

## ORIGINAL RESEARCH

# Misperceptions about added sugar, non-nutritive sweeteners and juice in popular children's drinks: Experimental and cross-sectional study with U.S. parents of young children (1-5 years)

Jennifer L. Harris<sup>1</sup>  | Jennifer L. Pomeranz<sup>2</sup>

<sup>1</sup>Rudd Center for Food Policy & Obesity, University of Connecticut, Hartford, Connecticut

<sup>2</sup>Department of Public Health Policy and Management, School of Global Public Health, New York University, New York, New York

**Correspondence**

Jennifer L. Harris, UConn Rudd Center for Food Policy & Obesity, One Constitution Plaza, Suite 600, Hartford, CT 06103.  
Email: jennifer.harris@uconn.edu

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**Summary**

**Background:** Experts recommend against serving sugary drinks and non-nutritive sweeteners to young children, but misperceptions about drink ingredients may contribute to consumption.

**Objectives:** Assess parents' ability to identify added sugar, non-nutritive sweeteners and juice in children's drinks.

**Methods:** Researchers recruited U.S. parents of young children (1-5 years) through an online survey panel ( $N = 1603$ ). In a randomized experiment, participants indicated whether eight popular children's drink products contained added sugar or non-nutritive sweeteners and percentage of juice after viewing (a) front-of-package alone or (b) front-of-package plus nutrition/ingredient information. Participants also viewed common statements of identity on children's drinks to identify product ingredients.

**Results:** When viewing front-of-packages alone, most participants accurately identified products with (83%-90%) and without (51%-65%) added sugar. Showing nutrition/ingredient information increased accuracy. However, the majority could not identify drinks with non-nutritive sweeteners (53%-58%), and many incorrectly believed that unsweetened juices contained added sugar (38%-43%), sweetened flavoured waters had no added sugar (24%-25%), and 100% juice contained less than 100% juice (37%). Furthermore, the majority could not identify product ingredients from statement of identity terms.

**Conclusions:** Misperceptions about product ingredients under current labelling practices indicate that updated regulations are necessary, including clear disclosures of sweetener and juice content on package fronts.

**KEYWORDS**

child nutrition, food labelling, food marketing, sugar-sweetened beverages

## 1 | INTRODUCTION

The American Academy of Pediatrics (AAP) and other health experts recommend that young children (1-5 years) should not consume sugar-sweetened drinks due to long-term health risks.<sup>1-3</sup> The Dietary Guidelines for Americans, 2020 to 2025 also recommends that children under age 2 avoid all foods and beverages with added sugar.<sup>4</sup>

Despite these recommendations, 25% of 1- to 2-year-olds and 45% of 2- to 4-year-olds in the United States consume sugary drinks on a given day.<sup>5</sup> Fruit drinks (including fruit-flavoured and juice drinks) are the most common type of sugary drink marketed for and consumed by young children (ie, children's drink) in the United States.<sup>6,7</sup> In addition to fruit drinks, popular U.S. sweetened children's drinks also include flavoured waters (fruit-flavoured drinks labelled as 'water'

beverages).<sup>7</sup> In 2018, U.S. sales of all sweetened children's drinks totaled \$1.4 billion, exceeding sales of children's drinks without added sweeteners (ie, 100% juice and diluted juice/water blends) by 67% (totaling \$838 million).<sup>7</sup>

Sweetened children's drinks contain up to 52 g of added sugar per serving with little or no juice (10% or less).<sup>7</sup> The majority of children's fruit drinks and flavoured waters also contain non-nutritive sweeteners (NNS),<sup>7</sup> and in 2012 13% of young children (2-5 years) consumed drinks with NNS on a given day.<sup>8</sup> Substituting caloric sweeteners with NNS may benefit individuals with certain conditions (eg, obesity, diabetes).<sup>9</sup> However, high-quality research has not examined NNS safety or potential benefits with young children, and evidence that NNS consumption may increase sweet preferences raises concerns about long-term effects on children's sugar consumption.<sup>9,10</sup> Therefore, a panel of child health and nutrition experts recommended against providing drinks with NNS, and instead primarily providing plain milk and water, to children under age 6.<sup>3</sup> AAP suggests 100% juice or diluted juice (100% juice diluted with water and no added sweeteners) as a healthier alternative to sweetened fruit drinks. However, it recommends serving whole fruit instead of juice and limiting juice to no more than 4 oz per day for toddlers (1-3 years) and 6 oz for young children (4-5 years) due to high consumption rates and potential detrimental effects, including excess calories and dental caries.<sup>11</sup>

Many factors likely contribute to the popularity of sweetened children's drinks in the United States despite expert recommendations, including extensive advertising to children and parents, appealing child-directed promotions on product packages, convenient packaging and lower cost than 100% juice.<sup>7,12</sup> Moreover, common labelling practices on children's drink packages may confuse consumers and make it more difficult for parents to select more nutritious products for their children.<sup>13,14</sup> For example, children's drink brands often offer both sweetened and unsweetened drinks with similar package features, including pictures of fruit, nutrient content claims (eg, 'no artificial flavours,' 'all-natural'), vitamin claims (eg, '100% Vitamin C'), sugar claims (eg, 'less' sugar, 'no high-fructose corn syrup') and words with no regulatory definitions (eg, 'water,' 'natural,' 'fruit').<sup>15,16</sup>

High incidence of NNS in children's drinks raises further confusion about the ingredients in these products.<sup>13</sup> Parents express concerns about artificial sweeteners<sup>17</sup> and believe that NNS are not safe for their children.<sup>14,18</sup> However, 74% of children's fruit drinks and flavoured waters contain NNS, and 38% contain both added sugar and NNS.<sup>7</sup> For most products, the ingredient list under the nutrition facts panel with each sweetener's chemical name (eg, sucralose, neotame and acesulfame potassium) provides the only indication of NNS presence. In a simulated shopping study, parents correctly recognized only 23% of children's products that contained NNS.<sup>14</sup> However, more than 50% of participants said they seek out items labelled 'reduced sugar' and/or 'no sugar added,' which are common claims on products with NNS.<sup>7</sup>

Although labelling on children's drinks may mislead parents to believe that sweetened children's fruit drinks and flavoured water are

healthy choices for their young children, most current practices are consistent with U.S. Food and Drug Administration (FDA) regulations.<sup>16</sup> With the exception of products labelled as '100% juice,' companies are not required to identify sweetener or juice content on the package front. All product packages must include a statement of identity, defined as a common or usual name or appropriately descriptive term for the product, prominently placed on the front, but these do not clearly convey product ingredients or appropriately describe the products.<sup>16</sup> Product packages must also display an information panel on the side or back of the package, containing three components: a nutrition facts label disclosing the amount of nutrients including added sugars; a full ingredients list, which lists types of juice and sugar and is the only location where NNS are required to be disclosed; and the percentage of juice in the product by volume on the top of the panel.

To inform effective labelling practices, research is needed to examine parents' understanding of the ingredients in the drinks they purchase for their children and whether U.S. packaging requirements provide sufficient information to consumers. In particular, experimental studies would help determine whether the nutrition and ingredient information provided on current product labels increases consumers' ability to identify product ingredients. To address these research gaps, the current study assesses parents' ability to identify ingredients (added sugar, NNS and percentage of juice) in popular sweetened and unsweetened children's drinks from product labels and commonly used statements of identity found on the front-of-package. Using a randomized experimental design, it also examines the effects of providing information found on the front-of-package alone compared to providing the front-of-package with nutrition and ingredient information from the information panel. We hypothesized that viewing the information panel would improve accuracy, but that many participants will still not accurately identify the ingredients in these drinks. Evidence of consumer confusion about the ingredients in sweetened and unsweetened children's drinks, even when presented with the full information panel, would support the need for revised FDA regulation to increase disclosure requirements, including additional information on the front of the package.

## 2 | METHODS

This study utilized a cross-sectional online survey of U.S. parents with young children (1-5 years old) to identify their understanding of ingredients in popular drinks for children. A randomized experiment assessed whether providing the information panel with additional nutrition and ingredient information improved participants' ability to accurately identify drink ingredients.

### 2.1 | Study sample

An online survey panel company (Innovate MR) recruited study participants. Innovate maintains a large panel whose members agree to

participate in online surveys.<sup>19</sup> Participation in individual surveys is voluntary. Panellists do not receive monetary incentives for completing individual surveys, but they receive gift cards and other rewards for participating in the panel. Innovate invited a random sample of panel members with young children (1-5 years) to participate and emailed the survey link if they agreed. Additional quota sampling ensured at least 150 each Black, Hispanic and Asian participants for comparisons. The 25-minute survey was administered via Qualtrics survey software. Data were collected in October 2019 and analysed January to April 2020.

## 2.2 | Measures and survey design

The survey screened participants for young children (1-5 years) living in their household, responsibility for feeding their children, and absence of children with a 'disease or condition that requires a special diet.'

Participants first reported the types and brands of drinks they had provided their child in the past month and their attitudes about those drinks (data not reported). They then indicated their familiarity with eight U.S. drink products, indicating whether they had 'purchased the product,' 'seen or heard' of it but 'never purchased it,' or 'never seen or heard' of it before. The eight products were chosen to represent drink products provided to children with the highest 2018 product sales (at least \$40 million).<sup>7</sup> The specific products were selected to include a variety of ingredient messages on product labels (see Table S1). Products included four sugar-sweetened fruit drinks and two flavoured waters. Four of the six sugar-sweetened drinks also included NNS. The highest-selling children's drinks in the unsweetened 100% juice and diluted juice categories were also included. If products came in more than one package type (eg, aseptic box/pouch or multi-serve bottle), the package type with the most shelf facings in one local supermarket was used.

In the experiment, participants were randomly assigned to view the package front alone (no IP condition) or the package front and back/side with the information panel, which includes the nutrition facts panel, ingredient list and percentage of juice (IP condition). Photographs of actual package fronts and backs/sides with the information panel were used. Participants viewed each product image in randomized order and indicated whether the product contained added sugar or NNS (yes or no) and its percentage of juice (0%-100% sliding scale). NNS were described as 'diet sweeteners' in the survey, a term that was best understood by parents in previous focus groups, but they were not provided any additional information about NNS.

Following this section of the survey, participants indicated how confident they were that they can tell whether children's drinks contain each ingredient (5-point Likert scale, from 'not confident' to 'extremely confident'). Participants were then presented with a list of eight statements of identity found on children's drink products, including four products with added sugar (two from the experiment drinks) and four unsweetened drinks. These statements of identity

were selected based on a previous analysis of children's drink packages<sup>16</sup> in order to compare pairs that seemed similar but differed by commonly used terms (including 'naturally,' 'water beverage', 'fruit-flavoured' and 'juice'). Participants were asked whether they thought drinks with 'these names,' which are used on 'product packages to let consumers know what type of drink it is,' had added sugar or NNS ('yes,' 'no,' or 'not sure') and the range of juice it contained (chosen from five options: 0%, 1%-24%, 25%-49%, 50%-99%, 100%). For each question, the list of eight statements of identity were presented in random order. At the end of the survey, participants provided demographic information.

The study was determined to be exempt by the University's Institutional Review Board. Survey questions were newly created for this study, as previous studies have not assessed understanding of drink ingredients in this way. Researchers pretested the survey with a sample of parents with young children ( $n = 32$ ) to ensure all questions were clear and easy to answer.

## 2.3 | Statistical analysis

To assess significant differences between experimental conditions, researchers calculated the percent of respondents who selected the correct responses for added sugar, NNS and percentage of juice in each drink. Chi-square analyses with Bonferroni corrections ( $P \leq .02$ ) to adjust for multiple comparisons compared accuracy between conditions for each product. Chi-square tests also examined whether randomization of participants to condition achieved equivalent distribution of demographic variables (child age and gender; parent gender, education, race and ethnicity; family disease status; WIC status) between conditions.

To assess the overall effect of the information panel on accuracy by ingredient and drink type, researchers first combined individual product results by drink type as follows: (a) added sugar analysis: sugar-sweetened drinks ( $n = 6$ ) and unsweetened drinks ( $n = 2$ ); (b) NNS analysis: unsweetened drinks ( $n = 2$ ), sugar-sweetened drinks without NNS ( $n = 2$ ); and sugar-sweetened drinks with NNS ( $n = 4$ ); and (c) percentage of juice analysis: sugar-sweetened drinks with 10% juice or less ( $n = 6$ ). For the juice analysis, the two unsweetened products were analysed separately due to large differences in juice content (one juice and water blend with 38% juice and one 100% juice).

To measure overall accuracy in assessing added sugar and NNS content, participants who provided the correct answer for more than 50% of products in each drink type were coded. An accuracy rate of 50% represents greater accuracy than would be achieved by chance for the two potential responses. Chi-square analyses assessed significant differences by information panel condition for each ingredient and drink type. To assess percentage of juice accuracy by drink type, participants' mean response for percentage of juice in all sugar-sweetened drinks was calculated. Independent samples  $t$  tests assessed differences by condition in percentage of juice responses for sugar-sweetened drinks combined and the juice/water blend and 100% juice products separately.

Planned comparisons between statement of identity pairs used chi-square analyses to assess perceived differences in added sugar and NNS content and percentage of juice ranges. Predicted probabilities of each response were adjusted for participants' experimental condition using ordered logistic regression with IP condition as a dummy variable.

### 3 | RESULTS

In total, 2591 participants responded to the survey invitation. Participants who declined to participate or did not meet eligibility requirements were removed ( $n = 776$ ). The survey had an 88% completion rate. Randomization achieved equivalent demographic distributions between conditions (all  $P$ 's  $> .20$ ). The final sample ( $N = 1603$ ) was primarily female (80%) and diverse in race, ethnicity and other socio-demographic characteristics (see Table 1). Less than half of participants (48%) indicated that they read the nutrition facts panel all or most of the time when choosing drinks for their child. Most participants (86% or more) were familiar with the specific drinks in the experiment, and more than 50% reported that they had purchased all of them (see Table S2). The majority of participants reported that they were confident to extremely confident in their ability to identify added sugar, NNS and percentage of juice in children's drinks (see Figure 1).

#### 3.1 | Accuracy in identifying ingredients based on front-of-package

Accuracy in identifying added sugar, NNS and percentage of juice varied widely by ingredient, product (Table 2) and drink type (Figure 2). When exposed to the front-of-package alone without the information panel (no IP condition), the majority of participants understood that the sugar-sweetened products contained added sugar, ranging from 55% for Vitaminwater to approximately 90% for Hawaiian Punch and Kool-Aid. Participants were somewhat less accurate in identifying drinks that did not contain added sugar; only 40% accurately indicated that both Honest Kids and Juicy Juice 100% Juice did not contain added sugar. Consistent with participants' lower reported confidence in knowing when drinks contained NNS, only 29% of participants who viewed the front-of-package alone correctly answered that products with NNS contained diet sweeteners. Participants were somewhat more accurate in identifying sugar-sweetened drinks without NNS (41% combined), and they were most accurate in knowing that unsweetened drinks did not contain NNS (69% combined).

Although approximately three-quarters of participants were confident in their ability to identify drinks with 100% juice, many could not assess the percentage of juice in most drinks. Without the information panel, only 51% correctly indicated that Juicy Juice had 100% juice even though it was stated on the package front. For the remaining products, fewer than 8% of participants identified the correct percentage of juice range. For products that contained 0% to 10% juice, the

**TABLE 1** Sample characteristics

Characteristic	No.	%
Gender <sup>a</sup>		
Male	314	19.6
Female	1272	79.4
Marital status <sup>a</sup>		
Single	402	25.1
Married	1077	67.2
Divorced or widowed	118	7.4
Education <sup>a</sup>		
High school degree/GED or less	351	21.9
Some college or 2-year college degree	658	41.0
4-year degree or higher	591	36.9
Race <sup>a</sup>		
White only	943	58.8
Black only	237	14.8
Asian only	166	10.4
Mixed/other	114	7.1
Other socio-demographic characteristics <sup>a</sup>		
Hispanic ethnicity	318	19.8
Born in USA	1404	87.6
WIC recipient	332	20.7
Diet-related disease diagnosis	522	32.6
Child's age <sup>b</sup>		
1-2 years old	623	38.4
3-5 years old	998	61.6
Child's gender <sup>b</sup>		
Boy	831	51.3
Girl	777	47.9
Read the nutrition facts panel <sup>b,c</sup>		
Never/first time	330	20.4
Sometimes	465	28.7
Most/all of the time	750	46.3

<sup>a</sup>For participant demographics questions,  $N = 1603$ . Totals do not add to 100% due to missing or uncategorized responses.

<sup>b</sup>Participants who answered the experimental question,  $N = 1621$

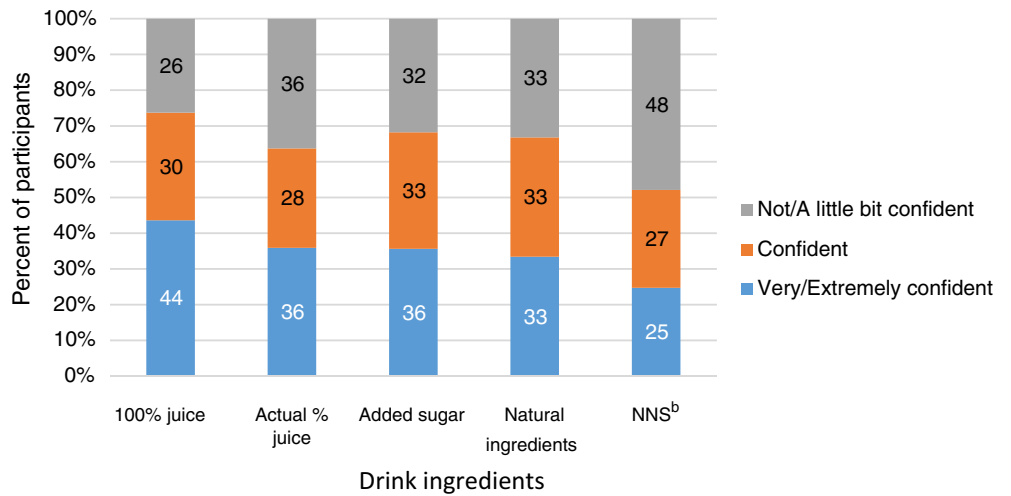
<sup>c</sup>Question: When you are in the store, how often do you look at the nutrition facts panel on the back or side of the package when you are deciding what juice, fruit drinks or flavoured waters to buy for your child? Answer options: All of the time, most of the time, sometimes, only the first time I buy it, never, other (please explain).

mean estimate for percentage of juice was 40%, and juice estimates were higher than actuals for all products except 100% juice.

#### 3.2 | Effects of providing the information panel

Viewing the information panel, which listed added sugar on the nutrition facts panel and in the ingredients list, increased accuracy for all

**FIGURE 1** Participant reported confidence<sup>a</sup> in knowing drink ingredients (N = 1614).  
<sup>a</sup>Question: Please indicate how confident you are that you can tell whether children's juice, fruit drinks, or flavoured waters contain these ingredients. Response options: Not at all confident, a little bit confident, confident, very confident, extremely confident. <sup>b</sup>NNS described as 'diet sweeteners' in the survey



**TABLE 2** Effects of viewing the information panel (IP) on accuracy in identifying drink ingredients

Product	Added sugar <sup>a</sup>				Non-nutritive sweeteners (NNS) <sup>a</sup>			
	Actual	Accurate responses <sup>b,c</sup>			Actual	Accurate responses <sup>b</sup>		
		IP %	No IP %	P <sup>c</sup>		IP %	No IP %	P <sup>c</sup>
Hawaiian Punch	Yes	89.9	89.9	.97	Yes	42.0	38.5	.16
Kool-Aid Jammers	Yes	86.0	88.8	.09	Yes	<b>45.8</b>	37.9	.001*
Sunny D	Yes	87.8	83.2	.01	Yes	<b>40.1</b>	32.4	.001*
Capri Sun Roarin' Waters	Yes	75.1	71.5	.10	Yes	<b>46.7</b>	32.6	<.001*
Capri Sun Fruit Punch	Yes	80.5	77.7	.18	No	<b>75.0</b>	66.4	<.001*
Vitaminwater	Yes	<b>75.5</b>	55.2	<.001*	No	52.9	50.1	.26
Juicy Juice 100% Juice	No	62.1	64.7	.28	No	84.8	80.7	.03
Honest Kids	No	56.6	50.6	.02	No	82.2	76.4	.004
Product	Percent juice <sup>d</sup>							
	Actual % juice	Estimate <sup>b</sup>				Accurate responses <sup>b</sup>		
		IP		No IP		IP %	No IP %	P <sup>c</sup>
		M	(SD)	M	(SD)			
Capri Sun Roarin' Waters	0	22.2	(32.1)	43.1	28.5	<b>50.3</b>	3.1	<.001*
Kool-Aid Jammers	0	17.5	(29.5)	35.2	30.4	<b>54.0</b>	7.8	<.001*
Vitaminwater <sup>e</sup>	0	23.5	(30.9)	36.7	30.3	<b>33.9</b>	7.4	<.001*
Sunny D	5	23.6	(30.4)	44.5	30.7	<b>48.1</b>	2.0	<.001*
Hawaiian Punch	5	19.8	(27.3)	34.9	29.6	<b>47.8</b>	2.2	<.001*
Capri Sun Fruit Punch	10	28.6	(28.5)	44.3	28.9	<b>50.0</b>	5.2	<.001*
Honest kids	38	50.8	(23.7)	66.5	26.7	<b>47.8</b>	0.9	<.001*
Juicy Juice 100% Juice	100	88.1	(21.8)	84.6	23.5	<b>62.6</b>	51.2	<.001*

<sup>a</sup>Question: Do you think this drink has any of these ingredients? Diet sweeteners? Added sugar? Response options: Yes, No.

<sup>b</sup>IP (information panel) condition (n = 808), No IP condition (n = 813).

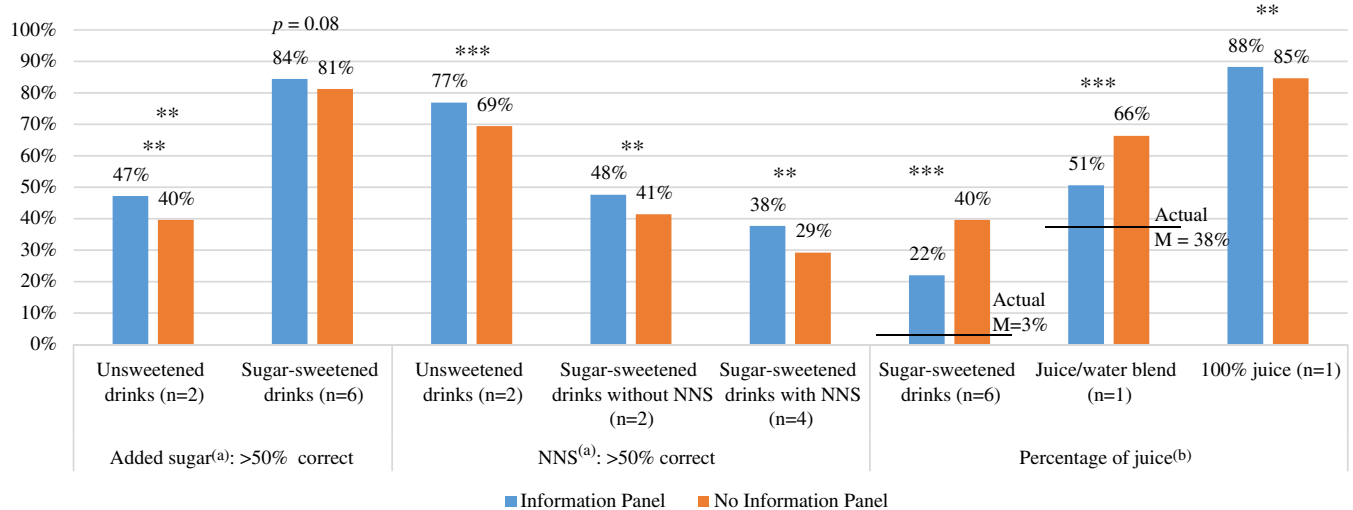
<sup>c</sup>Significance of unadjusted chi-square tests, all  $\chi^2$  (1, N = 1621). Asterisk and boldface indicate significantly higher accurate response. (\*P < .05, P < .002 after Bonferroni corrections to adjust for multiple comparisons).

<sup>d</sup>Question: How much juice do you think this product has? Response options: Percent juice: 0 to 100 (using a sliding scale).

<sup>e</sup>Vitaminwater was the only drink that did not list percent juice above the nutrition facts panel. Boldface indicates significantly higher accurate response (\*P < .05, P < .002 after Bonferroni adjustment).

ingredients and drink types, with the exception of added sugar in sugar-sweetened drinks (accuracy was >80% in both conditions) (Figure 2). Among individual sugar-sweetened products, showing the

information panel increased participants' accuracy in assessing added sugar for Vitaminwater alone (76% vs 55%) (Table 2). Conversely, participants' accuracy in identifying drinks that did not contain added



**FIGURE 2** Effects of showing the information panel (IP) on accuracy of identifying drink ingredients by ingredient and drink type. Responses were combined for drink types with similar ingredients (varies by ingredient). <sup>a</sup>For added sugar and non-nutritive sweeteners (NNS), participants who provided the correct answer for more than 50% of the products in the drink type (ie, greater than chance) were coded as correct. Chi-square analyses assessed significant differences by condition. <sup>b</sup>For percent juice, products with  $\leq 10\%$  juice (ie, fruit drinks/flavoured waters) were combined into one drink type. The juice/water blend and 100% juice products were analysed separately due to differing amounts of juice. Independent samples *t* tests assessed significant differences by condition. Significance: \*\**P* < .01; \*\*\**P* < .001

sugar increased significantly when shown the information panel. However, even with the information panel approximately 40% of participants incorrectly believed that Juicy Juice (100% juice) and Honest Kids (diluted juice) contained added sugar.

Viewing the information panel, which listed NNS in the ingredient list, significantly increased the proportion of parents who could accurately identify products that contained NNS overall. For individual products, the increase was greatest for Capri Sun Roarin' Waters (33% answered correctly without the information panel vs 47% with the panel). Providing the information panel also improved overall accuracy in identifying both sugar-sweetened and unsweetened products that did not contain NNS. However, even with the information panel, the majority of participants (62% overall) could not accurately identify products that contained NNS.

The information panel included juice content in the ingredient list and actual percent juice for all products except Vitaminwater. Providing the information panel significantly increased the proportion of participants who could identify the actual percent juice for all individual drink products and drink types overall. However, even when shown the information panel, estimates for percentage of juice in sugar-sweetened drinks that contained 0% to 10% juice averaged 22%, and participants overestimated the percentage of juice in all products except Juicy Juice (100% juice). Of note, 37% of participants who saw the information panel believed that Juicy Juice 100% juice contained less than 100% juice, and 66% incorrectly believed that Vitaminwater had some juice.

### 3.3 | Understanding of statement of identity terms

Participants also had difficulty ascertaining ingredients in children's drinks based on actual statements of identity (see Table 3). The

majority of participants accurately answered that three of the four statements of identity used on sugar-sweetened drinks contained added sugar, but only 45% accurately answered that the 'naturally flavoured water beverage' contained added sugar. Conversely, fewer than one-half of participants correctly determined that drinks did not contain added sugar based on the statements of identity. Accuracy was lowest for diluted juices (9% and 12%). At least 30% of participants selected the wrong NNS choice for all statements of identity except 100% juice, although only approximately 20% indicated that they were 'not sure.' In addition, fewer than half of participants selected the correct juice range for all statements of identity, except 100% juice. The majority of participants selected a higher-than-actual percentage of juice for statements of identity used on products with 10% or less juice and a lower-than-actual percentage for diluted juices (that contain 44%–66% actual juice). Overall, participants were most accurate in identifying ingredients in the '100% juice' statement of identity, although 38% incorrectly believed that it contained added sugar, 19% believed it contained NNS and 37% believed it contained less than 100% juice.

Planned comparisons between statement of identity pairs further demonstrate confusion about the meaning of common terms (see Table 4). Participants were significantly more likely to believe that statements of identity with the term 'natural' did not have added sugar or NNS and had higher juice content compared to products without the 'natural' term that had similar ingredients. Participants also were significantly less likely to identify that a drink labelled 'water beverage' contained added sugar than a 'flavoured juice beverage,' although the actual 'water beverage' contained added sugar and the juice beverages did not. In addition, participants did not consistently rate statements of identity with the term 'juice' (which are required to have some juice content) as more likely to contain

**TABLE 3** Perceived drink ingredients based on common statements of identity (SOI)<sup>a</sup>

SOI	Added sugar (% of participants) <sup>b</sup>			NNS (% of participants) <sup>b</sup>			Percent juice (% of participants) <sup>b</sup>			Examples				
	Actual product	Yes	No	Actual product	Yes	No	Actual product	0%	Low (1%-24%)		Mod <sup>c</sup> (25%-99%)	100%		
<b>Drinks with added sugar</b>														
Naturally and artificially fruit flavoured drink	Yes	<b>78.8</b>	13.2	8.0	Yes	<b>48.2</b>	29.4	22.4	0%	<b>15.4</b>	45.7	35.2	3.6	Fruit drink: Little Hugs
Flavoured water beverage	Yes	<b>62.9</b>	23.6	13.5	Yes	<b>45.9</b>	31.8	22.4	0%	<b>41.9</b>	31.3	23.2	3.5	Flavoured water: Capri Sun Roarin' Waters
Natural and artificial fruit flavoured juice drinks	Yes	<b>78.1</b>	14.5	7.4	Yes	<b>46.7</b>	30.7	22.6	5%	<b>11.9</b>	<b>44.4</b>	38.8	5.0	Fruit drink: Hawaiian Punch <sup>d</sup>
Naturally flavoured water beverage	Yes	<b>45.4</b>	40.2	14.3	No	<b>33.9</b>	<b>43.4</b>	22.8	10%	<b>32.4</b>	<b>35.4</b>	27.8	4.4	Flavoured water: Apple & Eve Water Fruits
<b>Drinks without added sugar</b>														
Flavoured juice beverage blend	No	84.5	<b>9.1</b>	6.4	No	42.3	<b>34.5</b>	23.2	44%, 60%	13.0	45.0	<b>38.3</b>	3.7	Diluted juices: Juicy Juice Splashers, Juicy Juice Fruitfuls
Juice drink	No	80.4	<b>12.3</b>	7.3	No	38.9	<b>38.9</b>	22.3	53%, 40%	12.0	35.9	<b>44.6</b>	7.5	Diluted juices: Motts for Tots, Apple & Eve Organic Quenchers
Naturally flavoured juice beverage	No	57.6	<b>30.2</b>	12.2	No	32.8	<b>44.5</b>	22.8	66%	8.3	37.0	<b>47.4</b>	7.3	Diluted juice: Apple & Eve Fruitables
100% juice	No	37.9	<b>49.8</b>	12.3	No	19.0	<b>62.4</b>	18.6	100%	3.4	5.4	28.3	<b>62.9</b>	All 100% juices

<sup>a</sup>Survey question: In the following questions, you will see some examples of types of drinks listed on different children's drink packages. Do you think these drinks have added sugar/diet sweeteners? Response options: Yes, No, Not sure. How much juice do you think these drinks have? Response options: 0%, 1% to 24%, 25% to 49%, 50% to 99%, 100%.

<sup>b</sup>Bold indicates accurate response.

<sup>c</sup>Combined 25% to 49% and 50% to 99% responses.

<sup>d</sup>Hawaiian Punch Light also uses the same SOI.

TABLE 4 Planned comparisons between statement of identity (SOI) pairs

SOI	Added sugar (%) <sup>a</sup>			NNS (%) <sup>a</sup>			Percent juice (%) <sup>a</sup>									
	Actual product	Yes	No	Not sure	P <sup>a</sup>	Actual product	Yes	No	Not sure	P <sup>a</sup>	Actual product	0%	Low (1%-24%)	Mod (25%-99%)	100%	P <sup>a</sup>
Flavoured water beverage	Yes	63.1	24.1	12.8	***	No	45.8	31.7	22.5	***	0%	41.4	32.8	22.5	3.3	***
Naturally flavoured water beverage	Yes	45.0	39.9	15.1		No	33.9	43.4	22.7		10%	33.3	33.9	28.3	4.6	
Flavoured juice beverage blend	No	84.6	9.5	5.9	***	No	42.3	34.6	23.1	***	44%, 60%	13.1	45.1	37.7	4.1	***
Naturally flavoured juice beverage	No	57.4	29.9	12.7		No	32.6	44.5	22.9		66%	8.2	37.0	48.1	6.8	
Flavoured water beverage	Yes	62.9	23.8	13.2	***	Yes	45.7	31.6	22.7	0.12 (NS)	0%	38.3	39.3	20.5	1.9	***
Flavoured juice beverage blend	No	84.5	8.9	6.6		No	42.4	34.7	23.0		44%, 60%	17.9	37.4	39.6	5.1	
Naturally and artificially fruit-flavoured drink	Yes	78.7	13.1	8.2	***	Yes	48.2	29.4	22.5	***	0%	15.1	46.2	35.3	3.4	0.21 (NS)
Flavoured juice beverage blend	No	84.5	9.3	6.2		No	42.3	34.6	23.2		44%, 60%	13.3	44.7	38.2	3.9	
Naturally and artificially fruit-flavoured drink	Yes	78.8	13.3	7.9	0.54 (NS)	Yes	48.4	29.7	21.9	***	0%	16.7	43.9	35.1	4.3	***
Juice drink	No	80.4	12.2	7.4		No	38.6	38.7	22.8		53%, 40%	10.7	37.6	44.9	6.8	

<sup>a</sup>Percent responses adjusted for experimental condition.<sup>b</sup>Significance of chi-square tests, all  $\chi^2$  (1, N = 1603). \*\*\* P < .001. Boldface indicates higher response than paired SOI for statistically significant chi-square tests



juice. There was no difference in participants' responses about the percentage of juice for the 'naturally and artificially fruit-flavoured drink' (with 0% juice) vs the 'flavoured juice beverage blend' (with 44%-60% juice). Furthermore, the difference between the proportion of participants who indicated that a 'juice drink' and a 'naturally and artificially flavoured fruit drink' contained added sugar was not significant, even though the fruit drink contained added sugar and the juice drink did not.

## 4 | DISCUSSION

These results demonstrate widespread misperceptions about added sugar, NNS and percentage of juice in popular drinks for children, which raises public health concerns as the majority of participants reported that they had purchased each of the drinks examined. Most participants were unable to identify drinks with NNS and overestimated the percent of juice in all products with less than 100% juice, while almost half misunderstood or did not believe 100% juice statements on package fronts and sides.

Participants' ability to identify ingredients across drink types increased when shown the information panel in addition to the front-of-package with the exception of added sugar in sugar-sweetened drinks. As more than 80% of participants could accurately identify drinks that contained added sugar in both conditions insignificant results could be due to ceiling effects. However, incorrect answers were common even when participants saw the full nutrition and ingredient information. For example, the mean estimate for percentage of juice in sugar-sweetened drinks (22%) far exceeded actual mean juice content (3%). In addition, fewer than one-half of participants correctly identified that unsweetened drinks did not contain added sugar. Moreover, these inaccuracies occurred even though two-thirds or more of participants indicated that they were confident in their ability to identify juice and added sugar in children's drinks.

In contrast, few participants were confident in their ability to identify NNS in children's drinks. Accordingly, only 29% of participants could accurately identify drinks with NNS, even when shown the ingredient list. Because U.S. food labelling laws do not require disclosure of NNS on package fronts or use of common terms, shoppers must be familiar with the chemical terms and read the ingredient list to identify inclusion of NNS in foods and beverages sold in the United States.

Moreover, participants seemed to distrust or not notice unambiguous statements on package fronts stating '100% juice' and 'no added sugar.' Approximately one-half of participants who viewed the package front alone (and 63% who also viewed the information panel) incorrectly answered that the 100% juice product contained less than 100% juice. In addition, approximately one-third of participants in both conditions indicated that it contained added sugar. Although 100% juice does not contain added sugar, it does contain large amounts of natural sugars. These findings indicate that parents may not understand the difference between natural and added sugars, or they may believe that both types of sugar have similar negative health

effects. These findings could also indicate that parents believe juice and sugar disclosures on product packages are not regulated and/or cannot be trusted.

The FDA requires statements of identity to be a principal feature on the front-of-package to provide information to consumers and reduce confusion from fruit images and fruit-flavoured names used on products with little or no juice.<sup>20</sup> However, most participants were unable to identify added sugar, NNS, or percentage of juice from the statement of identity alone. Approximately one-quarter believed that 'fruit-flavoured' drinks had similar amounts of juice as 'juice' drinks, although only juice drinks must contain juice according to FDA regulations. Moreover, most participants did not recognize that statements of identity used on diluted juices described products that did not contain added sugar or that these products contained more juice than statements of identity used on sugar-sweetened fruit drinks that had little or no juice. In addition, the term 'natural' appeared to imply no added sweeteners and more juice, although products with this term may or may not contain added sugar, NNS, or any juice. Similarly, participants were more likely to indicate that statements of identity with the term 'water' contained 0% juice and no added sugar compared to a 'juice beverage blend'. However, the terms 'water' and 'natural' have no inherent meaning and can be compositionally the same as other fruit-flavoured sweetened drinks or diluted juices.

### 4.1 | Limitations

This cross-sectional study utilized a large diverse U.S. sample, but findings are not representative of the entire US population, and not all findings (eg, the questions about statements of identity) demonstrate causal effects of package information. In addition, survey questions were created specifically for this study and have not been validated, and the experimental design and analysis were not pre-registered. The experiment did demonstrate that providing the required nutrition and ingredient information increased accurate assessment of drink ingredients, but we cannot determine whether participants who answered questions incorrectly did not read the information panel provided or they read it and did not understand the information. However, as 78% of participants indicated that they read the nutrition facts panel when choosing drinks for their children at least sometimes, we can infer that some portion of participants read but did not understand the information presented on the IP. Furthermore, the stimuli included actual package images and statements of identity used on existing drinks to increase ecological validity. Additional randomized controlled experiments should test for effects of individual package features (eg, statement of identity terms, claims, sweetener disclosures) on consumer understanding of drink ingredients. Finally, this study examined U.S. products in light of U.S. labelling regulations, and product ingredients and labelling regulations differ by country. Further research is needed to examine consumer understanding of drink ingredients and effectiveness of different labelling requirements in other countries. Cross-country research could also assess the effectiveness of different regulatory schemes.

## 4.2 | Implications

This study expands upon previous research demonstrating common misunderstanding about NNS among U.S. parents, including the chemical names of sweeteners and differences between 'artificial' and 'natural' sweeteners.<sup>13,14,17,18</sup> The current study also indicates widespread consumer misunderstanding of common terms used by U.S. nutrition and public health professionals, including 'added sugar' and '100% juice.' Moreover, participants appeared to misinterpret terms with no inherent meaning that are often used by companies to describe their products (eg, 'naturally,' 'water,' 'flavoured').

These results suggest that nutrition education and public health campaigns to discourage sugary drink consumption should provide information about the meaning (or lack of meaning) of common terms on product packages and how to identify added sugar and 100% juice in children's drinks. Nonetheless, education alone cannot adequately address consumer confusion about the ingredients in these products. Policy solutions must also address the widespread use of ambiguous and misleading images and statements on product packages allowed under current FDA regulations. The present findings support the need for revised regulations that clearly and consistently convey drink ingredients, including added sugar, NNS and type and percentage of juice.

All products in this study are considered drinks that contain juice or purport to contain juice through product names and images that imply fruit may be present, according to FDA regulations.<sup>21</sup> For these products, FDA regulations permit a wide range of names, statements of identity, fruit images and flavouring, fortification, and sweetener claims that this study indicates lead to consumer confusion about actual drink ingredients.

For all drinks except 100% juice, federal law requires that added sugar content and percent juice be disclosed on the information panel only; conversely, manufacturers of 100% juice must disclose these facts on the package front. These inconsistencies likely lead to consumer confusion about what to trust or where to look for information. Congress should allow the FDA to require a percent juice declaration on the front-of-package for all juice and fruit-flavoured drinks. Furthermore, at a minimum, the FDA should enforce existing regulations, such as the requirement to report juice content on the information panel. Although Vitaminwater purports to contain juice through its fruit flavour and colour, this product did not list the percentage of juice on the information panel, an apparent violation of FDA regulations.

The lack of required disclosure for NNS on the package front was established decades ago, before added sugar was required to be reported separately from total sugar and before water, juice and fruit-flavoured drinks routinely contained NNS. This obfuscation of NNS is often coupled with 'low sugar' or other ambiguous sweetener claims (eg, no high fructose corn syrup) on the front-of-package that do not necessarily reflect the full ingredient list (eg, added sugar plus NNS). The use of NNS as a food and drink ingredient is expected to increase with greater awareness of the health consequences of added sugar and recent requirements that the nutrition facts label disclose added

sugar content.<sup>22</sup> The FDA should require consistent reporting of all sweeteners on the front-of-package across all drinks and regulate sugar content claims accordingly. Canada, for example, requires a statement on the front-of-package indicating that products contain NNS (eg, 'contains aspartame'),<sup>13</sup> and Mexico requires NNS disclosure and a statement that such sweeteners are not recommended for children.<sup>23</sup> Alternatively, the European Union does not allow sugar or sweeteners to be added to juice.<sup>24</sup>

The FDA currently permits statements of identity and product names to reflect the characterizing flavour rather than the actual juice ingredients,<sup>20</sup> explaining that 'raspberry and cranberry flavoured juice drink' is a permissible statement of identity for a flavoured apple juice. However, this research demonstrates that statements of identity on children's drinks do not clearly convey ingredient information. Therefore, the FDA should require statements of identity that accurately describe the drink products and regulate the use of potentially deceptive terms, such as 'natural' and 'water.'

Common misperceptions about ingredients in popular children's drinks likely contribute to widespread consumption of sugar-sweetened fruit drinks by young children, despite expert recommendations. Current FDA requirements are inadequate for informing consumers about added sugar, NNS and juice content of fruit-flavoured and juice drinks. Clear disclosures of sweetener and juice content on package fronts are required.

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## CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

## ORCID

Jennifer L. Harris  <https://orcid.org/0000-0002-2155-3021>

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#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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