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Impact of warning labels on energy drink perceptions and purchase intentions among emerging adults in Uruguay

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Abstract

Background: The rapid expansion of energy drink markets over the past two decades have sparked growing policy debate surrounding their regulation, due to their potential adverse health effects, particularly among young people. In this context, mandatory warning labels have emerged as a promising public health intervention. The present work aims to explore the effect of warning labels on emerging adults' purchase intention and perceived healthfulness of energy drinks in Uruguay.

Methods: An online randomized controlled trial was implemented using a convenience sample of 340 emerging adults. Commercial energy drink cans, varying in brand (market-leading vs. lesser-known brand) and sugar content (regular vs. zero-added sugar variant), were used as stimuli. Participants were randomly assigned to either the control group (no warning label) or one of the four intervention groups, each of which was exposed to a warning label condition (Insomnia-graphic, Insomnia-textual, Tachycardia-graphic, Tachycardia-textual). The questionnaire comprised six main sections: (i) purchase intention; (ii) perceived effects of energy drink consumption and perceived healthfulness; (iii) perception of warning labels; (iv) comparison of warning labels; (v) socio-demographic characteristics; and (vi) energy drink consumption habits and perceived risk.

Results: The graphic warning referring to tachycardia led to a significant reduction in purchase intention compared with the control condition; not significant effect was observed for the remaining warning label conditions. Perceived healthfulness was consistently and statistically significantly reduced across all warning label conditions, except for the textual tachycardia warning. In addition, warning labels were consistently associated with an increased attribution of negative effects of energy drink consumption, in contrast to the limited and selective effects observed for positive outcomes. Results also provide emerging insights into the role of branding, consumption patterns and risk perception in shaping perceived healthfulness and purchase intention for energy

drinks. Regarding participants' perception of warning labels, the graphic tachycardia warning emerged as the most effective condition.

Conclusions: Results support the use of warning labels as a public health strategy to increase awareness of the potential harms associated with energy drink consumption and suggest that their impact may extend even to products with strong market presence and high consumer recognition.

Keywords: caffeinated beverages; front-of-pack; health warnings; food policy; labelling.

Background

Energy drinks are a category of non-alcoholic beverages typically containing caffeine combined with other stimulants such as taurine, glucuronolactone, ginseng extract, and B vitamins, sweetened with sugars or non-sugar sweeteners [1]. Globally, sales of these beverages have increased substantially over the past two decades, particularly among children, adolescents and emerging adults [2–4], fueled by heavy marketing strategies positioning them as an alternative to enhance alertness and physical or cognitive performance [5, 6].

A growing body of evidence has documented potential adverse health effects associated with energy drink consumption [7–9]. Regular consumption of energy drinks has been linked to cardiovascular symptoms, including increased heart rate and blood pressure, arrhythmias, as well as sleep disturbances, anxiety, hyperactivity, and gastrointestinal problems [2, 9, 10]. In light of these health risks, there is increasing recognition of the need for public health policies to discourage energy drink consumption, particularly among young people [11, 12].

Within the proposed policy landscape, mandatory warning labels have emerged as a potentially effective and feasible strategy [12]. Warning labels aim to make the health risks of energy drink consumption more salient at the point of purchase and discourage their purchase and consumption [13, 14]. Evidence from other product categories, such as tobacco and sugar-sweetened beverages, suggests that warning labels can influence consumers' perceptions, reduce product appeal, and lower purchase intentions [15–17]. However, the evidence base regarding warning labels on energy drinks is still limited.

Experimental studies have examined the effect of different types of energy drink warning labels, including labels highlighting caffeine presence (e.g., 'Contains caffeine'), labels describing potential adverse health effects (e.g., 'High levels of caffeine intake can cause headache, nausea, anxiety, irregular heartbeat, vomiting, and, in extreme cases, death'), and messages advising against consumption by specific population groups (e.g., 'Not recommended for children, pregnant women or people sensitive to caffeine') [18–23]. While some studies have reported that

warnings increase risk perception and reduce purchase or consumption intentions [19, 20, 22, 23], others have reported null or counterproductive effects [18, 21]. Variability in warning design, message framing, study samples, and outcome measures hinders direct comparison across studies and limits the ability to draw robust conclusions for policy development. In addition, most existing evidence originates from high-income, developed countries, constraining the generalizability of findings to other regulatory and cultural contexts.

Objectives and context

Given the rapid growth of energy drink markets globally and the evolving policy debate surrounding their regulation, further research is needed to assess the potential role of warning labels as a public health intervention beyond developed countries. The present study addresses this gap by examining the effect of warning labels on emerging adults' purchase intention and perceived healthfulness of energy drinks in Uruguay, contributing empirical evidence relevant to public health policy and regulation.

In recent years, Uruguay has experienced a dramatic rise in energy drink consumption. Between 2010 and 2024, sales increased by 1325%, reaching an estimated annual per capita volume of 1.7 L, and are expected to continue expanding at an annual rate of 8% between 2024 and 2029 [24]. Consumption is especially common among younger populations: 81.8% of high school students report having tried energy drinks at least once [25]. Despite this widespread uptake and growing concern regarding potential adverse health effects, no specific regulatory measures are currently in place to discourage or restrict energy drink consumption in the country.

The study focuses on emerging adulthood, a distinct developmental stage situated between adolescence and full adulthood, generally encompassing ages 18 to 29 [26]. This period is characterized by increasing autonomy, identity exploration, and instability across key life domains such as education, employment, and interpersonal relationships, which collectively heighten susceptibility to experimentation with health-related behaviors [27].

104

105 **Methods**

106 A randomized controlled trial was implemented to assess the effect of different types of warning
107 labels on emerging adult's perceived healthfulness and purchasing intentions of energy drinks.

108 The study was part of a larger project about strategies to discourage energy drink consumption
109 among adolescent and emerging adults. The project was reviewed and approved by the Ethics
110 Committee of the School of Chemistry of Universidad de la República (Uruguay).

111

112 ***Participants***

113 The study relied on a convenience sample of emerging adults. The inclusion criteria were being
114 between 18 and 30 years of age, residing in Uruguay, and consuming energy drinks at least
115 occasionally. Participants were recruited through two complementary strategies. First, invitations
116 were distributed via student mailing lists from four faculties of the Universidad de la República,
117 the country's largest public university, including the Schools of Chemistry, Psychology,
118 Architecture, and Nutrition. In addition, the association of students from the Northeast Regional
119 University Center of Universidad de la República was contacted and posted the link of the study
120 on their social media networks. The invitation included the following text: "A study is being
121 conducted to understand how young adults (18 to 29 years old) perceive energy drinks in our
122 country. If you fall within this age range and are interested in participating, please click on the link
123 below". Second, participants were also recruited through a paid advertisement on Facebook and
124 Instagram targeting individuals aged 18–30 years residing in Uruguay. The advertisement
125 featured an image of an energy drink can and the message: "If you are between 18 and 30 years
126 old, click the link to participate in our study about energy drinks", accompanied by background
127 imagery depicting either a blurred library setting with students or a social scene in which
128 individuals were holding an energy drink can. Recruitment was conducted between October and
129 December 2025.

