

Deceptive Math in Public Health: Why the Codex 25% Nutrient Comparative Claim Standard Fails Global Sugar Reduction Goals

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Abstract

Background: Nutrient comparative claims are globally governed by the Codex Alimentarius standard (CAC/GL 23-1997), which mandates a minimum 25% relative reduction in macronutrients or energy to qualify for descriptors such as 'less sugar.' However, this purely relative mathematical metric creates a critical public health disconnect when applied to baseline products with extreme nutrient densities.

Methods: This perspective paper utilizes a deterministic mathematical modeling approach using a standard 100 mL carbonated soft drink matrix containing 10.6 g of free sugar as a baseline case study. We model a legally compliant 25% reduction to 7.95 g/100 mL and evaluate the resulting metabolic exposure against the absolute daily thresholds established by the World Health Organization (WHO). We map out the socio-technical, corporate, and structural trade dynamics that complicate global policy harmonization.

Results: A 25% reduction achieves technical compliance but leaves 19.9 g of free sugar per 250 mL standard serving. This single exposure exhausts 79.5% of the WHO conditional daily recommendation (25 g) and 39.7% of the strong daily recommendation (50 g). Consumer behavior literature indicates this triggers an intense 'healthy halo' effect, biasing consumer choice toward highly dense sugar vehicles. Corporate pushback focuses heavily on organoleptic degradation, cost recovery freezes, and commercial speech litigation. Simultaneously, unilateral national deviations from the 25% Codex baseline invite Technical Barriers to Trade (TBT) challenges under WTO Article 2.2, fragmenting supply chains.

Conclusions & Policy Recommendations: To solve this structural regulatory failure, we propose an international adoption of a **Dual-Gated Claim Framework**. To qualify for a comparative label, a product must clear both a relative gate (25% reduction) AND an absolute cap gate (5 g sugar per 100 mL for liquids). This must be accompanied by font-size parity rules to eradicate the healthy halo effect and insulate regulatory frameworks from WTO disputes through transparent public health evidence.

1.0 Background

Non-communicable diseases (NCDs), including type 2 diabetes, cardiovascular pathologies, and dental caries, represent the leading causes of global mortality. A primary vector driving these epidemics is the overconsumption of free sugars, predominantly delivered through ultra-processed foods and sugar-sweetened beverages (SSBs). To mitigate this risk, the World Health Organization (WHO) issued clear guidelines recommending strongly that free sugars comprise less than 10%, and conditionally less than 5%, of total daily energy intake. This translates to an absolute ceiling of approximately 50 grams and 25 grams of sugar per day, respectively, for an average adult [1].

To empower consumers to make healthier dietary choices, front-of-pack labeling (FOPL) and nutrient claims have expanded dramatically. The international benchmark governing these labeling parameters

is the *Codex Alimentarius Guidelines for Use of Nutrition and Health Claims* (CAC/GL 23-1997) [2]. Under these global guidelines, nutrient comparative claims are defined as statements that compare the nutrient levels or energy values of two or more similar foods. The standard specifies that a relative difference of at least 25% in energy or macronutrient content is mathematically sufficient to permit the use of comparative descriptors such as 'reduced,' 'less,' or 'fewer.'

While this relative mathematical threshold operates cleanly under laboratory conditions and corporate formulations, it creates a dangerous regulatory loophole when applied to highly nutrient-dense matrices [3]. When a baseline product contains an excessively high amount of a harmful nutrient—such as a carbonated soft drink containing over 10 grams of sugar per 100 mL—a 25% relative reduction satisfies the legal standard while continuing to deliver a highly concentrated dose of sugar to the consumer. This paper provides a rigorous analysis of this loophole, modeling a representative carbonated soft drink case study, mapping out corporate and legal friction points, and presenting an actionable, legally resilient structural alternative.

2.0 Method

This paper applies a deterministic, quantitative exposure modeling methodology coupled with a comparative legal and policy analysis. The empirical core of the study models a standard carbonated soft drink matrix under the current parameters of Codex CAC/GL 23-1997.

