

Nutrient Warning Labels Reduce Intent to Purchase Unhealthy Ultra-Processed Foods in Addis Ababa, Ethiopia: A Randomized Controlled Trial

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Research Article

Keywords:

Posted Date: May 11th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-9248474/v1>

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Additional Declarations: Competing interest reported. MEH, LMS, and LJA report grant support from the National Institutes of Health. NK reports consulting fees from the Pan American Health Organization and UNICEF, participation on an advisory board for the Center for Food and Nutrition Policy, University of Pennsylvania, and the Department of Science and Technology, Philippines. NK is listed on the editorial board of BMC Nutrition at the time of submission. MM reports grant support from WHO and consulting fees from GiveWell, both outside of the present work. LJA reports additional grant support from the Sheikh Khalifa Stroke Institute, and Cigarette Restitution Fund of Maryland; consulting fees from GiveWell; and payments or honoraria from Wolters Kluwer, Cardiometabolic Health Congress Symposium, and Controversies to Consensus in Diabetes, Obesity and Hypertension, all outside of the present work. All other authors declare no competing interests.

Abstract

Background

The Ethiopian government is considering implementation of a front-of-package label policy to address the rising prevalence and burden of diet-related, non-communicable disease. The objective of this study was to determine the most effective labels to discourage purchase of less healthy packaged foods in Ethiopia.

Methods

This study was a randomized controlled trial with four arms (no label and three labels) among adults in Addis Ababa, Ethiopia (n = 1200). The primary outcome was mean intent to purchase on a 7-point Likert scale across four products. A secondary outcome was the proportion of participants correctly identifying excess sugar or sodium.

Results

The mean intent to purchase score among participants randomized to the Nutrient Warning Labels arm was 4.37 (95% CI: 4.16, 4.59), which was significantly lower ($p \leq 0.003$) than no label, Multiple Traffic Light Label, or Nutri-Score Label arms. 62% of participants in the Nutrient Warning Labels arm correctly identified that either sugar or sodium was in excess across all four products, which was significantly higher than other study arms. Participants reported that Nutrient Warning Labels and the Multiple Traffic Light Label aided in making purchasing decisions, drew attention, were trustworthy, and were easy to understand. Participants were significantly more worried about children consuming food and drink displaying Nutrient Warning Labels compared to other labels ($p < 0.001$).

Conclusions

Nutrient Warning Labels were the only label that significantly reduced intent to purchase packaged foods containing excess levels of sugar or sodium among consumers in Ethiopia. Implementation of a mandatory policy requiring packaged foods to display Nutrient Warning Labels is recommended in Ethiopia.

Trial Registration

This trial was registered at <https://www.clinicaltrials.gov> on September 9, 2022 (NCT05549388).

Background

In Ethiopia, rapid urbanization(1) and favorable economic conditions contributed to an 18-year increase in life expectancy between 1990 and 2015(2). Measurable reductions have been achieved in deaths from communicable diseases, maternal and neonatal mortality, and nutritional deficiencies(3). However, the burden of non-communicable disease (NCD), such as cardiovascular disease (CVD) and its risk factors, is increasing in the population(2). In 2019, 40% of all deaths were due to NCDs, including 14% from CVD alone(4). Two studies in Addis Ababa, one in 2018 with 3,560 participants and another in 2021 with 600 (5), both reported that almost one in four adults had high blood pressure, while one-third and almost one-tenth were overweight and obese, respectively. Obesity has been shown to increase the risk of high blood pressure, and high blood pressure is the predominant risk factor for the development of CVD. Nationally, studies have found that 19% of adults and more than 11% of children have obesity (6, 7).

Diet is a major modifiable risk factor for CVD and other NCDs (8). In 2013, almost half of CVD deaths were estimated to be due to diet in Ethiopia (9). The food environment has changed rapidly in Ethiopia (10) with the widespread availability and frequent consumption of ultra-processed products (industrial food formulations that are ready-to-eat/heat, durable, convenient, and highly-palatable and that contain cosmetic additives and little or no whole ingredients) (11). These ultra-processed products also contain added sugars, sodium, and unhealthy fats, generally in combination, in their formulation (11). High sodium intake is the main dietary factor in the development of high blood pressure. An analysis of the 2015 World Health Organization (WHO) STEPS survey reported that the average salt intake was estimated to be 8.3 grams per day in Ethiopia, with 96% of the population exceeding the WHO limit of 5 grams per day (12).

Ethiopia's national policies clearly outline a commitment to safeguarding and preserving healthy food environments. A key strategic initiative for addressing NCDs is to "facilitate the development and enforcement of comprehensive policies and legislations to address the rising burden of unhealthy diet and khat consumption" (13). Mandatory front-of-package labeling (FoPL) on packaged foods and beverages is one possible policy option that has been endorsed by leading health agencies including WHO (14), United Nations Children's Fund (UNICEF) (15, 16), and Pan American Health Organization (PAHO) (17–19). FoPL systems display simplified nutrition information on the front of the package, and are designed to capture consumer attention and assist in purchasing decisions (20). As manufacturers will likely want to avoid placement of warning labels on their products, FoPL may also motivate them to reformulate their products.

There are multiple types of FoPL systems, which have been adopted on a voluntary and mandatory basis globally (21). Systems that include nutrient-specific information signal to consumers that products contain levels of nutrients of concern in excess. Two such systems include Nutrient Warning Labels with "excess" or "high in" text displayed on a shape (octagon, triangle, or circle) associated with danger or caution (22), and the Multiple Traffic Light Label with amounts of nutrients of concern listed along with red, amber, and green coding. The Nutri-Score Label, in contrast, is a summary system that displays a single letter grade A-E based on an algorithm that accounts for healthier nutrients and nutrients of concern. Evidence from randomized controlled trials (RCT) from multiple countries have consistently

shown Nutrient Warning Labels are more effective at reducing consumers' intent to purchase products containing excess nutrients of concern compared to other types of FoPL in studies (23–29), and are the labels that have been adopted by most countries with mandatory FoPL regulations in the Americas (17). However, FoPL systems have rarely been tested in African countries and never in Ethiopia.

The objective of this study was to test the effects of different FoPL, including Nutrient Warning Labels, the Multiple Traffic Light Label, and the Nutri-Score Label, on intent to purchase packaged products containing excess added sugar or sodium among a sample of adults in Addis Ababa, Ethiopia. The results of the study can inform FoPL policies to address diet-related NCDs in Ethiopia.

Methods

Study Design Overview

This study was a parallel, four-arm RCT assessing the difference in the intent to purchase packaged foods with one of three different types of FoPL (Fig. 1: Nutrient Warning Labels, Multiple Traffic Light Label, or Nutri-Score Label) or no label. Participants were individually randomized in equal numbers to one of the four trial arms using an allocation table created by an independent statistician and the REDCap randomization module that assigned participants to study arms.