An a priori sample size calculation was conducted to determine the minimum number of participants required to detect differences between experimental conditions. Assuming a linear model comparing five groups, a significance level of 0.05, and a statistical power of 0.80, the analysis was based on a small-to-moderate effect size (Cohen's $f = 0.20$). Under these assumptions, a total sample size of approximately 305 participants (about 61 per group) was required.

Interventions

The intervention comprised four warning labels designed to highlight potential adverse effects of energy drink consumption. Labels were developed using a 2×2 experimental design that varied by health effect and presentation format. Two health outcomes, tachycardia and insomnia, were selected based on available evidence regarding commonly reported adverse effects of energy drink intake [2, 9, 10]. Informed by research on the effectiveness of tobacco warning labels [16], both textual and graphic formats were tested. Text-only warnings presented a brief description of the health effect ("Energy drink consumption can cause [health effect]"), whereas graphic warnings combined the same text with an illustrative image generated using ChatGPT. All labels prominently displayed the word "Warning" ("Advertencia" in Spanish) and a black triangle containing an exclamation mark, visual elements commonly associated with warning messages [28]. The four warning labels evaluated in the study are presented in Figure 1. Five experimental groups were created, comprising one control group and four intervention groups corresponding to each warning label.

Stimuli

Commercial energy drink cans were used as stimuli. To introduce variability and reduce brand-specific effects, each participant evaluated four cans representing two brands and two product variants. The market-leading brand (Monster) and a lesser-known brand (Baly) were selected

based on sales data [24]. For each brand, both a regular and a zero-added sugar variant were included. The can images were digitally modified to incorporate the assigned experimental condition (control or one of the four warning labels), resulting in five image variants for each commercial energy drink can. Figure 2 presents examples of the stimuli used for each can type.

Questionnaire

A questionnaire was developed by the research team based on previously published studies examining the effects of warning labels on perceptions and purchase intentions of energy drinks [18–23]. The questionnaire comprised six main sections: (i) purchase intention; (ii) perceived effects of energy drink consumption and perceived healthfulness; (iii) perception of warning labels; (iv) comparison of warning labels; (v) socio-demographic characteristics; and (vi) energy drink consumption habits and perceived risk. An English language version of the questionnaire is provided as an additional file (Additional File 1).

In the first section, participants were shown the four energy drink cans corresponding to one of the experimental groups. The cans were presented individually in a balanced order following a Williams' Latin square design. For each can, participants rated their purchase intention using a five-point scale in response to the question: "Would you purchase this drink?" (1 = definitely not; 3 = maybe yes/maybe not; 5 = definitely yes).

In the second section, the same cans were presented again, one by one. Participants first completed a check-all-that-apply (CATA) question regarding the perceived effects of consuming each beverage ("What effects could consuming this beverage have on you?"). Nine response options were included, based on findings from an open-ended question included in a previous survey with Uruguayan emerging adults [29]: increased concentration, fatigue reduction, increased energy, improvement in athletic performance, improvement in academic performance, tachycardia, insomnia, anxiety, and no effect. The presentation order of the response options was balanced across participants. Subsequently, participants rated the perceived healthfulness of

each drink on a five-point scale (“How would you rate the health effects of this drink?”; 1 = very bad for health; 2 = bad for health; 3 = neither bad nor good for health; 4 = good for health; 5 = very good for health).

The third section focused on participants’ perceptions of the warning labels and was therefore administered only to participants in the intervention groups. Participants were shown the warning label corresponding to their experimental condition and asked two closed-ended questions assessing warning recall and use (i.e., “Do you remember having seen this message on the cans you evaluated?” and, for those who answered affirmatively, “Did you take it into account when answering the questions?”). They were then asked to respond to an open-ended question regarding their opinion of the message (“What do you think about the message?”).

In the fourth section, participants were presented with the four warning labels and asked to select the one they considered most effective in discouraging energy drink consumption (“Which of the following messages do you think would be most effective in discouraging the consumption of energy drinks?”). Participants were also asked to justify their choice in an open-ended question (“Why?”).

The fifth section collected socio-demographic information, including gender, age, education level, student status, working status, and region of residence. The final section assessed energy drink consumption habits, including consumption frequency, usual brand, and perceived risk of energy drink consumption (“How risky do you think consuming energy drinks is?”; 1 = not at all risky; 2 = a little risky; 3 = moderately risky; 4 = very risky; 5 = extremely risky).

The questionnaire was pilot tested with 10 participants who met the inclusion criteria, and no issues related to comprehension or interpretation were identified.

Data collection and randomization

The questionnaire was implemented in the Compusense Cloud software (Compusense Inc., Guelph, Canada). Participants who clicked on the link were shown an information sheet and were

asked to provide their informed consent to participate through an online form. Then, they were randomly assigned by the software to either the control group (no warning label) or one of the four intervention groups, each of which was exposed to a warning label variant (Insomnia-graphic, Insomnia-textual, Tachycardia-graphic, Tachycardia-textual) and then derived to the questionnaire.

Data analyses

The first step of the data analysis involved removing participants who did not meet the inclusion criteria or who did not complete the whole questionnaire. To ensure data quality, completion time and responses to the open-ended questions were used to identify potential automated or non-genuine responses [30]. This procedure did not result in any exclusions, as all respondents spent more than four minutes completing the survey and provided coherent responses to the open-ended items. All analyses were conducted using R software [31].

Purchase intention and perceived healthfulness

The effect of warning labels on purchase intention and perceived healthfulness was estimated using a linear model with control variables. For each outcome, a separate linear model was fitted including the experimental group as the main independent variable, with adjustment for energy drink brand (well-known vs. lesser-known), energy drink variety (regular vs. zero-calorie) and individual-level covariates (gender, age group, education level, student status, employment status, region of residence, frequency of energy drink consumption, and perceived risk of energy drinks consumption). Regression coefficients and associated p-values were used to assess differences between each experimental condition and the control group. Model fit was evaluated using the coefficient of determination (R^2 and adjusted R^2), and overall model significance was assessed using the F statistic. Statistical significance was set at $p < 0.05$.

Perceived effects of energy drink consumption

Each perceived effect included in the check-all-that-apply question was modeled as a separate binary outcome (selected=1 vs. not selected=0). For each effect, logistic regression models were estimated including the experimental group as the main independent variable, with the control condition as the reference category. Models were adjusted for the same set of energy drink characteristics and individual-level covariates included in the linear models. Results are reported as odds ratios (ORs) with 95% confidence intervals. Therefore, an odds ratio greater than 1 indicates a higher likelihood of reporting a given effect compared with the control condition, whereas an odds ratio below 1 indicates a lower likelihood.

Warning label perception

The percentage of participants who reported recalling the labels and using them to answer the questions was calculated for each experimental condition. Logistic regression models were estimated to assess differences among warnings. Experimental group was considered as the main independent variable. The same set of energy drink characteristics and individual-level variables included in the linear models were included as covariates.

Responses to the multiple-choice question comparing the warnings in terms of effectiveness were analyzed using descriptive statistics. The percentage of participants who selected each warning as the most effective was calculated.

