

The "Dilution" of Sugar Tracking: A Perspective Paper on Front-of-Pack Volumetric Discrepancies and Regulatory Lacunae in Low- and Middle-Income Countries (LMICs)

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Abstract

Background

The rising incidence of diet-related non-communicable diseases (NCDs), notably obesity and dental caries, presents a profound public health challenge in Low- and Middle-Income Countries (LMICs) like Nigeria. Front-of-pack nutrition labeling is intended to guide informed consumer choices. Although Nigeria's National Agency for Food and Drug Administration and Control (NAFDAC) has launched commendable public health initiatives like the "Read Food Label" campaign, structural variations in baseline reference points can create confusing messaging that misleads even literate, label-reading consumers.

Objective

This perspective paper exposes regulatory loopholes and behavioral biases driven by structural variations in commercial beverage labeling. It examines the use of voluntary Guideline Daily Amount (GDA) thresholds alongside metric-volumetric serving sizes.

Methods

Utilizing a dietary intake assessment and risk reduction simulation framework, we evaluated a standard carbonated soft drink formulation (42 kcal and 10.8g total/free sugar per 100 mL) distributed in Nigeria. The analysis evaluated the nutritional profile using the World Health Organization Nutrient Profile Model for the African Region (WHO AFRO NPM). It contrasted a manufacturer's voluntary 250 mL serving size calculation against the actual 330 mL physical container volume, comparing these against the standard 2,000 kcal GDA framework and WHO free sugar recommendations.

Results

Under the WHO AFRO NPM, the beverage exceeds the threshold for marketing and is classified as "high in added sugars". The voluntary labeling on a 250 mL serving lists 27g of sugars as **29% GDA** (based on an un-harmonized 90g reference value). However, when evaluated against the WHO recommendation that free sugars comprise less than 10% of total energy intake (50g for a 2,000 kcal diet), a single 250 mL serving represents **54% of the daily limit**. When a consumer drinks the full 330 mL container, actual consumption rises to 35.64g of free sugar—representing **71.3% of the WHO daily limit**—while the physical label indicates a lower percentage.

Conclusion and Policy Recommendations:

Current voluntary GDA metrics can create a misleading impression of lower sugar content, and smaller declared serving sizes can obscure the total nutrients consumed from a single-unit package. Codex Alimentarius guidelines lack a definitive Nutrient Reference Value for Non-Communicable Diseases (NRV-NCD) for free sugars, creating a regulatory gap that allows un-harmonized labels to persist. We recommend that NAFDAC mandate single-unit container labeling based on total package volume, adopt the WHO AFRO NPM criteria, and shift toward interpretive warning labels rather than complex percentage matrices to truly empower the "Read Food Label" initiative.

1. Background

Global public health strategies increasingly emphasize the restriction of free sugars to mitigate the burden of diet-related non-communicable diseases (NCDs), including obesity, type 2 diabetes, and dental caries [1]. Free sugars include monosaccharides and disaccharides added to foods and beverages by manufacturers, cooks, or consumers, alongside sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrates. Clear evidence shows that an increase in free sugar intake is associated with a concomitant increase in body weight, driven primarily by excess energy intake [2].

To facilitate healthier food choices, front-of-pack labeling (FOPL) systems have been implemented globally [3]. In Nigeria, the National Agency for Food and Drug Administration and Control (NAFDAC) launched a highly progressive public health campaign encouraging citizens to "Read Food Label" to drive wise choices [4]. In many developing markets, including the West African region, industry actors voluntarily utilize the Guideline Daily Amount (GDA) framework on these labels. The GDA framework provides absolute values and percentage contributions per serving based on a reference daily intake, typically anchored around a 2,000 kcal diet [5].

However, a significant gap exists between what these labels say and what health agencies recommend. Consumer who are concerned about sugar intakes and explicitly want to select a beverage that does not contribute heavily to their daily limit can be fundamentally misled, even if they participate fully in NAFDAC's label-reading initiative.