Participant recruitment

Participants had to be at least 18 years old and indicate that they typically purchase packaged foods at hypermarkets, supermarkets, minimarkets, or suq/souqs. Souqs are small stores in which a clerk behind a single counter retrieves products for customers. Using a street-intercept survey methodology, trained staff invited food shoppers to participate in the study outside of supermarkets and souqs in the 11 sub-cities within Addis Ababa, Ethiopia (Supplementary Fig. 1) between December 2022 and January 2023. Participants were given a small token of appreciation in the form of mobile airtime upon completion of the study.

Procedures

All study procedures were conducted in Amharic, the most widely spoken language in Ethiopia. After consent and eligibility questions, participants were randomized to one of four trial arms before they were administered the survey. Study staff read survey questions to participants who could also view questions, images, and response options on an electronic tablet using the REDCap Mobile application. In addition, a booklet with study images and response options was provided as an option for participants who could not easily view the electronic tablet.

Stimuli

Products

Participants were shown two-dimensional (2D) images of four different products on an electronic tablet or in printed booklets. Chips, a savory snack, a sugar-sweetened beverage, and sweet biscuits (Fig. 2) were shown individually to evaluate intent to purchase and the ability to identify a nutrient of concern in excess. Each product was assigned nutritional values comparable to real products from the corresponding food category. At the time the study was designed, the study team did not have access to a complete packaged food database of products from Ethiopia. Summary statistics from two African countries, Kenya (30) and South Africa (<https://www.georgeinstitute.org/projects/foodswitch>) were used to inform representative nutritional values for each food product category. All products were considered to contain nutrients of concern in excess: sodium for chips and savory snack, sugar for sugar-sweetened beverage and sweet biscuits.

Labels

In this trial, participants were shown mock food products with labels (or no label) corresponding to their randomization assignment (Fig. 3).

The four study arms were:

1. Nutrient Warning Labels
2. No Label
3. Multiple Traffic Light Label
4. Nutri-Score Label

The design of the Nutrient Warning Labels were black triangles that stated “high in [nutrient]” in Amharic, along with “Ministry of Health – Ethiopia” at the bottom. The Nutrient Warning Labels were designed through formative research with consumers and experts in Ethiopia prior to this study. The Multiple Traffic Light Label was color-coded red, amber, or green and included nutrient-specific information in Amharic. The Nutri-Score Label was color-coded with summary letter grades (A, B, C, D, or E). The Nutri-Score Label letters were not translated, as it was assumed that the design would not be changed if this label system was adopted in Ethiopia.

The nutritional values assigned to each mock product remained consistent across study arms, and FoPL were applied according to the thresholds associated with each FoPL system.

At the time the study was designed, Ethiopia did not have a nutrient profile model (NPM) on which to base nutrient thresholds. The Nutrient Warning Labels were applied when thresholds for sugar or sodium were exceeded using the PAHO NPM (31). Sugar in levels of excess was defined as $\geq 5\%$ (liquids) or $\geq 10\%$ (solids) of total energy (resulting in application of the Nutrient Warning “High in Sugar” Label), and sodium in levels of excess was defined as 1mg/kcal (resulting in application of the Nutrient Warning “High in Salt” Label).

The Multiple Traffic Light Label nutrient information and colors were applied following the UK Guidelines (32). The highest threshold for sugar was defined as > 22.5 g/100g product (resulting in a red color for sugar), and the highest threshold for salt was defined as > 1.5g salt/100g product (resulting in a red color for salt).

The letter grade for the Nutri-Score Label was applied to each product following the calculator provided by the French Ministry of Health, Santé Publique France (33). The Nutri-Score Label letter assignment depends on an algorithm that assigns negative and positive points to various nutrients; cut-offs or limits for nutrients of concern are not provided as part of the NPM. (Supplementary Table 1 includes FoPL thresholds and Supplementary Table 2 includes nutritional values and FoPL applied).

Survey tasks

Within each arm, participants were randomized to see either products with excess sodium (chips and savory snack) or products with excess sugar first (sugar-sweetened beverage and sweet biscuits).

Intent to purchase

Participants were asked to rate their intent to purchase on a 7-point Likert scale (1 = would certainly not buy to 7 = would definitely buy) for each product.

Correct Identification of Nutrients of Concern

Participants were then asked which of the following statements were true for each product, that the product was a) high in sugar, b) high in protein, or c) high in salt. “None of the above” and “I don’t know” were also response options.

Label Acceptability and Opinion

Participants were then asked a series of label acceptability and opinion questions using stand-alone images of the FoPL (i.e., not on a mock product). Participants saw only their assigned FoPL (those assigned to the no label condition did not answer this set of questions). Participants were shown one Nutrient Warning Label, Multiple Traffic Light Label, or Nutri-Score Label. Responses for label acceptability and opinion questions were recorded on a 7-point Likert scale. For example, response scales ranged from 1 = I totally disagree with this statement to 7 = I totally agree with this statement, and 1 = I would not be worried at all to 7 = I would be very worried.

Descriptive Questions

Finally, participants were asked descriptive questions about their gender, education level, household size and composition, and frequency of packaged food purchases. (The English version of the data collection instrument can be found in the Supplementary Materials.)

Power and sample size

The pre-study sample size calculation was based on a mixed effects modeling approach. Our results suggested a study of 1,200 participants (300 for each of the arm) would be powered to detect a 0.4 point difference in purchase intention score assuming an intracluster correlation coefficient of 0.2 between sodium and sugar products, a standard deviation estimated at 1.7 points, 91% power, a 5% significance level, and a Bonferroni correction to adjust for multiple comparisons. The 0.4 point difference in purchase intention score was determined

based on findings from a previously conducted study in Brazil (34).

Patient and Public Involvement

Ethiopian consumers were not involved in developing research questions, the design of the study, choice of outcome methods, recruitment, or dissemination of results. Discussions were held with representatives from the Ethiopian government regarding approaches to understand and improve food environments and consumer purchasing behavior; the priorities, experience, and preferences expressed did inform research questions, design and conduct of the study, and outcome measures. Dissemination of results within this public group has taken place. Dissemination of results within the communities where the research took place, and more broadly across the Ethiopian population, has been planned.

Analysis

For participants characteristics, means and standard deviation (SD) or median and interquartile (IQR) were calculated for continuous variables, whereas percentages were computed for categorical variables.

A linear mixed effect model (LMM) was employed to model the effect of presence and type of FoPL on intent to purchase products. A random intercept for participant was included as well as an error term whose variance components modeled inter- and intra-participant variability, respectively. The estimated means and associated 95% confidence intervals (CI) of intent to purchase scores for each FoPL type were estimated from the mixed models using typical Gaussian LMM assumptions. In addition, a model adjusting for baseline covariates (age, gender, education, and presence of children in the household) was run to guard against any potential confounding.

The proportion of participants that correctly identified the nutrient of concern in excess for all four products were compared. For each product, one answer was considered correct (either high in sugar or high in salt, depending on the product), all other answer choices were considered incorrect.

Means and standard deviations were calculated by label arm for each of the label acceptability and opinion questions. Seven-point Likert scales were used to assess responses to each question: responses to the label acceptability questions ranged from 1 = totally disagree to 7 = totally agree, and

responses the label opinion question ranged from 1 = I would not be worried at all to 7 = I would be very worried. Linear regression models for each outcome were used to compare Multiple Traffic Light Labels to Nutrient Warning Labels, and Nutri-Score Labels to Nutrient Warning Labels.