Responses to the open-ended questions regarding the warning labels were analyzed using qualitative content analysis based on an inductive coding approach [32]. Initially, all responses were read repeatedly to achieve familiarization with the data. Codes were then generated inductively from the participants' own words, without imposing predefined categories, allowing salient themes and patterns to emerge from the data. The initial coding was conducted independently by one author, who developed a preliminary coding framework through an iterative process of constant comparison. This coding framework was subsequently reviewed by a second

researcher. Inter-coder discrepancies were identified in approximately 1% of the coded units and were resolved through open discussion and consensus, leading to minor refinements of category definitions. Following agreement on the final coding scheme, individual codes were grouped into higher-order categories that captured conceptually related responses. To provide a descriptive overview of the qualitative findings and facilitate comparison across experimental conditions, the percentage of participants mentioning at least one response within each category was calculated. These quantitative summaries were used to complement the qualitative interpretation, without implying statistical inference.

Results

Participant characterization

A total of 340 participants completed the questionnaire and met the inclusion criteria. As shown in Table 1, most participants were female, aged 18–24 years, had incomplete university education, were both working and studying, resided in the capital city, and reported occasional consumption of energy drinks.

The number of participants per experimental group ranged from 59 to 80 (Table 1). No statistically significant differences in socio-demographic characteristics were observed across experimental groups, supporting the adequacy of the randomization procedure.

Energy drink perception

Purchase intention

The mean purchase intention across experimental conditions was 2.6, indicating a low-to-moderate level of intention and falling slightly below the midpoint of the scale (3 = maybe yes/maybe not). Table 2 shows results of the linear regression model assessing the effect of the

experimental warning label conditions on purchase intention, using the control group as the reference. Overall, the model showed a good fit, explaining 26.5% of the variance in purchase intention ($R^2 = 0.265$; adjusted $R^2 = 0.256$), and was statistically significant ($F_{16, 1339} = 30.13$, $p < 0.001$).

Relative to the control condition, exposure to the tachycardia graphic warning label was associated with a significant reduction in purchase intention ($\beta = -0.21$, $p = 0.013$). The remaining warning label conditions (insomnia graphic, insomnia textual, and tachycardia textual) did not differ significantly from the control group.

Regarding control variables, brand emerged as a strong positive predictor of purchase intention, with well-known brands receiving significantly higher purchase intention scores than less well-known brands ($\beta = 0.96$, $p < 0.001$). Most sociodemographic characteristics were not significantly associated with purchase intention, with the exception of working status: participants who were currently working reported higher purchase intention than those who were not working (Table 2). Energy drink consumption frequency was also significantly associated with purchase intention, such that participants with lower consumption frequency assigned significantly lower purchase intention scores. Additionally, perceived risk of energy drink consumption was negatively associated with purchase intention, with ratings decreasing by 0.19 points for each one-point increase in perceived risk.

Expected effects of energy drink consumption

Figure 3 presents the percentage of participants who selected each perceived effect of energy drink consumption included in the CATA question across experimental groups. Negative effects involving tachycardia, insomnia, and anxiety were frequently selected, with selection rates ranging from 52.6% to 63.3%. In contrast, increased energy and fatigue reduction were the most commonly endorsed positive effects, selected by 49.6% and 43.5% of participants, respectively.

Only 9.9% of participants indicated that consuming the energy drink would have no effect on them.

The likelihood of selecting specific perceived effects of energy drink consumption was assessed using generalized linear models with a binomial distribution and logit link function. Table 3 presents the results of a series of generalized linear models assessing the association between the experimental warning label conditions and the likelihood of reporting specific perceived effects of energy drink consumption in a check-all-that-apply question.

Compared with the control condition, none of the warning label conditions were significantly associated with the likelihood of reporting increased concentration or fatigue reduction, as odds ratios were close to unity and confidence intervals included 1 across all experimental groups. Exposure to three of the warning label conditions was, however, associated with a higher likelihood of selecting increased energy. As shown in Table 3, the insomnia graphic (OR = 1.11), the insomnia textual warning labels (OR = 1.10), and the tachycardia textual warning (OR = 1.10) showed a modest but statistically significant increase in the odds of selection of this effect relative to the control condition, whereas no significant differences were observed for the tachycardia graphic warning label.

Regarding perceived improvement in athletic performance, only the insomnia textual warning label was associated with a small but statistically significant increase in the likelihood of selection compared with the control group (OR = 1.06). For improvement in academic performance, most experimental conditions did not differ significantly from the control condition. However, exposure to the tachycardia graphic warning label was associated with a slightly lower likelihood of selection (OR = 0.95).

In addition, several covariates showed consistent associations with an increased likelihood of selecting positive effects. Brand familiarity was positively associated with the likelihood of selecting increased concentration, fatigue reduction, increased energy and improvement in both athletic and academic performance, indicating more favorable evaluations

for the well-known brand. In addition, frequency of energy drink consumption was strongly associated with higher odds of selecting positive effects such as increased energy and improved performance, suggesting that more frequent consumers were more likely to attribute functional benefits to energy drink consumption. The zero-calorie variety and most sociodemographic variables showed no consistent or substantial associations with the selection of positive effects.

In contrast to the limited and selective effects observed for positive outcomes, warning labels were consistently associated with a higher likelihood of selecting negative effects of energy drink consumption. Compared with the control condition, exposure to the insomnia textual, tachycardia graphic and tachycardia textual warning labels was associated with significantly higher odds of selecting tachycardia as an effect of energy drink consumption (ORs ranging from 1.16 to 1.30). In a similar vein, the insomnia graphic, insomnia textual and tachycardia graphic warning labels were associated with an increased likelihood of selecting insomnia and anxiety, relative to the control group (Table 3).

Covariates also played a role in the attribution of negative effects. Perceived risk of energy drink consumption was positively associated with the likelihood of selecting negative effects, including tachycardia, insomnia, and anxiety. In addition, participants with higher level of education were significantly more likely to select negative effects associated with energy drink consumption, including tachycardia, insomnia and anxiety, compared to those with complete secondary education or less. However, other sociodemographic variables showed no systematic patterns of association across negative outcomes, and when statistically significant, effects were small in magnitude.

Finally, participants exposed to warning labels, except for the insomnia graphic warning, were significantly less likely to indicate that energy drinks would have no effect compared with the control condition, indicating a shift away from neutral evaluations toward a more explicit attribution of effects.

Perceived healthfulness

The mean perceived healthfulness score was 2.0, indicating that energy drinks were, on average, evaluated negatively, corresponding to “bad for health” on the scale. Results of the linear regression model examining perceived healthfulness are shown in Table 2. The model demonstrated a satisfactory fit, accounting for 30.8% of the variance in perceived healthfulness ($R^2 = 0.308$; adjusted $R^2 = 0.300$), and was statistically significant ($F_{16, 1339} = 37.32$, $p < 0.001$). Compared with the control group, all warning label conditions except for the tachycardia textual warning were associated with significantly lower perceived healthfulness of energy drinks.

Among the control variables, brand familiarity was positively associated with perceived healthfulness, with the well-known brand being perceived as healthier than the less well-known brand. The zero-calorie variety was perceived significantly more healthful than the regular counterpart. Sociodemographic variables showed no consistent associations, although education level was modestly and negatively related to perceived healthfulness. Specifically, participants with complete university or postgraduate studies perceived energy drinks as less healthy than those with secondary school or less. Finally, perceived risk of energy drink consumption was strongly and negatively associated with perceived healthfulness, indicating substantial consistency between prior beliefs and post-exposure evaluations.