This structural discrepancy is driven by three main factors:

1. **The Codex Regulatory Loophole:** The Codex Alimentarius Guidelines on Nutrition Labelling provide specific Nutrient Reference Values associated with NCD risk reduction (NRV-NCD) for saturated fatty acids and sodium, but they do not establish an authoritative NRV-NCD for free or total sugars [6]. Without this level-not-to-exceed metric, un-harmonized metrics persist.
2. **Volumetric Downsizing:** Manufacturers routinely designate a serving size (e.g., 250 mL) that is smaller than the actual physical container (e.g., a 330 mL non-resealable aluminum can), masking the total nutritional impact.
3. **Regional regulatory frameworks create a dual-reporting environment.** In Nigeria, NAFDAC regulations mandate a baseline declaration of key nutrients per 100 mL. However, the policy allows manufacturers to voluntarily append supplementary front-of-pack percentage Guideline Daily

Amount (GDA) matrices calculated against arbitrary portion choices, typically a 250 mL serving. This creates a metric mismatch within a single package label.

This paper evaluates these reporting discrepancies within LMICs, using current market availability in Nigeria as a case study to demonstrate how un-harmonized metrics downplay sugar contribution to human diets.

2. Methodology

2.1 Baseline Product Profile

The simulation utilized empirical data from a standard carbonated soft drink formulation available in the Nigerian market (noting that this formulation is generic to several competitive beverage brands in the region) [7]. The physical container is a single-serve **330 mL aluminum can**. The chemical and nutritional declaration per 100 mL comprises:

- **Energy:** 42 kcal
- **Sugars:** 10.6 g
- **Volumetric serving size specified on label:** 250 mL
- **Stated Label Metrics for Serving (250 mL):** 105 kcal (5% GDA), 27g Sugar (29% GDA). Evidently, energy and sugar %GDAs are based on a 2,100 kcal not the 2,000 kcal stated on the label, and on a 90g reference value respectively.

2.2 Nutrient Profiling (WHO AFRO NPM)

The product's nutritional content was evaluated against the World Health Organization Nutrient Profile Model for the African Region (WHO AFRO NPM) [8]. This model establishes strict diagnostic thresholds for food and beverage categories to regulate marketing to children and identify products high in energy, saturated fats, trans-fats, free sugars, or sodium. For the water-based flavoured and non-flavoured drink category, the threshold for total/added sugar is cross-referenced to classify the product's eligibility status.

2.3 Intake Assessment and Risk Reduction Simulation Modeling

Mathematical modeling was applied to simulate sugar and energy intake under two distinct behavioral scenarios across two regulatory frameworks:

Scenario A Volumetric Parsing: Consumer ingests exactly the declared serving size of 250 mL.

Scenario B Container Monophagy: Consumer ingests the entire single-unit 330 mL container.

The intake data were calculated against two reference frameworks:

- 1. **The Package GDA Framework:** Anchored on an industry-applied reference total sugar value of 90g and an energy ceiling of 2,000–kcal.
- 2. **The WHO Free Sugar Directive:** Mandating that free sugar intake constitute less than 10% of total energy intake. For a standard 2,000 kcal diet, this translates to an absolute upper limit of **50g of free sugar per day**. A conditional target of less than 5% (25g) was integrated as an optimized health benchmark.

3. Results

3.1 WHO AFRO Nutrient Profile Classification

Under the WHO AFRO Nutrient Profile Model, the beverage significantly exceeds the threshold for carbonated soft drinks. Containing 10.6g of free sugar per 100 mL, it surpasses acceptable health limits, classifying the product clearly as **"High in Added Sugars"** and rendering it ineligible for marketing to children [8].

3.2 Volumetric Intake Assessment

The mathematical rendering of nutritional intake across serving configurations reveals a clear divergence between the values communicated on the label and actual consumer intake. Table 1 shows nutritional parameter content per 100 mL, 250 mL and 330 mL volumes.

Table 1
Nutritional Parameter Content per 100 mL, 250 mL and 330 mL Volumes

Nutritional Parameter Content	Per 100 mL	Per Label Serving (250 mL)	Per True Container (330 mL)
Energy (kcal)	42 kcal	105 kcal	138.6 kcal
Free Sugars (g)	10.6 g	27.0 g	35.64 g

3.3 Reference Framework Comparison Modeling

When the absolute nutritional values are integrated into the comparative risk models, structural discrepancies become apparent. Table 2 shows sugar intake contribution profiles of 250 mL serving versus 330 mL can consumed.:

