



Research article

Nutritional Composition and Labelling Profiles of Sugar-Containing Sports and Energy Drinks Available in Supermarkets in Egypt

Adham Elkeryouni¹, Wantanee Kriengsinyos^{2*}, Yuraporn Sahasakul², Thanit Vinichagoon²

¹*Master of Science Program in Nutrition and Dietetics, Institute of Nutrition,
Mahidol University, Salaya, Nakhon Pathom, Thailand*

²*Institute of Nutrition, Mahidol University, Salaya, Nakhon Pathom, Thailand.*

ABSTRACT

Energy and sports drinks are widely available in Egyptian supermarkets; however, local evidence on their nutritional composition remains limited. This cross-sectional study characterized the label-reported nutritional profiles of sugar-containing sports and energy drinks sold in selected major supermarket chains in Cairo, Alexandria, and Giza and compared package-level sugar and caffeine contents with selected Saudi Food and Drug Authority daily reference limits. Eighty unique products were included (38 sports drinks and 42 energy drinks). Nutritional information was extracted from product labels and verified against manufacturer sources when clarification was required. Between-category comparisons were performed using the Mann-Whitney U test, and exploratory principal component analysis (PCA) was used to identify correlated nutrient patterns. Energy drinks had higher median concentrations than sports drinks of energy (44.7 vs 20.0 kcal/100 mL), carbohydrate (10.8 vs 5.0 g/100 mL), sugar (10.75 vs 4.45 g/100 mL), and caffeine (32 vs 0 mg/100 mL; all $p < 0.001$). Sports drinks had higher label-reported magnesium and potassium contents (both $p < 0.001$), whereas sodium did not differ significantly ($p = 0.916$). Despite their lower sugar concentration, the larger package sizes of sports drinks resulted in substantial package-level sugar exposure: only 50.0% of sports drinks and 31.0% of energy drinks contained no more than 25 g sugar per package. All products were below both the 200- and 300-mg caffeine reference values per package; however, cumulative exposure, other dietary sources, individual body weight, and the adolescent weight-based criterion were not assessed. PCA identified two components explaining 70.3% of total variance: an energy-sugar-caffeine component (47.7%) and an electrolyte-mineral component (22.6%). These findings demonstrate distinct formulation patterns and show that lower nutrient concentration does not necessarily indicate lower package-level exposure. Clear per-package labeling, consumer guidance, reformulation, regulatory surveillance, and laboratory verification of label-declared values are warranted.

Key words: Energy drinks; Sports drinks; Sugar; Caffeine; SFDA guidelines.

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*Corresponding author's email: wantanee.krieng@mahidol.ac.th

INTRODUCTION

Energy and sports drinks are widely marketed to adolescents, university students, shift workers, athletes, and other consumers seeking improved alertness, concentration, hydration, or physical performance. Although these beverages are sometimes perceived as interchangeable, they are formulated for different purposes. Energy drinks are non-alcoholic beverages that typically contain caffeine as the principal stimulant and are promoted for enhancing alertness and reducing perceived fatigue. They may also contain sugar, taurine, B-vitamins, botanical extracts, and other ingredients¹⁻⁴. In contrast, sports drinks are carbohydrate–electrolyte beverages designed to support fluid replacement, provide exogenous carbohydrates, and replace electrolytes during or after prolonged or vigorous physical activity^{5,6}. Distinguishing between these beverage categories is important because their intended uses, nutritional compositions, and potential health implications differ substantially⁷.

Sports drinks may be beneficial in situations involving extended exercise, substantial sweating, or increased carbohydrate requirements. However, routine consumption outside these conditions may contribute unnecessary sugar and energy intake, while beverage acidity and their carbohydrate concentrations may delay gastric emptying and increase the risk of dental erosion^{6,7}. Energy drinks, however, present different physiological concerns because of their caffeine and sugar contents. High or repeated caffeine exposure may be associated with sleep disruption, anxiety, palpitations, increased blood pressure, and other adverse cardiovascular or neurological effects,

particularly among children, adolescents, pregnant women, individuals with caffeine sensitivity, and those with underlying cardiovascular conditions⁸⁻¹¹. Frequent consumption of sugar-containing beverages may also contribute to excessive energy intake, weight gain, impaired metabolic health, and dental caries¹²⁻¹⁴. The health implications of these products depend not only on nutrient concentration but also on package size, number of servings consumed, frequency of consumption, and concurrent intake of sugar or caffeine from other dietary sources.