Perception of warning labels

Self-reported warning recall and use

Among participants exposed to the warning labels, 63.3% reported recalling the labels, and of these, 72.0% indicated that they had taken them into account when answering the questions. No statistically significant differences in self-reported recall or use were observed across warning label conditions (Supplementary Material Table 1). Additionally, individual-level variables were not significantly associated with either warning recall or use.

389

390 *Opinions about the warning labels*

391 As shown in Table 4, across all conditions, a substantial proportion of participants expressed
392 positive evaluations of the warnings, highlighting their appropriateness and awareness-raising
393 function, and in some cases their potential effectiveness in discouraging energy drink
394 consumption. Participants also expressed support for mandatory implementation, viewing the
395 warnings as a legitimate source of information to support informed consumer choice. Several
396 respondents emphasized the accuracy of the messages, noting that they already known risks
397 associated with energy drink consumption, while others drew comparisons with warning labels
398 on cigarette packages and packaged foods and beverages, situating energy drink warnings
399 within a broader regulatory context. With respect to format, participants frequently highlighted
400 the impact of images in graphic warnings.

401 Despite these generally favorable perceptions, some participants described the warnings
402 as ineffective or irrelevant, and in some cases argued that the messages were incomplete, as
403 they failed to capture other relevant health risks . Others perceived the information as
404 redundant, stating that the health effects were already widely known, while a subset regarded
405 the warnings as exaggerated. In the case of insomnia-related warnings, some participants
406 emphasized the low perceived severity of the health effect, and others framed insomnia as a
407 potentially intended outcome of energy drink consumption, which undermined the perceived
408 relevance of the warning.

409

410 *Comparative perceived effectiveness*

411 Warnings referring to tachycardia were most frequently selected as the most effective. The
412 graphic tachycardia warning was chosen by 42.9% of participants, while the text-based
413 tachycardia warning was selected by 31.2%. In contrast, insomnia-related warnings were selected

less often: 21.5% of participants chose the graphic insomnia warning, and only 4.4% selected the text-based insomnia warning.

As shown in Table 5, participants' justifications for selecting a warning as the most effective revealed clear differences according to both the type of health effect and the warning format. Overall, perceived effectiveness was strongly associated with the warning's capacity to increase risk perception, capture attention, and evoke emotional and cognitive responses.

Participants most commonly justified their selection of tachycardia warnings by referring to the perceived severity of the health effect, as well as the warnings' ability to raise awareness and attract attention. Tachycardia warnings were consistently framed as more effective because they were associated with a higher perceived health risk and greater potential severity, making them more compelling and persuasive. By contrast, insomnia-related warnings were often dismissed through references to the normalization of insomnia, with participants describing it as a common or manageable condition, or even as a desirable outcome of energy drink consumption. Nevertheless, participants who selected insomnia warnings as the most effective emphasized the importance of raising awareness about sleep-related harms.

Regarding label format, image-based warnings were primarily selected due to their visual salience and emotional impact, regardless of the health effect depicted. Participants frequently described these warnings as more noticeable and harder to ignore, highlighting their capacity to shock or generate strong reactions. In the specific case of the graphic tachycardia warning, participants underscored the value of depicting a real person experiencing health consequences, which was perceived as enhancing emotional engagement and awareness.

In contrast, text-based warnings were more often selected for their clarity and informational value. Participants who preferred text emphasized that these messages were less intrusive than images while still communicating the health risk.

Discussion

This study examined the effects of different types of warning labels on emerging adults' evaluations of energy drinks, focusing on purchase intention, perceived healthfulness, and the attribution of perceived effects of consumption. Overall, the findings showed that warning labels, particularly graphic warnings, were effective in shaping health-related perceptions and increasing the salience of adverse effects, while their impact on purchase intention was more limited and selective. These results are consistent with, and extend, existing evidence on the role of warning labels as public health tools [17, 33–36].

Perceived healthfulness was consistently and statistically significantly reduced across all warning label conditions, with the exception of the textual tachycardia warning. This pattern is consistent with previous studies examining the effects of caffeine warnings on perceptions of the safety of energy drinks [19, 20]. The findings also align with evidence from research on front-of-package nutrition labeling and health warnings on packaged foods and beverages, which indicates that warning labels are particularly effective in shifting cognitive evaluations of product healthfulness [33, 34, 37].

The results from the logistic regression models performed on participants' responses to the attribution of perceived effects of energy drinks consumption provided further insight into how warning labels influence consumers' interpretations of energy drink effects. Warning labels tended to be consistently associated with increased attribution of negative effects, including tachycardia, insomnia, and anxiety. In addition, warnings tended to reduce the likelihood of reporting “no effect” among participants exposed to warning labels suggesting that such labels encourage consumers to engage more actively with the health implications of energy drink consumption, shifting perceptions away from neutrality. This pattern is consistent with evidence from tobacco, alcohol, sugary drink warning labels, as well as nutritional warning labels on packaged foods, which suggests that warnings primarily operate by making the composition and health harms of products more salient on consumers' mind [33, 35, 36, 38]. Interestingly, the warnings did not only increase the likelihood of endorsing the specific health effect they depicted, but also other negative effects.

This finding suggests that warning labels may activate broader associative networks of health risks, rather than functioning as narrowly framed messages. In other words, exposure to a specific warning may prompt consumers to reflect more generally on the adverse consequences of energy drink consumption.

Conversely, warning labels had limited impact on the endorsement of positive effects, such as increased concentration or reduced fatigue, which aligns with previous research showing that alcohol warnings rarely diminish positive product associations [34, 36]. However, meaningful differences emerged across warning types. The graphic tachycardia warning was the only condition associated with a reduced likelihood of endorsing a positive effect (specifically, a significant decrease in the likelihood of selecting improved academic performance was observed) while not significantly increasing endorsement of other effects. In contrast, the remaining warnings were associated with an increased endorsement of stimulation-related effects. Insomnia warnings increased the likelihood of endorsing increased energy, and the textual insomnia warning was associated with a higher likelihood of selecting improved athletic performance. These patterns suggest that insomnia may be cognitively linked to desirable stimulation-related outcomes. Qualitative findings support this interpretation, as several participants explicitly framed insomnia as an intended or even desirable consequence of energy drink consumption. The textual tachycardia warning was also associated with increased endorsement of higher energy levels, highlighting how text-based messages may be interpreted in ways that inadvertently reinforce positive associations.

The effects of warning labels on perceived healthfulness did not consistently translate into reduced purchase intentions. Only the graphic warning referring to tachycardia led to a significant reduction in purchase intention compared with the control condition. Similar effects of warning labels have been reported in previous studies examining caffeine warnings [19, 20]. Importantly, this result represents an improvement over the effects of octagonal warnings displaying the message “Contains caffeine,” which were previously found to increase purchase intention among

Uruguayan adults [21]. These findings are also consistent with broader evidence showing that warning labels tend to have stronger effects on cognitive evaluations than on behavioral intentions, although warnings that depict concrete, severe, and personally relevant health risks are more likely to influence consumption-related intentions [17, 33–36]. The dissociation observed in the present study between perceived healthfulness and purchase intention reinforces prior evidence suggesting that changes in risk perception often precede, but do not guarantee, behavioral change, particularly for habitually consumed products.