The statistician was initially blinded to the labels that corresponded to each study arm, until the analysis of the primary outcome was complete. A code for the study arm, which included no information about the label, was used in the dataset. R Statistical Software (version 4.4.1) was used for all analyses.

Results

The study was conducted between December 2022 and January 2023; 1,247 entrants were assessed for eligibility (age 18 or over, typically shops for packaged foods at food markets, and agree to participate). One declined to participate after the consent form and eligibility were presented, and six were excluded for failing to meet the inclusion criteria (Fig. 4). 1,240 participants were randomized. 40 did not complete the survey or there was missing data within the survey; data were not analyzed for these participants. The analyzed sample included 1,200 participants who were randomized to the intended study arm.

Participants reported a mean age of 31.6 years, 53.2% were female, and 30.8% had no more than a high school education. The mean number of adults in the household was 3.3, regardless of the presence of children in the household. Around two-thirds of all households (n = 800) included children 18 years of age or under; with an average of 1.9 children per household. About three-fourths of all participants reported purchase of packaged foods at least every month and one-third reported purchases at least once a week (Table 1). Supplementary Table 3 displays the percentage of participants recruited by sub-city within Addis Ababa.

Table 1
Participant
characteristics
by
randomization
assignment

Intent to purchase

The mean intent to purchase score for all products containing excess sodium or sugar (chips, savory snack, sugar-sweetened beverage, and sweet biscuits) among participants randomized to the Nutrient Warning Labels arm was 4.37 (95% CI: 4.16, 4.59). This was significantly lower ($p \leq 0.003$) than no label (4.73, 95% CI: 4.52, 4.94), Multiple Traffic Light (4.75, 95% CI: 4.53, 4.96), or Nutri-Score Label (4.75, 95% CI: 4.54, 4.96) arms (Fig. 5). Results were similar in the adjusted model (Supplementary Table 4).

Correct Identification of Nutrients of Concern

Among participants in the Nutrient Warning Labels arm, 62% (95% CI: 56%, 67%) correctly identified the nutrient of concern in excess for all four products (i.e., that the chips and savory snack contained excess

salt, and that the sugar-sweetened beverage and sweet biscuits contained excess sugar) (Fig. 6). Correct identification of nutrients of concern was significantly lower in the other three arms: 36% (95% CI: 31%, 42%) in the no label arm, 49% (95% CI: 43%, 54%) in the Multiple Traffic Light Label arm, and 34% (95% CI: 28%, 39%) in the Nutri-Score Label arm (Supplementary Table 5).

Label Acceptability

Participants in the Nutrient Warning Labels arm reported that the Nutrient Warning Labels were effective in informing their purchasing decisions (mean 6.2, SD 1.6), drew their attention (mean 5.7, SD 1.8), were trustworthy (mean 5.8, SD 1.6), and were easy to understand (mean 5.8, SD 1.7), in comparison to participants in the Nutri-Score arm. There was no significant difference between the Nutrient Warning Labels and the Multiple Traffic Light Label arms for each of these questions (Supplementary Table 6).

Label Opinion

Participants in the Nutrient Warning Labels arm reported they would be significantly more worried if their children consumed food and drinks that displayed this label (mean = 4.8, SD = 2.2) compared to both the Multiple Traffic Light Label (mean = 4.0, SD = 2.3) and Nutri-Score Label (mean = 4.1, SD = 2.1) (p-values for both comparisons < 0.001) (Supplementary Table 3).

Discussion

In this RCT of Ethiopian consumers, Front-of-Package Nutrient Warning Labels were more effective in reducing intent to purchase package foods high in nutrients of concern among Ethiopian consumers compared to no label, a Multiple Traffic Light Label, or a Nutri-Score Label. The Nutrient Warning Labels and Multiple Traffic Light Label had greater acceptability than the Nutri-Score Label. Participants were significantly more likely to report being worried if their children consumed food and drinks displaying Nutrient Warning Labels compared to Nutri-Score and Multiple Traffic Light Labels. These findings support Nutrient Warning Labels as a strategy acceptable to Ethiopian consumers and effective in informing their purchasing behaviors.

Our findings are consistent with previously developed conceptual frameworks that indicate Nutrient Warning Labels are effective due to their binary nature, which facilitates rapid decision-making, and their association with warnings, which discourage purchasing behavior (22, 35). The black-and-white triangle is an internationally standardized shape for warnings (36, 37). Additionally, Nutrient Warning Labels are simple, easy to understand, and clearly visible against colorful packaging (38, 39). A systematic review of RCTs and quasi-experimental studies also found Nutrient Warning Labels were more effective than the Multiple Traffic Light Label in discouraging unhealthy food purchasing behavior (40). Our results are also consistent with the majority of RCTs among adults in other countries that have specifically tested black-and-white Nutrient Warning Labels against other types of FoPL systems using consumers' intent to purchase products high in nutrients of concern as the outcome. RCTs conducted in Canada (25), Brazil (28), Jamaica (29), South Africa (23), and Panama (27) found lower intent to purchase foods high in one or more nutrients of concern when Nutrient Warning Labels were applied, compared to Multiple

Traffic Light Labels (with and without numerical values) and no label. Trials in Argentina (24) and Costa Rica (26) also included Nutri-Score Labels. Although each study used different methodology in different contexts, the results are consistent with the present study. When examining across all categories of packaged products, the Nutrient Warning Label was effective at lowering intent to purchase less healthy foods, while Multiple Traffic Light and Nutri-Score labels were not effective at influencing intent to purchase.

Only one RCT that tested black-and-white Nutrient Warning Labels against other types of FoPL, conducted in India (41), found no statistically significant difference in intent to purchase for any label tested relative to the control label (a bar code); however, the Nutrient Warning Labels performed well on other tasks in the study, including on label acceptability (41). The Nutrient Warning Labels were the most frequently chosen label by consumers in India to discourage consumption of processed foods by children, which is consistent with the present findings (41).

Our results are consistent among the RCT studies above that included identification of nutrients of concern as an outcome. The Nutrient Warning Label was more effective across all products when tested against the Multiple Traffic Light for facilitating the identification of sugar, sodium, or saturated fat (23, 26–29, 41). Gomes et al. (26) additionally tested the Nutri-Score Labels and found, similar to the present study, that Nutri-Score was ineffective at this task.

An online longitudinal multi-country study (42) reported that the Nutri-Score Label performs better than other FoPL in assisting consumers in ranking ultra-processed foods. However, the ability of an FoPL to assist consumers in ranking unhealthy foods is a distinctly different objective that was not examined in this study. The health goal of Nutrient Warning Labels (supported by the underlying NPM) is to warn consumers when nutrients of concern are present in excess and reduce consumption of the unhealthiest ultra-processed products. The Nutri-Score Label (supported by the underlying NPM) allows beneficial ingredients like fiber or protein to “offset” unhealthy ingredients, i.e. sugar, sodium, or saturated fat (43), and does not easily support identification of individual nutrients of concern on the label.