Energy drinks generally contain higher concentrations of caffeine and sugar, whereas sports drinks are typically formulated with water, carbohydrates, sodium, potassium, and other electrolytes to support hydration during exercise^{6, 15,16}. Nevertheless, considerable variation may exist within each category because of differences in product formulation, package size, fortification practices, and labeling requirements. Consequently, evaluation of both nutrient concentrations per 100 mL and total amounts per package is important for estimating potential consumer exposure. Product-label surveys can provide useful market-level information, although label-declared values may not necessarily correspond precisely with laboratory-measured nutrient contents.

Energy and sports drinks are widely available in Egyptian supermarkets, gyms, convenience outlets, and other retail settings. However, published product-level information on their nutritional composition in the Egyptian market remains limited. Evidence from other countries may not be directly applicable because beverage formulations, package sizes,



fortification practices, consumer preferences, and labeling regulations may differ across markets¹⁷⁻¹⁹. The limited availability of local data may constrain the ability of consumers, health professionals, policymakers, and regulatory agencies to assess these products and develop appropriate nutrition guidance.

Therefore, the primary objective of this study was to characterize and compare the label-declared nutritional composition of sugar-containing sports and energy drinks currently available in Egyptian supermarkets, with particular emphasis on energy, carbohydrate, sugar, caffeine, selected electrolytes, and vitamins. Package-level sugar and caffeine contents were also compared with selected reference values established by the Saudi Food and Drug Authority for specific population groups. The findings are intended to provide market-specific evidence that may support consumer education, product reformulation, nutrition policy, regulatory surveillance, and future laboratory-based evaluation of label accuracy.

MATERIALS AND METHODS

Study Design and Sample Selection

This descriptive cross-sectional study evaluated the nutritional composition and on-pack labeling of commercially available energy and sports drinks in Egypt. Products were surveyed between December, 2023 and July, 2024 at selected branches of Carrefour, Fathallah, Metro, Spinneys, and Seoudi Market) located in Cairo, Alexandria, and Giza. These cities were selected because they are Egypt's largest metropolitan areas and represent major retail markets with access to a broad range of beverage products. The supermarket chains were purposively

selected because they are widely used retail outlets with multiple branches and commonly stock both locally manufactured and imported beverage brands. Surveying several major chains across the three cities was intended to maximize product coverage and reduce the likelihood that the findings would reflect the inventory of a single retailer or geographical area.

All available products displayed in the energy- and sports-drink sections of the selected stores were screened against predefined eligibility criteria before inclusion in the dataset. Eligible products included ready-to-drink, carbonated, or non-carbonated energy and sports beverages. Energy drinks were identified from the product name, marketing term, such as "energy," "stimulant" or similar terminology, or the presence of a high-caffeine warning. Sports drinks were defined as non-caffeinated carbohydrate-electrolyte beverages marketed for hydration and electrolyte replenishment. Exclusion criteria comprised naturally caffeinated beverages (e.g., tea, coffee), caffeinated soft drinks, dairy- or protein-based beverages, powdered beverage mixes, energy gels or shots, and alcoholic drinks. Sugar-free products were also excluded because the study focused specifically on sugar-containing beverages and aimed to ensure comparability of sugar content across products. Following eligibility screening and the removal of duplicate products, 80 sugar-containing beverages were included in the analysis, comprising 38 sports drinks and 42 energy drinks.

Data Collection and Extraction

For each eligible product, all sides of the package were systematically photographed, including the product name, package volume,

ingredient list, nutrition information panel, caffeine declaration, warning statements, and manufacturer information. Nutritional and labeling information were extracted both per labelled serving and per 100 mL, where available. Extracted variables included serving size, energy content (kcal), total carbohydrates (g), sugars (g), sodium (mg), potassium (mg), magnesium (mg), vitamins and caffeine content (mg). The extracted data were compiled and cleaned using Microsoft Excel. Where a nutrient value was reported only per serving, the value per 100 mL was calculated using the labeled serving size and package information. Identical products encountered in more than one store were recorded only once. Products sold in different package sizes were also treated as duplicates when the product name, formulation, ingredient list, and nutrient composition were identical. Each distinct formulation therefore represented one observation in the final dataset. To verify the accuracy of data extraction, unclear, incomplete, or apparently inconsistent label information was cross-checked against information available from the manufacturer's official website. Where necessary, additional clarification was sought through direct communication with the manufacturer. The U.S. Department of Agriculture Food Data Central database was also searched using the product's Universal Product Code when relevant product information was available. When minor discrepancies were found between information sources, priority was given to the information displayed on the product package available during the survey, unless a more complete or updated value was confirmed by the manufacturer. The photographs were retained to permit rechecking of the entered values during

data cleaning. Verification was therefore based on comparison with manufacturer and database information; no independent laboratory analysis of the beverage contents was conducted. Sugar and caffeine concentrations were subsequently compared with the relevant daily intake recommendations and labeling criteria established by the Saudi Food and Drug Authority (SFDA).

