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Validation of the NOVA score for the consumption of ultra-processed foods by young women of Medellín, Colombia

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Abstract

Ultra-processed foods (UPFs) are associated with deterioration in dietary quality and the development of chronic diseases. The NOVA score, developed in Brazil to assess UPF consumption quickly and inexpensively, is adapted and validated here using a sample of 203 young women from Medellín, Colombia. Food consumption was evaluated using 24-hour dietary recall and with the NOVA-UPF score. Food items were classified using the NOVA categories. The energy consumed from UPFs and its percentage of the total energy consumed was estimated. The association between the NOVA-UPF score and the percentage of energy from UPF (%UPF/E) was evaluated. Both variables were categorized into quintiles and concordance was estimated using prevalence and bias-adjusted kappa (PABAK). A regression model was used to assess the association between the NOVA-UPF score and critical nutrients. The mean NOVA-UPF score among study participants was 4.5, with 27% of the total energy they consumed coming from UPFs. There was a positive, linear association between the NOVA-UPF score and %UPF/E ($p < 0.001$) and substantial agreement (PABAK = 0.75) in the classification of participants between UPF energy quintiles and NOVA-UPF score quintiles. The NOVA-UPF score was positively and significantly associated with sodium, total fat, and saturated fat intake. We conclude that the adapted NOVA-UPF score may help monitor the consumption of UPFs among young women in Medellín.

KEYWORDS
Colombia, diet quality, Medellín, NOVA score, ultra-processed products, young women, NOVA score for the consumption of ultraprocessed foods (NOVA-UPF score)

INTRODUCTION

The 2017 Global Burden of Disease Report found that at least 11 million adults in the world died that year due to diseases associated with an inadequate diet. Those diets are characterized by suboptimal consumption of healthy foods, such as fruits and vegetables, whole grains, nuts, seeds, and milk, and by the consumption above recommended levels of ultra-processed foods (UPFs), such as sugary drinks, cured meats, and high-sodium foods.[1,2]

In recent years, global food supplies have undergone a displacement of natural food and typical culinary preparations by industrialized ready-to-eat products.[3,4] Given this, the NOVA classification system was proposed to classify foodstuffs and beverages, not only by their botanical origin and nutritional contribution but also according to the

degree and purpose of industrial processing.[5] According to this system, UPFs are defined as industrial food formulations that include substances not commonly used in culinary preparations and additives meant to imitate the sensory qualities of unprocessed foods. Examples of marketed UPFs include soft drinks; packaged snacks and candies; mass-produced packaged bread and buns, cookies, pastries, and cakes; margarine and other spreads; breakfast cereals; preprocessed meat, cheese, pasta, and pizza dishes; poultry and fish nuggets and sticks; and sausages, burgers, and hot dogs, among others.

Regarding edible products that belong to the category of UPFs, evidence from different countries has shown that they are high in ingredients that present health risks and low in protective nutrients. Compared to people with lower UPF intake, people who consume more UPFs were found to have poorer quality diets, characterized by higher intakes of energy and nutrients, such as total fat, saturated fat, trans fat, and free sugars, as well as lower intakes of protein, fiber, vitamins A, C, D, B6, and B12, and minerals, such as zinc, iron, calcium, magnesium, phosphorus, and potassium.[6–17] Similarly, a randomized controlled clinical trial comparing the effects on energy intake of an ultra-processed diet to an unprocessed diet showed that energy, carbohydrate, and fat intake were 25% higher on average in the ultra-processed diet, while protein intake was lower.[18] Longitudinal studies further showed that subjects with a higher intake of UPFs have a higher risk of developing obesity,[19] type 2 diabetes,[20] cancer,[21] cardiovascular disease,[22] hypertension,[23] metabolic syndrome, and double-burden malnutrition in children and adolescents,[24,25] as well as all-cause mortality.[26]

A nutritional food profile conducted in the Department of Antioquia in 2019 (not including Medellín) using 24-hour dietary recalls revealed that 57% of the energy consumed came from minimally processed foods, 19% from culinary ingredients, 9% from processed foods, and 15% from UPFs. An unbalanced nutritional profile featuring a high energy density and high consumption of total and saturated fat was associated with higher consumption of UPFs, with children and adolescents having higher consumption of these unhealthy products—double the consumption of those over 50 years old.[27] Based on those findings, the Food and Nutritional Security Plan for Antioquia 2020–2031 set a goal to reduce the consumption of UPFs to less than 10% of the total energy consumed.[28]