There is evidence of the effectiveness of Nutrient Warning Labels from real-world evaluations. In 2016, Chile became the first country to implement Nutrient Warning Labels, and it remains one of the few countries with an available FoPL policy evaluation to date. The Nutrient Warning Labels were implemented along with public education and extensive engagement with political leaders and partner agencies and organizations within Chile. Policy implementation was associated with lowering purchases of products high in nutrients of concern (44–46), and product reformulation reducing sugar and sodium levels in packaged foods (47). Peru implemented a similar policy in 2019, and two years later researchers found the prevalence of any beverage or food carrying Nutrient Warning Label dropped 28% and 20%, respectively (48).

Researchers in Mexico also found significant reductions in the percentage of products subject to warning labels after mandatory Nutrient Warning Label policy implementation in 2020. For example, a 40% reduction in products exceeding a strict warning-label cutoff for sodium (350mg/100g for foods)

was found in the salty snacks and instant food groups, and a 60–70% relative reduction was found for cereal-based desserts, bread, and other cereals (49).

The use of a multi-arm parallel-group randomized controlled design is a strength of this study, allowing the results to be attributed to FoPL systems. In this study, the street intercept methodology was designed to reflect the diversity of the population of Addis Ababa among consumers that typically purchase packaged foods at different types of markets. This methodology likely reached a more representative sample of consumers of packaged products in Ethiopia than an online survey biased toward a more privileged group with internet access that may or may not visit markets to purchase food. Additionally, no explanation of how to read or interpret the labels was provided, so there was no additional influence on the decision to purchase products within the study setting. Finally, adjusting for education and gender did not impact the estimates for the primary outcome, indicating that the Nutrient Warning Label had a similar impact across the educational levels and gender represented in the study sample, and suggesting that the Nutrient Warning Label would not have a negative impact on health equity in Ethiopia.

This trial also has limitations. The educational level attained in this sample was high overall, and there was a geographic limitation as the study was conducted entirely in the city of Addis Ababa. Participant knowledge regarding diet-related disease was not assessed. A more diverse sample that included a measure of consumer nutrition and health knowledge could have better contextualized the results and informed a mass media and education campaign to maximize the effectiveness of a policy to implement a national Nutrient Warning Labels policy.

This study focused on participants' intent to purchase products high in nutrients of concern and label acceptability. It was not possible to assess the impact of labels on actual purchasing decisions in this study, but the outcomes are part of the pathway from warning exposure to behavioral change (22, 50). In the label acceptability and opinion section of the survey, the Multiple Traffic Light Label was shown with two red panels instead of an amber and red panel. The label was shown alone (and not on a product) in this section, and was a generic example of the style of label, and is not anticipated to have influenced the answers in this section other than to possibly overestimate the effect of the label compared to if the label had correctly been shown with less red. Finally, the long-term impact of FoPL and their effect when implemented with other policies was outside the scope of this study, but should be evaluated in real-world settings.

This study has implications for health policy in Ethiopia. It should be noted that the burden of undernutrition in Ethiopia remains high, despite decades of attention and improvement (51). More progress will be made when the perception that too few calories drives undernutrition and too many calories drives overnutrition shifts to a recognition that improving diet quality and the variety of healthy foods available to a population addresses malnutrition in all its forms (52). The development of the Ethiopian food-based dietary guidelines in 2022, led and coordinated by the Ethiopian Public Health Institute (EPHI), the technical arm of the Ministry of Health – Ethiopia, recognizes the central role that

healthy, safe and nutrient-dense diets are the foundation of good health (53, 54). The implementation of Nutrient Warning Labels could also help support healthier diets for the Ethiopian population, and specifically address the national policy objectives set under the Department of Health’s *Health Sector Transformation Plan II* aimed at enhancing the nutritional status of Ethiopians and preventing CVD and type 2 diabetes mellitus (55). Raising public awareness regarding the connection between these chronic diseases and diet will likely enhance the effectiveness of Nutrient Warning Labels.

Conclusions

This RCT demonstrated that the Front-of-Package Nutrient Warning Labels were more effective in reducing intent to purchase package foods high in nutrients of concern among Ethiopian consumers compared to no label, a Multiple Traffic Light Label, or a Nutri-Score Label. Only the Nutrient Warning Labels decreased consumers’ intent to purchase products containing excess sugar and sodium. The Nutrient Warning Labels were also significantly better in helping consumers identify packaged foods containing excess levels of sugar or sodium. These results support mandatory Front-of-Package Nutrient Warning Labels to decrease the purchase of packaged foods high in nutrients of concern in Ethiopia.

Abbreviations

Addis Continental Institute of Public Health	ACIPH
cardiovascular disease	CVD
confidence interval	CI
Ethiopian Public Health Institute	EPHI
front-of-package label	FoPL
institutional review board	IRB
interquartile range	IQR
Johns Hopkins Bloomberg School of Public Health	BSPH
Johns Hopkins University	JHU
linear mixed effect model	LMM
non-communicable disease	NCD
nutrient profile model	NPM
Pan American Health Organization	PAHO

randomized controlled trial	RCT
standard deviation	SD
United Nations Children's Fund	UNICEF
World Health Organization	WHO

Declarations

Ethics approval and consent to participate

Institutional Review Boards (IRB) of the Addis Continental Institute of Public Health (ACIPH) and the Johns Hopkins University (JHU) Bloomberg School of Public Health (BSPH) approved the study (IRB numbers 16498/FSR567 and ACIPH/IRB/007/2021, respectively). This study adhered to the Declaration of Helsinki. All participants were at least 18 years old and provided informed consent. This trial was registered prior to data collection at <https://www.clinicaltrials.gov> on September 9, 2022 (NCT05549388). This study adheres to CONSORT guidelines.

Consent for publication

Not applicable

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

MEH, LMS, and LJA report grant support from the National Institutes of Health. NK reports consulting fees from the Pan American Health Organization and UNICEF, participation on an advisory board for the Center for Food and Nutrition Policy, University of Pennsylvania, and the Department of Science and Technology, Philippines. NK is listed on the editorial board of BMC Nutrition at the time of submission. MM reports grant support from WHO and consulting fees from GiveWell, both outside of the present work. LJA reports additional grant support from the Sheikh Khalifa Stroke Institute, and Cigarette Restitution Fund of Maryland; consulting fees from GiveWell; and payments or honoraria from Wolters Kluwer, Cardiometabolic Health Congress Symposium, and Controversies to Consensus in Diabetes, Obesity and Hypertension, all outside of the present work. All other authors declare no competing interests.

Funding

This study was funded by Resolve to Save Lives and Bloomberg Philanthropies. The funders did not play a role in the design, conduct, analysis, or reporting of the trial.

Authors' contributions

MEH, DZ, MM, LJA, HYB, NF, SB, KF, NK, and LMS contributed to the study design. MEH, DZ, MM, NF, and KF analyzed data and performed statistical analysis. MEH wrote the manuscript. All authors made critical revisions and approved the final version of the manuscript.