Results suggest that both the content of the health message and its format play a critical role in shaping consumers' interpretations and potential reactions to warning labels. The graphic tachycardia warning emerged as the most effective condition, in line with participants' responses in the comparative evaluation task. Qualitative insights indicate that its superiority can be explained by two main factors: the perceived severity of the health effect and the graphic format, which heightened attention and emotional impact. These findings are consistent with evidence from tobacco control, alcohol, and sugary drink labeling, which shows that graphic warnings depicting salient physiological harms tend to exert stronger effects on intentions than text-only messages [33, 35, 36]. Moreover, the greater perceived effectiveness of cardiovascular-related warnings aligns with recent studies conducted among young adults in Australia, where warnings about heart-related risks were regarded as more impactful than those highlighting obesity [22, 23]. In terms of design, participants described graphic warnings as more attention-grabbing, intuitive, and difficult to ignore, echoing findings from eye-tracking research in the tobacco field [39].

Interestingly, the effects of warning labels observed in the present study emerged despite the use of well-established commercial brands. Previous research suggests that warning labels tend to be less effective when applied to familiar products, as brand familiarity can attenuate risk perception and reinforce positive associations built through repeated exposure and marketing [40]. In this context, the observed effects indicate that well-designed warnings, particularly those

that are graphic and reference severe and personally relevant health risks, may partially counteract the protective influence of brand familiarity. This finding underscores the potential of warning labels and suggests that their impact may extend even to products with strong market presence and high consumer recognition.

Another noteworthy finding of the present study concerns participants' support for the implementation of warning labels on energy drinks, which mirrors previous research documenting substantial public support for warning labels on different product categories [41–43]. Public support has been identified as a key factor facilitating the adoption and sustainability of regulatory policies [44, 45]. The favorable attitudes expressed by participants suggest that such measures may be socially acceptable among emerging adults, a group that represents a key target population for energy drink consumption.

The results also provide emerging insights into the role of branding and consumption patterns in shaping perceived healthfulness and purchase intention for energy drinks. Consistent with prior research [46, 47], brand familiarity emerged as a strong determinant of consumer evaluations, with well-known brands associated with higher purchase intention, greater perceived healthfulness, and a lower likelihood of endorsing negative health effects. Similarly, frequency of energy drink consumption was positively associated with the endorsement of both positive and no perceived effects. This pattern aligns with previous evidence indicating that energy drink consumption is positively associated with perceived benefits and inversely related to perceived risk [29]. Taken together, these findings underscore the importance of interventions aimed at increasing risk perception and attenuating the perceived benefits associated with energy drink consumption.

In closing, several limitations should be acknowledged. First, the study relied on a convenience sample of participants who took part without financial compensation, which may have resulted in an overrepresentation of individuals with a greater interest in health-related issues. In addition, the sample was largely composed of infrequent energy drink consumers,

which may limit the generalizability of the findings to more regular users. Second, study outcomes were based on self-reported perceptions and intentions rather than observed purchasing or consumption behaviors. Although measures were taken to minimize response bias, such as assessing purchase intention prior to health-related questions across all stimuli, responses may still be subject to social desirability bias. Third, the experimental design captured short-term responses and did not account for potential habituation or desensitization to warning labels over time. Despite these limitations, the study provides robust evidence that warning labels can shape health-related perceptions and, to a more limited extent, purchase intentions related to energy drink consumption.

Conclusions

In line with evidence from other regulated product categories, this study supports the use of warning labels as a public health strategy to increase awareness of the potential harms associated with energy drink consumption. While their influence on purchase intention may be limited, graphic warning labels highlighting the association between energy drink consumption and tachycardia may contribute to reduce perceived healthfulness and increasing recognition of negative health effects, outcomes that are essential for informed consumer decision-making.

Declarations

Ethics approval and consent to participate

The study was conducted according to the guidelines laid down in the Declaration of Helsinki. The full study protocol was approved by the Ethics Committee of the School of Chemistry of Universidad de la República, Uruguay (Protocol 101900-000041-24). Written informed consent was obtained through an online form.

570 ***Consent for publication***

571 Not applicable.

572

573 ***Availability of data and materials***

574 The datasets used during the current study are available from the corresponding author on
575 reasonable request.

576

577 ***Competing Interests***

578 The authors declare no competing interests.

579

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585

586 ***Authors' contributions***

587 All authors were involved in the conception and design of the study, as well as in the interpretation
588 of the results. GA, LA, FA, VN, LM and VG participated in the acquisition of the data. LA, MG,
589 SG, JV, and GA were responsible for data analysis. LA and GA drafted an initial version of the
590 manuscript, to which all other authors made relevant contributions. All authors read and approved
591 the final manuscript.

592

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Tables

Table 1. Socio-demographic characteristics of the participants, overall and separate by experimental group.

Characteristic	All participants (n=340)	Experimental group					χ^2 (p-value)
		Control (n=65)	Insomnia graphic (n=72)	Insomnia textual (n=59)	Tachycardia graphic (n=80)	Tachycardia textual (n=64)	
Gender							4.05
Female	225	44	54	36	52	39	(0.399)
Male	115	21	18	23	28	25	
Age							4.63
18-24 years	212	38	40	41	55	38	(0.328)
25-30 years	128	27	32	18	25	26	
Education level							5.75
Complete secondary school or less	91	13	19	13	25	21	(0.218)
Incomplete University	195	39	37	37	45	37	
Complete University or postgraduate studies	54	13	16	9	10	6	
Student status							4.81
Currently studying	214	47	42	38	45	42	(0.307)
Not currently studying	126	18	30	21	35	22	
Working status							3.36
Currently working	201	44	43	31	45	38	(0.500)
Not currently working	139	21	29	28	35	26	
Region of residence							5.63
Montevideo (capital city)	207	45	48	35	46	33	(0.229)
Rest of the country	133	20	24	24	34	31	
Frequency of energy drink consumption							7.87
Once a week or more	45	6	6	7	12	14	(0.446)
1 to 3 times a month	68	13	13	14	18	10	
Less than once a month	227	46	53	38	50	40	

Table 2. Linear regression models assessing the association between warning label conditions and (a) purchase intention and (b) perceived healthfulness of energy drinks, adjusted for product characteristics and individual covariates.