Different methodologies can be used to monitor population consumption of these products, including dietary recording, food frequencies, dietary history, brief assessment tools, and single or multiple 24-hour dietary recalls, the latter being considered the gold standard.[29] However, some of these methodologies can be complex and costly to implement, especially for middle- and low-income countries. A simple, fast, and inexpensive method that allows the evaluation and monitoring of UPF consumption and provides a reliable summary measure for decision-making would be preferable. Instruments that were developed, tested, and validated in other populations may be adapted to overcome the scarcity of data needed for decision-making.

This work aimed to adapt and validate the NOVA score developed in Brazil[30] to measure UPF consumption in the population of adolescent women in the city of Medellín, Colombia.

METHODOLOGY

Sample

This study was conducted with 203 nonpregnant, nonbreastfeeding young women (14–20) years old who were randomly selected from a larger sample of 793 young women of low socioeconomic status in the city of Medellín from whom a detailed NOVA-UPF score questionnaire and 24-hour dietary recall had been collected.

Data collection

This research was conducted following the guidelines established in the Declaration of Helsinki and was classified as being of minimal risk. All procedures involving human subjects were approved by the bioethics committee of the "Sede de Investigación of the Universidad de Antioquia." Each participant or their caregiver received a preliminary call (recorded and protected) to obtain consent (parental consent for participants aged 14–17 years, informed consent for adolescents aged 14–17 years, and consent for participants aged 18–20 years) and to be informed about the study purpose. If agreeing to participate, the time and place of the in-person interview were set up. The NOVA-UPF score for the consumption of UPFs was collected by trained nutritionists, as well as a 24-hour dietary recall of all foods consumed the day before, and their amounts.

Adaptation of the NOVA-UPF score

Three English graduates translated the questionnaire. Linguistic adjustments were made to the translation to improve the definition and understanding of each of the UPF items. Subsequently, it was sent for peer review by experts in the evaluation of food consumption in Colombia, and the final version of the questionnaire was obtained, with a linguistic and cultural adaptation for the population of Antioquia. To obtain the individual score for UPF consumption with the adapted NOVA-UPF score, a score of 1 was assigned if at least one of the foodstuffs/drinks from each category had been consumed, and a score of 0 if no product of the category had been consumed. The total possible individual score was between 0 and 23 (see Table 1 for the 23 categories of the NOVA-UPF score).

The 24-hour dietary recall

The EVINDI software was used to compute the net amount of nutrients consumed by respondents over the last 24 h. Food items from the survey were then classified according to their degree of processing into one of the four categories of the NOVA system.[4,5,31] For items for which the degree of processing was unknown, the websites of product makers were consulted to identify their composition and classify them accordingly. The remaining unidentified items were located in local supermarkets and then classified. Culinary preparations were identified from Colombia's food composition table, which uses standardized

TABLE 1 Categories of the NOVA-UPF score.

Ultra-processed drinks
Regular or noncaloric, light, or zero calorie sodas
Juice in a box or in a bottle
Powdered mixes to prepare soft drinks
Powdered mixes for chocolate drinks (powdered and ready-to-drink)
Tea drinks (powdered and ready-to-drink)
Fruit-flavored milk drinks
Ultra-processed groceries
Sausage, hamburger meat, or chicken nuggets
Ham or mortadella
Sliced bread, hot dog bun, or hamburger bun
Table and cooking margarines
Frozen french fries or fast-food-chain fries
Ketchup, mayonnaise, or mustard sauce
Salad dressings or vinaigrettes (ready-to-eat)
Instant noodles or packaged soups
Frozen or fast-food restaurant pizza
Lasagna or other frozen meals to heat or prepare at home
Ultra-processed snacks
Salted packaged products (chips or crackers)
Sweet biscuits with or without filling
Cake or packaged cake
Cereal bars
Ice cream or frozen popsicles
Chocolates and chocolate bonbons
Commercial breakfast cereal

recipes to assess ingredient contents, and then classified based on the degree of processing of the ingredients in the recipe. For example, culinary preparations with a higher proportion of unprocessed culinary ingredients were classified as NOVA group 1, while preparations using ultra-processed ingredients or high amounts of sugar, oil, or salt fell into a different group.