Acknowledgements

The authors would like to thank Emily Busey, MPH, RDN for her work on the graphic design and Elena Blasco-Colmenares PhD, MD, MPH for assistance with interpretation of data.

References

1. United Nations Department of Economic and Social Affairs/Population Division. World Urbanization Prospects 2018 [Available from: <https://population.un.org/wup/>]
2. Jembere GB, Cho Y, Jung M. Decomposition of Ethiopian life expectancy by age and cause of mortality; 1990–2015. *PLoS ONE*. 2018;13(10):e0204395.
3. Misganaw A, Haregu TN, Deribe K, Tessema GA, Deribew A, Melaku YA, et al. National mortality burden due to communicable, non-communicable, and other diseases in Ethiopia, 1990–2015: findings from the Global Burden of Disease Study 2015. *Popul Health Metr*. 2017;15:29.
4. Institute for Health Metrics and Evaluation (IHME). GBD Compare Data Visualization: University of Washington. 2019 [Available from: <http://vizhub.healthdata.org/gbd-compare>]
5. Mekonene M, Baye K, Gebremedhin S. Epidemiology of hypertension among adults in Addis Ababa, Ethiopia. *Prev Med Rep*. 2023;32:102159.
6. Gebrie A, Alebel A, Zegeye A, Tesfaye B, Ferede A. Prevalence and associated factors of overweight/obesity among children and adolescents in Ethiopia: a systematic review and meta-analysis. *BMC Obes*. 2018;5:19.
7. Kassie AM, Abate BB, Kassaw MW. Prevalence of overweight/obesity among the adult population in Ethiopia: a systematic review and meta-analysis. *BMJ Open*. 2020;10(8):e039200.
8. Pagliai G, Dinu M, Madarena MP, Bonaccio M, Iacoviello L, Sofi F. Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. *Br J Nutr*. 2021;125(3):308–18.
9. Melaku YA, Temesgen AM, Deribew A, Tessema GA, Deribe K, Sahle BW, et al. The impact of dietary risk factors on the burden of non-communicable diseases in Ethiopia: findings from the Global Burden of Disease study 2013. *Int J Behav Nutr Phys Act*. 2016;13(1):122.
10. Melesse MB, van den Berg M, de Brauw A, Abate GT. Understanding Urban Consumers' Food Choice Behavior in Ethiopia: Promoting Demand for Healthy Foods. Ethiopian Development Research Institute (EDRI); 2019. Contract No.: Working Paper 131.

11. Monteiro CA, Cannon G, Levy RB, Moubarac JC, Louzada ML, Rauber F, et al. Ultra-processed foods: what they are and how to identify them. *Public Health Nutr.* 2019;22(5):936–41.
12. Challa F, Tadesse Y, Mudie K, Taye G, Gelibo T, Bekele A, Sileshi M, Getahun T, Geto Z, Ayalkebet A. Urinary Sodium Excretion and Determinates among Adults in Ethiopia: Findings from National STEPS Survey. *Ethiop J Health Dev.* 2017;31(1):370–77.
13. Ministry of Health Ethiopia. Health Sector Transformation Plan II 2020/21-2024/25. Addis Ababa, Ethiopia; 2021.
14. World Health Organization. Guiding Principles and Framework Manual for Front-of-Pack Labelling for Promoting Healthy Diet. Geneva, Switzerland: WHO; 2019.
15. UNICEF. Front-of-Pack Nutrition Labelling: A 'How-to' Guide for Countries. 2021 2021.
16. UNICEF, Policy, Brief. Front-of-pack nutrition labelling of foods and beverages. 2021.
17. Crosbie E, Gomes FS, Olvera J, Rincon-Gallardo Patino S, Hoeper S, Carriedo A. A policy study on front-of-pack nutrition labeling in the Americas: emerging developments and outcomes. *Lancet Reg Health Am.* 2023;18:100400.
18. Pan American Health Organization (PAHO). Front-of-package labeling [Available from: <https://www.paho.org/en/topics/front-package-labeling>
19. Pan American Health Organization (PAHO). Front-of-Package Labeling as a Policy Tool for the Prevention of Noncommunicable Diseases in the Americas. 2020.
20. Kanter R, Vanderlee L, Vandevijvere S. Front-of-package nutrition labelling policy: global progress and future directions. *Public Health Nutr.* 2018;21(8):1399–408.
21. Afroza U, Abrar AK, Nowar A, Sobhan SMM, Ide N, Choudhury SR. Global overview of government-endorsed nutrition labeling policies of packaged foods: a document review. *Front Public Health.* 2024;12:1426639.
22. Taillie LS, Hall MG, Popkin BM, Ng SW, Murukutla N. Experimental Studies of Front-of-Package Nutrient Warning Labels on Sugar-Sweetened Beverages and Ultra-Processed Foods: A Scoping Review. *Nutrients.* 2020;12(2).
23. Bopape M, De Man J, Taillie LS, Ng SW, Murukutla N, Swart R. Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase the products- A randomised controlled trial in South Africa. *Appetite.* 2022;179:106283.
24. Castronuovo L, Tiscornia MV, Guarnieri L, Martins E, Gomes FS, Allemandi L. Efficacy of different front-of-package labeling systems in changing purchase intention and product healthfulness perception for food products in Argentina. *Rev Panam Salud Publica.* 2022;46:e137.
25. Franco-Arellano B, Vanderlee L, Ahmed M, Oh A, L'Abbe M. Influence of front-of-pack labelling and regulated nutrition claims on consumers' perceptions of product healthfulness and purchase intentions: A randomized controlled trial. *Appetite.* 2020;149:104629.
26. Gomes FS, Madriz-Morales K, Valenzuela DR, Blanco-Metzler A, Amador N, Benavides-Aguilar K, et al. Comparison of front-of-package nutrition labelling schemes in Costa Rica: A multi-arm parallel-