Effect	Coefficient (p-value)	
	Purchase intention	Perceived healthfulness
<i>Experimental group</i>		
Insomnia – Graphic	-0.15 (0.167)	-0.12 (0.026)*
Insomnia – Textual	-0.12 (0.277)	-0.17 (0.003)*
Tachycardia - Graphic	-0.21 (0.013)*	-0.15 (0.007)*
Tachycardia – Textual	-0.14 (0.194)	-0.11 (0.066)
<i>Energy drink brand</i>		
Well-known brand	0.96 (<0.001)*	0.11 (0.002)*
<i>Energy drink variety</i>		
Zero	-0.11 (0.113)	0.09 (0.012)*
<i>Gender</i>		
Male	-0.10 (0.196)	0.02 (0.689)
<i>Age</i>		
25-30 years	-0.07 (0.384)	0.04 (0.374)
<i>Education level</i>		
Incomplete University	0.03 (0.721)	-0.07 (0.296)
Complete University or postgraduate studies	0.13 (0.278)	-0.10 (0.029)*
<i>Student status</i>		
Currently studying	0.17 (0.057)	0.00 (0.996)
<i>Working status</i>		
Currently working	0.16 (0.038)*	0.02 (0.585)
<i>Region of residence</i>		
Montevideo (capital city)	-0.04 (0.573)	0.05 (0.147)
<i>Frequency of energy drink consumption</i>		
1 to 3 times a month	-0.45 (<0.001)*	-0.23 (<0.001)*
Less than once a month	-1.29 (<0.001)*	-0.48 (<0.001)*
<i>Perceived risk of energy drink consumption</i>	-0.19 (<0.001)*	-0.40 (<0.001)*

Notes: The reference level in the models were: Experimental group (control), Energy drink brand (lesser-known brand), Energy drink variety (regular), Gender (female), Age (18-24 years), Education level (Secondary school or less), Student status (not currently studying), Working status (not currently working), Region of residence (Rest of the country), Frequency of energy drink consumption (Once a week or more). Perceived risk of energy drink consumption was measured as a continuous variable on a 5-point scale.

Table 3. Results of the logistic regression models assessing the association between warning label conditions and likelihood of selection of perceived effects of energy drink consumption in a check-all-that-apply question, adjusted for product characteristics and individual covariates.

Effect	Odds-ratio [95% confidence interval]								
	Increased concentration	Fatigue reduction	Increased energy	Improvement in athletic performance	Improvement in academic performance	Tachycardia	Insomnia	Anxiety	No effect
<i>Experimental group</i>									
Insomnia – Graphic	0.99 [0.94-1.05]	1.01 [0.93-1.09]	1.11 [1.02-1.21]*	0.98 [0.93-1.04]	0.98 [0.93-1.02]	1.05 [0.97-1.14]	1.13 [1.04-1.23]*	1.10 [1.01-1.20]*	0.97 [0.92-1.01]
Insomnia – Textual	1.00 [0.94-1.07]	1.06 [0.97-1.16]	1.10 [1.01-1.13]*	1.06 [1.00-1.12]*	0.96 [0.92-1.01]	1.16 [1.07-1.26]*	1.22 [1.12-1.32]*	1.14 [1.04-1.24]*	0.92 [0.87-0.97]*
Tachycardia - Graphic	0.99 [0.94-1.05]	0.95 [0.88-1.03]	1.04 [0.96-1.13]	0.96 [0.91-1.01]	0.95 [0.91-0.99]*	1.30 [1.20-1.40]*	1.14 [1.06-1.24]*	1.13 [1.04-1.23]*	0.87 [0.83-0.91]*
Tachycardia – Textual	1.04 [0.98-1.10]	1.03 [0.95-1.12]	1.10 [1.01-1.20]*	0.98 [0.93-1.04]	1.02 [0.97-1.07]	1.22 [1.13-1.33]*	0.96 [0.87-1.04]	1.04 [0.95-1.13]	0.86 [0.82-0.91]*
<i>Energy drink brand</i>									
Well-known brand	1.06 [1.02-1.10]*	1.08 [1.02-1.13]*	1.08 [1.02-1.13]*	1.03 [1.00-1.12]*	1.05 [1.01-1.08]*	0.99 [0.95-1.04]	0.99 [0.94-1.04]	1.00 [0.95-1.05]	0.98 [0.92-1.02]
<i>Energy drink variety</i>									
Zero	1.00 [0.97-1.04]	1.00 [0.94-1.05]	0.97 [0.92-1.03]	0.99 [0.96-1.02]	1.01 [0.98-1.04]	0.97 [0.92-1.02]	0.95 [0.90-1.01]	0.96 [0.91-1.01]	1.02 [0.99-1.05]
<i>Gender</i>									
Male	1.04 [0.94-1.05]	1.05 [1.00-1.12]	0.99 [0.93-1.05]	1.12 [1.08-1.16]*	1.06 [1.03-1.10]*	0.98 [0.93-1.04]	1.03 [0.98-1.09]	0.87 [0.82-0.92]*	0.96 [0.93-1.00]
<i>Age</i>									
25-30 years	0.94 [0.90-0.99]	1.05 [0.98-1.12]	0.92 [0.86-0.98]	0.94 [0.90-0.98]*	0.95 [0.92-0.98]*	0.92 [0.86-0.97]	1.00 [0.94-1.07]	0.94 [0.88-1.01]	0.99 [0.95-1.03]
<i>Education level</i>									
Incomplete University	1.06 [1.01-1.12]*	0.99 [0.92-1.06]	1.04 [0.94-1.14]	0.98 [0.94-1.03]	0.98 [0.94-1.02]	1.08 [1.01-1.15]*	1.08 [1.01-1.16]*	1.05 [0.98-1.12]	0.99 [0.95-1.03]
Complete University or postgraduate studies	1.17 [1.10-1.26]*	1.06 [0.97-1.17]	1.05 [0.98-1.13]	1.09 [1.02-1.16]*	1.09 [1.04-1.15]*	1.27 [1.16-1.38]*	1.23 [1.12-1.34]*	1.16 [1.06-1.28]*	0.94 [0.89-0.99]*
<i>Student status</i>									
Currently studying	1.04 [0.99-1.09]	1.05 [0.99-1.13]	1.00 [0.94-1.07]	1.04 [1.00-1.09]	1.05 [1.01-1.09]*	0.95 [0.89-1.02]	0.98 [0.92-1.05]	0.98 [0.92-1.05]	0.92 [0.88-0.95]*
<i>Working status</i>									
Currently working	0.99 [0.95-1.03]	1.03 [0.97-1.10]	1.00 [0.94-1.06]	0.92 [0.89-0.96]*	0.98 [0.94-1.01]	0.97 [0.92-1.03]	0.91 [0.86-0.96]*	1.02 [0.96-1.08]	1.00 [0.97-1.04]
<i>Region of residence</i>									
Montevideo (capital city)	1.06 [1.02-1.10]	1.08 [1.02-1.14]	1.15 [1.09-1.22]*	1.03 [0.99-1.06]	1.00 [0.98-1.04]	1.02 [0.97-1.08]	0.97 [0.92-1.02]	1.03 [0.97-1.08]	1.02 [0.99-1.05]
<i>Frequency of energy drink consumption</i>									
1 to 3 times a month	0.79 [0.74-0.85]*	0.92 [0.84-1.01]	0.96 [0.88-1.06]	0.87 [0.82-0.92]*	0.87 [0.83-0.92]*	0.92 [0.84-1.01]	0.91 [0.83-1.00]	1.00 [0.91-1.10]	0.90 [0.85-0.95]*
Less than once a month	0.75 [0.71-0.80]*	0.88 [0.81-0.96]*	0.87 [0.80-0.95]*	0.78 [0.74-0.82]*	0.78 [0.74-0.82]*	1.05 [0.97-1.14]	0.99 [0.92-1.08]	1.08 [0.99-1.17]	0.92 [0.87-0.96]*
<i>Perceived risk of energy drink consumption</i>									
	0.98 [0.95-1.00]	0.92 [0.89-0.96]*	0.99 [0.95-1.02]	0.98 [0.96-1.00]	0.98 [0.96-1.00]	1.09 [1.05-1.13]*	1.05 [1.05-1.12]*	1.07 [1.03-1.11]*	0.97 [0.95-0.99]*

Notes: The reference level in the models were: Experimental group (control), Energy drink brand (lesser-known brand), Energy drink variety (regular), Gender (female), Age (18-24 years), Education level (Secondary school or less), Student status (not currently studying), Working status (not currently working), Region of residence (Rest of the country), Frequency of energy drink consumption (Once a week or more). Perceived risk of energy drink consumption was measured as a continuous variable on a 5-point scale.