Table 2
Sugar Intake Contribution Profiles: 250 mL VS. 330 mL Consumed

Voluntary Industry GDA (90g Sugar Baseline)	Framework 1		WHO Conditional Risk Boundary (< 5% Energy / 25g Upper Limit)	Framework 2		WHO Standard Risk Boundary (< 10% Energy 50g Upper Limit)	Framework 3	
	250 mL Serving	29.0% GDA		250 mL Serving	108.0% WHO Limit		250 mL Serving	54% WHO Limit
	330 mL Can	39.6% GDA		330 mL Can	142.6% WHO Limit		330 mL Can	71.3% WHO Limit

- **Energy Discrepancy:** The package states an energy level of 105 kcal per 250 mL, calculated as 5% of a 2,100 kcal diet. However, consuming the full 330 mL container delivers 140 kcal, increasing the actual energy contribution by 33%. Furthermore, the label displays internal un-harmonized references (such as calculating the energy's percentage against a 2,100 kcal framework while utilizing a 2,000 kcal energy baseline to calculate other metrics).
- **The Sugar Percentage Gap:** For a 250 mL serving, the label lists **29% GDA** for sugars. Evaluating that same 250 mL serving against the strict WHO standard risk limit (50g) shows it actually accounts for **54% of the daily limit**.
- **Total Container Discrepancy:** A consumer who finishes the 330 mL can receives 35.64g of free sugars. This single consumption event represents **39.6% of the voluntary GDA**, but accounts for **71.3% of the maximum daily sugar intake** recommended by the WHO [1].

4. Discussion

4.1 Serving Size Parsing, Consumer Psychology, and Diet

The presentation of nutrition data based on a 250 mL serving size within a 330 mL single-serve container introduces a metric mismatch. In practice, liquid carbonated beverages packaged in single-unit aluminum cans are typically consumed in a single setting because the container cannot be resealed.

Does 250 mL mean that is what is consumed? Mechanistically, no. Describing a 330 mL can as containing approximately 1.3 servings utilizes a partitioning approach that alters consumer perception. It allows for the presentation of lower absolute numbers and modest percentages (e.g., 29% vs 54%).

This layout strongly implies to a health-conscious consumer that the beverage does not contribute a large volume of sugar to their daily diet, suggesting that frequent or daily consumption could occur without exceeding recommended allowances. In reality, a consumer drinking one can per day has already exhausted nearly three-quarters (71.3%) of the maximum WHO sugar allowance in a single sitting, skewing the nutritional profile of the remainder of their daily diet.

4.2 The Codex Alimentarius Regulatory Gap

A key systemic factor enabling this variation is the current structure of the Codex Alimentarius guidelines. While Codex has established NRV-NCD metrics for sodium and saturated fatty acids to address cardiovascular risks, it has not finalized an equivalent global baseline for free sugars [6].

Without a standardized Codex reference point, manufacturers can select alternative baseline values, such as a 90g total sugar threshold. This 90g value combines both naturally occurring and added sugars, which dilutes the apparent impact of high free sugar concentrations in ultra-processed products and acts as a regional regulatory loophole.

4.3 LMIC Context and Regional Impact

In lower- and middle-income countries (LMICs), public health systems face a dual burden of undernutrition and overnutrition. In Nigeria, NAFDAC has taken proactive steps via the "Read Food Label" initiative [4]. However, when labels feature complex, non-standardized GDA matrices, even a highly compliant consumer reading the label is left unprotected from distorted dietary calculations.

Compared to other LMICs, the West African regional framework remains overly reliant on voluntary informative tables. For instance, South Africa has aggressively pushed for mandatory front-of-pack warning labels [9], while Latin American nations (such as Chile, Peru, and Mexico) have pioneered high-visibility black octagonal stop-sign warnings for products "High in Sugar" [10–11]. These warning systems completely bypass serving-size manipulation by utilizing standardized thresholds per 100 mL, providing clear, actionable signals to consumers regardless of literacy level.

4.4 Regulatory Dualism: NAFDAC's 100 mL Mandate vs. Back-of-Pack Voluntary Servings

Nigeria's current food labeling policies highlight a distinct challenge in low- and middle-income country (LMIC) market governance. By mandating nutrient profiling per 100 mL, NAFDAC ensures a level of objective chemical accountability across all liquid food matrices. However, allowing a voluntary, secondary nutritional breakdown on the back-of-pack panel based on a 250 mL volume introduces conflicting data.