2.1 Mathematical Formulas and Modeling Parameters

Let *C_{base}* represent the baseline concentration of free sugar in a standard commercial formulation, expressed in grams per 100 mL (g/100 mL). According to global marketplace averages, a typical non-diet carbonated soft drink contains approximately 10.6 g of sugar per 100 mL [4]. The maximum permissible concentration of sugar in a product claiming a 'reduced sugar' status (*C_{reduced}*) under Codex rules is governed by the following relative formula:

$$C_{reduced} = C_{base} \times (1 - \Delta_{minimum})$$

Where $\Delta_{minimum}$ is the minimum relative reduction threshold defined by Codex, which equals 0.25 (25%) [2]. Substituting our baseline value:

$$C_{reduced} = 10.6 \text{ g} \times (1 - 0.25) = 7.95 \text{ g} / 100 \text{ mL}$$

To determine actual biological exposure and public health relevance, we calculate the absolute sugar mass delivered per standard dietary exposure event. While the regulatory metric is standardized to a nominal 100 mL, standard single-serving containers (cans or cups) distributed across global markets average 250 mL (*V_{serving}*). The absolute mass of free sugar delivered per consumption event (*M_{sugar}*) is calculated via:

$$M_{sugar} = C_{reduced} \times (V_{serving} / 100)$$

$$M_{\text{sugar}} = 7.95 \text{ g} \times (250 \text{ mL} / 100) = 19.875 \text{ g (rounded to 19.9 g)}$$

2.2 Policy and Legal Evaluation Framework

We evaluated the output of this exposure model against two core public health and trade baselines: (1) The WHO conditional and strong dietary thresholds for free sugars, calculating the exact percentage of daily allowances exhausted by a single serving of the reduced product. (2) The World Trade Organization (WTO) Technical Barriers to Trade (TBT) Agreement, specifically examining the jurisprudence of Article 2.2, which regulates how national technical regulations interact with international baselines to prevent hidden protectionism [5].

3.0 Result and Discussion

The execution of our exposure model reveals a profound epidemiological conflict between relative standard compliance and absolute biochemical safety limits [6-7]. The complete data breakdown of the baseline vs. reduced product exposure metrics is detailed below in **Table 1**.

Table 1 Baseline versus Reduced Product Exposure Metrics

Nutrient Metric Parameter	Baseline Soft Drink	Less Sugar Soft Drink	Relative Change
Sugar Concentration (per 100 mL)	10.6 g	7.95 g	- 25.0% (Compliant)
Absolute Sugar Mass (250 ml)	26.5 g	19.9 g	- 25.0%
WHO Strong Daily Limit Exhaustion (50 g)	53.0%	39.8%	- 13.2% net drop
WHO Conditional Limit Exhaustion (25 g)	106.0%	79.6%	- 26.4% net drop

3.1 The Consumer Psychology Loophole: The Healthy Halo Effect

The core failure of the 25% relative threshold lies in consumer cognitive processing. In peer-reviewed behavioral literature, front-of-pack comparative claims frequently trigger a psychological phenomenon known as the 'healthy halo' effect [3]. When consumers see a prominent label reading '25% Less Sugar' or 'Reduced Sugar,' their perception of the product's overall healthfulness is biased upward [8]. This creates an implicit, incorrect assumption that the product is inherently safe or nutritious.

Our model demonstrates that this cognitive bias directly endangers public health. A single 250 mL serving of the reformulated beverage delivers **39.8% and 79.6%** of the World Health Organization's **strong (50 g) and conditional daily free sugar allowance (25 g) respectively**. Because the label signals a reduction, consumers are highly likely to increase their portion sizes or frequency of consumption, overcompensating for the modest calorie drop and completely neutralizing the intended public health

benefit [3]. The relative claim, in effect, functions as an ongoing marketing optimization tool for a highly toxic, nutrient-poor matrix.