Table 4. Percentage of participants who mentioned responses corresponding to the categories identified in the content analysis when expressing their opinion about the warning label they were assigned.

Category	Examples of responses	Insomnia – Graphic	Insomnia - Textual	Tachycardia - Graphic	Tachycardia - Textual
Perceived appropriateness	"It's good that it's there", "It's excellent", "That way people can decide taking the information into account"	19.8	27.9	33.8	48.8
Risk awareness and informative function	"They warn about risks", "Inform about the effects", "Quite informative"	24.4	25.0	36.5	36.3
Clarity and brevity of the message	"Appropriate", "short and clear message", "Relevant"	25.6	22.1	17.6	7.5
Perceived ineffectiveness	"It doesn't generate an effect on consumption", "In most cases it's not taken into account", "consumers often don't pay the attention they should to these warning signs"	8.1	17.6	16.2	13.8
Perceived accuracy	"Correct", "The insomnia claim is real", "True", "A possibly common effect of energy drinks"	11.6	13.2	2.7	12.5
Conditional risk interpretation	"I don't consume these drinks frequently, only occasionally, and in my case I don't think it would cause major harm to my health", "The warning is appropriate for people prone to heart problems", "It doesn't always have that effect", "Insomnia depends more on other factors"	9.3	2.9	9.5	11.3
Perceived incompleteness of the message	"There are other effects (for example heart rate issues / tachycardia, anxiety, etc.), sleep disorders, cardiac risks", "It's incomplete"	8.1	14.7	4.1	0.0
Comparison with warnings on cigarettes	"It is similar to warnings on cigarettes", "It simulates what they put on cigarette packages"	7.0	5.9	6.8	3.8
Perceived effectiveness	"Effective", "It could influence some people's decision", "Useful to reduce consumption"	9.3	2.9	6.8	2.5
Suggestions to improve the warning	"It should be more sober", "It's very abrupt and not very serious", "I would use more colors so it draws more attention"	3.5	5.9	5.4	5.0
Lack of familiarity	"Cans in Uruguay don't have them", "I had never seen them before"	0.0	5.9	4.1	7.5
Reference to warning signs on packaged foods	"They are as important as in everyday foods", "I agree as with octagons"	0.0	11.8	0.0	5.0
Perceived redundancy of information	"Most people already know the effects", "It's obvious", "We all know it's harmful"	7.0	5.9	0.0	3.8
Lack of knowledge on health effects of energy drinks	"Many of us don't know everything it causes or we don't see its effects", "There is a lot of misinformation circulating about these drinks"	1.2	4.4	2.7	6.3
Perceived exaggeration	"Excessive", "Exaggerated", "Extremist"	3.5	2.9	5.4	2.5
Perceived relevance for younger populations	"It would be important for all young people to read it", "There is a lack of discouragement of use among minors"	4.7	2.9	2.7	3.8
Low perceived severity of the health effect	"Insomnia is not that concerning", "I don't think it's an adverse effect", "I don't know if people consider it a problem"	4.7	8.8	0.0	0.0
Support for mandatory implementation	"It should be on all cans on the market", "It should be mandatory for all energy drinks to have it"	2.3	1.5	4.1	5.0
Impact of graphic elements	"The image causes rejection", "it makes you think twice before buying it", "The image is impactful"	8.1	0.0	4.1	0.0
The warning depicts intended effects of energy drinks	"That's what I use it for", "Excessive use to avoid sleeping or to be more productive"	2.3	8.8	0.0	0.0

Perceived irrelevance	"Unnecessary", "Indifferent in my case", "Insignificant"	3.5	4.4	1.4	0.0
Others	"I drink energy drinks for their flavour", "Minors still can buy them"	12.8	2.9	1.4	3.8

Table 5. Percentage of participants who mentioned responses corresponding to the categories identified in the content analysis when justifying their choice of the most effective label.

Category	Examples of responses	Insomnia – Graphic (n=73, 21.5%)	Insomnia – Textual (n=15, 4.4%)	Tachycardia – Graphic (n=146, 42.9%)	Tachycardia – Textual (n=106, 31.2%)
Attentional capture and effectiveness of images	"Images catch attention", "People react to graphical images", "Images connect more with people"	81.0	0.0	45.2	0.0
Perceived severity of tachycardia	"The heart is more striking", "Heart problems carry more weight than insomnia"	3.8	0.0	40.8	34.2
Impact and shock value	"Shocking image", "The image has more impact", "The image is very striking"	49.4	0.0	15.9	3.5
Awareness raising	"I think that when people read 'tachycardia' they would be more alert", "It produces more awareness", "It generates more fear"	8.9	12.5	17.8	21.9
Attentional capture	"It draws more attention", "It seems more eye-catching"	13.9	0.0	14.0	18.4
Perceived effectiveness of the image of a person	"Maybe because there's an image of a person", "Seeing a person would generate more effect", "Real image"	27.8	0.0	12.1	0.0
Raises awareness about insomnia	"We need to pay more attention to insomnia", "The sleep cycle is a very important aspect of life"	7.6	25.0	0.0	0.0
Message clarity and brevity	"Clear message", "Important message", "It directly shows the problem it causes"	3.8	6.3	2.5	19.3
Perceived ineffectiveness of images	"Images have no effect", "People won't pay attention to images of people", "Photos take away seriousness"	0.0	6.3	0.0	25.4
Focus on the most relevant health effects	"It better informs about the most important dangers of energy drinks", "It warns about their real effect on health", "It's the most common case of consequences when consuming"	5.1	6.3	8.3	9.6
References to cigarette warnings	"It is impactful as warnings on cigarette packages", "Similar to the strategies from cigarette packaging"	8.9	6.3	5.1	7.0
Insomnia may be a desired effect	"Insomnia can be seen as an advantage", "Maybe staying awake is the desired effect"	2.5	0.0	7.6	14.9
Perceived intrusiveness of images	"An image seems more invasive than something written", "It's not invasive advertising, even if that is the goal"	0.0	18.8	0.0	5.3
Perceived ineffectiveness of the warnings	"Nobody pays attention to this type of signs", "None would work but I had to choose one"	8.9	6.3	2.5	2.6
Use of real person suffering the consequences	"Image with a person suffering consequences: the image makes it more tangible and personal", "I think having a person in the warning creates a closer connection", "Humans empathize more with other humans"	0.0	0.0	0.0	19.3
Normalization of Insomnia	"Insomnia is temporary", "Uruguayans tend to sleep few hours and go to bed very late, they're not afraid of insomnia"	0.0	0.0	8.3	5.3
Perceived informational value of images	"You don't need to read to know it's bad", "The use of visual images directly linked to the consequence of energy drink consumption facilitates understanding"	1.3	0.0	3.8	0.0