When a health-conscious consumer turns the can over to make an informed choice under NAFDAC's 'Read Food Label' initiative, they are met with two competing sets of numbers on the same panel: the mandatory 10.6g of sugar per 100 mL and a voluntary 27g of sugar (29% GDA) per 250 mL. Because the percentage presentation (29%) looks significantly less threatening than the reality of sugar density, it can inadvertently minimize the perceived health risk. This dual-declaration system dilutes the impact of NAFDAC's educational campaigns by shifting consumer focus from standardized nutrient density (per 100 mL) to a fractional, industry-friendly math problem.

5. Conclusion and Policy Recommendations

This analysis highlights a clear difference between voluntary front-of-pack GDA labeling and international public health guidelines regarding sugar content in carbonated beverages. Relying on arbitrary serving sizes and un-harmonized total sugar reference values can obscure the nutritional reality of single-serve products, potentially undermining excellent domestic initiatives like NAFDAC's "Read Food Label" campaign.

To improve consumer transparency and strengthen public health protections, the following policy measures are recommended:

- **Mandate Container-Wide Labeling for Single-Serve Packages:** NAFDAC should update labeling regulations to require that any non-resealable food or beverage container under 500 mL display its nutritional percentages based on the total volume of the package, rather than fractional serving sizes.
- **Adopt the WHO AFRO Nutrient Profile Model:** Incorporate regional WHO diagnostic thresholds into national food standards to clearly identify and monitor products with high added sugar content.
- **Transition to Interpretive Front-of-Pack Labeling (FOPL):** Shift from voluntary GDA percentage tables to simple, high-visibility interpretive labeling systems, such as color-coded traffic lights or front-of-pack warning seals (e.g., "High in Sugar"). These formats have been shown to improve consumer comprehension across diverse literacy levels.
- **Advocate for Global Codex Harmonization:** Support initiatives within the Codex Alimentarius Commission to establish a formal Nutrient Reference Value for Non-Communicable Diseases (NRV-NCD) specifically for free sugars, helping to standardize labeling practices globally.

Declarations

- **Funding:** This perspective analysis received no external institutional or corporate funding.
- **Conflicts of Interest:** The author declares no competing financial or personal interests. The product profile analyzed was selected strictly as a representative case study of standard commercial labeling practices across competitive brands within the regional marketplace.

References

1. World Health Organization. Guideline: Sugars intake for adults and children. Geneva: World Health Organization; 2015.
2. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review and meta-analysis. *Am J Clin Nutr.* 2013;98(4):1084-1102.
3. Popkin BM, Ng SW. Dynamics of the global nutriscape: Front-of-pack labeling and scaling up product reformulation. *Obes Rev.* 2021;22(6):e13211.

4. National Agency for Food and Drug Administration and Control (NAFDAC). NAFDAC launches nationwide campaign urging Nigerians to read food labels. Abuja: NAFDAC; 2026 [cited 2026 Jul 16]. Available from: <https://www.premiumtimesng.com/health/health-news/890975-nafdac-launches-nationwide-campaign-urging-nigerians-to-read-food-labels.html>
5. International Food & Beverage Alliance (IFBA). IFBA global points of commitment on nutrition labelling. Geneva: IFBA; 2021.
6. Codex Alimentarius Commission. Guidelines on Nutrition Labelling (CXG 2-1985). Rome: Food and Agriculture Organization / World Health Organization; 2021.
7. Fregene CE, et al. Dietary Intake Assessment of Sugar in Several Pack Sizes of Carbonated Soft Drinks in Nigeria. J Public Health Nutr. 2026. [In press]
8. World Health Organization Regional Office for Africa. Nutrient Profile Model for the WHO African Region. Brazzaville: WHO AFRO; 2019.
9. National Department of Health, South Africa. Regulations relating to the labelling and advertising of foodstuffs (Draft Regulation R3337). Pretoria: Government Gazette; 2023 [cited 2026 Jul 16]. Available from: <http://www.gov.za>
10. Corvalán C, Reyes M, Garmendia ML, Uauy R. Structural responses to the obesity epidemic: the Chilean Law of Food Labeling and Advertising. Obes Rev. 2013;14(S2):79-87. doi:10.1111/obr.12114.
11. Taillie LS, Reyes M, Popkin BM. Evaluating the impacts of front-of-pack nutrition warning labels: lessons from Latin America. Lancet Glob Health. 2020;8(2):e174-e175. doi:10.1016/S2214-109X(20)30005-5.