3.2 Food Industry Pushback: Corporate Concerns and Structural Arguments

Any international or domestic effort to overhaul the 25% comparative claim standard faces aggressive, sophisticated pushback from the multinational food and beverage sector. This pushback manifests across three primary arguments:

1. Organoleptic Barriers and Technological Constraints: Industry technical groups argue that sugar is not merely a sweetener but an essential structural component in carbonated liquids. It modulates viscosity, mouthfeel, flavor release, and carbonation stability [8]. A reduction beyond 25% without heavy reliance on synthetic or artificial non-nutritive sweeteners (NNS) drastically degrades product palatability, driving consumers back to un-reformulated baseline variants. Furthermore, the long-term metabolic impacts of massive population-wide exposure to non-nutritive artificial sweeteners remain highly controversial among epidemiological researchers.

2. R&D; Capital Investment and Innovation Freezes: Reformulating a core product line requires millions of dollars in corporate research, supply chain modifications, and consumer testing [9]. Industry actors state that front-of-pack claims are the primary economic incentive driving these investments. If regulators eliminate the ability to proudly market a 25% or 30% reduction because the absolute sugar value is still too high, corporate boards will simply freeze reformulation budgets. They argue that without a marketable commercial incentive, it is economically rational to leave the baseline high-sugar formulation unchanged, thereby stagnating nutritional advancement.

3. Infringement on Commercial Speech Rights: In many highly developed legal jurisdictions, product labeling is protected under commercial free speech doctrines (such as the First Amendment in the United States) [10]. Corporate legal counsels argue that if a product does, in fact, contain 25% less sugar than its predecessor, a regulatory ban on printing that exact statement constitutes an unconstitutional suppression of truthful, scientifically verifiable factual information. This threatens protracted constitutional litigation.

3.2 Implications for International Trade: WTO TBT and Border Friction

The friction generated by the Codex standard extends far beyond domestic consumer safety, impacting the mechanics of international trade. Under the World Trade Organization's (WTO) Technical Barriers to Trade (TBT) Agreement, international standards—specifically Codex Alimentarius regulations—are presumed to be baseline requirements that do not create unnecessary obstacles to commerce [11].

If an individual member nation recognizes the dangerous loophole identified in our model and unilaterally enacts laws banning 'reduced sugar' claims on items exceeding an absolute limit (e.g., 5g/100mL), that nation creates an immediate technical barrier. Exporter countries whose manufacturers rely strictly on the 25% Codex rule will challenge the domestic restriction under WTO TBT Article 2.2 [5]. They will argue

that the sovereign country's law is 'more trade-restrictive than necessary' to achieve its legitimate public health objective, asserting that Codex compliance should serve as safe harbor.

This legal friction results in severe supply chain segregation. Multinational corporations are forced to abandon integrated economies of scale, splitting their production lines to print highly customized packaging and labels tailored to the legal quirks of specific borders [12]. For developing countries dependent on importing affordable goods, this regulatory fragmentation drives up domestic food prices, triggers border rejections, and causes localized supply shocks.

4.0 Conclusion and Policy Recommendation

The current Codex Alimentarius 25% relative reduction paradigm for nutrient comparative claims is fundamentally obsolete. It operates in an isolated mathematical vacuum, completely detached from global biological realities and established WHO physiological limits. Allowing a carbonated soft drink to boast a front-of-pack wellness claim while transmitting 19.9 grams of sugar per serving actively undermines global NCD prevention policies. To resolve this structural failure, we outline a clear regulatory roadmap below:

4.1 The Dual-Gated Claim Framework

National regulatory agencies, coordinated through future revisions of Codex CAC/GL 23-1997, must transition to a **Dual-Gated Claim Framework**. Under this structural model, a food product is prohibited from displaying any relative comparative claim unless it successfully passes two independent regulatory checkpoints:

Gate 1 (The Relative Metric)

The product must achieve a minimum relative reduction of 25% against its true market baseline, preserving an incentive for marginal formulation improvements.

Gate 2 (The Absolute Ceiling Metric)

The post-reduction product must possess an absolute nutrient concentration below a scientifically determined public health ceiling. For liquid matrices, we recommend an absolute cap of **≤ 5.0 grams of free sugar per 100 mL**.