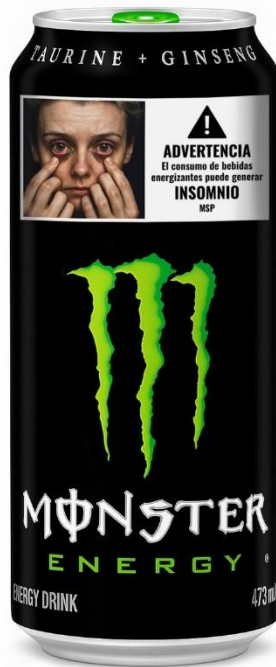
Suggested changes	"Please don't use AI", "If children consume more, use images of children", "Warning symbol in red"	0.0	0.0	3.2	1.8
Perceived informational value of text and image	"Combining text and image", "It is understood more completely with the image"	1.3	0.0	2.5	0.0
Others	"It happened to me that I got tachycardia once", "These images could also be included on alcoholic beverages"	1.3	0.0	5.7	4.4
No response		1.3	0.0	3.2	3.5

Figures

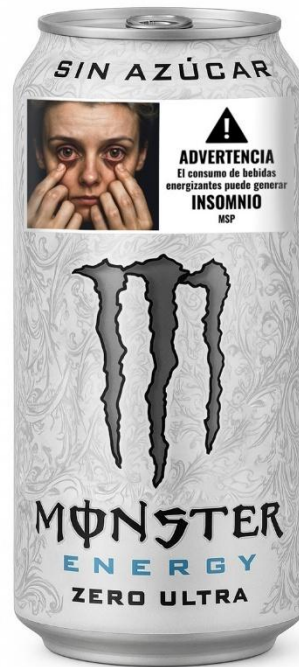
Figure 1. Warning labels evaluated in the study: (a) graphic warning about insomnia, (b) text-only warning about insomnia, (c) graphic warning about tachycardia and (d) text-only warning about tachycardia. Both, textual and graphic formats, contain the text “WARNING Energy drink consumption can cause [health effect]”.



Figure 2. Example of the stimuli presented to one of the experimental groups (those assigned to the graphic warning about insomnia). Cans (a) and (b) corresponded to the market-leading brand (Monster) in its regular and zero-added sugar variant, respectively, while (c) and (d) corresponded to a lesser-known brand (Baly) in its regular and zero-added sugar variant, respectively.



(a)



(b)

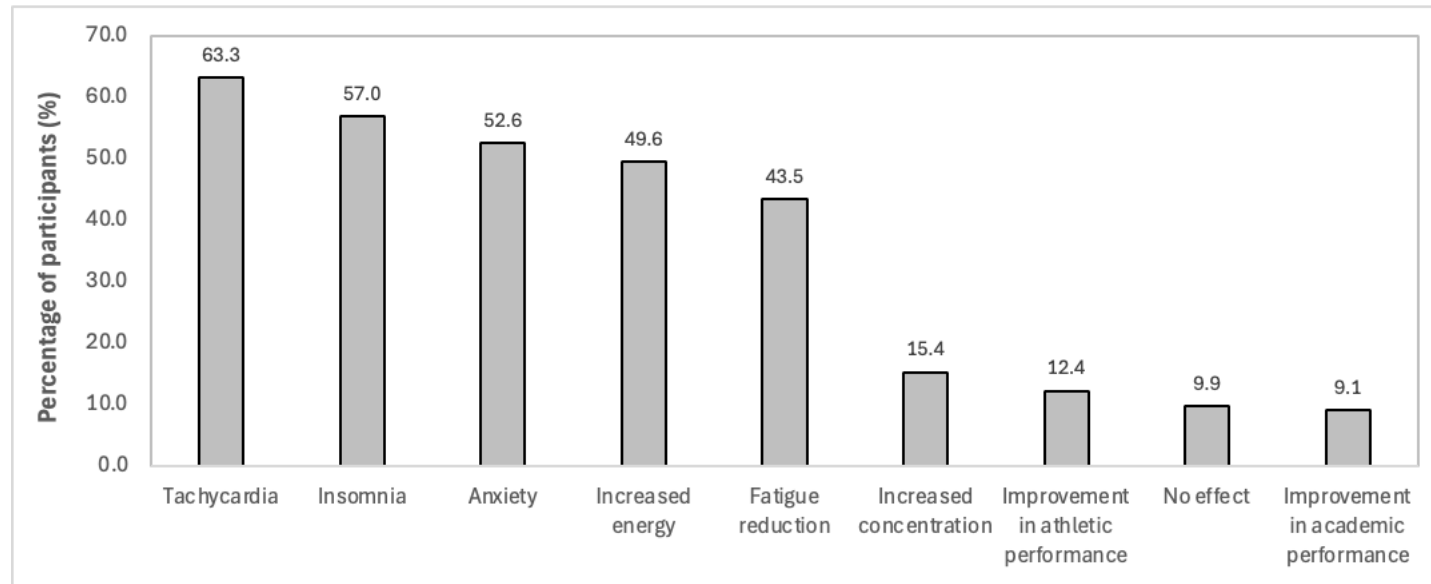


(c)



(d)

Figure 3. Percentage of participants who selected each of the effects of energy drink consumption included in the check-all-that-apply question across experimental groups.



Supplementary Material

Table 1. Results of the logistic regression models assessing the association between experimental group and warning recall and use, adjusted for product characteristics and individual covariates.

Effect	Odds-ratio [95% confidence interval]	
	Warning recall	Warning use
<i>Experimental group</i>		
Insomnia – Textual	0.88 [0.74-1.04]	0.85 [0.70-1.04]
Tachycardia - Graphic	0.86 [0.72-1.01]	0.99 [0.81-1.21]
Tachycardia – Textual	0.92 [0.78-1.08]	0.92 [0.76-1.11]
<i>Gender</i>		
Male	1.04 [0.92-1.18]	0.96 [0.83-1.11]
<i>Age</i>		
25-30 years	1.05 [0.91-1.21]	0.92 [0.77-1.10]
<i>Education level</i>		
Incomplete University	0.83 [0.67-1.02]	1.20 [0.93-1.56]
Complete University or postgraduate studies	0.96 [0.82-1.13]	1.01 [0.84-1.21]
<i>Currently studying</i>		
Yes	0.97 [0.83-1.13]	1.00 [0.83-1.21]
<i>Currently working</i>		
Yes	0.90 [0.78-1.03]	0.95 [0.81-1.11]
<i>Region of residence</i>		
Montevideo (capital city)	1.02 [0.90-1.15]	0.96 [0.83-1.11]
<i>Frequency of energy drink consumption</i>		
1 to 3 times a month	1.11 [0.90-1.35]	0.79 [0.62-1.00]
Less than once a month	1.12 [0.93-1.34]	0.93 [0.76-1.17]
<i>Perceived risk of energy drink consumption</i>	0.93 [0.86-1.01]	1.00 [0.91-1.10]

Notes: The reference level in the models were: Experimental group (Insomnia - Graphic), Gender (female), Age (18-24 years), Education level (Secondary school or less), Student status (not currently studying), Working status (not currently working), Region of residence (Rest of the country), Frequency of energy drink consumption (Once a week or more). Perceived risk of energy drink consumption was measured as a continuous variable on a 5-point scale.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionalfile.docx](#)