Statistical Analysis

Continuous variables were summarized as mean $\pm$ standard deviation when their distributions were approximately symmetric and as median, interquartile range, and minimum–maximum values when distributions were markedly skewed or contained a substantial number of zero values. Categorical variables, including compliance with the Saudi Food and Drug Authority recommendations, were summarized as frequencies and percentages. The distributions of continuous variables were assessed using histograms, normal Q–Q plots, and the Shapiro–Wilk test. Homogeneity of variances between sports drinks and energy drinks was assessed using Levene's test. For variables that were approximately normally distributed, differences between beverage categories were evaluated using an independent-samples t-test; Welch's t-test was used when the assumption of equal variances was not met. Variables with marked skewness, extreme outliers, or a high proportion of zero values were compared using the Mann–Whitney U test. All tests were two-sided, and a p-value of <0.05 was considered statistically significant. Exact p-values were reported where appropriate.



Principal component analysis (PCA) was conducted as an exploratory analysis to identify major patterns in the nutritional composition of the surveyed beverages. The PCA included energy, total carbohydrate, sugar, magnesium, sodium, potassium, and caffeine content. These variables were selected on the basis of their nutritional relevance and the completeness of the label information. Vitamin variables were excluded because a large proportion of products had zero or undeclared values, which could indicate either true absence or incomplete label reporting. No missing values were present among the variables included in the PCA. Because the variables were expressed in different measurement units and had substantially different ranges, each variable was standardized to a z-score before analysis, and PCA was performed on the correlation matrix. Sampling adequacy and factorability of the correlation matrix were evaluated using the Kaiser–Meyer–Olkin measure and Bartlett’s test of sphericity. Components were retained by considering eigenvalues greater than 1.0, inspection of the scree plot, the cumulative proportion of variance explained, and the interpretability of the component loadings. An unrotated solution was used because the purpose of the analysis was dimensionality reduction and the derivation of component scores rather than the estimation of latent factors. Absolute component loadings of ≥ 0.50 were considered salient for interpretation. Component scores were calculated for each beverage and used to examine the distribution of sports drinks and energy drinks in the principal-component score plot. All statistical analyses, including principal component analysis were

performed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA).

RESULTS

A total of 80 unique sugar-containing beverages were included, comprising 38 sports drinks and 42 energy drinks. The continuous variables were non-normally distributed and several nutrient variables contained a high proportion of zero values. Accordingly, between-category comparisons are presented as medians and interquartile ranges and were evaluated using the Mann-Whitney U test.

Packaged Characteristics and Price

The median price per package was also higher for sports drinks (US\$2.84; IQR, US\$1.81–3.70) than for energy drinks (US\$1.25; IQR, US\$0.83–1.99; $p < 0.001$) (**Table 1**). Sports drinks were sold in larger packages than energy drinks, with median package volumes of 500 mL (IQR, 500–591 mL) and 330 mL (IQR, 250–455 mL), respectively ($p < 0.001$). The median price per package was also higher for sports drinks (US\$2.84; IQR, US\$1.81–3.70) than for energy drinks (US\$1.25; IQR, US\$0.83–1.99; $p < 0.001$) (**Table 1**).

Energy, carbohydrate, and sugar

Energy drinks had higher energy, carbohydrate, and sugar concentrations than sports drinks. Median energy content was 44.7 versus 20.0 kcal/100 mL, median carbohydrate content was 10.8 versus 5.0 g/100 mL, and median sugar content was 10.75 versus 4.45 g/100 mL, respectively (all $p < 0.001$). (**Table 1**).

Caffeine Content

Consistent with their functional marketing, recorded caffeine content differed drastically between the two beverage categories. Thirty-six of the 38 sports drinks (94.7%) had a recorded caffeine value of 0 mg/100 mL, whereas all energy drinks had a positive recorded caffeine value. Median caffeine concentration was 0 mg/100 mL (IQR, 0-0 mg/100 mL) in sports drinks and 32 mg/100 mL (IQR, 30-32 mg/100 mL) in energy drinks ($p < 0.001$). On a per-package basis, the median caffeine content was 0 mg (IQR, 0-0 mg) for sports drinks and 80 mg (IQR, 75-159.84 mg) for energy drinks ($p < 0.001$).