- group randomised controlled trial assessing objective understanding and purchase intention. *Appetite*. 2025;206:107774.
27. Gomes FS, Rios-Castillo I, Correa LRL, Cruzado B, Rojas CFU, Ares Devincenzi G, et al. Effects of front-of-package nutrition labelling systems on objective understanding and purchase intention in Panama: results from a multi-arm parallel-group randomised controlled trial. *Public Health Nutr*. 2024;27(1):e192.
 28. Khandpur N, de Moraes Sato P, Mais LA, Bortoletto Martins AP, Spinillo CG, Garcia MT et al. Are Front-of-Package Warning Labels More Effective at Communicating Nutrition Information than Traffic-Light Labels? A Randomized Controlled Experiment in a Brazilian Sample. *Nutrients*. 2018;10(6).
 29. White-Barrow V, Gomes FS, Eyre S, Ares G, Morris A, Caines D, et al. Effects of front-of-package nutrition labelling systems on understanding and purchase intention in Jamaica: results from a multiarm randomised controlled trial. *BMJ Open*. 2023;13(4):e065620.
 30. Ndanuko R, Maganja D, Kibet A, Coyle DH, Kimiywe J, Raubenheimer D et al. Sodium Content and Labelling Completeness of Packaged Foods and Beverages in Kenya. *Nutrients*. 2021;13(4).
 31. Pan American Health Organization (PAHO). Nutrient Profile Model. Washington, DC 2016.
 32. Department of Health. Food standards agency. Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets. London, United Kingdom 2016. [Available from: https://www.food.gov.uk/sites/default/files/media/document/fop-guidance_0.pdf
 33. French Ministry of Health Santé publique France. Nutri-Score 2024 [Available from: <https://www.santepubliquefrance.fr/en/nutri-score>
 34. LA NK, dMS MP, CG APBM, CFU S. R, et al. Choosing a front-of-package warning label for Brazil: A randomized, controlled comparison of three different label designs. Ottawa, Ont: Food research international; 2019. p. 121.
 35. Roberto CA, Ng SW, Ganderats-Fuentes M, Hammond D, Barquera S, Jauregui A, et al. The Influence of Front-of-Package Nutrition Labeling on Consumer Behavior and Product Reformulation. *Annu Rev Nutr*. 2021;41:529–50.
 36. Standardization IOF. ISO 3864: Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings. 2011.
 37. Wogalter MS, Silver NC, Leonard SD, Zaikina H. Handbook of warnings. Warning symbols. 2006.
 38. Arrua A, Machin L, Curutchet MR, Martinez J, Antunez L, Alcaire F, et al. Warnings as a directive front-of-pack nutrition labelling scheme: comparison with the Guideline Daily Amount and traffic-light systems. *Public Health Nutr*. 2017;20(13):2308–17.
 39. Cabrera M, Machin L, Arrua A, Antunez L, Curutchet MR, Gimenez A, et al. Nutrition warnings as front-of-pack labels: influence of design features on healthfulness perception and attentional capture. *Public Health Nutr*. 2017;20(18):3360–71.
 40. Song J, Brown MK, Tan M, MacGregor GA, Webster J, Campbell NRC, et al. Impact of color-coded and warning nutrition labelling schemes: A systematic review and network meta-analysis. *PLoS Med*. 2021;18(10):e1003765.

41. Singh SK, Taillie LS, Gupta A, Bercholz M, Popkin B, Murukutla N. Front-of-Package Labels on Unhealthy Packaged Foods in India: Evidence from a Randomized Field Experiment. *Nutrients*. 2022;14(15).
42. Egnell M, Talati Z, Hercberg S, Pettigrew S, Julia C. Objective Understanding of Front-of-Package Nutrition Labels: An International Comparative Experimental Study across 12 Countries. *Nutrients*. 2018;10(10).
43. Hall KD, Ayuketah A, Brychta R, Cai H, Cassimatis T, Chen KY, et al. Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake. *Cell Metab*. 2019;30(1):67–77. e3.
44. Taillie LS, Reyes M, Colchero MA, Popkin B, Corvalan C. An evaluation of Chile's Law of Food Labeling and Advertising on sugar-sweetened beverage purchases from 2015 to 2017: A before-and-after study. *PLoS Med*. 2020;17(2):e1003015.
45. Taillie LS, Bercholz M, Popkin B, Reyes M, Colchero MA, Corvalan C. Changes in food purchases after the Chilean policies on food labelling, marketing, and sales in schools: a before and after study. *Lancet Planet Health*. 2021;5(8):e526–33.
46. Taillie LS, Bercholz M, Popkin B, Rebolledo N, Reyes M, Corvalan C. Decreases in purchases of energy, sodium, sugar, and saturated fat 3 years after implementation of the Chilean food labeling and marketing law: An interrupted time series analysis. *PLoS Med*. 2024;21(9):e1004463.
47. Reyes M, Smith Taillie L, Popkin B, Kanter R, Vandevijvere S, Corvalan C. Changes in the amount of nutrient of packaged foods and beverages after the initial implementation of the Chilean Law of Food Labelling and Advertising: A nonexperimental prospective study. *PLoS Med*. 2020;17(7):e1003220.
48. Saavedra-Garcia L, Meza-Hernandez M, Diez-Canseco F, Taillie LS. Reformulation of Top-Selling Processed and Ultra-Processed Foods and Beverages in the Peruvian Food Supply after Front-of-Package Warning Label Policy. *Int J Environ Res Public Health*. 2022;20(1).
49. Salgado JC, Pedraza LS, Contreras-Manzano A, Aburto TC, Tolentino-Mayo L, Barquera S. Product reformulation in non-alcoholic beverages and foods after the implementation of front-of-pack warning labels in Mexico. *PLoS Med*. 2025;22(3):e1004533.
50. Grummon AH, Hall MG. Sugary drink warnings: A meta-analysis of experimental studies. *PLoS Med*. 2020;17(5):e1003120.
51. Woldeyohannes M, Girma M, Petros A, Hussen A, Samuel A, Dinssa DA, et al. Ethiopia National Food and Nutrition Survey to inform the Ethiopian National Food and Nutrition Strategy: a study protocol. *BMJ Open*. 2023;13(4):e067641.
52. Swinburn BA, Kraak VI, Allender S, Atkins VJ, Baker PI, Bogard JR, et al. The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *Lancet*. 2019;393(10173):791–846.
53. Federal Government of Ethiopia MoH, Ethiopian Public Health Institute. Ethiopia: Food-Based Dietary Guidelines–2022. Addis Ababa, Ethiopia; 2022.

54. Bekele TH, de Vries JJ, Trijsburg L, Feskens E, Covic N, Kennedy G, et al. Methodology for developing and evaluating food-based dietary guidelines and a Healthy Eating Index for Ethiopia: a study protocol. *BMJ Open*. 2019;9(7):e027846.

55. Bekele TH, Trijsburg L, Brouwer ID, de Vries JH, Covic N, Kennedy G, et al. Dietary Recommendations for Ethiopians on the Basis of Priority Diet-Related Diseases and Causes of Death in Ethiopia: An Umbrella Review. *Adv Nutr*. 2023;14(4):895–913.

Table 1

Table 1 is available in the Supplementary Files section.

