**Methodology for Nutrition Ingestion Index Calculation**

This Nutrition Ingestion Index is calculated to provide an integrative score reflecting various aspects of a person’s nutritional status based on commonly measured laboratory markers. One of the key challenges in nutritional research is accurately assessing both dietary intake and its impact on health. Traditional approaches often rely on self-reported dietary questionnaires, which, while useful, are subject to various biases and inaccuracies, including recall errors and misreporting. To address these limitations, researchers increasingly turn to biomarkers—objective, biological measures that can reflect nutritional intake and physiological status more accurately than self-reports. Biomarkers derived from lab tests provide a clearer picture of nutrient consumption and metabolic health, enabling the assessment of nutrient adequacy and dietary effects on the body without the variability and subjective bias of self-reporting(1, 2). Various studies have demonstrated that biomarkers, including blood parameters like serum albumin, glucose levels, lipid profiles, and electrolyte balances, can serve as reliable indicators of nutritional intake and health status(3)

We used these biomarkers from LIFE dataset to represent nutritional profile of subjects. Our index comprises six core component categories, each representing distinct nutritional dimensions, and calculates an average score across these components to generate a balanced final index. Each component score reflects the degree to which measured values align with established healthy reference ranges, indicating adequacy in nutrient intake and absorption.

**1. Electrolytes and Minerals (electrolyte intake and balance)**

Electrolytes—including **sodium**, **potassium**, **chloride**, **calcium**, and **carbon dioxide (CO₂)**—are essential for maintaining cellular function, fluid balance, nerve conduction, and muscle contraction. The electrolyte score was derived by averaging the binary scores for each electrolyte, where each component scored 1 if it fell within its respective healthy range and 0 otherwise. This category's average score reflects the body’s mineral intake and electrolyte balance, critical for hydration, nerve, and muscle function.

2.  **Glucose (carbohydrate intake and metabolic health)**

Glucose levels serve as a primary indicator of carbohydrate intake and metabolic health. A fasting glucose level in the healthy range (70-99 mg/dL) indicates balanced carbohydrate metabolism and a lower risk of metabolic complications. Elevated glucose levels suggest an increased dietary intake of carbohydrates or issues with glucose metabolism, potentially indicating prediabetic or diabetic states . Glucosed on a binary scale, contributing directly to the index without further averaging due to its singular importance as an independent marker of dietary carbohydrate ingestion.

**3. Lipid Profile (reflects fat quality and quantity in diet)**

The lipid profile reflects fat intake and lipid metabolism and includes **total cholesterol**, **high-density lipoprotein (HDL)**, **low-density lipoprotein (LDL)**, and **triglycerides**. Each lipid marker was scored based on its alignment with optimal health ranges and averaged to generate a single lipid profile score. HDL cholesterol, for example, is a well-recognized protective factor, while high LDL and triglyceride levels are linked to excessive intake of saturated fats and carbohydrates . The lipid scores dietary fat quality, cardiovascular health, and lipid metabolic balance.

**4. Protein Status (overall protein balance, immune)**

Protein status, essential for immune function and cellular repair, was assessed using **albumin**, **globulin**, and the **albumin-to-globulin (A/G) ratio**. Albumin and globulin are the primary proteins in blood serum, with albumin indicating adequate protein intake and globulin often associated with immune function and inflammation. A balanced A/G ratio suggests adequate dietary protein and efficient protein utilization . Each variable was scoredlly, and the scores were averaged to create a composite protein status score.

**5. Kidney Function (protein metabolism)**

**Blood urea nitrogen (BUN)** levels provide insight into protein metabolism and renal function. Within healthy ranges, BUN reflects efficient dietary protein utilization and kidney function. Elevated BUN levels can indicate excessive protein intake, dehydration, or kidney impairment . BUN was scored as a standalone vaen its relevance as a single marker for dietary protein impact on kidney health.

**6. Blood Cell Markers (iron and micronutrient intake)**

**Hemoglobin**, **red cell count**, and **hematocrit** provide information on anemia, iron status, and overall oxygen-carrying capacity, directly impacted by iron, vitamin B12, and folate intake. These markers are critical for identifying nutritional deficiencies, especially those associated with anemia . The scores for each blood cell marker wereto create a composite blood health score.

**Final Nutrition Ingestion Index**

The final Nutrition Ingestion Index is the average of the scores from each of the six component categories described above. This methodology ensures that each category contributes equally to the overall index, preventing overrepresentation of multi-variable categories (e.g., electrolytes) and balancing the weight of single-variable components (e.g., glucose and BUN).

**Interpretation of the Index**

The final index provides an interpretable scale of nutritional adequacy, indicating the likely balance of nutrients in the diet:

* **Excellent** (0.8–1.0): Most laboratory values within optimal ranges, suggesting well-balanced nutrition.
* **Good** (0.6–0.79): Generally healthy ranges with minor deviations, indicating adequate dietary intake.
* **Average** (0.4–0.59): Some markers out of range, suggesting areas for nutritional improvement.
* **Poor** (<0.4): Multiple markers outside healthy ranges, suggesting potential deficiencies or dietary imbalances.

This index serves as a composite reflection of the individual's nutritional state, informed by a variety of biochemical markers commonly used in clinical nutrition research. The approach allows a balanced assessment of diet or nutritional domains, providing a practical and interpretable measure for clinical or research applications in nutrition science.

Ref:

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