The food and beverages classified as UPFs were grouped into 1 of 13 subcategories previously established by research in Colombia.[32] These subcategories are (1) distilled alcoholic beverages; (2) sugar-sweetened beverages, juices, nectars, vegetable drinks, and dairy beverages; (3) industrial infant formulas and supplements; (4) noncaloric beverages; (5) processed types of meat; (6) industrial types of breakfast cereal; (7) confectionery (chocolate, candies, sweets); (8) industrial types of bread; (9) commercial desserts; (10) ready-to-eat "junk food" preparations; (11) seasonings, spreads, and powdered preparations; (12) snack foods (sweet and savory); and (13) other ultra-processed products, such as cream cheese, protein supplements, and nondairy creamers.

Statistical analyses

Characterization of intake

The average total calorie and gram or milliliter intake of all foods and beverages consumed was estimated based on the 24-hour dietary recall data. The mean energy consumed and its standard deviation (95% confidence interval) were calculated for the NOVA categories and their subcategories. Calories derived from UPF consumption were estimated, and the percentage share of this category relative to the total average calorie intake was calculated.

Association and concordance analysis between the NOVA-UPF score and the percentage of energy from UPF

The association between the percentage of energy from UPF (%UPF/E) and the NOVA-UPF score was assessed using Spearman's correlation coefficient, followed by a simple linear regression between the two variables. A table was constructed with the distribution of the population according to the quintiles of the %UPF/E and the approximate quintiles of the NOVA-UPF score. The degree of concordance between the variables was evaluated using WinPepi software's kappa index adjusted for prevalence and bias (PABAK). The following reference was used for interpretation: almost perfect agreement for values $\geq$0.80; substantial agreement for values $\geq$0.61 and $\leq$0.80; moderate agreement for values $\geq$0.41 and $\leq$0.60; regular agreement for values $\geq$0.21 and $\leq$0.40; and slight agreement for values $\leq$0.20.[33]

Association between NOVA-UPF score and the content of critical nutrients (total fat, saturated fat, and sodium) related to chronic diseases

The percentage of energy from total fat and saturated fat was calculated relative to the average total energy consumed, and the average sodium intake (mg) was estimated. To establish whether there was an association between the NOVA-UPF score and the content of critical nutrients, Spearman's correlation coefficient was calculated. Subsequently, linear regression models were constructed (with critical nutrients as dependent variables).

RESULTS

Characterization of intake

For the 203 adolescent women participating in the study, a total intake of 392 food items was identified and the average energy consumed

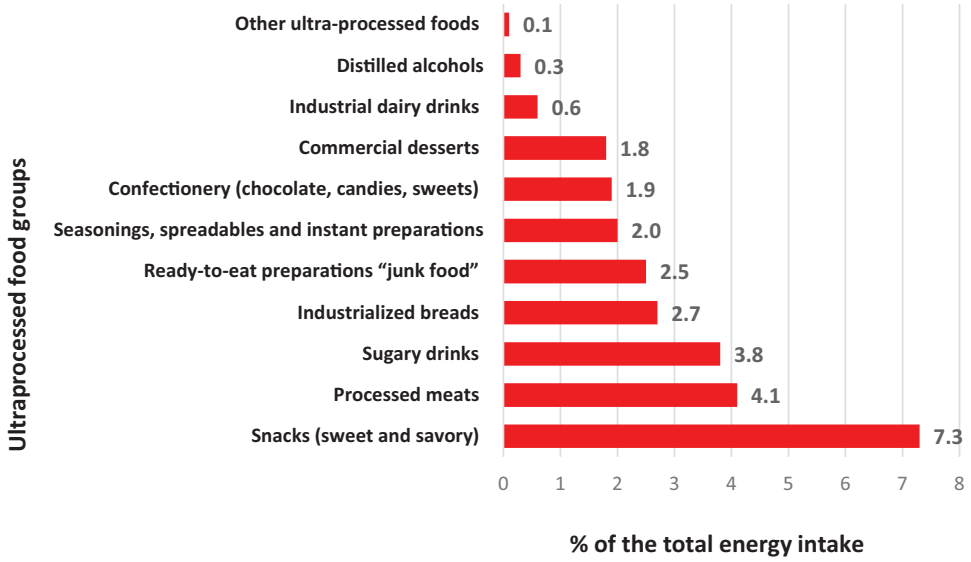

FIGURE 1 Distribution of total energy consumed (%) in ultra-processed products according to the 24-hour dietary recall.

was 2247 kilocalories (kcal) (SD = 67.1). Minimally processed foods contributed 48.7% of the total energy consumed, UPFs (as per the NOVA classification) came in second with 27.3%, while culinary ingredients (15.7%) and processed foods (8.3%) contributed the remainder. The UPF subcategories that contributed most to the total energy intake were sweet and salty snacks (7.3%), processed meats (4.1%), sugar-sweetened beverages (3.8%), and industrialized bread (2.7%) (Figure 1).

Evaluation of concordance between NOVA-UPF score and %UPF/E

The average NOVA-UPF score in our sample of young women in Medellín was 4.5 (± 2.57). The minimum score was 0 and the maximum score was 12. Spearman's correlation between the NOVA-UPF score and the %UPF/E (rho = 0.5075; $p < 0.001$) was positive, moderate, and significant. A linear regression was also performed between the two variables, confirming the previously found association. The beta of the NOVA-UPF score allows us to interpret that for each unit increase in the score, the proportion of energy from UPF increases on average by 2.8% (95% CI: [2.1, 3.6]; $p < 0.001$).

The mean %UPF/E associated with each approximate NOVA-UPF score quintile was estimated. This showed that %UPF/E increased linearly and significantly as the NOVA-UPF score increased ($p < 0.001$; Figure 2).

The UPF items with the highest frequency of consumption were salted and packaged snacks (48.5%); tomato sauces, mayonnaise, or mustard (46.5%); table and cooking margarine (39.2%); chocolate drinks (35.2%); sausage, hamburger meat, or chicken nuggets (34.3%); and normal or noncaloric soft drinks (33.3%). Between 15% and 25% of participants consumed industrialized bread, fruit-flavored milk

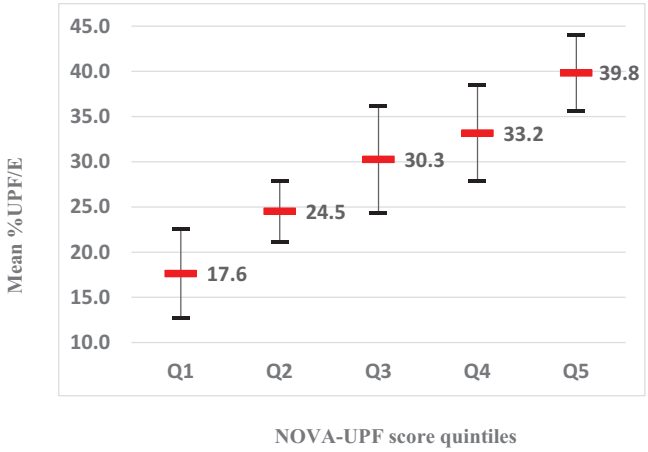

FIGURE 2 Variation in mean %UPF/E by approximate NOVA-UPF score quintiles. The mean (red line) and 95% confidence interval are shown for the %UPF/E of each NOVA-UPF score quintile.

drinks, powdered drink mixes, sweet cookies with or without fillings, chocolate bars and chocolates, and ice cream or frozen popsicles. Less than 15% reported consuming UPFs from the other subgroups (Table 2).

The agreement between the NOVA-UPF score and %UPF/E using the PABAK index was 0.75, which indicated substantial agreement between the two criteria (Table 3).

Performance test of the NOVA score questionnaire

A significant association was identified between the NOVA-UPF score and critical nutrients related to chronic diseases ($p < 0.001$).

The simple linear regression models suggest that for each point increase in the NOVA-UPF score, there is a significant increase of

TABLE 2 Frequency of consumption of the UPFs of the NOVA-UPF score.