Figures

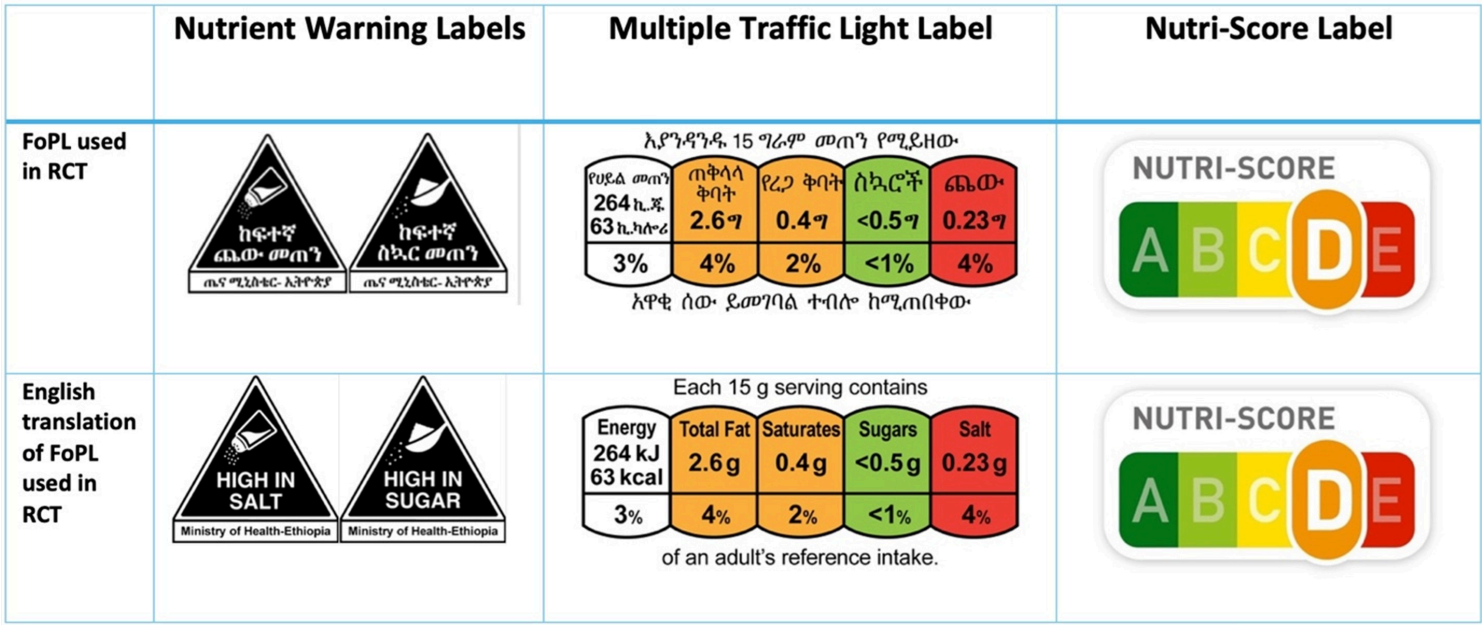


Figure 1

Front-of-Package Label designs used in RCT with English translations



Figure 2

Mock products: A) chips, B) savory snack, C) sugar-sweetened beverage, and D) sweet biscuits