Electrolytes and Vitamin Declarations

Sports drinks had higher recorded magnesium and potassium concentrations than energy drinks (both $p < 0.001$), whereas sodium concentrations did not differ between categories ($p = 0.916$). Energy drinks had higher recorded riboflavin, niacin, and pyridoxine values, while sports drinks had higher recorded vitamin C, vitamin E, and vitamin A values. However, the vitamin distributions were highly zero-inflated; therefore, these comparisons primarily reflect differences in label declarations and fortification patterns rather than uniformly measured nutrient contents.

Comparison with SFDA daily reference limits

For this comparison, the content of one entire package was evaluated against each selected daily reference limit. Sports drinks consistently showed higher compliance with SFDA sugar intake limits than energy drinks across all demographic groups. For the 50-g sugar limit (adolescents and pregnant or lactating women), 36 sports drinks (94.7%) and 35 energy drinks (83.3%) did not exceed the limit. At the 36-

g limit (for individuals with heart or coronary disease), the corresponding proportions were 94.7% and 59.5%, and at the 25-g limit (for female cardiac patients), they were 50.0% and 31.0%, respectively (**Table 2**). All products contained no more than 300 mg caffeine per package, and all contained no more than 200 mg per package. The adolescent caffeine criterion of 2.5 mg/kg body weight could not be evaluated at the product level because no reference body weight or individual consumption data were available.

Principal Component Analysis

The correlation matrix was considered suitable for PCA, with an acceptable Kaiser–Meyer–Olkin measure of sampling adequacy ($KMO = 0.701$) and a significant Bartlett’s test of sphericity, $\chi^2(21) = 474.49$, $p < 0.001$. Two components had eigenvalues greater than 1 and together explained 70.3% of the total variance. PC1 had an eigenvalue of 3.383 and explained 47.7% of the variance. It had high positive loadings for sugar (0.975), carbohydrate (0.958), energy (0.956), and caffeine (0.682) and was interpreted as an energy-sugar-caffeine component. PC2 had an eigenvalue of 1.601, explained 22.6% of the variance, and had high positive loadings for potassium (0.740), magnesium (0.697), and sodium (0.645); it was interpreted as an electrolyte-mineral component (**Table 3**). The score plot showed separation of the beverage categories primarily along PC1: 37 of 38 sports drinks had negative PC1 scores, whereas 34 of 42 energy drinks had positive PC1 scores. The two categories overlapped more substantially along PC2, although a small number of sports drinks had high positive PC2 scores



corresponding to comparatively high electrolyte concentrations (**Figure 1**).

Table 1. Package characteristics and label-reported nutritional composition of sports and energy drinks

Characteristic	Sports drinks (n=38)	Energy drinks (n=42)	p-value
Price per package (US\$)	2.84 (1.81-3.7); 0.49-7.11	1.25 (0.83-1.99); 0.39-6.99	<0.001
Net content per package (mL)	500 (500-591); 237-1000	330 (250-455); 240-500	<0.001
Caffeine per package (mg)	0 (0-0); 0-59.1	80 (75-159.84); 11.25-200	<0.001
Caffeine (mg/100 mL)	0 (0-0); 0-10	32 (30-32); 4.5-56.3	<0.001
Energy (kcal/100 mL)	20 (16.9-24.45); 6-50	44.7 (34.35-48); 3-70.3	<0.001
Carbohydrate (g/100 mL)	5 (4.43-6); 1.4-14	10.8 (7.38-11.82); 1-16.8	<0.001
Sugar (g/100 mL)	4.45 (3.37-5.8); 1-12	10.75 (6.62-11.23); 1-16.7	<0.001
Magnesium (mg/100 mL)	0.15 (0-5.08); 0-124	0 (0-0); 0-75	<0.001
Potassium (mg/100 mL)	14.95 (0.42-82.5); 0-900	0 (0-0); 0-133	<0.001
Sodium (mg/100 mL)	42 (13-50.4); 0-490	36.9 (15.5-63.05); 0-260	0.916
Thiamine, B1 (mg/100 mL)	0 (0-0); 0-0.08	0 (0-0); 0-0.08	0.078
Riboflavin, B2 (mg/100 mL)	0 (0-0); 0-0.08	0 (0-0.3); 0-1.1	0.001
Niacin, B3 (mg/100 mL)	0 (0-0.83); 0-16	3.7 (0-7.97); 0-8.5	<0.001
Pantothenic acid, B5 (mg/100 mL)	0 (0-0.74); 0-5	0 (0-1.98); 0-2.5	0.067
Pyridoxine, B6 (mg/100 mL)	0.02 (0-0.3); 0-3.4	0.53 (0.05-0.8); 0-2	0.003
Cobalamin, B12 (microgram/100 mL)	0.13 (0-0.47); 0-4.8	0.53 (0-1.5); 0-2.5	0.092
Vitamin C (mg/100 mL)	0 (0-13.01); 0-90	0 (0-0); 0-25.4	0.007
Vitamin E (mg/100 mL)	0 (0-0); 0-900	0 (0-0); 0-0	0.004
Vitamin A (microgram/100 mL)	0 (0-0); 0-900	0 (0-0); 0-0	0.008

