ADDED SUGARS IN BABY AND TODDLER FOODS: DOES THE CURRENT BABY AND TODDLER FOODS MARKET ENABLE AVOIDANCE OF ADDED SUGARS?

by

JANELLE PERALEZ GUNN

(Under the Direction of Janani Rajbhandari-Thapa)

ABSTRACT

The most recent edition of the Dietary Guidelines for Americans (2020-2025) recommended that children < 2 years of age avoid added sugars. Further, a 2016 regulation, effective in 2020, mandates manufacturers to disclose added sugars information on a product's Nutrition Facts Label. However, no recent studies on the added sugar content in baby and toddler food exist, as this information was previously unavailable.

Two chapters present cross-sectional data on the added sugar content and presence in baby and toddler foods. The first chapter assess added sugars in baby and toddler foods sold in 2023. The second chapter compares baby and toddler foods from 2015 (n=1,015) to 2023 (n=946). Foods from 2015 came from a database used for a previous study. A 2023 baby and toddler food database was developed to answer the research objectives. Foods were categorized by type and baby stage. For each comparison, median serving size, total sugar per serving, and total sugar per 100 grams, as well as the proportion of products with one or more added sugar ingredient was calculated. The hypothesis is there are no added sugars in packaged baby foods and few in packaged toddler foods.

In 2023, most baby food (stages 1-3) categories contain few products (<15%) with added sugar ingredients, except for the dairy-based, dry cereals and baby snack categories. Almost half (48%) of the dairy-based category contained an added sugar and more than 75% of baby snack products contained an added sugar ingredient. Most toddler (stage 4) foods also did not have added sugars, though 65% of grain-based snacks and desserts contained at least one added sugar.

Many baby and toddler foods in 2023 did not contain added sugars, overall, about 2 in 10 down from 3 in 10 in 2015. However, most baby and toddler food snacks contained an added sugar. Public health efforts could implement additional policy actions and educate parents and caregivers on products with and without added sugars.

INDEX WORDS: sugars, infant nutrition, toddler nutrition

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DEDICATION

This doctorate is dedicated to a loving aunt, educator, and role model. She taught me about perseverance, challenging the norm, and to not be so hard on myself. She instilled in me the value of education. She always encouraged me to graduate; she would say “the world needs more Latinas with doctorates.” The world needs more Aunt Esthers.

Dr. Esther Peralez

1949-2023

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Note: *The findings and conclusions in this report are those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention.*

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CHAPTER 1: INTRODUCTION AND BACKGROUND

The foods we eat have a profound impact on health. They can provide essential nutrients for growth and development, help prevent or manage chronic conditions (e.g., type 2 diabetes, cancer and heart disease), and promote overall health (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Similarly, quality nutrition in the first years of life can have lifelong impact, thanks to the rapid growth and establishment of taste preferences that occurs during this life stage (Schwarzenberg, 2018). Conversely, nutrient-poor foods, and foods high in added sugar and sodium, can negatively affect the health of children and adults (United States Department of Health and Human Services and United States Department of Agriculture, 2020).

Decisions about what to feed a baby start at birth. Exclusive breastfeeding or formula feeding is recommended for the first six months of life, at which time caregivers introduce babies to new foods (United States Department of Health and Human Services and United States Department of Agriculture, 2020). These foods, which should be nutrient-dense and developmentally appropriate, typically start as purees and expand to semisolids and solids. Parents have reported using commercial baby and toddler foods because they feel reassured that the products are an appropriate and cost-effective option for babies (Isaacs, 2022).

Prior to 2020, there were no national specific dietary recommendations for babies and toddlers. While various organizations and countries released a variety of recommendations, most lacked a dissemination plan or strategy (National Academies of Sciences, Engineering, and Medicine, 2020). The 2020 release of the 2020-2025 Dietary Guidelines for Americans (DGA)

changed this, for the first-time national nutrition recommendation were included for children less than two years of age (previous editions of the DGA focused on Americans two years and older) (United States Department of Health and Human Services and United States Department of Agriculture, 2015).

Among the 2020-2025 DGA recommendations for children <2 years was avoidance of added sugars (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Added sugars are sugar or syrup ingredients, such as honey, brown rice syrup or high-fructose corn syrup, that are added to the food products or beverages when it is prepared or processed (United States Department of Agriculture, 2019). The accompanying guidance explained that 1) the high nutrient requirements for this age group do not allow for excess calories, and 2) taste preferences are forming during this life stage (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Added sugars, they continue, provide excess calories, and foods high in added sugar are typically low in nutrients.

In response to concerns over added sugars in processed food and other dietary concerns, the Food and Drug Administration (FDA) implemented a regulatory intervention by strengthening the federal requirements for nutrition facts labelling. The 2016 revision to the nutrition labeling of food required manufacturers to disclose the amount, in grams, of added sugars on a product's nutrition facts label (Nutrition Labeling of Food, 2016). This requirement went into effect in January 2020 (Food and Drug Administration, 2018). Previously, industry has reformulated in response to new labeling requirements. For example, industry removed many *trans fats* from products when *trans fats* content was added to the Nutrition Facts Label (Rahkovsky et al., 2012).

Despite both the updated labelling requirement disclosing added sugar content and the 2020 recommendations to avoid added sugars, most babies and toddlers consume added sugars on a given day (Herrick et al., 2020). Research has linked this consumption of added sugars with a long list of detrimental health conditions in children, such as dental caries, excess weight, and elevated blood pressure, suggesting a public health nutrition problem in need of solutions.

Problem Statement

Foods introduced to the diets of babies and toddlers can come from a variety of sources, but often include packaged foods marketed as baby and toddler foods, from here on referred to as baby and toddler foods. This use of packaged baby and toddler foods is pervasive, both in the American diet (Roess et al., 2018) and in other developed countries (Maslin et al., 2017). Among polled caregivers of infants aged 6-11.9 months, about half reported their baby consumed a baby food grain product, and a similar proportion reported consuming a baby food fruit (Roess et al., 2018).

Baby and toddler food products are typically grouped together in a store aisle, and indicate, through marketing, packaging, and labeling they are designed for babies and toddlers. The label used is a Nutrition Facts Label that indicates that their product is designed for 1) infants through 12 months of age, 2) children 1-3 years of age, or 3) both (Appendix A).

In two important studies from the Centers for Disease Control and Prevention, Cogswell and colleagues (2015) and Maalouf and colleagues (2017) created a commercial database of product information from the products Nutrition Fact Label and ingredient list to determine the existence of added sugars in foods intended for babies and toddlers. Added sugars was among nutritional items assessed, as was sodium, due to its negative impact on health. Added sugars, as opposed to natural sugars, are typically not nutrient-dense (United States Department of Health

and Human Services and United States Department of Agriculture, 2015). Both studies found limited added sugars in certain food categories, such as stage 1 (purees) and stage 2 items, and that the majority of non-vegetable and non-meat products (e.g., bars, snacks, and cereals) contained at least one added sugar ingredient. While both studies were able to assess the total amount of sugars, in grams, and identify the unquantified presence of added sugars from the label ingredient list, neither was able to determine grams of added sugar per serving, as that information was not yet required, and therefore unavailable (Maalouf et al., 2017; Cogswell et al., 2015).

The Maalouf (2017) and Cogswell (2015) assessments, conducted before the FDA's regulatory requirement to disclose added sugars on the nutrition facts label and the new 2020-2025 DGA recommendations, serve as pre-policy evidence of the state of baby and toddler foods. Public health concerns suggest the need for a current, post-policy assessment of the presence and amount of added sugars in baby and toddler foods. An updated study is needed to indicate both the presence (from the ingredient list) and the amount (in grams, from the nutrition facts label) of added sugars in these foods. In addition, new data can be compared to the previous findings, providing a policy analysis to determine whether these levels changed over time and how toddler and baby food manufacturers may have responded to national recommendations and regulatory labeling changes. Also, research on baby and toddler foods is timely: this food sector is growing (Statista, 2022b), and interest from the Food and Drug Administration could mean future voluntary or regulatory actions (Food and Drug Administration, n.d.). For these reasons, and due to the inclusion of added-sugar content concerns in other public health efforts (e.g., that of the New York City Health Department who set industry related targets to reduce added sugars (City of New York, n.d.), the current added-sugar content of baby and toddler foods is of

significant interest to public health (Food and Drug Administration, n.d., Lurie 2023). The current dissertation seeks to examine these current levels, according to the research areas below.

Research Goals and Hypotheses

The research goal of this dissertation is to provide evidence of food manufacturers' response to a major U.S. federal regulation that went into effect in 2020 and a 2020 national recommendation related to baby and toddler foods, using data collected in 2023. The practical aim of informing policy that supports healthy food options in the baby and toddler food sector. This goal will be accomplished through two research objectives; each will be developed as an independent research paper for peer-reviewed publication, represented by two manuscripts to follow in chapters three and four. Specific hypotheses can be found below, as well as in each respective chapter.

Manuscript 1, in chapter three, will assess the added sugars present in 2023 in U.S. baby and toddler foods, by baby and toddler food category.

H1: While baby foods will remain low in added sugars in 2023 post-regulatory intervention (2020), given previous assessments, toddler meals and snacks will continue to contain added sugars.

Manuscript 2, in chapter four, will assess the changes in total sugar and presence of added sugar ingredients, by baby and toddler food category, from 2015 ("pre-" added-sugar discloser on the nutrition facts label and 2020 DGA guidance) to 2023 ("post-" requirements to disclose added sugar content and dietary guidance).

H2: Both the presence of added sugar and total amount of sugar in baby and toddler products will have decreased from pre-policy levels (data from 2015) over the policy period.

Chapter Summaries

The following four chapters present findings of two research studies, as part of a publication-option dissertation. Chapter 2 reviews the known literature on added-sugar consumption among babies and toddlers, added-sugar content in baby and toddler foods, and related policy, economic, and environmental activities that may be influencing the inclusion of added sugars in these products. This chapter also presents a conceptual framework and logic model.

Chapter 3, a manuscript chapter titled "Does the United States Baby and Toddler Foods Marketplace (2023) Enable Babies and Toddlers to Avoid Added Sugars, as per U.S. Dietary Recommendations?," assesses the overall state of baby and toddler foods. This paper will assess the extent to which baby and toddler foods contain added sugars in the US Marketplace in 2023. In addition, the proportion of products with an added sugar in a category will be determined.

Chapter 4, a manuscript chapter titled "Has the Type and Amount of Added Sugar in Baby and Toddler Foods Changed Since the Requirement to Disclose Added Sugars on the Nutrition Facts Panel and a National Recommendation to Avoid Added Sugars?," examines the extent to which the presence of added sugars in baby and toddler foods changed, by product matches and by brand, over the course of the policy period (2015-2023). This paper also assesses for any overall changes in total sugar content as added sugar content was not available in 2015. Both chapters 3 and 4 contain an analysis of data and discussion of the findings, including strengths and limitations.

Lastly, Chapter 5 integrates the findings of these two manuscripts in a wider discussion on the role and responsibility of public health in managing sugar consumption in babies and

toddlers. It discusses the industry response to these two policy interventions, recommendations for future policy, research, and practice, and implications for public health.

CHAPTER 2: LITERATURE REVIEW

This dissertation consists of two manuscripts examining the presence and amount of added sugars in baby and toddler foods in the United States. Using findings from a baseline Center for Disease Control and Prevention (CDC) study (Maalouf et al., 2017), this work seeks to determine whether two policy interventions, updated nutrition label requirements (2016) and the 2020-2025 Dietary Guidelines for Americans (DGA) national nutrition recommendations for children less than two years of age, impacted industry response, measured by current levels of total and added sugars in baby and toddler foods.

For decades, the U.S. public health system has sought to reduce population-level consumption of added sugars. Added sugars are sugar or syrup ingredients, such as cane sugar, honey, brown rice syrup, or high-fructose corn syrup, that are added to the food products or beverages when it is prepared or processed (United States Department of Agriculture, 2019). Added sugars do not include sugars naturally found in products such as in plain dairy milk or fruit. Linked National Health and Nutrition Examination Survey Data shows a significant relationship among adults between increased added-sugar intake and mortality from cardiovascular disease (Yang et al., 2014). In 2012, an estimated 52,000 deaths were linked to sugary drink intake (Micha et al., 2017).

Dietary Intake and Recommendations

Multiple national policy documents have presented specific recommendations for reducing added sugars. Healthy People, an initiative of the U.S. Office of Disease Prevention and Health Promotion, sets data-driven national objectives to improve health and well-being over the

next decade. The national indicators for health in the Healthy People 2030 edition included an indicator to “reduce consumption of added sugars by people aged 2 years and over” (Office of Disease Prevention and Health Promotion, 2020). The Healthy People 2030 baseline for added sugar as a mean percentage of calories is 13.5%, and they aim to reduce that ratio to 11.5% by the end of the Healthy People 2030 cycle (Office of Disease Prevention and Health Promotion, 2020). The Healthy People 2030 added-sugar indicator was elevated to a “leading health indicator,” a small subset of factors with a high potential to impact health, due to added sugars’ contribution to excess calories, classifications of overweight and obesity, cardiovascular diseases, and type 2 diabetes (Office of Disease Prevention and Health Promotion, 2020; Centers for Disease Control and Prevention, 2019).

Another influential national policy document is the Dietary Guidelines for Americans (DGA). The DGA is updated every five years, serve as federal nutrition policy. The 2015-2020 edition of the DGAs, for the first time, listed a specific quantitative recommendation to lower added sugars, for those two years and older, to less than 10% of total calories (United States Department of Health and Human Services and United States Department of Agriculture, 2015). For a typical 2,000-calorie diet, that would mean fewer than 200 calories from added sugars, just under the amount found in one 20-ounce bottle of full-sugar soda. The next edition of the DGAS (2020-2025) was the first to include dietary recommendations for infants and toddlers 0-24 months old, and included a specific advisory for this age group to avoid added sugars (United States Department of Health and Human Services and United States Department of Agriculture, 2020).

Other entities have also recommended lowering added sugars over the last decade. The American Heart Association maintained that added sugars, which contain calories but are

nutritionally poor, can negatively impact health and contribute to dental caries, and recommended that children under two avoid them (Vos et al., 2017). The European Society of Paediatric Gastroenterology, Hepatology and Nutrition Committee recommended reducing "free sugar" (added sugar plus processed fruits, such as fruit juices) intake to <5% of total energy intake (Fidler, 2017). Public Health England recommends that manufacturers 1) lower the sugar content of baby and toddler foods and 2) label products high in sugars "as not being suitable for eating between meals" (Tedstone et al., 2019).

The new DGA recommendation to avoid added sugars among babies and toddlers supports the safeguarding of the health of this population and establishing healthier dietary habits going forward. According to the United States Department of Health and Human Services and United States Department of Agriculture, toddlers aged 12-23 months consume about 104 calories a day from added sugars (about 25 grams) (2020). In a separate study, Herrick and colleagues (2020), using National Health and Nutrition Examination Survey (NHANES) data from 2011-2016, found that, on a given day, about six in 10 infants (aged 6-11 months) and almost all toddlers (aged 12-23 months) consumed an added sugar. Most added sugars consumed by infants and toddlers came from commercial foods or beverages (Herrick et al., 2020). Their study identified the top contributors of added sugars in the diets of babies (i.e., yogurts, baby snacks and sweets, and sweet bakery products) and toddlers (i.e., fruit drinks, sweet bakery products, sugar, and candy (Herrick et al., 2020). Baby and toddler food products were among the top five sources of added sugars for children in both age groups.

In an earlier study of infants and toddlers in the Baltimore area, published in 2013, researchers found that consumption of added sugars increased with age. Sweetened drinks accounted for 4.8% of the sugar consumed by children 7-12 months and 20.4% of the sugar

intake for children 13-24 months (Sharma et al., 2013). In addition, a 2021 study suggested that about 78% of the 3,800 children who participate in the Special Supplemental Nutrition Program for Women, Infants and Children were introduced to added sugars before 14 months of age (Bably et al., 2021). The top added-sugar-containing food among this age group was baby cereal (Bably et al., 2021).

Nestle, the global food giant, has also conducted varied dietary studies among infants and children. Their research showed that most infants and toddlers consumed commercial baby and toddler foods, with the highest rates for the subcategory of infant cereals (Roess et al., 2018). According to 2008 data from the Nestle Feeding Infants and Toddlers Study (FITS), and reconfirmed with FITS 2016, infants (6-11.9 months) who consumed commercial baby food were more likely to eat a variety of fruits and vegetables, less likely to consume white potatoes and sweets, and had more favorable energy-adjusted nutrient intakes compared to those who did not report consuming commercial baby food (Reidy et al., 2018). In the study, commercial baby foods were also an important source of vitamin C and vegetables in the diet of infants. Dietary modeling using FITS data showed that baby food fruits fortified with vitamin C help breastfed infants meet vitamin C intake recommendations (Reidy et al., 2018).

Baby and Toddler Food Composition

Baby food refers to foods intended for babies aged four months to less than 12 months, and toddler food refers to that intended for children aged 12 months to two years. The FDA requires manufacturers to apply separate designs for the Nutrition Facts Label for each age group, one for infants through 12 months of age and another for children and toddlers aged one to three years (Nutrition Labeling of Food, 21 CFR 101.9(j)(5)(i) (2016)).

Babies and toddlers may be eating foods from a variety of sources, including baby and toddler foods, homemade foods, and other foods consumed by the family. When foods or drinks other than breastmilk or formula are introduced, they are called complementary foods. Initially the foods are adding on to or "complementing" the nutrition received through breastmilk or formula. Complementary foods begin with purees and then advance to add more textures and consistencies, i.e., finger foods (Food and Nutrition Service, n.d.). Similarly, manufacturers use (typically four) stages to describe this transition, from single-ingredient purees (stage 1, for infants four months and older), to chunkier foods, to finger foods, to products marketed towards toddlers (stage 4) (Ianelli, 2021).

Baby and toddler foods appeal to parents and caregivers for multiple reasons. Stage guidance may be convenient for parents, as they identify ages and milestones ("sitting" or "crawler") (Gerber, 2021) or numbered, sequential stages (e.g., Stage 1 (4+ months) or Stage 2 (6+ months)) (Plum Organics, 2022). In addition, the items are generally prepackaged, carefully labeled to indicate stage and/or age range, visually appealing, and conveniently grouped together in a store aisle (though some have now been moved to the refrigerated section). When determining a child's diet, parents and caregivers should be mindful of an infant's development and readiness for complementary foods and how much and what types to introduce (Division of Nutrition, Physical Activity and Obesity, 2023).

Study Baseline

Previous research studies by Maalouf and colleagues (2017) and Cogswell and colleagues (2015) examined the incidence and amount of added sugars in foods intended for babies. While various items, such as stage 1 and stage 2 foods, contained limited added sugars the majority of

non-vegetable and meat products, such as bars, snacks, and cereals, contained more than one added sugar (Maalouf et al., 2017; Cogswell et al., 2015).

Cogswell and colleagues (2015) found that few infant foods contained added sugars, with the exception of ready-to-serve mixed grains and fruits; more than half of these products contained an added sugar. About a third of toddler dinners and most toddler cereal bars/breakfast pastries, savory snacks, desserts, and fruit and dry fruit-based snacks contained at least one added-sugar ingredient. Across all baby and toddler products, fruit juice concentrate, sugar, and cane topped the list of commonly used added sugars, and approximately three in four products listed an added sugar ingredient among the first four ingredients (Cogswell, 2015).

A follow-up study by Maalouf and colleagues (2017) also assessed added sugars in baby and toddler foods, with one important variance from the earlier study: the later piece did not consider fruit-juice concentrate and water, if reconstituted to full strength, to fit into the added-sugar category. However, if the product contained fruit-juice concentrate but no water, the fruit-juice concentrate was considered an added sugar (Maalouf et al., 2017). Among the 1032 baby and toddler foods considered in the study, 440 contained at least one added sugar ingredient, most commonly fruit-juice concentrate. Within this group of 440 products with an added sugar, 95% listed the added sugar within the first five ingredients 95% of the time; more than three in four of these contained fruit-juice concentrate. The next most common sources were sugar, cane, and syrup. Though fruit-juice concentrate was used in another 46 products, these included water added to restore the concentration back to 100% juice. Most toddler food categories (cereal bars and breakfast pastries, dry grain-based desserts, dry fruit-based snacks, toddler meals, and dairy-based desserts) included at least one added sugar. Several categories had at least 70% of products containing at least one added sugar source (Maalouf et al., 2017).

Additional Research

Limited additional projects have assessed the nutritional composition of baby and toddler foods. Some at the local level and others at the country level. At the local level, a study from New York City (Samuel et al., 2014) examined sodium and sugar in toddler foods, comparing 272 products in stores in high-income zip codes (n=12) and low-income zip codes (n=17). Overall, more than 33% of products had more than 20% of their calories from sugar; four in 10 listed high fructose corn syrup or sugar among the first five ingredients (Samuel et al., 2014). They found differences between the two groups in the sugar content of breakfast foods and cereals (Samuel et al., 2014).

International work includes assessments from Canada, Australia and the United Kingdom. A 2011 study from Canada compared the percentage of calories from sugar in a series of baby/toddler products and adult product equivalents (Elliott, 2011). The study found that more than half of products had ≥ 20% of calories from sugars; the baby/toddler items and their adult equivalents had a similar percentage of calories from (Elliott, 2011). Elliott and colleagues (2015) repeated this baby and toddler food study in the United States collecting data on 240 foods in 2010. They found 56% of products assessed had high sugar content, defined as >20% of energy from sugar. Among those products, one in six listed sugar as the first or second ingredient (Elliott et al., 2015).

A 2022 Australian study found that toddler foods in the nation had a poorer nutritional profile than regular foods; e.g., fruit-based snacks marketed for toddlers contained more total sugars then their general-age counterpart (McCann et al., 2022). Similar, in 2020, University of Glasgow researchers (Garcia et al., 2020) compared changes in baby food product offerings from 2013 to 2019. They found an increase in overall products, the use of fruit-juice concentrate in

sweet snacks, and the utilization of sweet vegetables or fruits in savory snacks (Garcia et al., 2020).

While most of the above studies collected data from product Nutrition Facts Labels (Cogswell et al., 2015; Maalouf et al., 2017; Samuel et al., 2018), at least one research team conducted laboratory studies on the foods in question. Walker and colleagues (2015) assessed 100 samples of foods targeted to children (infant formula, baby foods, and common grocery items). They found that about three in four tested products contained 20% or more of their total calories from added sugars. There were no specific national recommendations at the time, however 20 percent is high relative to current recommendations to avoid added sugars (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Further, they continued, for about one fourth of products, the nutrition facts label under- or overestimated sugars values by more than 10% (Walker, 2015). While the relevant federal regulation allows actual amounts to vary from that listed on the Nutrition Facts Label the variance must represent no more than a "reasonable deficiency" (21 C.F.R § 101.9 (2022)). For products with 20% or more of their calories from added sugars, even if 20% were an underestimate added sugar content would still be of concern.

Labeling

Nutrition facts labels, as we know them today, did not exist prior to 1994. The 1990 passage of the Nutrition Labeling and Education Act required manufacturers to affix a nutrition facts label to product packaging containing certain nutritional declarations. Initial requirements included the disclosure of total sugars, in grams, and a separate requirement to provide a list of ingredients in descending order (Food Labeling, 2022). In 2016, the Food and Drug Administration issued an amendment to the nutrition facts labeling regulations. The new

requirements called for a similar design, but with 1) a larger font size for calories, 2) a declaration of added sugars, both in grams and as a percentage of daily value, and 3) an updated list of nutrients germane to public health concerns (vitamins A and C were dropped and vitamin D and potassium were added) (Food and Drug Administration, 2022).

The original compliance date for the amendment to nutrition label requirements was July 26, 2018 for large manufacturers (those with ≥ $10 million in annual food sales), and was later extended to January 1, 2020 (Food Labeling, 2018). Industry compliance with this update means that, as of January 2020, product packaging displayed new information to consumers, and public health researchers, about the amount of added sugars in food products marketed as baby and toddler foods. While prior research was forced to deduce the presence of added sugars by assessing total sugars and looking for added sugars in the package's ingredient list, current research can easily find the amount of added sugars.

Other labeling requirements have been effective at changing manufacturer or consumer behavior, through various possible mechanisms. Manufacturers may reformulate to adhere to labeling requirements, to either increase the positive perception of existing products or introduce new products with a profile more favorable to the regulatory requirement. Consumers may demand modified products based on their awareness of the policymaking process or after educational efforts (Wang et al., 2016). Researchers from the United States Department of Agriculture found that food manufacturers reduced trans fats in their products in response to new trans fats disclosure requirements; further, new product introductions were lower in trans fats (Rahkovsky et al., 2012). In a study focused on margarines and spreads, authors found an increase in consumer purchases of "trans fat free" labeled products (Wang et al., 2016). Finally, in 2022, mandatory labeling of genetically-engineered food went into effect (Fan et al., 2022). A

post-implementation assessment of soup sales found an impact from the labeling: sales on non-genetically modified soups went up by 2.5%, while sales of foods with the now-mandatory "genetically-modified" label dropped by 5.9% (Fan et al., 2022).

Monitoring the Nutritional Content of Commercial Foods

Monitoring changes in the composition of branded foods can be difficult. According to the Economic Research Service (2022), some federal agencies and private firms develop and maintain a wide variety of data on various details of food composition and consumer food choice behavior. Data sources may offer sales and/or nutritional information, but at a cost (Economic Research Service, 2022; Nutritionix, n.d.). The University of Minnesota's Nutrition Coordinating Center (NCC) offers a food and nutrient database of over 8,300 branded foods across all food categories (NCC, n.d.).[1]

In 2013, the United States Department of Agriculture identified a gap in databases of nutritional information for branded foods. In response, in a public-private partnership with other federal units and private firms, they launched the USDA Global Branded Food Products Database (Institute for the Advancement of Food and Nutrition Sciences, n.d.). The April 2023 update to this database contained products released in the years 2017-2020. A subsequent search of this database for two large brands of baby and toddler foods, Gerber and Parent's Choice, yielded just five unique products (Agricultural Research Services, n.d.).

To address these gaps in available data on added sugars in baby and toddler foods in the United States, and to accomplish the research objectives, the author of the current dissertation built a baby and toddler food database, composed of brands that met one of three criteria: 1) inclusion in the 2015 database (Maalouf et al., 2015) if still selling baby and toddler foods in

[1] For context, the average full-service grocery store carries more than 40,000 unique products (Malito et al., 2017).

2023; 2) availability at three large retailers (Walmart, Kroger, and Dollar General); or, 3) designation as a top-10 brand in terms of revenue, production, and other factors (BizVibe, 2022) (see Appendix B for the data inclusion process, and the methods sections of chapters 3 and 4 for additional details). Once brands were identified for inclusion, the author assessed each brand website and captured images of the front of the package, the Nutrition Facts Label and the ingredient list. These images of nutrition facts labels and the ingredient list were used to populate a new database (see Appendices C and D for the specific data fields collected and images collected).

Theoretical/Conceptual Framework

In 2018, Canadian researchers conceptualized a theory of change model to inform evaluations of school food and beverage sales environments (Levay et al., 2018). This model lends itself well to research on baby and toddler foods. Levay et al, initially developed a logic model and theory of change to inform evaluations related to school food and beverage sales guidelines (Levay, 2018). The research objectives align in an important way: the primary interventions in both Levay's study and the current research are related, but not specific to, the end consumer (i.e., Levay's student and the current study's baby/toddler/parent); rather, both models are specific to the food environment, with a focus on guidelines and implementers. The resulting conceptual theory identifies what mechanisms may lead the stakeholder (industry) to take action (i.e., make change) (Levay et al., 2018). In addition, Levay and colleagues included the reciprocity theory (the social norm suggesting that a party will respond to one favorable action with another) in the framework, which captures any reciprocity between parents' concerns for children and industry's concerns for possible future economic benefits (2018).

Below is the conceptual model for the current baby and toddler food research, adapted from Levay and colleagues (2018). Note that this new conceptual theory adds in factors related to the interventions under consideration for this research, namely national nutrition recommendations and nutrition facts labeling. This model relates to both the assessment of the current market landscape and changes over time.

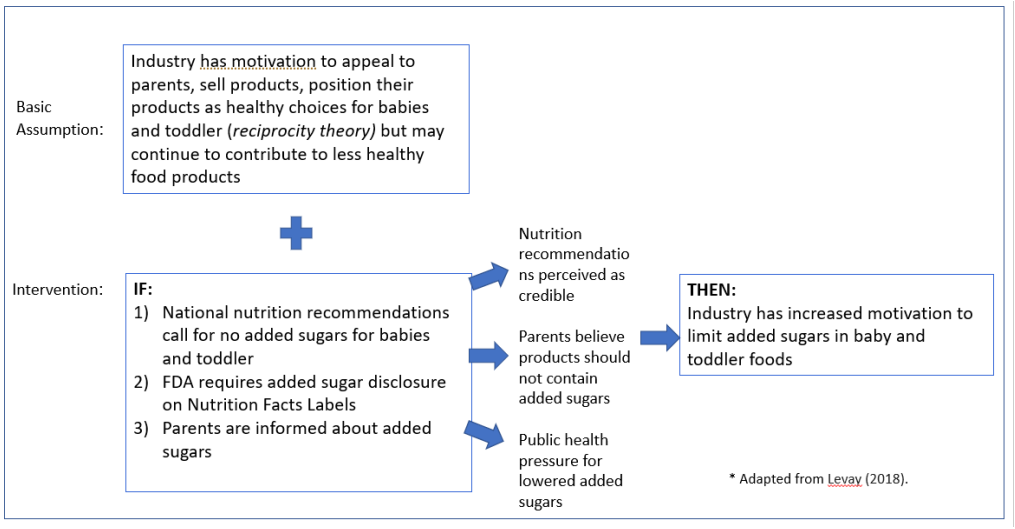


Figure 1: Conceptual Model

Logic Model

In order to capture the broader policy landscape, i.e., the 2020-2025 Dietary Guidelines for Americans added-sugar recommendations for children 0-2 years of age and the 2016 requirement to list added sugars on the Nutrition Facts Label, a logic model was created. Figure 2 below shows potential outputs and short- and long-term outcomes demonstrating the impact of these policy changes. Possible short-term outcomes may consist of increased awareness of the harms of added sugars, application of the new nutrition facts label to all products, and decreased uptake of added sugars. Longer-term outcomes may include a decrease in the incidence and amount of added sugars in baby and toddler foods, a decreased preference for added sugars

among children, and, eventually, the adults they grow into, and overall improved nutritional status.

Resources	Activities	Outputs	Short Term Outcomes (1-3 years)	Long Term Outcomes (4-5 years)	Impact (7-10 years)
Federal staff Public Industry staff Technology – labeling	Update Nutrition Facts Label (NFL) Update Dietary Guidelines for Americans (DGA) Industry labels Launch updated NFL and DGA tools and resources	Published NFL requirements and DGA # of promotions, places, impressions Products contain new NFL	↑ awareness of added sugar harms ↑products with new NFL ↓ added sugar content in products ↓ use of added sugar ingredients ↓ consumption of added sugars	↓ added sugars in baby and toddler foods ↓ preference of added sugars taken into childhood ↑ nutrition status	↓ chronic disease markers ↓ obesity ↓ health care costs

Assumptions – industry complies (NFL), industry awareness of DGA, public interest	External factors – federal funding and requirements, advertising, consumer awareness, ingredient costs, production practices

Figure 2: Logic Model - New Dietary Guidelines for Americans Recommendations (No Added Sugars for Babies and Toddlers) and New Regulations for Nutrition Facts Labels (to Disclose Added Sugars)

Study Rationale and Relevance

The proposed studies are important to public health. To date, no studies have examined the impact of these two policy interventions, the 2020-2025 DGA recommendations and the 2016 updates to regulatory labeling requirements, on the grocery sector, particularly baby and toddler foods. The previously used database from Maalouf and colleagues and the creation of an updated database of baby and toddler product information and subsequent analysis will provide a snapshot of the sugar and added sugar content of baby and toddler foods in the wake of these

changes. This work will also evaluate the effectiveness of the two policies in question and may be useful for future dietary policy formulations. Additionally, these findings may have relevance for the growing food and grocery sectors.

Insights into the Growing Food Sector

Findings from this study will provide insights into the baby and toddler food sub-sector, including which new brands have entered and maintained presence in the market and which existing brands have introduced new products with a different nutritional profile or discontinued old ones. Market data on product popularity and expected growth indicate the extent to which parents rely on these products. A 2017 Mintel study of 1,000 household found that about half of children aged three years and younger eat pouches, a common packaging type of baby and toddler foods. Of those who eat pouches, more than half, 58%, eat more than one a day (Mintel, 2017; Callahan, 2021).

Meanwhile, the baby and toddler food market continues to expand both at home and abroad. According to Statista (2022b), "The market for infant formula and baby food is expected to grow in North America in the coming years, with a forecast market value of almost 30 billion U.S. dollars by 2025."

Interest in this Grocery Sector

This research is also relevant to a separate public health concern. Recently, the discovery and documentation of contaminants in baby foods, including heavy metals and bacteria, led the FDA to take action and identify the product contents. The agency launched the Closer to Zero initiative, which seeks to lower babies' and young children's dietary exposure to toxic elements from baby and toddler foods (Food and Drug Administration, n.d.). The FDA rationale for focus on this area was due to a baby's smaller body size and greater metabolic needs that increase their

susceptibility to the effects of contaminants. In addition, the FDA noted that age-appropriate healthy food is important for growth and development. In , the FDA established voluntary sodium reduction targets for three categories within the baby and toddler grocery sector: 1) toddler meals, 2) baby/toddler cookies, 3) and baby/toddler puffed snacks (Food and Drug Administration, 2021). Recently, the Centers for Science and the Public Interest, along with the New York City Department of Health and Mental Hygiene (NYCDHMH) petitioned the FDA to establish similar targets for added sugars, along with a public database of products included in the targeted food categories (Lurie et al., 2023). The NYCDHMH, as part of their National Salt and Sugar Reduction Initiative, released their own sugar reduction targets in February 2021 (City of New York, n.d.).

Summary

The process of assessing the added-sugar content of baby and toddler foods reflects food's complex regulatory structure, the difficulty of capturing nutrition facts labeling information in a systematic way, and the state of dietary recommendations and scholarship regarding the intake levels and sources of added sugars for this population. Some baby and toddler foods have been shown to contain added sugars, particularly those marketed for toddler consumption.

No recent assessment exists on the added sugar content of baby and toddler foods. Even more importantly, there has been no evaluation of the impact of the 2016 changes to nutrition facts labeling requirements and the 2020-2025 DGA guidance to avoid added sugars. Over the following chapters, this dissertation assesses the current marketplace and provides a post-evaluation snapshot of the relevant nutritional content of baby and toddler foods.

The studies set forth in the two following manuscript chapters required the creation of a new database of products in the baby and toddler food sector, to compare with findings from the pre-regulation study mentioned above (Maalouf et al., 2017). The necessary comprehensive nutrition information was gleaned from the newly-required nutrition facts label disclosure of added sugar. Finally, the creation of this new database provides the unique opportunity to compare current findings to those contained in the previous database from Maalouf and coauthors (2017), allowing for the tracking of baby and toddler food products over time.

Research Questions/Null Hypotheses/Hypotheses

This dissertation seeks to provide evidence of food manufacturers' response to a major U.S. federal regulation and national recommendations related to baby and toddler foods, with the practical aim of informing policy that supports healthy food options in the baby and toddler food sector. This goal will be accomplished through two research objectives; each will be developed as an independent research paper for peer-reviewed publication, represented by two manuscripts to follow in chapters three and four. Specific hypotheses can be found below, as well as in each respective chapter.

Manuscript 1, in chapter three, will assess the added sugars present in U.S. baby and toddler foods, by baby and toddler food category.

H1: While baby foods will remain low in added sugars post-regulatory intervention, given previous assessments, toddler meals and snacks will continue to contain added sugars.

Manuscript 2, in chapter four, will assess the changes in total sugar and presence of added sugar ingredients, by baby and toddler food category, from 2015 ("pre-" added-sugar discloser on the nutrition facts label and 2020 DGA guidance) to 2023 ("post-" requirements to disclose added sugar content and dietary guidance).

H2: Both the incidence of added sugar and total amount of sugar in baby and toddler products will have decreased from pre-policy levels (2015/2017) over the policy period.

CHAPTER 3: DOES THE UNITED STATES BABY AND TODDLER FOODS MARKETPLACE (2023) ENABLE BABIES AND TODDLERS TO AVOID ADDED SUGARS AS PER U.S. DIETARY RECOMMENDATIONS?[2]

[2] Gunn, J, Moore, Cotright, & Rajbhandari-Thapa. To be submitted *to American Journal of Clinical Nutrition* as an original research article.

Abstract

Background: The most recent edition of the Dietary Guidelines for Americans (2020-2025), for the first time, recommended that children < 2 years of age avoid added sugars. Further, 2016 regulation, effective 2020, now mandates manufacturers to disclose added-sugars information on a product's Nutrition Facts Label (NFL). However, no recent studies on the added-sugar content in baby and toddler food exist, as this information was previously unavailable.

Objective: Assess the presence and amount of added sugars in baby and toddler foods, by volume, and identify any potential differences in added-sugar content by product categories, to test for industry alignment with dietary guidance and regulations. We first hypothesize that there are no added sugars in packaged baby foods and few in packaged toddler foods. Methods: Information from NFL (e.g. grams of added sugar, ingredient lists) for baby and toddler foods from 24 brands (n=946) was collected from websites from May-November 2023. This data collection represented brands included in a 2015 baby and toddler food assessment, brands sold in 2 of the 3 largest grocery sellers, and top brands by sales. Added sugars was assessed by grams listed on the Nutrition Facts Label and by presence in the ingredient list. Foods were assessed by serving size, by100 grams of food and added sugar per 1,000 calories.

Results: Most baby (stages 1-3) food product categories contain few products (<15%) with added sugar ingredients, except for the dairy-based, dry cereals and baby snack categories. Almost half (48.3%) of the dairy-based category contained an added sugar and more than 75% of baby snack products contained an added sugar ingredient. Most toddler (stage 4) foods also did not have added sugars, though 65% of grain-based snacks and desserts contained at least one added sugar. However, among all products with added sugars, all toddler food categories contained a median added sugar of .8-5 grams of added sugars.

Conclusions: Many baby and toddler foods do not contain added sugars. However, most baby and toddler food snacks contained an added sugar. Public health efforts could implement additional policy actions and educate parents and caregivers on products with and without added sugars. This is the first assessment of added sugars since the addition of added sugars to the Nutrition Facts Label and national recommendations for baby and toddlers to avoid added sugars.

Key words: Sugars, Added sugar, Infant nutrition, Toddler nutrition, Complementary feeding

Introduction

Dietary quality in the first years of life can have a lifelong impact due formation of taste preferences and the rapid development and growth that occurs during the early years (Schwarzenberg et al., 2018). Around six months of age, babies transition from breastmilk or formula alone to a diet of breastmilk/formula plus complementary foods. These dietary additions can come from a variety of sources, including homemade foods, commercially-prepared foods, and packaged products marketed as baby and toddler foods. Use of these packaged baby and toddler foods is prevalent in the United States (Roess et al., 2018). Parents have reported using commercial baby and toddler foods for multiple reasons, including assurance that the product in age-appropriate and cost-effective (Isaacs et al., 2022).

One dietary concern is consumption of added sugars. Added sugars can provide excess calories to the diet and are typically low in micronutrients; consuming too much added sugar can make it challenging to stay in within calorie limits and meet nutrient needs (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Babies and toddlers may be particularly susceptible to harmful impacts from foods containing added sugars, as 1) the high nutrient requirements for this age group do not permit intake of excess calories, and 2) taste preferences are forming during this life stage (United States Department of Health and Human Services and United States Department of Agriculture, 2020).

Trends data have shown a recent decrease in added sugar intake among adults 19-49 years and children 2-18 years, though it remains above recommended levels (DiFrancesco et al., 2022; Ricciuto et al., 2022). Though experts, including the American Heart Association, recommend that babies and toddlers avoid added sugar, according to 2020 data, 84% consumed

an added sugar on a given day (Vos et al., 2017; United States Department of Health and Human Services and United States Department of Agriculture, 2020; Herrick et al., 2020).

Concerns about the health effects of added sugars have informed policy shifts designed to make the relevant information more readily available to consumers. When the Food and Drug Administration (FDA) updated requirements for the Nutrition Facts Label (NFL) in 2016, they mandated that food manufacturers must disclose the amount of added sugars per serving, in grams (Nutrition Labeling of Food, 2016). This mandate was active as of January 2020, meaning that all baby and toddler food products sold since that point should be labeled with an updated nutrition facts label disclosing the amount of added sugar (FDA, 2022). Before the policy intervention requiring disclosure of amounts of added sugars, scholars could only assess their incidence by checking the ingredients list of a nutrition facts label for any added-sugar ingredients (e.g., sugar, cane juice, corn syrup, etc.) (Maalouf et al., 2017; Cogswell et al., 2015).

Furthermore, the 2020-2025 edition of the Dietary Guidelines for Americans (2020-2025) introduced first-time dietary recommendations for consumers < 2 years of age, i.e., babies and toddlers. These included guidance for this age group to completely avoid added sugars (United States Department of Health and Human Services and United States Department of Agriculture, 2020).

Previous analysis on baby and toddler foods includes data from 2012 and 2015 (Cogswell et al., 2015; Maalouf et al., 2017), before the Nutrition Fact Label regulation changes and 2020-2025 DGAs went into effect in 2020 (Food and Drug Administration, 2018; United States Department of Health and Human Services and United States Department of Agriculture, 2020). The reports using 2012 and 2015 data found that many commercial baby and toddler foods (marketed for babies less than one year of age) did not contain an added sugar ingredient.

However, particular categories did contain more than one gram of added sugar, including infants' ready-to-serve mixed grains and fruits and toddler dinners, cereal bars/breakfast pastries, savory snacks, desserts, and fruit and dry fruit-based snacks (Cogswell et al., 2015; Maalouf et al., 2017). No recent assessment of this important grocery category, that plays a role in the diet at a critical stage in life, has been published, nor in other U.S. grocery categories.

With new recommendations and labeling requirements, a current assessment of added sugars in baby and toddler foods is warranted. The research goal of this dissertation is to provide evidence of food manufacturers' response to a major U.S. federal regulation and national recommendations related to baby and toddler foods, with the practical aim of informing policy that supports healthy food options in the baby and toddler food sector. We assessed the added sugars present in U.S. baby and toddler foods, by category, using data from the Nutrition Facts Label. We developed an a priori expectation, though skeptically, that there are limited added sugars in packaged baby foods and few in packaged toddler foods in 2023, 2-3 years after the Nutrition Fact Label regulatory changes and with new dietary guidance in effect.

Methods

Study Design

This study is a cross-sectional assessment of added sugar content, derived from the nutrition facts labels and ingredient lists of baby and toddler foods. This approach is similar to the 2017 study by Maalouf and colleagues; from a list of the top-20 grocers by sales volume, the authors visited nine retail and wholesale grocers and two drugstores to identify brands of baby and toddler foods. For each brand, the authors consulted manufacturer websites to identify all of its current baby and toddler food products.

Data Collection

A 2023 baby and toddler food database was established by following steps to support the generalizability of its content. Initially Walmart, Kroger, and Dollar General websites and stores were visited to determine extent of products and brands of baby and toddler foods they had available. Brands were identified if they had products that were targeted for consumption by a baby (up to 12 month of age) or toddler (12 months of age to 24 months of age) by front of package or website wording such as baby, infant, toddler, or any age range indicating <24 months of age or corresponding stage. Theses stores were selected as they make up a significant portion of the grocery store market and represent the largest retailers, by sales, for their sector (big box, supermarket, or dollar format, respectively) (Bizvibe, 2020). Overall, Walmart and Kroger rank first and third by sales among stores (Bizvibe, 2020), and represent 30% of all grocery sales (Statista, 2022a). Dollar General was ranked sixteenth on the list by sales (Bizvibe, 2020). In addition to brands sold at Walmart, Kroger, and Dollar General, brands were included if they were in the 2015 database established by Maalouf and colleagues (2017) or if the brand was identified as a top seller (Bizvibe, 2020). Building from the 24 brands included in Maalouf et al., 8 additional brands were identified from Walmart, Kroger or Dollar General, plus one additional brand identified from the top sales list equaling 33 brands of baby and toddler foods. Nine of these brands were no longer selling baby or toddler food products in 2023, and were excluded, leaving a final sample of 24 brands. Two of these brands, Gerber and Beechnut, are estimated to control over three-fourths of the total market share (Chen, 2009; Statista, 2024).

Websites for brands were searched and information was collected for each product identified, establishing a census of products. For all product an image of the front of package, ingredient list and Nutrition Facts Label were captured, and corresponding data was entered into

a database during May-November 2023. In cases in which the manufacturer's website was missing relevant information (about 2% of products), other websites, primarily Walmart.com, were visited in order to fill in information.

Infant and toddler formulas, juices or oral electrolytes were not included. A recent analysis assessed the added sugar content of toddler milks (Du, 2023) and therefore this category was not included. In total 946 products were identified across 24 brands. This study does not involve humans; therefore, an Institutional Review Board review does not apply.

Food Categories

The 946 products, across 24 brands, were divided across 14 baby and toddler food categories, including eight categories of baby foods (stages 1-3) and six categories of toddler foods (stage 4). To establish these food categories, the FDA product categories for Reference Amount Customarily Consumed per eating occasion was used as a starting point. (Center for Food Safety and Applied Nutrition, 2018). Some categories were further subdivided, based on the main ingredients (separating fruits and vegetables for example) or stage.

Products were categorized as baby foods if packaging indicated 4-12 months of age, or stages 1-3; toddler foods' packaging indicated ≥ 12 months, or stage 4. Product types in the baby category represented more distinct offerings (i.e., dry cereals and pure vegetables), resulting in more baby than toddler food categories.

Study Measures

Total sugar and added sugar in grams for each product, per serving, were calculated from nutrition facts label information. In addition, the ingredient list was reviewed, to identify ingredients classified as an added sugar, such as sugar, cane, juice concentrate, and molasses. Added sugars were identified from a list provided by the United States Department of

Agriculture MyPlate platform (United States Department of Agriculture, n.d.) and the Code of Federal Regulations (Nutrition Labeling of Food, 2016). Ingredients on these lists would be subject to the regulation and served as the master list for assessment. Examples of ingredients include juice concentrate, sugar, and molasses. If an added sugar was present in the ingredient list the specific added sugar(s) was documented. As manufacturers may have used an artificial sweetener, the ingredient list was also assessed for presence of these ingredients.

In addition to added sugars per serving, the authors conducted additional analyses of added sugars per 100g of foods and per 1,000 calories. The Nutrition Facts Label reports grams per serving; since serving sizes can vary, the measures of added sugars per 100 grams of food and per 1,000 calories would allow for a standard comparison across food categories.

Statistical Analysis

For each category, initially means and standard deviations were calculated, and distributions were assessed. In the end, median was selected, as the added sugar content was not normally distributed and the standard deviations were high, therefore a measure of central tendency was preferred. For each category of baby and toddler foods, the median and interquartile range was calculated for serving size, total sugar per serving, added sugar per serving, added sugars per 100 grams of food, and added sugar per 1,000 calories. The latter two amounts were selected to ease comparison within and across categories. The proportion of products with added sugars in a specific category was also estimated. All descriptive measures were calculated using Microsoft Excel (Microsoft 365).

Next, a second analysis was conducted, including only those products with an added sugar, as identified through the Nutrition Facts Label or listed on the ingredient list. As with the full sample, for each category of baby and toddler foods, the median and interquartile range was

calculated for serving size, total sugar per serving, added sugar per serving, added sugars per 100 grams of food, and added sugar per 1,000 calories. Then mean and range of added sugar ingredients was calculated for each category of products. For the category the total number of different types of added sugars that were used was assessed as well as the three most common added sugars in the category.

Results

The number of food products across the 8 baby food categories (stages 1-3) ranged from 11 in the cereal category to 151 in the fruits and vegetables mixture category, followed by 144 items in the fruits category and 141 in the dinners/meal category. Most (83%) of the baby food products, stages 1-3, did not contain an added sugar ingredient. Five (prepared cereals, fruits, vegetables, fruit and vegetable mixtures, and dinners/meals) of the 8 categories had <15% of products in the category with an added sugar ingredient (last column, Table 1). By baby food category the proportion of products with an added sugar ranged from 0% (vegetables – single or combined) to 76.2% (baby snacks). More than 70% of baby cereals listed an added sugar amount on the Nutrition Facts Label, "<1 gram", but did not disclose an added sugar on the ingredient list. The highest amount of added sugar was in the dairy-based category; median added sugar for dairy with or without fruits and vegetables was 2.6 grams per serving (IQR 2.9) and contained 2.3 grams of added sugar per 100 grams of product. The highest added sugar per 100 grams of food was baby snacks (11.3 grams), although this category had a small serving size (Table 1). Median servings per container for this category was 5.

Within each toddler food categories (stage 4), the proportion of products with an added sugar ranged from 6.3% (savory snacks) to 65.8% (grain-based snacks and desserts). Median added sugar per serving ranged from 0 grams (five categories) to 2 grams (grain-based snacks

and desserts). Overall, the median added sugar content per 100 grams of food product ranged from .5 (toddler dinners or meals) to 33.9 (toddler sweet dessert dry/freeze dried) (see Table 1).

When analysis was limited to products that contain an added sugar, the median added sugar per serving was higher, as expected, but better reflects amounts of added sugars in products with added sugars. The quantity was nearly a gram or a gram for seven of the 13 categories and 2-6 grams per serving for the remaining five categories. Median added sugar per 1,000 calories ranged from 6.3 grams (toddler meals) to 57.3 grams (baby dairy with or without fruits and vegetables) (Table 2). Mean number of added sugar ingredients among products with added sugars ranged from 1-1.2 among baby food categories and 1.2 to 3.3 (toddler dinner or meals) among toddler food categories. Across the categories, the number of different added sugar ingredients used ranged from one (baby cereal, dry instant, undisclosed) to 17 (toddler grain-based snacks). The most common added sugar ingredients across categories was juice concentrate, sugar and "undisclosed" (a product that contained an unlabeled added sugar. Each of the 14 food categories used at least one of these. Other common sugars included maltodextrin, tapioca syrup, invert cane sugar, or malt extract (Table 2).

Discussion

This study is the most current findings on added sugars in baby and toddler foods in the United States. In addition, this work is the first broad assessment of foods marketed for baby and toddlers since the 2020 introduction of the new dietary recommendations for children <2 years of age to avoid added sugar and implementation of the new Nutrition Facts Label labeling requirements. These products are of public health interest: they are marketed and designed for babies and toddlers, who are consuming them daily (Herrick et al., 2020; Bably et al., 2021; Roess et al., 2020).

In 2012 (n=1,071) and 2015 (n=1,032), two studies assessed the presence of an added sugar ingredient in products in this grocery sector (Cogswell et al., 2015; Maalouf et al., 2017). According to 2012 data (Cogswell et al.,) and 2015 data (Maalouf et al.,), many commercial baby foods (marketed for babies less than one year of age) did not contain an added sugar ingredient, though some did. In 2012 about 17% of stage 1-3 fruits contained an added sugar, and more than half of ready-to-serve mixed grains and fruits (Cogswell et al, 2015). In 2015 among these same categories about 40% of stage 1-3 fruits contained at least one added sugar, as did more than a quarter of ready-to-serve mixed grains and fruits. Added sugar ingredients in toddler foods (stage 4) were more prevalent; most dinners, meals, cereal bars, and breakfast pastries contained at least one added sugar (Cogswell et al., 2015; Maalouf et al., 2017). In addition, nearly all dry grain-based desserts contained an added sugar (Cogswell et al., 2017).

This study identified several food categories with a high proportion of products with an added sugar ingredient, including dairy products with or without fruits and vegetables (baby), grain-based snacks and desserts (toddler), cereals, dry instant (baby), and baby snacks. Across these categories, added sugar per serving ranged from .6-2.6 grams. Previous data also showed limited added sugars in baby foods and added sugar in a large proportion of grain-based toddler snacks (Cogswell et al., 2015; Maalouf et al., 2017). Unlike previous research which found 32% (Cogswell et al., 2015) and 72% (Maalouf, et al., 2017) of toddlers meals with an added sugar ingredient, this study found fewer baby and toddler meals with added sugar ingredients (proportion 18% and 11% respectively).

Similar to Maalouf and colleagues (2017), juice concentrate and sugar were common added sugar ingredients. Among products with added sugars, in Maalouf et al 77% used a juice concentrate (2017), in the present study 58% had a juice concentrate ingredient. Further, the

current study had access to Nutrition Facts Label data. There were several foods that reported an added sugar amount on the Nutrition Facts Label but no added sugar ingredient in the ingredient list, most commonly cereals or other products with added vitamins or minerals. One potential explanation for this is the processing of vitamins and minerals involves a starch that breaks down to a sugar ingredient (Beech-Nut, personal communication, January 2, 2024).

The FDA identified the contents of products in this grocery sector of interest through their Closer to Zero initiative, which focuses on lowering childhood exposure to contaminants, such as arsenic (Food and Drug Administration, n.d.). The current study may be particularly timely and useful for the Closer to Zero project and therefore of interest to the FDA, as it establishes whether or not the baby and toddler food industry responded to a federal dietary regulation by using less added sugar in these products over the policy period.

The current study also has implications for product packaging. Parents, caregivers, and their health professionals may be willing to avoid added sugars but may be confused by the existing nutrition information on packaging. The present study reveals instances across categories in which the label must be assessed very carefully to identify added sugars. In cases in which a product contained an added sugar, the amount per serving was nearly one gram, which adds up as babies and toddlers eat multiple servings or a variety of products throughout the day.

There are at least four limitations to this study. First, the study focused on commercial baby and toddler food marketplace and does not represent the total foods consumed by children <2 years of age, therefore cannot be generalized to children's diets. Second, while this study included baby and toddler food products from 24 different brands that were either 1) sold at three major stores, 2) were top overall sellers, or 3) were included in previous assessments, not all brands were not included in the 2023 database. Some smaller brands may provide healthier or

more niche offerings. Third, these findings represent the overall market availability of the products within these 24 brands and were not weighted by sales. It does capture all the major brands but sales of products will vary even within brand and these products may contain more or less added sugars. Lastly, data was collected from websites and not the actual food package. However, the images on websites were recent as evidenced by use of the new Nutrition Facts Label. The FDA recently sought information related to this issue (Food and Drug Administration, 2023a).

This food sector continues to change rapidly. The data from the current study captures what was available during 2023; new products are continuing to be introduced and existing products discontinued.

Conclusion

In conclusion, even with dietary guidance for babies and toddlers to avoid added sugars and their mandated disclosure on Nutrition Facts Labels, some baby and toddler food products and categories continue to contain added sugars. In particular, a high proportion of dairy products with or without fruits and vegetables (baby), grain-based snacks and desserts (toddler), cereals (dry instant), and baby snacks contain at least one added sugar ingredient. Industry could continue to lower use added sugar ingredients. Parents and caregivers can read Nutrition Facts Labels and select products without added sugars.

Table 1: Added Sugar Related Characteristics of Baby and Toddler Foods, 2023

Food product category	N	Serving Size Median (IQR)	Total Sugar/Serving Median (IQR)	Added Sugars/Serving Median (IQR)	Added Sugars/ 100 g food Median (IQR)	Added Sugars/ 1,000 calories Median (IQR)	≥ 1 added sugar N, (%)
Baby Foods (Stages 1-3)							
Vegetables (single or combined)	75	113 (0)	4.0 (2.2)	0 (0)	0 (0)	0 (0)	0 (0)
Cereals, prepared (with or without fruits)	42	113 (14)	10 (5.3)	0 (0)	0 (0)	0 (0)	4 (9.5)
Fruit and vegetable mixtures	151	113 (14)	9.4 (3.2)	0 (.3)	.0 (.3)	.5 (4.0)	3 (2.0)
Dinners or meal	141	113 (14)	4.3 (3.5)	.1 (.5)	1.6 (6.0)	1.6 (6.0)	18 (12.8)
Fruits (single or combined)	144	113 (10.5)	13.2 (3.6)	.1 (.6)	.1 (.5)	1.4 (6.7)	10 (6.9)
Cereals, dry instant	11	15 (1)	1.2 (.94)	.6 (.4)	3.6 (2.3)	9.3 (6.0)	8 (72.7)
Baby snacks	101	7 (1)	1.7 (1.5)	.8 (.7)	11.3 (9.5)	28.5 (22.3)	77 (76.2)
Dairy with or without fruits or veggies	29	113 (14)	9.8 (2.6)	2.6 (2.9)	2.3 (2.5)	24.9 (27.7)	14 (48.3)
Toddler Foods (Stage 4)							
Fruits and vegetable with or without grains	53	113 (14)	10 (3.5)	0 (0)	0 (0)	0 (0)	5 (9.4)
Savory snacks	16	7 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (6.3)
Dinner or meals (poultry, beans and pasta)	60	117 (29)	6.5 (5)	0 (0)	0 (0)	0 (0)	11 (18.3)
Sweet dessert dry/freeze dried	14	7 (8)	4 (5.3)	0 (5.3)	0 (33.3)	0 (100)	5 (35.7)
Dairy-based (with or without fruits and vegetables)[1]	30	113 (14)	12 (4.25)	0 (2.5)	0 (2.1)	0 (24.7)	8 (26.7)
Grain-based snacks and desserts (biscuits, toast, cookies)	79	20 (7)	4 (5)	2 (3)	11.1 (20)	33.3 (50)	52 (65.8)

Table 2: Characteristics Among Baby and Toddler Food Products with Added Sugars (in grams), 2023

Food product category	N	Total Sugar/ Serving[1] Median (IQR)	Added Sugars/ Serving Median (IQR)	Added Sugars/ 100 g food Median (IQR)	Added Sugars/ 1,000 calories Median (IQR)	Mean number of added sugar ingredients (range)[3]	Types of added sugars	Most common added sugars
Baby Foods (Stages 1-3)[2]								
Cereals, prepared (with or without fruits)	4	2 (.8)	.8 (.8)	.8 (0)	12.5 (0)	1 (1)	2	Undisclosed[4], juice concentrate
Fruit and vegetable mixtures	3	13 (3)	2 (3)	1.8 (3.0)	25 (48.9)	1 (1)	2	Juice concentrate, undisclosed[4]
Dinners or meal	18	2 (7.3)	.8 (1)	.7 (.9)	12.5 (16.7)	1.2 (1-3)	4	Undisclosed[4], juice concentrate, sugar
Fruits (single or combined)	10	17.5 (4.3)	1 (2.4)	.9 (2.2)	11.8 (35.7)	1 (1)	2	Juice concentrate, undisclosed[4]
Cereals, dry instant	8	.9 (.3)	.8 (0)	5 (0)	12.5 (0)	1 (1)	1	Undisclosed[4]
Baby snacks	77	1 (3.3)	1 (.3)	12.5 (4.9)	33.3 (15)	1.4 (1-5)	5	Sugar, juice concentrate, maltodextrin
Dairy with or without fruits or veggies	14	9 (3)	6 (.8)	5.3 (.7)	57.3 (10.8)	1.2 (1-3)	3	Sugar, juice concentrate, undisclosed[4]
Toddler Foods (Stage 4)								
Fruits and vegetable with or without grains	5	8 (4.5)	2 (4.1)	2.0 (3.2)	40 (37.9)	1.2 (1-2)	2	Juice concentrate, sugar
Savory snacks	1	2	.8	3.8	8.3	3	3	Sugar, invert cane sugar, malt extract

Food product category	N	Total Sugar/ Serving[1] Median (IQR)	Added Sugars/ Serving Median (IQR)	Added Sugars/ 100 g food Median (IQR)	Added Sugars/ 1,000 calories Median (IQR)	Mean number of added sugar ingredients (range)[3]	Types of added sugars	Most common added sugars
Dinner or meals (poultry, beans and pasta)	11	3 (4)	.8 (2)	.5 (1.3)	6.3 (11.8)	3.3 (1-6)	4	Juice concentrate, sugar, maltodextrin
Sweet dessert dry/freeze dried	5	8 (3.5)	6 (2.5)	33.3 (9.0)	100 (36.7)	2.2 (1-3)	2	Juice concentrate, sugar
Dairy-based (with or without fruits and vegetables)[1]	8	14 (2.5)	5 (1)	5.1 (1.7)	55.6 (16.7)	1.5 (1-2)	3	Sugar, juice concentrate, undisclosed[4]
Grain-based snacks and desserts (biscuits, toast, cookies)	52	4 (3.75)	3 (2)	16.7 (15)	40 (33.3)	2.7 (1-6)	17	Sugar, juice concéntrate, tapioca syrup

1. Serving size not displayed. Median serving size remained unchanged when data was limited to just those with an added sugar.
2. Vegetables excluded as they did not have any products with an added sugar.
3. Individual products may have multiple added sugar ingredients in the product.
4. Nutrition Facts Label indicated added sugar by listing a numeric value for added sugar but no added sugar ingredient was on the ingredient list.

CHAPTER 4: HAS THE TYPE AND AMOUNT OF ADDED SUGAR IN BABY AND TODDLER FOODS CHANGED SINCE THE REQUIREMENT TO DISCLOSE ADDED SUGARS ON THE NUTRITION FACTS PANEL AND A NATIONAL RECOMMENDATION TO AVOID ADDED SUGARS?[3]

[3] Gunn, Moore, Cotwright, & Rajbhandari-Thapa. To be submitted to *American Journal of Clinical Nutrition* as an original research article.

Abstract

Background: The most recent edition of the Dietary Guidelines for Americans (2020-2025) recommended that children < 2 years of age avoid added sugars. Added sugars information is now required on Nutrition Facts Labels (NFL), while previous research assessed total sugars and checked for added sugars in ingredient lists. **Objective**: Compare presence of added sugar ingredients and total sugars by baby and toddler food category using data from 2015 and 2023. The hypothesis is that total sugars and use of added sugars went down between 2015 and 2023, and that toddler foods will still contain some added sugars.

Methods: This cross-sectional study of baby and toddler foods compared baby and toddler foods from 2015 (1,015) to 2023 (946). Foods from 2015 came from a database used for a previous study. Similar to how foods were identified for the 2015 database, a 2023 baby and toddler food database was developed. Foods were categorized by type and baby stage. A comparison was calculated for 2015 to 2023 overall. Additional comparisons were conducted among all brands that matched in 2015 and 2023, at the brand level for 6 brands that contained at least 50 products in 2015 and 2023 and among 401 specific matched products. For each comparison set, median serving size, total sugar per serving, and total sugar per 100 grams, as well as the proportion of products with one or more added sugar ingredient.

Results: In the 2105 database 1,015 baby and toddler food products were identified and 946 in 2023. Median total sugar per serving was the same for both years. Overall, 2023 had fewer products with an added sugar ingredient (21.1%) compared to 2015 (29.8%). Baby fruits, snacks and toddler fruits and vegetables and dairy-based products all had a lower proportion of products with added sugars in 2015 compared to 2023. Baby dinners had a greater proportion of products with added sugars. When comparing matched brands from 2015 to 2023 proportion of products

with added sugar ingredients was lower (30.6% compared to 19.3%). One brand had fewer products with added sugars. When products were matched (401 pairs), no significant differences were seen.

Conclusions: About 2 in 10 baby and toddler food products contain an added sugar, down from 3 in 10 in 2015. While the proportion of baby snacks with an added sugar decreased, the proportion of products with an added sugar remains high (76.2%). Public health efforts can educate parents and caregivers on reading labels and avoiding products with added sugars, and manufacturers can continue to lower added sugars in their products. This is the first assessment to compare pre and post national dietary recommendations and changes to the Nutrition Facts Label.

Key words: Sugars, Added sugar, Infant nutrition, Toddler nutrition, Nutrition Facts Label

Introduction

The reduction of the consumption of added sugars, and reduced added sugars in foods are public health priorities (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Added sugars are of concern as they are low in nutritional value and can contribute to excess caloric intake (United States Department of Health and Human Services and United States Department of Agriculture, 2020). The harms of dietary sugars are well documented by public health researchers (Huang et al, 2023).

The Dietary Guidelines for Americans (DGA) are science-based guidelines that serve as federal nutrition policy. The DGA in the 2020-2025 edition, released dietary recommendations for the first time for infants and toddlers 0-24 months old. This edition included a specific recommendation to avoid added sugars for those less than two years of age (no added sugars) (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Public Health authorities have called for food manufacturers to lower the added sugar content foods (Food and Drug Administration, 2003, City of New York, n.d. & Tedstone, 2019).

The new DGA recommendation to avoid added sugars among babies and toddlers is important for the health of this young age group and in establishing healthier dietary habits going forward. Toddlers aged 12-23 months consume about 104 calories a day from added sugars (about 25 grams) (United States Department of Health and Human Services and United States Department of Agriculture, 2020). Herrick et al., using National Health and Nutrition Examination Survey (NHANES) data found that on a given day, about 6 in 10 infants aged 6 to 11 months and almost all toddlers aged 12 to 23 months consumed an added sugar (Herrick, 2020) which does not follow the DGA for this age group. Furthermore the Herrick, 2020 study

found that most of the added sugars consumed by infants and toddlers came from commercial foods or beverages (Herrick, 2020).

The FDA is at the forefront in making adequate information related to packaged foods available to the public with a goal to maintain and improve population health. As such, the FDA regulates the information required in the Nutrient Facts Label (NFL) of processed foods. As a response to concern of health impacts of added sugars and limited information about their presence in packaged foods (Food and Drug Administration, 2019), the FDA added a requirement to disclose the amount of added sugars during the 2016 update of the NFL (Food Labeling, 2018), an update after 20 years of NFL. Food manufacturers had until January 2020 to comply with the new NFL (Food and Drug Administration, 2020).

In the context of demand for processed food for babies and toddlers it is imperative to understand the added sugar content of these products. However, the evidence is scant on added sugar content of baby and toddler foods. The last comprehensive assessment of baby and toddler foods, to our knowledge, assessed Nutrition Facts Label information from all products among 24 major brands and found most baby foods used limited added sugars, although many toddler foods contained at least one added sugar ingredient (Maalouf et al., 2017). One study did assess added sugars in toddler milks (also known as step up formulas) (Du, 2023). No current data assesses how the presence of added sugars changes after the DGA recommendation to avoid added sugars and the addition of added sugars information to Nutrition Facts Label.

To assess the baby and toddler food environment post dietary recommendation and NFL addition, a comparison of the added sugar levels in the marketplace, matched brands, within-brand, and matched products sold in 2015 and 2023 was conducted. We hypothesized that total sugars in baby and toddler foods has decreased with a decrease of added sugar ingredients.

Methods

This study is a pre-post-policy comparison of total and added sugar presence in U.S. baby and toddler foods. Products from two databases of baby and toddler foods, covering two different time periods (2015 and 2023), eight years apart, were compared. Both the databases were designed to include the vast majority of baby and toddler foods in the marketplace during that time period. For this food sector, a few brands represent the vast majority of sales (Chen, 2009; Statista, 2024). Both databases included brands from major retail outlets and from lists of top brands by sales.

Study Design and Data Collection

The 2015 database contained baby and toddler foods, nutrition information from the Nutrition Facts Label and ingredient lists from 24 brands, described elsewhere (Maalouf et al., 2017), and used with permission in this study. The 2015 database assessed major stores for brands of baby and toddler foods sold. They identified 24 brands and gathered Nutrition Facts Label and ingredient information from the manufacturer's websites (2017). The 2023 database was developed using similar methods used to establish the 2015 database collected by Maalouf and collegaues. The 2023 database also included 24 brands but with a slightly different composition. The 24 brands were 15 of the same brands from 2015 database and 9 new brands identified because they were sold at Walmart, Kroger or Dollar General or were on a news list of leading brands in the current market (Bizvibe, 2022). Nine brands from the 2015 database were not included in 2023 because they were no longer doing business in the United States or no longer carried a baby food line (see chapter 3). For each brand all baby and toddler foods sold by that brand were included in the database. A few product types were excluded. Juices, electrolyte drinks and toddler milks were not part of this study. Juices were outside of the scope of the 2023

database as most contain 100% juice or diluted 100% juice, and these products were removed from the 2015 dataset (n=22). Neither database included toddler milk.

This study does not involve humans; therefore, an Institutional Review Board review does not apply.

Both 2015 and 2023 database products were categorized into subcategories of baby and toddler foods. Categorization was both by stage, baby foods being stages 1-3 and toddler foods stage 4 and the type of product (baby snacks and toddler meals as examples). In total there were 8 baby food categories and 6 toddler food categories.

Statistical Analysis

Descriptive statistics, more specifically measures of frequency and central tendency, were used to compare 2015 data to 2023 data. Marketplace comparison data was analyzed by categories overall, all baby foods, all toddler foods, and by specific product types.

Study Measures

For each area of categorization (overall, all baby, all toddler, and product categories), the number and percent of total products was determined. After assessing means, standard deviations which showed large dispersion, and the distributions, median and interquartile ranges were selected as units of measure, as the data was not normally distributed. Median and interquartile ranges were calculated for serving size, total sugar per serving, total sugar per 100 grams of food, and total sugar per 1,000 calories, easing comparison across non-standard serving sizes. For each category, the proportion of products with an added sugar ingredient was calculated. Presence of added sugar ingredients was determined by a review of the ingredient list. Proportion of products with added sugar from 2015 to 2023 were compared using the two independent population proportions at a 95% confidence level, with $p<.05$ considered significant. To compare

medians over time, a nonparametric test was selected. A Mood's median test was conducted, as it provides a nonparametric test, and considered significant if $p<.05$.

To better examine manufacturer response to policy change, as opposed to changes from new brands entering the marketplace, a sub analysis was conducted for the 15 brands included in both the 2015 (n=896) and 2023 (n=776) databases. Initially, this analysis was limited to brands in both databases (n=15). Then, six of the 15 brands with at least 50 products in the 2015 database were analyzed; lastly, analysis proceeded at the product level, for 401 products that matched over time (for example, 2015 baby chicken and stars and 2023 baby chicken and stars). For each category, the number and percent of total products was determined. Median serving size, total sugar per serving, and total sugar per 100 grams of food was calculated, as the data was not normally distributed.

For each category, the proportion of products with an added sugar ingredient was calculated. In addition, since some products contained a value for added sugars on the NFL but not in the ingredient list, we determined the proportion of products with added sugars, either by ingredient or amount greater than 0, on the NFL for 2023. Proportions across time were compared at a 95% confidence level, with $p<.05$ considered significant. As with the other categorization medians over time, these were compared by conducting a Mood's median test, which was considered significant if $p<.05$.

Results

The 2015 database contained 1,015 products and the 2023 database contained 946. The proportion of products with an added sugar ingredient significantly decreased over the policy period, from 29.8% in 2015 to 21.1% in 2023 (Table 1). All but two categories (one of which was the same pre and post) showed a decrease in the proportion of products with added sugar,

although this decrease was only significant for baby fruits and snacks and toddler fruits, vegetables, and dairy-based products. Baby dinners had a greater proportion of products with added sugars (4.1% to 12.1%). Overall, and for most categories, the median total sugar per serving did not change. There were some differences in total sugar per 100 grams of food and total sugar per 1,000 calories

When looking at changes among the products from the 15 brands included in both databases, there was no difference in median total sugar per serving. There was a difference, similar to what was seen in the marketplace overall, among products with at least one added sugar ingredient (30.6% in 2015 vs. 20.8% in 2023). With the added information of labeled added sugar in 2023, the actual percentage was slightly higher (20.8%). However, the 2015 database likely contained products that reflected added sugar on the NFL but not in the ingredient list. Among matched brands, percent of toddler foods with an added sugar also decreased, from 59.8% in 2015 to 37.3% in 2023. Median total sugar overall was not significantly different. However, in 2023, total sugar per 100 grams of food was lower overall and higher for toddler foods (table 2).

To further assess manufacturer behavior a brand-level comparison followed (e.g., Gerber 2015 vs. Gerber 2023) on six of the 15 brands with at least 50 products in both databases. Presence of an added sugar ingredient was not significantly different for five of the six brands. The sixth brand showed a significant decrease, from 38.8% of products in 2015 down to 18.6% in 2023. When looking only at matched products (n=401 matches) no difference were seen for any category (table 2).

Discussion

In 2023, about two in 10 baby products contain an added sugar, down from three in 10 in 2015. While the proportion of baby snacks with an added sugar decreased over the policy period (from 87.8% in 2015 to 76.2% in 2023), the proportion of products with an added sugar remains high. Median total sugar overall did not change; however, a few specific categories reflected this change, as did total sugar per 100 grams of food. Additional analysis could reveal whether the change results from different median serving sizes or the increased use of sweet fruits, such as apples and bananas, in place of added-sugar ingredients.

Limiting analysis to brands in both databases showed a reduction in the proportion of products with an added sugar among toddler products. This finding suggests that brands are reducing added sugars in their portfolio over time, and that marketplace changes are not solely a result of new brands entering the marketplace. However, a brand-by-brand comparison revealed that the decreased proportion of added sugars in products was only significant for one brand; an increase was noted for another brand. When specific products were matched, there were no significant differences for any of the variables assessed, implying that brands kept existing products the same but may have discontinued or introduced others.

Public health attention remains focused on added sugars (United States Department of Health and Human Services and United States Department of Agriculture, 2020; Office of Disease Prevention and Health Promotion, 2020; City of New York, n.d.; Food and Drug Administration, 2023b). While the current study found some progress over the policy period, there are also opportunities to education caregivers on selections of baby and toddler food products. Currently, caregivers must read labels carefully, especially among baby and toddler snack foods, to avoid added sugars. Public health efforts can educate parents and caregivers on

reading labels and avoiding products with added sugars. Finally, manufacturers can continue to lower incidence and amounts of added sugars in their products.

This is the first assessment to compare pre and post national dietary recommendations and changes to the nutrition facts label, capturing relevant nutrition information on over 900 baby and toddler food products. However, there are some limitations to the study. First, although the databases capture products from 24 brands of baby and toddler foods, it excludes other brands available in the marketplace. Second, this data captures the reported content of the products rather than measuring the exact amount consumed by a baby or toddler. Third, the study's comparison of nutrition information from 2015 to 2023 is limited, since specific added-sugar content was not listed on nutrition facts labels in earlier study period. Some products from the 2015 database, while containing an added sugar ingredient as identified from the nutrition facts label, may have more or less of that ingredient in the product. Fourth, categorizing the data in the categories selected provided one assessment of the market place, using different categories may have provided different results although totals (baby, toddler and overall) would not have been impacted. Steps were taken to assure correct categorization such as review of serving sizes and ingredient lists. Fifth, for some products, if product reformulations were significant enough that they no longer appeared to be the same product changes of matched products would not be captured. The last study limitation affects establishment of causality. Although the databases represent a pre/post time period, any manufacturer changes to the products in question may be due to other causes such as sales pressures or consumer demand, rather than as a result of federal dietary policy.

Results from this study shed light on the how the baby and toddler foods sector changed over a seven-year period marked by expanded public health interest in dietary recommendations

for this age group. While, overall, fewer products contained added sugar ingredients, some baby and toddler food categories remain of concern.

Table 3 Dissertation/ Table 1 Manuscript: Characteristics of Baby and Toddler Foods, 2015 and 2023

	2015						2023					
	N (%)	Serving Size Median (IQR)	Total Sugar/ Serving Median (IQR)	Total Sugar/ 100g Food Median (IQR)	Total Sugar /1,000 calories Median (IQR)	≥ 1 added sugar N (%)	N (%)	Serving Size Median (IQR)	Total Sugar/ Serving Median (IQR)	Total Sugar/ 100g Food Median (IQR)	Total Sugar /1,000 calories Median (IQR)	≥ 1 added sugar N (%)
Overall	1015	99 (53)	7 (8)	9.9 (8.7)	120 (121.2)	302 (29.8)	946	**113 (42)***	7 (8)	**9.1 (8.0)***	**112.5 (119.3)***	**200 (21.1)***
Baby overall	730 (71.9)	99 (42)	7 (8)	9.1 (8.1)	123.6 (127)	138 (18.9)	694 (73.4)	**113 (22)***	7 (8)	8.8 (7.5)	120 (123.8)	118 (17.0)
Cereals, dry instant	20 (2.0)	15 (1)	1 (2)	6.7 (13.3)	16.7 (33.3)	0	11 (1.16)	15 (1)	1 (.3)	6.7 (2.1)	16.7 (7.5)	0
Cereals, prepared (w or wo fruits)	78 (7.7)	113 (14)	9 (6.3)	8.2 (6.5)	121.8 (80.8)	10 (12.8)	**42 (4.4)***	**113 (14)***	10 (5.3)	8.8 (4.4)	135.4 (48.7)	4 (9.52)
Fruits (single or combined)	159 (15.7)	113 (23)	12 (5)	12.0 (3.3)	186.7 (28.6)	23 (16.4)	144 (15.2)	113 (10.5)	13 (4)	12.2 (3.8)	183.3 (33.3)	**10 (6.9)***
Vegetables (single or combined)	87 (8.6)	99 (42)	4 (3)	4.0 (3.0)	100 (58.3)	1 (1.0)	75 (7.9)	**113 (0)***	3 (3)	3.5 (1.8)	100 (59.5)	0
Fruit and vegetable mixtures	121 (11.9)	113 (14)	10 (4)	9.6 (2.9)	160 (50)	5 (4.1)	**151 (16.0))***	113 (14)	9 (3.3)	8.8 (3.6)	150 (46.4)	2 (1.3)
Dairy with or without fruits or veggies	37 (3.7)	113 (14)	12 (2.5)	11.12 (2.4)	120 (31.9)	18 (48.6)	29 (3.1)	113 (14)	**9 (3)***	**8.0 (2.7)***	109.1 (48.8)	14 (48.3)
Baby snacks	82 (8.1)	7 (0)	1 (2.3)	14.3 (10.7)	40 (21.4)	72 (87.8)	**101 (10.7)***	**7 (1)***	1 (2.3)	12.5 (33.5)	33.3 (95)	**77 (76.2)***
Dinner or meal	146 (14.5)	113 (29)	3 (4)	2.8 (2.9)	42.9 (35.6)	6 (4.1)	141 (14.9)	**113 (14)***	3 (4.5)	2.7 (1.6)	**37.5 (61.1)***	**17 (12.1)***
Toddler Foods	285 (28.1)	99 (105)	7 (9)	11.7 (16)	109.1 (108.9)	164 (57.5)	254 (26.8)	99 (94)	8 (7)	**10 (9.6)***	88.9 (93.3)	82 (32.2)
Fruits and vegetable with	71 (7.0)	120 (21)	12 (4)	10.9 (4.1)	166.7 (57.1)	23 (32.4)	53 (5.6)	**113 (14)***	**10 (3.5)***	**9.2 (3.1)***	**133.3 (50.0)***	**5 (9.4)***

	2015						2023					
	N (%)	Serving Size Median (IQR)	Total Sugar/ Serving Median (IQR)	Total Sugar/ 100g Food Median (IQR)	Total Sugar /1,000 calories Median (IQR)	≥ 1 added sugar N (%)	N (%)	Serving Size Median (IQR)	Total Sugar/ Serving Median (IQR)	Total Sugar/ 100g Food Median (IQR)	Total Sugar /1,000 calories Median (IQR)	≥ 1 added sugar N (%)
or without grains												
Dairy-based (with or without fruits and vegetables)[1]	62 (6.1)	113 (15)	12 (4)	11.4 (3.7)	130 (57.3)	39 (62.9)	**30 (3.2)***	**113 (14)***	12 (4.3)	11.2 (5.1)	135.4 (42.2)	**8 (26.7)***
Grain-based snacks and desserts (biscuits, toast, cookies)	63 (6.2)	14 (11)	3 (3)	25 (8.6)	66.7 (21.4)	48 (76.2)	79 (8.4)	**20 (7)***	4 (5)	**21.1 (13.6)***	50 (47.0)	52 (65.8)
Savory snacks	20 (2.0)	13 (1)	1.5 (1.9)	8.7 (21.4)	23.6 (43.4)	10 (50)	16 (1.7)	**7 (0)***	**0 (0)***	**0 (0)***	**0 (0)***	1 (6.3)
Sweet dessert dry/freeze dried	26 (2.6)	7 (3.5)	4 (3.3)	57.1 (17.1)	151.9 (44.7)	12 (46.2)	14 (1.5)	7 (8)	**4 (5)***	**60 (13.1)***	**160 (50)***	5 (35.7)
Dinner or meals (poultry, beans and pasta)	43 (4.2)	152 (57)	3 (4)	1.8 (2.2)	20 (31.0)	32 (74.4)	**60 (6.3)***	**770 (29)***	**6.5 (5.0)***	**5.7 (5.2)***	**61.4 (79.9)***	11 (18.3)

1. Added sugars was determined by presence of an added sugar ingredient in the ingredient list. Some products disclosed an added sugar amount on the nutrition facts label without an added sugar in the ingredient list; these were not included in this analysis.
2.* significant at $p<.05$ for either the Mood medians test or a two proportion z-test

Table 4 Disseratation/ Table 2 Manuscript: Total and Added Sugars Per Same Brands and by Matched Products, 2015 and 2023.

	2015					2023					
	N (%)	Serving Size Median (IQR)	Total Sugar/ Serving Median (IQR)	Total Sugar/ 100g Food Median (IQR)	≥ 1 added sugar ingredient N (%)	N (%)	Serving Size Median (IQR)	Total Sugar/ Serving Median (IQR)	Total Sugar/ 100g Food Median (IQR)	≥ 1 added sugar ingredient N (%)	≥ 1 added sugar Labeled or ingredient list
	Matched Brands					Matched brands					
Overall	896	105 (50.30	7 (9)	9.7 (8.1)	274 (30.6)	776	113 (42)	8 (8)	5.4 (7.1)	**183 (19.3)***	**197 (20.8)***
Baby	662 (73.9)	99 (42)	6 (8)	9.1 (8.1)	134 (20.2)	575 (74.1)	113 (17)	8 (9)	5.3 (6.9)	108 (11.4)	122 (21.2)
Toddler	234 (26.1)	113 (100)	8 (9)	11.1 (9.5)	140 (59.8)	201 (25.9)	99 (93.5)	7 (7)	37.5 (95.8)	**75 (37.3)***	**75 (37.3)***
	Brands ≥50 products					Brands ≥ 50 products					
Brand 1	130	107 (53)	6 (7)	8.8 (6.5)	7 (5.4)	99	113 (14)	10 (9)	6.1 (6.8)	10 (10.1)	**13 (13.1)***
Brand 2	140	113 (57.3)	5 (7.8)	5.3 (9.5)	27 (19.3)	76	113 (14)	5.5 (9.8)	.3 (9.6)	18 (23.7)	22 (28.9)
Brand 3	272	99 (35)	8 (9)	10.1 (9.1)	102 (37.5)	219	113 (57)	6 (8.5)	3.5 (8.8)	65 (29.7)	72 (32.9)
Brand 4	85	99 (106)	6 (9.5)	10.1 (7.5)	33 (38.8)	97	113 (88)	7 (8)	8.8 (5.4)	**18 (18.6)***	**18 (18.6)***
Brand 5	75	99 (28)	7 (8)	8.8 (6.3)	25 (33.3)	62	99 (42)	8 (3)	8.0 (5.3)	17 (1.8)	17 (1.8)
Brand 6	50	113 (12.8)	7.5 (8)	7.9 (7.6)	10 (20.0)	60	99 (88)	7.5 (6)	4.2 (7.4)	6 (10)	6 (10)
	Matched Products					Matched Products					
Overall	401	113 (53)	8 (8.75)	10 (7.8)	116 (28.9)	401	113 (25.5)	8 (8)	9.7 (7.5)	101 (25.2)	113 (28.2)
Baby	330 (82.3)	99 (53)	7.5 (8)	9.9 (7.7)	80 (24.2)	328 (81.8)	113 (23)	8 (9)	9.7 (8.0)	61 (18.6)	73 (22.3)

Toddler	71 (17.7)	113 (95)	8.5 (9)	10.0 (10.0)	37 (51.3)	73 (18.2)	113 (100)	8 (7)	10 (8.1)	40 (54.8)	40 (54.8)

CHAPTER 5: DISCUSSION, CONCLUSIONS, RECOMMENDATIONS, AND PUBLIC HEALTH IMPLICATIONS

The foods they eat have a profound impact on the health of babies and toddlers. Good nutrition in the first years of life can have lifelong impact, due to the rapid growth and establishment of taste preferences that occur during this life stage (Schwarzenberg, 2018). Conversely, nutrient-poor foods, and foods high in added sugar and sodium, can have a negative impact on the health of adults and children (United States Department of Health and Human Services and United States Department of Agriculture, 2020).

Only recently, in 2020, has the United States released federal national dietary recommendations for children under two to avoid added sugars. Additionally, in 2020, added sugar content became available on the nutrition facts label, as a result of FDA regulations (United States Department of Health and Human Services and United States Department of Agriculture, 2015; Food and Drug Administration, 2022). Most babies and toddlers consume added sugars on a given day (Herrick et al., 2020). Will the food supply and baby and toddler intake of added sugars decrease overtime?

Problem Statement

Foods introduced to the diets of babies and toddlers can come from a variety of sources, One source being baby and toddler food products. New dietary guidance and labeling regulations supports reducing added sugars. In a previous study Maalouf and colleagues (2017) developed a baby and toddler food database to determine the presence of added sugars in foods intended for

babies and toddlers. New information is available on the amount of added sugars in baby and toddler foods.

The two studies presented here provide an assessment of the status of the baby and toddler food marketplace (2023), and changes that occurred over a seven-year time period. To complete the assessment, data was used from a previous publication (Maaslouf et al., 2017) and a new 2023 database of over 900 products was constructed.

Study Findings

In 2023, most baby food product categories (stages 1-3) contained few added sugars, except for the dairy-based and baby snack categories. Almost half of the dairy-based category contained an added sugar, as did more than 75% of baby snack products. While most toddler foods also lacked added sugars, 65% of grain-based snacks and desserts contained at least one added sugar. Among products that contained an added sugar, the median added sugar per serving ranged from .8 grams to six grams.

The overall 2023 data contained fewer products with an added sugar ingredient (21.1%) compared to 2015 (29.8%). Baby fruits and, snacks and toddler fruits and vegetables and dairy-based products all had a lower proportion of products with added sugars in 2023 compared to 2015. Baby dinners had a greater proportion of products with added sugars. Surprisingly, when products were matched from 2015 to 2023, no differences were observed. Therefore, reductions were mainly driven by new products of existing brands or by new brands.

There are several limitations to the studies presented in chapters 3 and 4. First, the 2023 database is not a complete assessment of the marketplace and excludes some brands. Although, the database was robust with all baby and toddler food products from 24 brands (>900 products) included. Second, the data represents what is sold on the marketplace but is not weighted by

sales, therefore equal consideration was given to all products regardless of their popularity. Alternatively, it does show broadly the nutritional content of what is available for consumers to purchase. Third, because added sugar per serving was not available in 2015, it was not possible to perfectly compare added sugar content across time periods. However, by review of the ingredient list the proportion of products containing added sugars was able to be assessed. Fourth, while the data in this assessment include a pre/post time period of changes in regulations and guidance, manufacturers may have made changes in their products for other reasons, such as sales or other external pressures (e.g., arsenic in baby cereals) (Food and Drug Administration, n.d.). Lastly, data was categorized by the researcher and may be subject to misclassification either by the categories selected (feature selection) or other human biases such as assigning a category. Steps were taken to decrease potential misclassification by review of ingredient lists (if a fruit was found in a vegetable category then the product was moved) and by review of serving sizes.

Stakeholder Analysis

Data on baby and toddler foods is of interest to several stakeholders. Primary stakeholders, those that are directly affected by the pre/post assessment, include food manufacturers and the Food and Drug Administration. Food manufacturers may be pleased to learn how their products compare to other products, or enjoy the public attention that may come from news that they use little or no added sugars. Some may perceive the evaluation as negative, with concerns that the results may draw negative attention to their products and the added sugar content in particular food categories, such the snack categories. The Food and Drug Administration would be interested in confirming that food manufacturers are compliant with the new nutrition facts label regulation and understanding the extent of added sugars in baby and

toddler foods. If they find high amounts of added sugars remain in these products, they may consider if additional educational, voluntary, or regulatory actions are needed. Further, this data could build on information they gathered as part of public meetings on reducing added sugars (Food and Drug Administration, 2023). The addition of front-of-package labeling could also bring additional insights (Food and Drug Administration, 2024).

Secondary stakeholders include parents and care givers, nutrition educators, and public health officials and researchers. Parents and caregivers may be interested in learning the subcategories of baby and toddler foods that contain added sugars, and may choose to purchase different products with lower or no added sugars. The data may flag categories they may want to avoid, such as snacks, if they are trying to avoid added sugars for their baby or toddler. Nutrition educators may recommend avoiding certain products or within-subcategory swaps to avoid or lower added sugars. In addition, they may want to raise overall awareness of the DGA recommendation and which baby and toddler foods contain added sugars. Further, these results may help educators train on how to use the Nutrition Facts Label.

Public health officials may be considering a variety of strategies to lower added sugar intake (Healthy Food America, n.d.). Results of this policy analysis could inform consumer messaging. In addition, public health researchers could be interested in the 2023 database constructed to conduct the policy evaluation, or adding in additional information, such as calcium or sodium content.

Lastly, other stakeholders include community-based organizations (CBOs) and advocacy groups at the national, state, and local levels. For example, the American Heart Association's Voices for Healthy Kids program is providing national leadership to decrease sugar-sweetened beverages and increase water, and strategies to improve nutrition in the early care and education

setting (Voices for Healthy Kids, n.d.). Other organizations, such as those supporting sugar-sweetened beverage taxes or community nutrition efforts, may also be interested. Such organizations could increase engagement and interest from other CBOs and residents.

Policy Implications

Public health authorities may consider the results of this research and additional data in light of their current public health strategies. The current research shows the status of added sugar content in baby and toddler foods after the addition of added sugar disclosure on the Nutrition Facts Label and dietary recommendations. As part of the 2022 White House National Strategy on Hunger, Nutrition and Health, there is a commitment for the FDA to "begin assessing the evidence base for further strategies to reduce added sugar consumption.." it continues "…such as developing targets for categories of foods, similar to the voluntary targets FDA developed for sodium (Executive Office of the President, 2022)." The FDA developed sodium targets included specific targets for baby and toddler foods (Food and Drug Administration, 2021). In 2019, The Robert Wood Johnson Foundation supported Healthy Eating Research released a consensus statement on Healthy Beverage Consumption in Early Childhood. The report identified appropriate beverages for young children to drink, those to limit and those to avoid. The added sugar, low calorie sweetener and nutrient content were factors considered in making their recommendation (Lott et al., 2019). The same group has feeding recommendations for 2–8-year-olds that include foods in addition to beverages (Fisher et al., 2021). Based on what we know about what baby and toddlers are consuming, and the added sugar content of baby and toddler foods, there is an opportunity to create feeding recommendations for the 0-2 years age group that would address baby and toddler food categories of concern.

Recommendations for Future Research

Use of Database to Answer Public Health Questions

One of the major contributions of this dissertation and its component studies was the establishment of a 2023 baby and toddler food database. The database was designed and built with the intention to conduct additional research projects. For each product included, a picture was captured of the front of package, the nutrition facts label, and the ingredient list. Data from the nutrition facts label was added to the database. The present studies focused on sugars and added sugars, but other macro and micronutrients may be of interest.

As healthy nutrition is essential for this age group, other key public health questions could be answered using the database:

- Vitamin D - Vitamin D was identified as a nutrient of public health concern (United States Department of Health and Human Services and United States Department of Agriculture, 2020) and added to the updated requirements of the nutrition facts label (Nutrition Labeling of Food, 2015). The 2020-2025 Dietary Guidelines for Americans also identified Vitamin D as a nutrient of public health concern (United States Department of Health and Human Services and United States Department of Agriculture, 2020). An analysis to assess vitamin D content in baby and toddler foods could inform its potential availability and help dietitians and WIC providers educate on appropriate food selections to meet vitamin D needs. A preliminary assessment of the database shows that very few products contain vitamin D. Given the relationship between vitamin and calcium absorption, pairing this data with calcium data could be informative.

- Iron – Iron is an essential nutrient during childhood. The CDC prioritized iron, along with zinc, iodine, folate, and vitamins A and D, as part of its micronutrient work (Division of Nutrition, Physical Activity and Obesity, 2022). The 2020-2025 DGAs emphasized adequate iron consumption being a concern, especially for young children United States Department of Health and Human Services and United States Department of Agriculture, 2020. Also, the WIC food package has included iron-rich foods, such as infant cereals, to support young children's access to such food (WIC Works Resource System, n.d.). Recently, the National Academies of Sciences, Engineering, and Medicine conducted a study on revising the WIC food package, finding low iron intake to be of concern (National Academies of Sciences, Engineering and Medicine, 2017). Some manufacturers are asking the USDA to consider other sources of iron (such as baby food meats) for future updates to the WIC food package. An analysis can confirm iron content of foods such as infant cereals and also potentially identify other good sources. This could inform policy development and nutrition educators who are advising parents.

- Sodium and potassium – Previous studies assessed the sodium content of baby and toddler foods (Cogswell et al., 2015; Maalouf et al., 2017). Sodium remains a concern, as population intake is above recommended limits (Ricciuto, 2022). In addition, current data could be compared to previous data, and inform progress on the FDA voluntary sodium reduction targets (Food and Drug Administration, 2021). On the other hand, potassium, which is under-consumed, can lessen the harm of too much sodium. Previously, manufacturers could voluntarily disclose potassium, but it is now required on the nutrition facts label. An analysis that looks at current sodium and

potassium content of baby and toddler foods could identify foods high in sodium or good sources of potassium and provide a first-ever assessment of potassium content in baby and toddler foods. Further, FDA changed regulations around the naming of potassium chloride (can now be called potassium salt) (Food and Drug Administration, 2020). Ingredient lists could be used to assess for utilization of potassium chloride.

While there was no significant change in total sugar per serving, there were some changes related to total sugar per 100 grams of food, both overall and in some specific categories. One hypothesis is that foods may now contain more sweet fruits. This report did find an increase in the proportion of mixed fruit and vegetable products. Using the available ingredient lists, an analysis could be conducted for use of specific fruits, such as apples, bananas, and pears. A preliminary scan of ingredients lists showed more than half of all products contained at least one apple or banana ingredient.

Marketing is also of concern. The captured product packaging images could inform an assessment of the types of marketing on baby and toddler food products. Areas of interest would be use of fruit and vegetable imagery, the deployment of cartoon or other "friendly" characters, and content claims (such as "no added sugars" or "good source of iron"). One study found that most fruit drinks, 100% juices, and favored waters purchased by households with a child 0-5 years of age posted front-of-package claims and used imagery (such as pictures of fruits) that may have led consumers to believe that the products were healthy (Musicus, 2021). Musicus and colleagues also found, through simulation, that warning labels and limits on imagery and acclaims may reduce purchases for young children (2022).

Several additional research questions could build on the present studies and inform public health. First, what is the significance of the placement of added sugars in the ingredient list? Some products used a variety of added sugars (one product contained five). If the individual added-sugar ingredients were combined, they would be higher up on the ingredient list. In addition, in some cases, the same added-sugar ingredient was used in the ingredient list more than once (e.g., as part of the "crust" and part of the "filling"). Although the content is disclosed, consumers may be deterred from purchasing if they see added sugar in the first few ingredients on the ingredient list. An analysis of the ingredient lists would be informative and show industry trends. For this current research project, several ingredients present in 2023 did not appear in 2015, such as agave inulin, betaglucan, and fructooligosaccharides. A future analysis could assess ingredients used in 2015 versus 2023 and check for any commonalities among ingredients discontinued or introduced. Next, given that total sugars remained the same, an assessment of use of other ingredients, such as sweet fruits (bananas, apples and dates, for example) could inform industry changes.

The present study assessed changes by brands included in 2015 and 2023; an alternative examination could compare new brands in the marketplace compared to the existing, long-standing brands. Are new brands bringing something different to the baby and toddler food marketplace?

One of the limitations of this database was that it represented products in the marketplace but not necessarily what products baby and toddlers are eating. This data could support the backend of databases, or other research projects that are monitoring the intake of baby and toddlers though their caregiver proxy. The database could also be paired with sales data and weighted based on sales.

Closing

Early childhood is an important time period for growth and development. Also, taste preferences can start to be established during this period, influencing lifelong eating patterns. Early childhood is also a transition period from breastmilk or formula to complementary foods and the family diet. The baby and toddler food sector offer many options to caregivers and is expected to grow and expand.

Added sugar intake is a concern for this age group and beyond. The most recent DGA recommendations are for children <2 years of age to avoid added sugars. In addition, due to concerns over added sugars, the Food and Drug Administration now requires that the amount of added sugar in a serving size is disclosed on the nutrition facts label. Added sugars are still in about 20% of baby and toddler foods. While many 2023 baby and toddler food products lack added sugars, but some categories, such as snacks for both age groups, remain of concern.

Addressing baby and toddler foods remains relevant as most infants and toddler consume commercial baby and toddler foods as part of their overall diet, it's a leading food source of added sugars and parents report liking some features of baby and toddler foods. In addition, this grocery category is of concern to public health authorities and is projected to increase in sales.

Several opportunities exist based on these new findings. Parents and caregivers can read nutrition facts labels and select products with no added sugars. Nutrition educators and health professional may educate parents and caregivers, they may want to launch communication efforts and consider if additional policies recommendations are needed. Manufacturers can continue to take steps to lower the added sugars in their baby and toddler food products.

REFERENCES

Agricultural Research Services. (n.d.). *Download Food Data Central.* United States Department of Agriculture. https://fdc.nal.usda.gov/download-datasets.html

Bably, M. B., Paul, R., Laditka, S. B., & Racine, E. F. (2021). Factors Associated with the Initiation of Added Sugar among Low-Income Young Children Participating in the Special Supplemental Nutrition Program for Women, Infants, and Children in the US. *Nutrients*, *13*(11), 3888. https://doi.org/10.3390/nu13113888

Bizvibe. (2022, September 1). Top 10 best baby food brands in the world 2022, top baby food makers, baby food market fact sheet. https://blog.bizvibe.com/blog/food-beverages/best-baby-food-brands

Bizvibe. (2020, June 9). Top 50 grocery stores by sales in North American, 2020, Grocery Store Rankings. https://blog.bizvibe.com/blog/top-50-grocery-stores

Callahan, A. The truth about food pouches. (2021, April 17). *The New York Times.* https://www.nytimes.com/2020/04/17/parenting/baby-food-pouches.html

Center for Food Safety and Applied Nutrition. (2018, February). *Reference Amounts Customarily Consumed: List of Products for Each Product Category. Guidance for Industry.* Food and Drug Administration. https://www.fda.gov/media/102587/download

Centers for Disease Control and Prevention. (2019, April 3). *Know your limits for added sugar.* https://www.cdc.gov/healthyweight/healthy_eating/sugar.html

Chen, V. (2009). The evolution of the baby food industry 2000-2008. Working paper no 297. Federal Trade Commission.

https://www.ftc.gov/sites/default/files/documents/reports/evolution-baby-food-industry-2000-2008/wp297_0.pdf

City of New York. (n.d.). *National Salt and Sugar Reduction Initiative.* https://www.nyc.gov/site/doh/health/health-topics/national-salt-sugar-reduction-initiative.page

Cogswell, M. E., Gunn, J. P., Yuan, K., Park, S., & Merritt, R. (2015). Sodium and sugar in complementary infant and toddler foods sold in the United States. *Pediatrics*, *135*(3), 416–423. https://doi.org/10.1542/peds.2014-3251

DiFrancesco, L., Fulgoni, V. L., 3rd, Gaine, P. C., Scott, M. O., & Ricciuto, L. (2022). Trends in added sugars intake and sources among U.S. adults using the National Health and Nutrition Examination Survey (NHANES) 2001-2018. *Frontiers in nutrition*, *9*, 897952. https://doi.org/10.3389/fnut.2022.897952

Division of Nutrition, Physical Activity and Obesity. (2022, February 1). Micronutrient Facts. *Centers for Disease Control and Prevention.* https://www.cdc.gov/nutrition/micronutrient-malnutrition/micronutrients/index.htm

Division of Nutrition, Physical Activity and Obesity. (2023, June 27). When, what and how to introduce solid foods. *Centers for Disease Control and Prevention.* https://www.cdc.gov/nutrition/infantandtoddlernutrition/foods-and-drinks/when-to-introduce-solid-foods.html

Du, N., DiMaggio, D. M., & Porto, A. F. (2023). Nutrition Content of Young Child Formulas. *Journal of pediatric gastroenterology and nutrition*, *76*(4), 512–516. https://doi.org/10.1097/MPG.0000000000003712

Garcia, A. L., Curtin, L., Ronquillo, J. D., Parrett, A., & Wright, C. M. (2020). Changes in the UK baby food market surveyed in 2013 and 2019: the rise of baby snacks and sweet/savoury foods. *Archives of disease in childhood*, *105*(12), 1162–1166. https://doi.org/10.1136/archdischild-2020-318845

Elliott, C. D., & Conlon, M. J. (2015). Packaged baby and toddler foods: questions of sugar and sodium. *Pediatric obesity*, *10*(2), 149–155. https://doi.org/10.1111/j.2047-6310.2014.223.x

Elliott C. D. (2011). Sweet and salty: nutritional content and analysis of baby and toddler foods. *Journal of public health (Oxford, England)*, *33*(1), 63–70. https://doi.org/10.1093/pubmed/fdq037

Economic Research Service. (2022). Food Related Data Sources. *United States Department of Agriculture.* https://www.ers.usda.gov/about-ers/partnerships/strengthening-statistics-through-the-icars/food-related-data-sources/#:~:text=ERS%20encourages%20research%20that%20makes%20appropriate%20use%20of,of%20data%3A%20Store%20sales%20Consumer%20purchases%20Consumption%20Availability

Executive Office of the President. (2022). White House National Strategy on Hunger, Nutrition and Health. Executive Office of the President. (2022). White House National Strategy on Hunger, Nutrition, and Health [PDF]. https://www.whitehouse.gov/wp-content/uploads/2022/09/White-House-National-Strategy-on-Hunger-Nutrition-and-Health-FINAL.pdf

Fan, L., Stevens, A.W., and Thomas, B. (2022). Consumer purchasing response to mandatory genetically engineered labeling. *Food Policy.* 110. https://doi.org/10.1016/j.foodpol.2022.102296

Fidler Mis, N., Braegger, C., Bronsky, J., Campoy, C., Domellöf, M., Embleton, N. D., Hojsak, I., Hulst, J., Indrio, F., Lapillonne, A., Mihatsch, W., Molgaard, C., Vora, R., Fewtrell, M., & ESPGHAN Committee on Nutrition: (2017). Sugar in Infants, Children and Adolescents: A Position Paper of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. *Journal of pediatric gastroenterology and nutrition*, *65*(6), 681–696. https://doi.org/10.1097/MPG.0000000000001733

Fisher, J., Lumeng., J, Miller, L,, Smethers, A., Lott M. (2021). Evidence based recommendations and best practices for promoting healthy eating behaviors in children 2 to 8 Years. Healthy Eating Research. https://healthyeatingresearch.org/wp-content/uploads/2021/10/her-heg-technical.pdf

Food and Drug Administration. (n.d.). *Closer to Zero: Trends in exposure to toxic elements from food for babies and young children.* https://www.fda.gov/media/147324/download

Food and Drug Administration. (2018). *FDA Extends Nutrition Facts Label Compliance Dates.* https://www.fda.gov/food/cfsan-constituent-updates/fda-extends-nutrition-facts-label-compliance-dates

Food and Drug Administration. (2019). *FDA's Legal Authority. https://www.fda.gov/about-fda/changes-science-law-and-regulatory-authorities/fdas-legal-authority*

Food and Drug Administration. (2020). Guidance for industry: the use of an alternate name for potassium chloride in food labeling. https://www.fda.gov/regulatory-information/search-fda-guidance-documents/guidance-industry-use-alternate-name-potassium-chloride-food-labeling

Food and Drug Administration. (2021). FDA Guidance for Industry: Voluntary Sodium Reduction Goals.

https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.fda.gov%2Fmedia%2F98277%2Fdownload&wdOrigin=BROWSELINK

Food and Drug Administration. (2022). Changes to the Nutrition Facts Label. https://www.fda.gov/food/food-labeling-nutrition/changes-nutrition-facts-label

Food and Drug Administration. (2023a). FDA issues request for information on food labeling in online grocery shopping. https://www.fda.gov/food/cfsan-constituent-updates/fda-issues-request-information-food-labeling-online-grocery-shopping

Food and Drug Administration. (2023b). Virtual Public Meeting and Listening Session on Strategies to Reduce Added Sugar Consumption in the United States. https://www.fda.gov/food/workshops-meetings-webinars-food-and-dietary-supplements/virtual-public-meeting-and-listening-sessions-strategies-reduce-added-sugars-consumption-united

Food and Drug Administration. (2024). Front-of-package nutrition labeling. https://www.fda.gov/food/food-labeling-nutrition/front-package-nutrition-labeling

Food Labeling: General Provisions. (2022). 21 C.F.R § 101.9

Food and Nutrition Service. Infant nutrition and feeding: a guide for use in the Special Summplemental Nutrition Program for Women, Infants and Children (WIC). United States Department of Agriculture. https://wicworks.fns.usda.gov/sites/default/files/media/document/infant-feeding-guide.pdf

Food Labeling: Revision of the Nutrition and Supplement Facts Labels and Serving Sizes of Foods That Can Reasonably Be Consumed at One Eating Occasion; Dual-Column Labeling; Updating, Modifying, and Establishing Certain Reference Amounts Customarily

Consumed; Serving Size for Breath Mints; and Technical Amendments; Extension of Compliance Dates. 21 C.F.R. part 101. (2018).

Gerber. (2021). Shop. Nestle. https://www.gerber.com/shop-by-product

Healthy Food America. (n.d.). Reducing sugar exposure. https://www.healthyfoodamerica.org/sugartoolkit_exposure

Herrick, K. A., Fryar, C. D., Hamner, H. C., Park, S., & Ogden, C. L. (2020). Added Sugars Intake among US Infants and Toddlers. *Journal of the Academy of Nutrition and Dietetics*, *120*(1), 23–32. https://doi.org/10.1016/j.jand.2019.09.007

Huang, Y., Chen, Z., Chen, B., Li, J., Yuan, X., Li, J., Wang, W., Dai, T., Chen, H., Wang, Y., Wang, R., Wang, P., Guo, J., Dong, Q., Liu, C., Wei, Q., