommendations; subsidized fruit/vegetable schemes largely absent	Poland: 2015 school nutrition rules restricting high sugar/salt/fat sales; enforcement inconsistent
Comprehensive multi-component approach (labeling + marketing + fiscal, cf. Chile)	Not present in any CEE country	-

Research gaps and limitations of the current evidence base

Several critical research gaps limit the ability to draw definitive conclusions about the UPF-obesity relationship in CEE. First, representative dietary survey data with NOVA-applicable food consumption information are absent or incomplete for most CEE countries. National dietary surveys have historically used food frequency questionnaires or 24-hour recall methodologies that were not designed with processing-level classification in mind, making retrospective NOVA classification imprecise [8].

Second, longitudinal cohort studies examining UPF consumption as a predictor of obesity onset in CEE populations are lacking. The observational evidence base derives predominantly from Western European cohorts, and direct extrapolation to CEE populations is complicated by differences in food supply composition, baseline dietary patterns, socioeconomic structures, and healthcare system characteristics.

Third, the NOVA classification system itself, while widely used and endorsed by the FAO and WHO, has attracted methodological criticism. Multiple alternative classification systems have been proposed, reflecting broader concerns about NOVA's reliance on processing extent rather than nutritional content as its primary organizing principle and its grouping of nutritionally heterogeneous foods under the same UPF label [25]. These limitations should be acknowledged when interpreting evidence based on NOVA-classified UPF consumption data.

Finally, the food environment research tradition in CEE remains underdeveloped relative to Western Europe, with few studies systematically mapping the density, accessibility, and nutritional composition of retail food environments in the region. The FEEDcities project, initiated by the WHO Europe, represents a partial attempt to fill this gap, but available data remain limited to select cities [43].

Conclusions

The post-communist transition in CEE created a set of conditions favorable to rapid UPF market expansion: liberalized trade, entry of multinational food corporations, rapid retail modernization, erosion of traditional food cultures, and structural increases in demand for convenient foods. These changes unfolded over a compressed timeframe of one to two decades, providing a unique chance to see how food system transformation correlates with people's health.

The available evidence is suggestive but causally limited. Ecological and cross-sectional associations between rising UPF availability and the disproportionate overweight and obesity burden observed in CEE countries are consistent with the hypothesis that UPF expansion has contributed to the regional dietary transition. However, they do not establish causation specifically in CEE populations. Longitudinal cohort data with NOVA-applicable dietary measurements remain largely absent for this region. At the same time, the biological mechanisms through which UPF consumption may promote weight gain, encompassing energy density, hyperpalatability, gut microbiome disruption, and appetite dysregulation, are increasingly well characterized in experimental and Western cohort studies and provide a biologically plausible framework within which the CEE epidemiological signal can be interpreted [22,27]. It should also be emphasized that the post-transition period in CEE coincided with numerous concurrent societal changes, such as shifts in physical activity

patterns, motorization, urbanization, and socioeconomic structure. They plausibly contributed to rising obesity independently of, or in interaction with, UPF availability.

Public health and regulatory responses in CEE have been insufficient relative to the scale of the challenge. The region requires urgent investment in:

1. standardized, representative dietary surveillance systems capable of capturing NOVA-classified UPF consumption at the population level;
2. longitudinal cohort studies examining UPF intake as a determinant of obesity and non-communicable disease incidence in CEE-specific populations;
3. evidence-based policy development, including mandatory FOPNL, restrictions on UPF marketing to children, and fiscal measures targeting energy-dense, nutrient-poor products;
4. food environment interventions improving physical and economic access to minimally processed food alternatives, particularly in deprived urban areas.

The transformation of CEE food environments represents a civilization-level health challenge in the precise sense articulated by the WHO and FAO: the unintended consequences of economic development, urbanization, and market integration for population health. Addressing it will require equally structural responses, not only individual behavior change programs, but systemic reforms to the food supply and regulatory environments in which dietary choices are embedded.

Disclosures and acknowledgments

The author declares no conflicts of interest with respect to the research, authorship, and/or publication of this article.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Artificial intelligence (Grammarly and Claude Anthropic) was used solely for the initial language editing and grammar correction of the English text to improve readability and linguistic accuracy. All the scientific content, ideas, data interpretation, conclusions and intellectual contributions were conceived and written by the author. No AI language model was used to generate new scientific content, replace author judgment, or fabricate results.

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