Data are median (interquartile range); minimum-maximum. P-values were obtained using two-sided Mann-Whitney U tests. A recorded value of zero may indicate that the nutrient was absent or was not declared on the product label. Caffeine and sugar per package were calculated from the value per 100 mL and the labeled package volume.

Table 2. Products for which the content of one package did not exceed selected SFDA daily reference limits

Nutritional Parameter & Demographic (SFDA Limit)	Sports Drinks (n=38)	Energy Drinks (n=42)
	Compliant, n (%)	Compliant, n (%)
Sugar Compliance:		
Adolescents (≤ 50 g)	36 (94.7%)	35 (83.3%)
Pregnant & Lactating Women (≤ 50 g)	36 (94.7%)	35 (83.3%)
Heart Disease - Male (≤ 36 g)	34 (89.5%)	25 (59.5%)
Heart Disease - Female (≤ 25 g)	20 (52.6%)	13 (31%)
Caffeine Compliance:		
Adolescents (≤ 2.5 mg/kg)	38 (100%)	42 (100%)
Pregnant & Lactating Women (≤ 300 mg)	38 (100%)	42 (100%)
Heart & Coronary Disease (≤ 200 mg)	38 (100%)	42 (100%)

The table does not establish overall dietary compliance or safety because it assumes consumption of one package and does not account for multiple packages, caffeine or sugar from other foods and beverages, or individual body weight.

Table 3. Loadings for the first two principal components

Variable	PC1 (47.7%)	PC2 (22.6%)
Energy	0.956	0.170
Carbohydrate	0.958	0.216
Sugar	0.975	0.086
Magnesium	-0.229	0.697
Sodium	0.124	0.645
Potassium	-0.263	0.740
Caffeine	0.682	-0.262
Eigenvalue	3.383	1.601
Variance explained (%)	47.7	22.6
Cumulative variance (%)	47.7	70.3

Bold values indicate absolute component loadings ≥ 0.50 . PCA was performed using standardized values for energy, carbohydrate, sugar, magnesium, sodium, potassium, and caffeine.

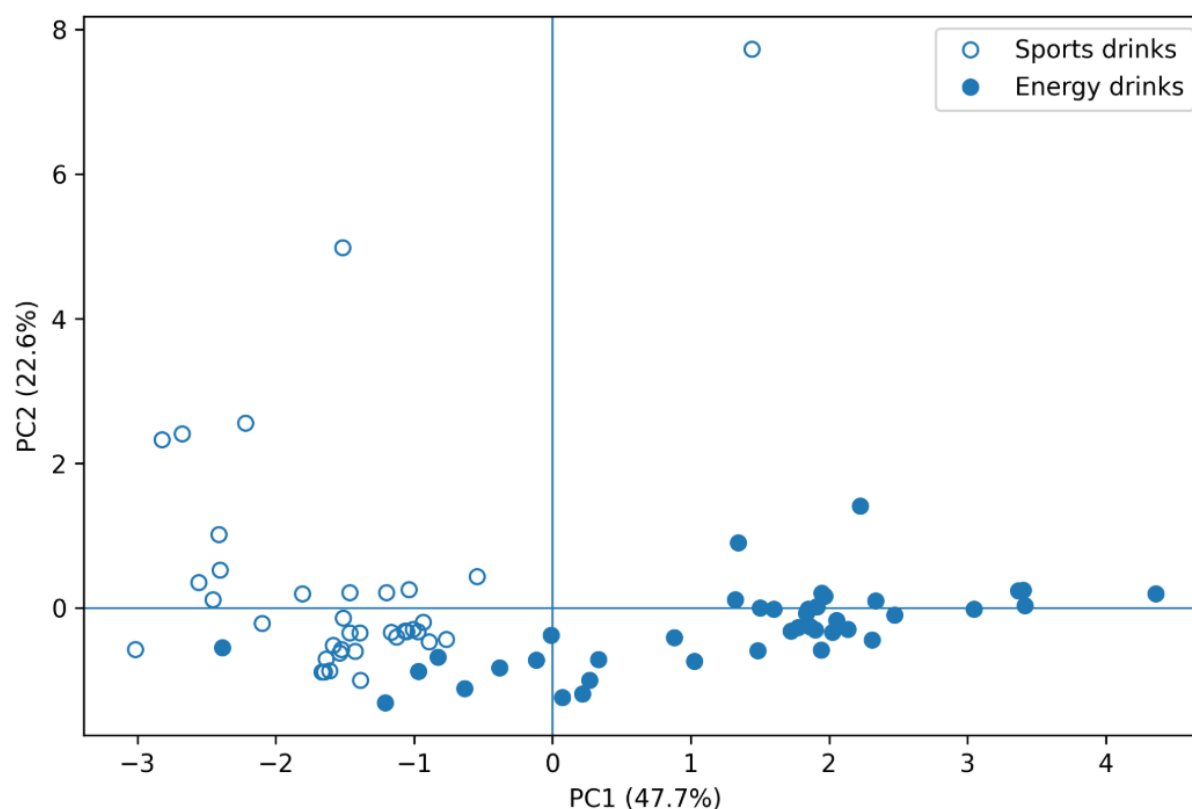


Figure 1. Principal component score plot of sports and energy drinks. Open circles represent sports drinks, and filled circles represent energy drinks. PC1 primarily reflects the energy-sugar-caffeine profile, whereas PC2 primarily reflects the electrolyte-mineral profile.

DISCUSSION

This study identified clear differences between sugar-containing sports drinks and energy drinks available in the surveyed Egyptian retail market. Energy drinks had substantially higher concentrations of energy, carbohydrate, sugar, and caffeine, whereas sports drinks were sold in larger packages and had higher label-reported magnesium and potassium contents. Sodium concentrations did not differ between the two categories. The principal component analysis supported these univariate findings: the first component, explaining 47.7% of the variance, represented an energy-sugar-caffeine profile and separated most energy drinks from sports drinks, while the second component, explaining 22.6%, represented an electrolyte-mineral profile. Together, these two components explained

70.3% of the variability in the selected nutritional characteristics. The PCA should be interpreted as a summary of correlated product-composition patterns rather than as a measure of product healthfulness or clinical risk.

The distinction between nutrient concentration and exposure from an entire package is important. Although sports drinks contained less sugar per 100 mL, their larger package sizes resulted in substantial sugar exposure when the full package was consumed. At the 25-g daily reference level, only 50.0% of sports drinks and 31.0% of energy drinks contained no more than the reference amount per package. Thus, approximately one-half of the sports drinks and more than two-thirds of the energy drinks exceeded 25 g of sugar in a single package. This finding indicates that sports drinks

should not automatically be regarded as low-sugar beverages. Their intended role is to provide fluid, carbohydrate, and electrolytes during prolonged or vigorous physical activity; routine consumption outside these circumstances may add energy and sugar without a corresponding physiological need.

The composition of the energy drinks in the present study was broadly consistent with findings from other markets. Energy drinks sold on the island of Ireland had mean caffeine and sugar concentrations of 30.7 mg/100 mL and 10.6 g/100 mL, respectively, which are close to the medians of 32 mg caffeine/100 mL and 10.75 g sugar/100 mL observed in the current study²⁰. A United Kingdom survey similarly reported caffeine concentrations of approximately 31 mg/100 mL and found that mean sugar content decreased from 10.6 to 9.5 g/100 mL between 2015 and 2017 following product reformulation²¹. The present median sugar concentration was therefore similar to that reported in Ireland and to the earlier UK market, but somewhat higher than the reformulated UK average. In the Middle Eastern region, a 2024 analysis of 1,400 pre-packaged beverages in Saudi Arabia found a median total sugar content of 11 g/100 mL across beverage categories and classified 46.2% of products as high in sugar using traffic-light criteria²². Differences in sampling frames, inclusion of sugar-free products, package sizes, and the use of means versus medians should be considered when comparing studies; nevertheless, the overall consistency suggests that high sugar and caffeine concentrations are common features of conventional energy-drink formulations across markets.

The sugar findings have important health implications. The World Health Organization recommends reducing free-sugar intake to less than 10% of total energy intake and suggests a further reduction to below 5%, equivalent to approximately 25 g/day in a 2,000-kcal diet, to provide additional health benefits²³. High intake of free sugars, particularly through sugar-sweetened beverages, contributes to dental caries and excess energy intake, and an umbrella review found that high dietary sugar exposure was generally associated with adverse health outcomes, particularly cardiometabolic outcomes²⁴. A single package containing more than 25 g of sugar could therefore use or exceed the more protective daily free-sugar target before sugar from other foods and beverages is considered. This is particularly relevant for adolescents, individuals with obesity or diabetes risk, and people with cardiovascular disease. However, the present study extracted total sugar from nutrition labels and did not analytically distinguish free or added sugars from naturally occurring sugars. Comparison with daily free-sugar recommendations should therefore be regarded as a conservative screening approach rather than a precise assessment of free-sugar exposure.

Caffeine exposure requires similarly cautious interpretation. Energy drinks contained a median of 80 mg caffeine per package, with values ranging from 11.25 to 200 mg. Although every product contained no more than the selected SFDA limits of 200 and 300 mg per package, remaining below a daily reference level in one package does not establish safety. The comparison did not account for multiple packages, coffee, tea, cola, chocolate, medicines,



or other caffeine sources consumed on the same day. International recommendations also differ: the European Food Safety Authority considers single doses up to 200 mg and total daily intakes up to 400 mg unlikely to raise safety concerns for healthy adults, but recommends no more than 200 mg/day from all sources during pregnancy and lactation; it also notes that a single 100-mg dose may affect sleep in some adults, particularly when consumed close to bedtime²⁵. Consequently, an energy drink at the upper end of the observed range could by itself reach the more conservative pregnancy limit, leaving no allowance for other caffeine sources.

Sleep disturbance is a plausible practical consequence even when total caffeine intake remains below an adult daily upper level. A systematic review and meta-analysis of 24 studies reported that caffeine reduced total sleep time by approximately 45 minutes, decreased sleep efficiency, and increased sleep-onset latency and nocturnal wakefulness²⁶. This is relevant because energy drinks are frequently used to counter fatigue or extend wakefulness, potentially creating a cycle in which caffeine use delays sleep and subsequent sleep loss encourages further stimulant consumption. Cardiovascular effects also warrant caution. In a randomized trial in healthy young adults, high-volume energy-drink consumption prolonged the corrected QT interval and increased blood pressure compared with placebo²⁷. The dose and volume used in that trial were greater than those in many individual products in the present survey, so the results should not be directly extrapolated to every product or occasional intake. Nevertheless, the findings support a precautionary approach for people with

hypertension, arrhythmias, long-QT syndrome, cardiovascular disease, or heightened caffeine sensitivity. A caffeine threshold should be treated as a population-level reference rather than a guarantee that a product is appropriate for every individual.

The implications are particularly important for children and adolescents. The adolescent SFDA criterion expressed as milligrams per kilogram of body weight could not be evaluated because this product-level study had no individual body-weight or intake data. In addition, the American Academy of Pediatrics has concluded that caffeine-containing energy drinks have no place in the diets of children and adolescents, while caloric sports drinks should be used only in limited circumstances associated with prolonged, vigorous physical activity²⁸. The present findings support maintaining a clear distinction between the two categories: sports drinks are carbohydrate-electrolyte products, whereas energy drinks are stimulant-containing beverages. Similar branding, packaging, placement, or marketing could obscure this distinction for consumers.

The electrolyte and micronutrient findings require careful interpretation. The higher magnesium and potassium values in sports drinks and the electrolyte-mineral second principal component are consistent with formulations intended to replace fluid and electrolyte losses during exercise. However, sodium did not differ between categories, and the wide ranges indicate considerable heterogeneity within each category. Moreover, the presence of electrolytes or added vitamins does not offset the sugar content or make routine consumption necessary. Several vitamin variables contained

many zero values, and a zero could indicate either true absence or non-declaration. The observed differences in B vitamins, vitamins C, E, and A therefore describe label-declaration and fortification patterns rather than confirmed differences in analytically measured nutrient content. Claims of nutritional superiority based on vitamin fortification would not be justified by these data alone.