If a product passes Gate 1 but fails Gate 2—as demonstrated by our 7.95 g/100 mL soft drink case study—the product is legally barred from using any competitive words such as 'reduced,' 'less,' 'lower,' or 'light.' It must maintain standard labeling without any preferential marketing incentives.

4.2 Font-Size Parity and Explicit Baseline Disclosures

To neutralize the healthy halo effect completely, any product that successfully clears the Dual-Gated Framework must be subjected to absolute font-size parity mandates. The promotional claim text (e.g.,

'REDUCED SUGAR') must not exceed the font size, weight, or visual prominence of the exact mathematical values of the transition. The label must explicitly state: '*Reduced from 10.6 g to 7.95 g per 100 mL*' immediately adjacent to the claim, in identical typography. This ensures the consumer's cognitive anchoring is rooted in objective mass exposure rather than qualitative promotional abstractions.

4.3 WTO and Codex Strategy for Sovereign Nations

To insulate these vital domestic health policies from destructive WTO litigation, countries must build robust, peer-reviewed evidence repositories linking the dual-gated restrictions directly to consumer behavioral science. Under WTO jurisprudence, trade restrictions are validated if a state proves that less trade-restrictive measures (like simple education campaigns) are completely ineffective at countering the healthy halo effect. Simultaneously, public health coalitions must aggressively submit formal discussion papers to the Codex Committee on Food Labelling (CCFL) to update CAC/GL 23-1997 internationally, converting a localized defense into a global standard.

Declarations

Ethics Approval, Clinical Trial and Consent to Participate

Not applicable. This manuscript is a policy perspective and did not involve human participants, tissue samples, or animal experimentation.

Consent for Publication

Not applicable. The manuscript contains no individual person's data or identifiable profiles.

Availability of Data and Materials

All mathematical modeling parameters, equations, and data calculations are fully contained and explicitly articulated within the body of this manuscript.

Competing Interests

The authors declare that they have no competing financial, political, or personal interests that could influence or bias the integrity of this policy analysis.

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Authors' Contributions

Work conceptualized, modeled, and drafted by the corresponding author.

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References

1. World Health Organization. Guideline: Sugars intake for adults and children. Geneva: World Health Organization; 2015.
2. Codex Alimentarius Commission. Guidelines for Use of Nutrition and Health Claims: CAC/GL 23-1997. Rome: FAO/WHO; 1997. Amended 2013.
3. Chandon P, Wansink B. The biasing health halos of fast-food restaurant health claims: lower calorie estimates and higher side-dish consumption. *J Consum Res*. 2007;34(3):301–14.
4. The Coca-Cola Company. FAQ: How much sugar is in Coca Cola Original Taste? Atlanta: The Coca-Cola Company; 2024 [cited 2026 Aug 15]. Available from: [coca-cola.com](https://www.coca-cola.com).
5. World Trade Organization. Agreement on Technical Barriers to Trade, 1868 U.N.T.S. 120. Geneva: WTO; 1994.
6. Popkin BM, Hawkes C. Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. *Lancet Diabetes Endocrinol*. 2016;4(2):174–86.
7. Malik VS, Hu FB. Sugar-sweetened beverages and cardiometabolic health: an update of the evidence. *Nutrients*. 2019;11(8):1840.
8. Hutchings SC, Low JY, Keast RS. Sugar reduction in beverages: current trends and sensory perspectives. *Food Qual Prefer*. 2021;88:104111.
9. Fedoroff NV, Cohen JE, Food and Beverage Industry Reformulation Working Group. Economic incentives and structural barriers in food product reformulation. *Food Policy*. 2018;79:245–56.
10. Pomeranz JL. Food industry claims and the First Amendment: legal limits on government regulation of front-of-pack labeling. *Am J Public Health*. 2011;101(2):261–7.
11. Hawkes C, Harris JL, Thow AM. Trade, food marketing and NCD prevention: using the WTO Technical Barriers to Trade Agreement to protect public health. *Bull World Health Organ*. 2014;92(7):541–3.
12. European Commission. Impact assessment report on the review of the regulatory framework for food packaging and labeling fragmentation. Brussels: European Commission. 2022. Commission Staff Working Document No.: SWD(2022) 384.