Nutrient Warning Labels	No Label	Multiple Traffic Light Label	Nutri-Score Label

Figure 3

Examples of a mock food product (chips) as displayed across study arms

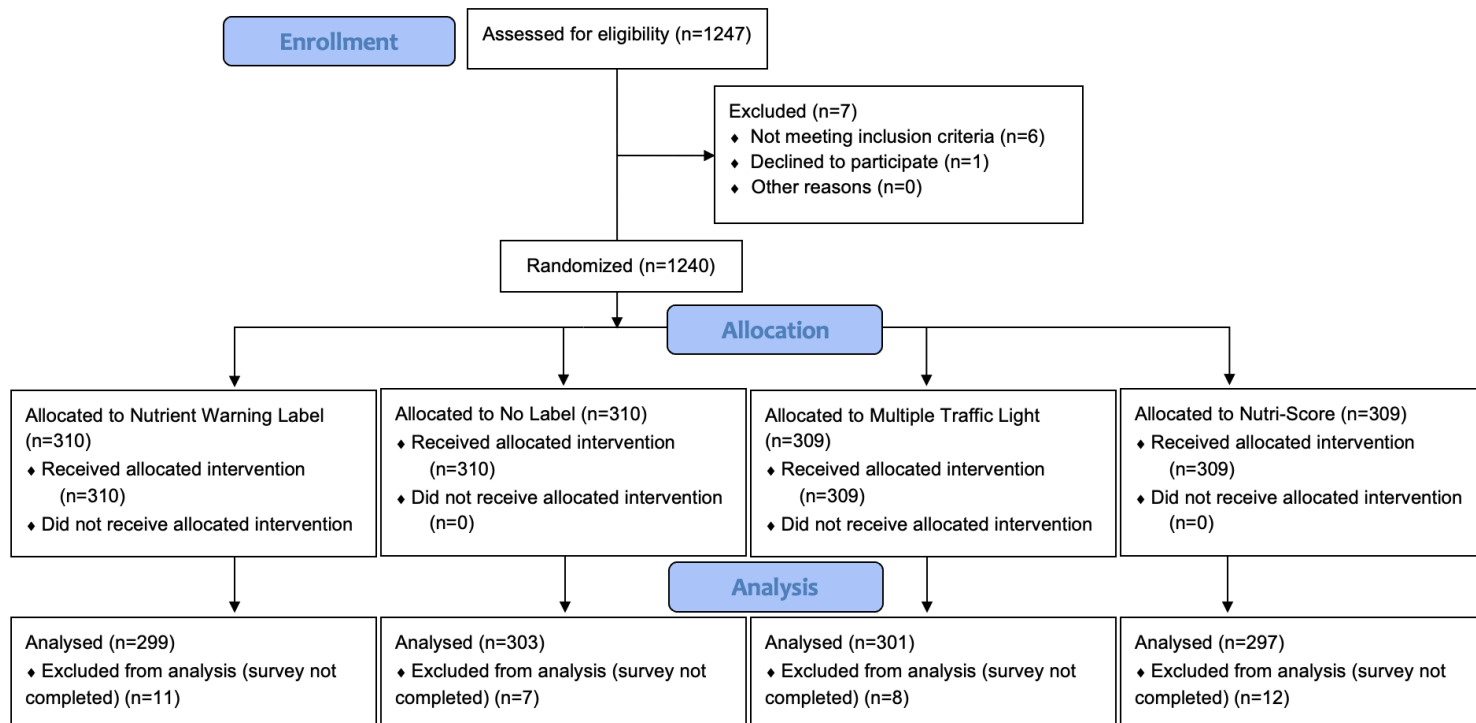


Figure 4

Trial Profile

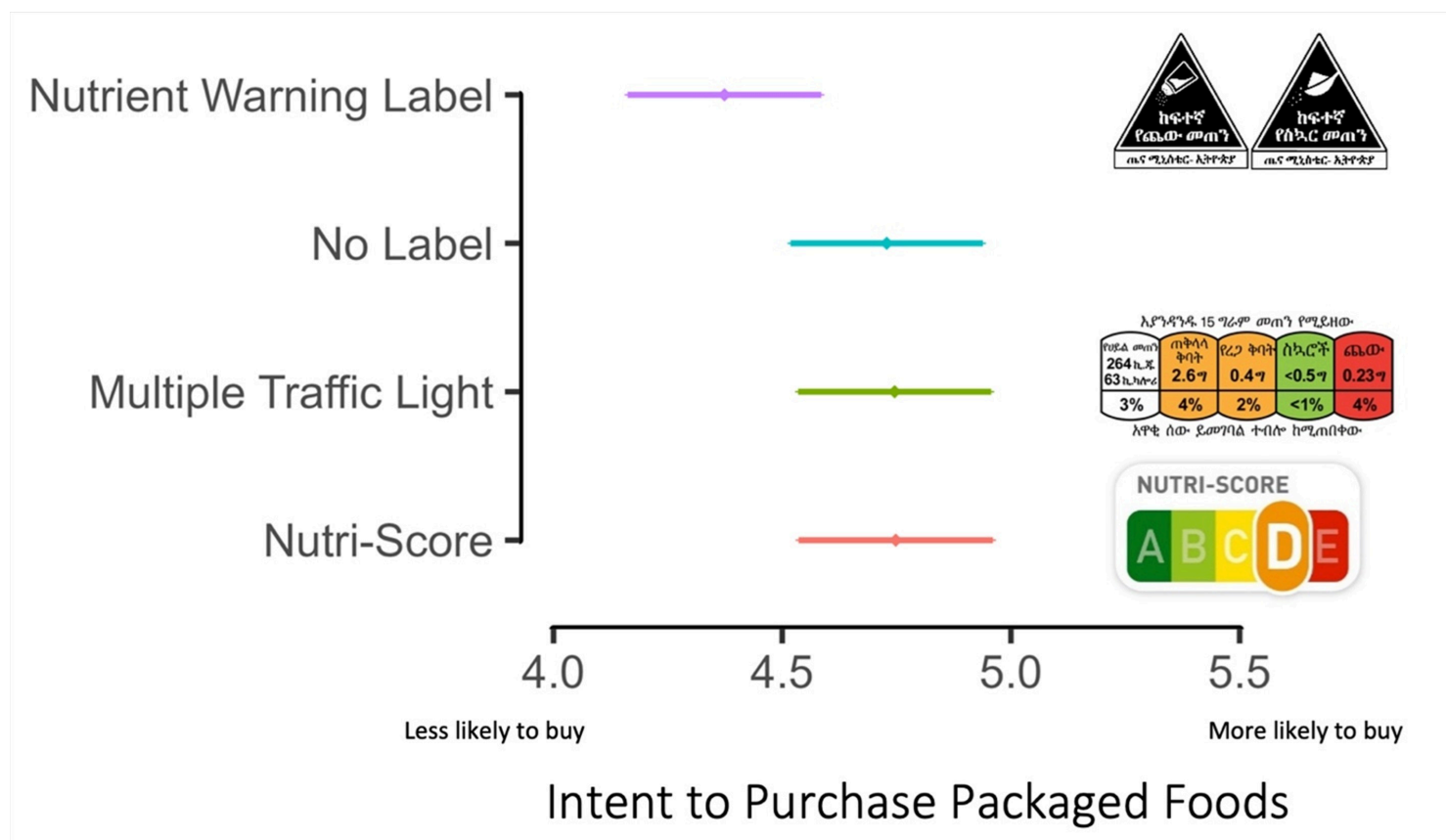


Figure 5

Mean (95% CI) intent to purchase four packaged foods containing excess sugar or sodium by Front-of-Package Label type among participants (n=1200)

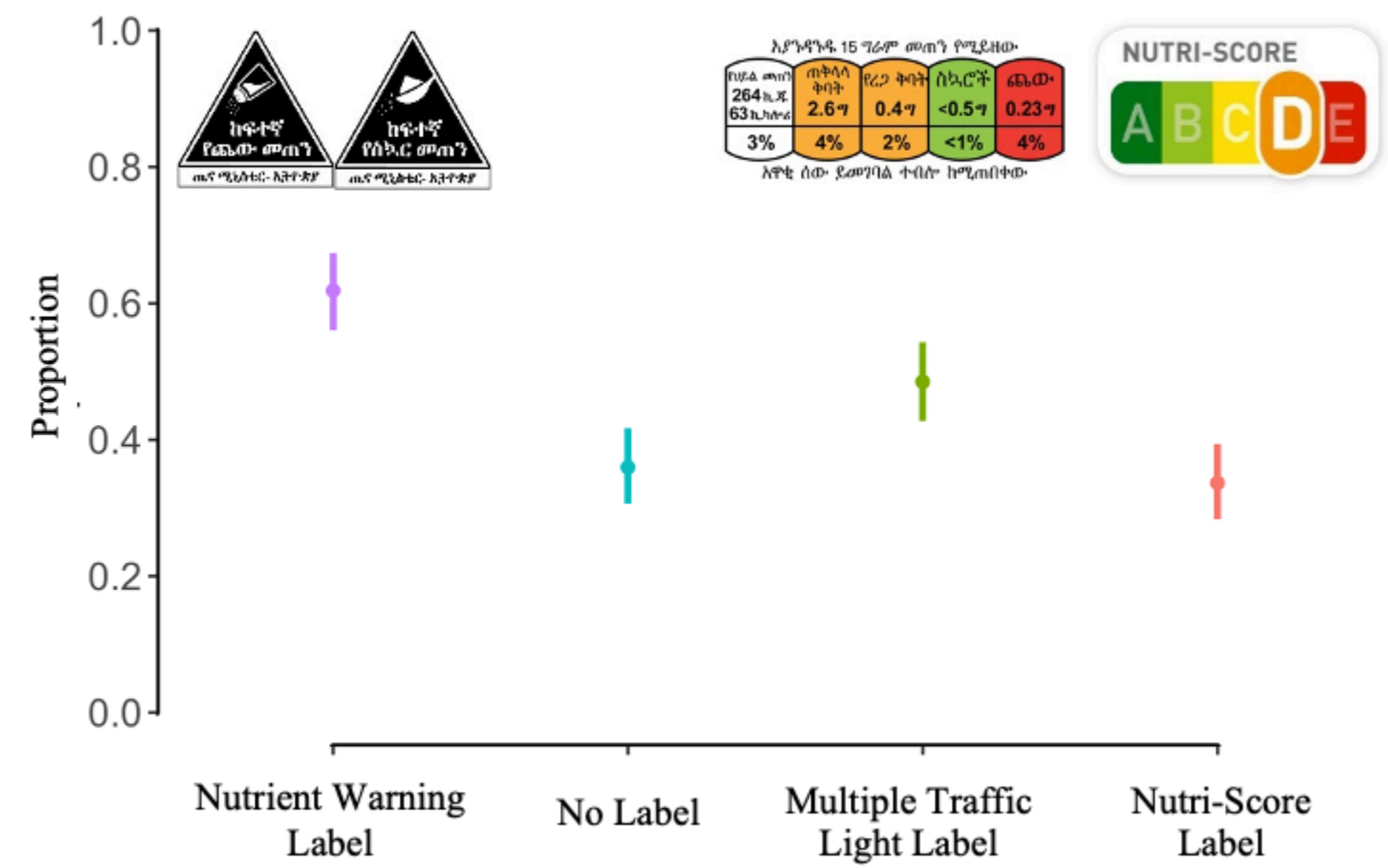


Figure 6

Proportion (95% CI) of participants correctly identifying sugar or sodium in excess in four packaged foods by Front-of-Package Label type

Supplementary Files

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- [20260327FoPLRCTBMCPaperSupplementaryMaterial.docx](#)
- [20260419FoPLRCTPaperCONSORT2025Checklist.docx](#)
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