Implications and recommendations

For consumers, water should remain the default beverage for routine hydration. Sports drinks may be useful during prolonged, high-intensity exercise, heavy sweating, or other circumstances in which carbohydrate and electrolyte replacement is physiologically indicated, but they are generally unnecessary for ordinary daily activities or short-duration exercise. Consumers should evaluate sugar and caffeine per package, not only per 100 mL, because the package may contain more than one labeled serving and is often consumed at one time. Children and adolescents should avoid energy drinks. Pregnant or lactating women and individuals with hypertension, arrhythmias, cardiovascular disease, anxiety, sleep disorders, or high caffeine sensitivity should avoid these products or seek individualized advice from a health professional. Consumers should also avoid taking several products in a short period or consuming them late in the day, and should include caffeine from all dietary and medicinal sources when estimating total intake.

For policymakers and regulatory agencies, the results support clearer differentiation and labeling of sports and energy drinks. Caffeine should be declared quantitatively both per 100

mL and per entire package, accompanied by prominent statements that total daily intake includes all caffeine sources. Total sugar should likewise be displayed per 100 mL and per package, and interpretive front-of-pack warnings could help identify products high in sugar or caffeine. Regulators may consider standardized definitions for sports drinks and energy drinks, standardized serving-size rules, prominent warnings for children and pregnant or breastfeeding women, and restrictions on marketing and sales in schools or directly to minors. WHO identifies nutrition labeling, consumer education, regulation of marketing, and fiscal measures as potential strategies to reduce exposure to products high in free sugars²⁹. Periodic monitoring of the marketplace, public reporting of product composition, reformulation targets, and risk-based enforcement would allow agencies to assess whether manufacturers reduce sugar, limit large package sizes, and provide accurate caffeine declarations over time.

Strengths, limitations, and future research

Strengths of this study include the systematic survey of several major supermarket chains across three large metropolitan areas, use of predefined eligibility criteria, photographic documentation of all package panels, standardization of nutrient values per 100 mL and per package, and the complementary use of PCA to identify correlated formulation patterns. The analysis also distinguished product concentration from package-level exposure and explicitly considered the limitations of comparing one package with daily reference values.

Several limitations should be acknowledged. First, the supermarkets and cities were purposively selected; therefore, the sample



may not include products sold only through small independent retailers, pharmacies, gyms, convenience stores, e-commerce platforms, or rural markets. Product availability and formulation can change over time, so the findings represent the survey period rather than a permanent description of the market. Second, only sugar-containing beverages were included, and the results cannot be generalized to sugar-free or low-sugar formulations. Third, nutrient contents were obtained primarily from labels and manufacturer information rather than independent laboratory analysis. Recorded zeros, particularly for vitamins and minerals, may reflect non-declaration rather than absence. Fourth, total sugar was used as a proxy when comparing products with daily sugar references, and the exact proportion of free or added sugar was unknown. Fifth, comparison with daily reference limits assumed consumption of one complete package and did not include habitual intake, multiple-package consumption, body weight, timing of intake, or other dietary sources. The SFDA values were applied as external screening benchmarks and should not be interpreted as Egyptian regulatory standards or as clinical cut-offs establishing safety for an individual consumer. Sixth, price was compared per package; because package sizes differed, this analysis should not be interpreted as a direct comparison of price per unit volume or affordability. Finally, the PCA was exploratory, was based on seven label-reported variables, and may have been influenced by extreme electrolyte values. It describes the sampled products but does not demonstrate causal relationships with health outcomes.

Future studies should validate label declarations using representative laboratory sampling across brands, production batches, package sizes, and purchase locations. Both reassuring and discordant findings have been reported internationally: a Slovenian study found that measured sugars in sampled sugar-sweetened beverages were within regulatory tolerance ranges and generally agreed with labels²⁹, whereas a Croatian analysis found caffeine values both above and below declared amounts, with deviations ranging from approximately 9% above to 19% below the labeled values³⁰. These findings demonstrate that label data can be useful for surveillance but should be periodically verified rather than assumed to be exact.

CONCLUSION

Sports and energy drinks available in selected Egyptian supermarkets showed distinct nutritional profiles. Energy drinks generally contained higher concentrations of energy, sugar, and caffeine, whereas sports drinks contained higher levels of selected electrolytes. However, the larger package sizes of sports drinks also resulted in substantial package-level sugar exposure. These findings highlight the importance of clear labeling, appropriate consumer guidance, product reformulation, and regulatory monitoring. Laboratory-based analyses are also needed to confirm the accuracy of label-declared nutrient values.

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