UPF items	Proportion (%)
Packaged salty snacks (chips or crackers)	48.5
Ketchup, mayonnaise, or mustard sauce	46.6
Table and cooking margarines	39.2
Chocolate drinks (powdered and ready-to-drink)	35.3
Sausage, hamburger (piece of ground beef), or chicken nuggets	34.3
Regular or noncaloric sodas (sugared and sugar-free)	33.3
Sliced bread, hot dog bun, or hamburger bun	24.0
Fruit-flavored milk drinks	23.0
Powdered drink mix	22.1
Sweet biscuits with or without filling	19.1
Chocolate bars and chocolates	18.1
Ice cream or frozen popsicles	15.7
Fruit juice in a box or in bottle	14.7
Instant noodles or packaged soups	14.7
Ham, salami, or mortadella	14.2
Cake or packaged cake	11.8
Frozen french fries or fast-food chain fries	9.8
Tea-based drinks	8.8
Commercial breakfast cereal	7.8
Salad dressings or vinaigrettes (ready-to-eat)	7.4
Lasagna or other frozen meals	1.9
Cereal bars	1.9
Frozen or fast-food restaurant pizza	0.5

Abbreviation: UPF, ultra-processed food.

212.3 mg of sodium, and the proportion of calories derived from total fat and saturated fat increases significantly by 0.73% and 0.32%, respectively (Table 4).

DISCUSSION

The results obtained in this study indicate that the Medellín-adapted NOVA-UPF score was linearly and positively associated with the percentage of energy from UPFs among adolescent females. Substantial agreement was also found in the classification of the approximate quintiles of the distribution of the NOVA-UPF score and the quintiles of the %UPF/E. In addition, for each point increase in the NOVA-UPF score, there was a significant increase in the consumption of total fat, saturated fat, and sodium.

When analyzing the contribution of NOVA groups, almost one-third of the young women in this study consume UPFs. This fact confirmed a high intake of these products among adolescents in the country, and similar results were found in a representative sample in Colombia in 2005 and in Antioquia in 2019, where adolescents consumed two times more UPFs than those individuals 50 years old or more.[27,34] This evidence suggests that the adult population may be more resistant to marketing practices that appeal to the younger generation of women, who have less stable dietary patterns and are, therefore, more likely to try these products.[34]

The substantial agreement between the classification of the approximate quintiles of the distribution of NOVA-UPF score and the quintiles of the %UPF/E (PABAK = 0.75) coincide with those of a similar study in Sao Paulo, Brazil (n = 300, PABAK = 0.67), which is the study that it is used as the methodological reference for the current work.

The NOVA-UPF score is useful to assess UPF consumption in adolescent women in Medellín, Colombia. The good performance of the questionnaire could be explained by the fact that the 23 UPF items that make up the NOVA-UPF score substantially describe the categories and variety of UPFs available in both populations (Brazil and Medellín). This availability of products is due to the dynamics used by transnational corporations that manufacture UPFs to distribute, commercialize, and maintain their products in the market around the world, generating a homogeneous food pattern, especially in countries of the same region.[35–37] It is also important to note that the similarities between the two populations can influence the performance of the questionnaire, as both are countries with great food diversity, culinary richness, similar historical, social, and political characteristics, and also because they are middle-income countries. Therefore, the questionnaire can be considered as an option to make population-based diagnoses of UPF consumption, monitor changes in consumption, and develop epidemiological studies of a longitudinal nature. Additionally, it can be used as a public policy tool, to evaluate changes in UPF consumption among young women in Medellín following the implementation of Law 2120 for the regulation of UPF consumption in school environments in Colombia.[38]

The association reported here between UPF consumption and intake of critical nutrients (sodium, total fat, and saturated fat) is also in line with that reported in several other countries.[6] These results are worrying in terms of public policy, and highlight the displacement of natural or minimally processed foods by UPFs,[7] a delicate issue in Colombia and Brazil given their great biodiversity of plant and animal species.[39]

The high intake of critical nutrients associated with a high intake of UPF could explain its association with the development of cardiometabolic disease,[6] which is the main cause of death in the world. In Colombia, cardiometabolic diseases are among the top 10 causes of death in the population. In this context, and coupled with the increase in the figures of excess weight in the population,[40] it is important to have tools that allow evaluating and monitoring diet according to the needs of the different population groups.

The Food and Nutrition Security Plan 2020–2031, a regional planning document that includes the analysis of UPF consumption, established a goal "to reduce to less than 10% the total caloric intake kcal/day/person from ultra-processed products."[41] This makes it essential to have tools and indicators that facilitate the monitoring of UPF consumption in the population, especially in children and

TABLE 3 Population distribution of %UPF/E quintiles by approximate NOVA-UPF score quintiles.

	Approximate NOVA-UPF score					
%UPF/E quintiles	Q 1 score (0, 1, and 2) % (*n*)	Q 2 score (3 and 4) % (*n*)	Q 3 score (5) % (*n*)	Q 4 score (6 and 7) % (*n*)	Q 5 score (≥ 8) % (*n*)	Total % (*n*)
Q1 (≤12.1)	**10.8 (22)**	7.4 (15)	1.5 (3)	0.5 (1)	0.0 (0)	20.2 (41)
Q2 (12.2–23.1)	4.4 (9)	**9.9 (20)**	2.5 (5)	3.0 (6)	0.5 (1)	20.2 (41)
Q3 (23.2–29.4)	2.5 (5)	8.9 (18)	**3.0 (6)**	3.4 (7)	2.0 (4)	19.7 (41)
Q4 (29.5–39.4)	2.5 (5)	5.4 (11)	3.4 (7)	**4.4 (9)**	4.4 (9)	20.2 (41)
Q5 (≥39.4)	2.0 (4)	3.4 (7)	2.5 (5)	3.9 (8)	**7.9 (16)**	19.7 (41)
Total	22.2 (45)	35.0 (71)	12.8 (26)	15.3 (31)	14.8 (30)	100.0 (203)

TABLE 4 Association between NOVA-UPF score and the diet content of nutrients related to chronic disease.

	Unadjusted model	
Critical nutrients related to chronic disease	Beta	95% CI
Sodium	212.3	[162.6–262.0][a]
Total fat	0.73	[0.30–1.16][a]
Saturated fat	0.32	[0.13–0.51][a]

[a] $p < 0.001$.

adolescents. The instrument validated in this research project is a versatile tool that can be used to make diagnoses and follow-up of UPF consumption in adolescent females of low socioeconomic status in Medellín.

However, the NOVA-UPF score has some limitations. That is to say, if a UPF belonging to one of the NOVA-UPF score categories was consumed more than once, it will still only add one point to the score. However, these characteristics of the score make its application easy, simple, quick, and, therefore, economical compared to other methodologies for measuring food intake. Also, now that the NOVA-UPF score has been validated in Colombia, the generally complex process of classifying each food item into NOVA-UPF score categories can be replicated easily as it has been reviewed by researchers familiar with the process. The study was based on a very specific and homogeneous convenience sample.

Future application of the NOVA-UPF score at the population level should consider the following:

- Have trained professionals apply the NOVA-UPF score to facilitate the recall of UPF consumption
- Train interviewers to recognize the variety of ultra-processed groceries, drinks, and snacks beyond the examples available in the questionnaire; and
- Build and permanently update a reference database that includes UPFs of different brands.

The results obtained lead us to conclude that the simplified NOVA-UPF score, after being linguistically and culturally adapted for the population of adolescent women in Medellín, was significantly associated with the reference indicator for assessing the percentage of energy derived from UPF consumption. Likewise, a positive and significant association was found between the NOVA-UPF score and the intake of critical nutrients (sodium, total fat, and saturated fat) related to chronic noncommunicable diseases. Given that the adapted NOVA-UPF score performed adequately against those cutoffs, it may be used to monitor the progress of the Food and Nutrition Security Plan 2020–2031, especially in adolescents, because of their higher consumption of UPFs in comparison with the older population.

AUTHOR CONTRIBUTIONS

M.C.C.-M. contributed to drafting the article, as well as data analysis and interpretation, under the supervision of G.C. N.C.-G., G.B., and S.L.R.-M. contributed to the critical review of the article. G.C. led the design of the study and contributed to the critical review of the article.

COMPETING INTERESTS

The authors declare no competing interests.

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PEER REVIEW

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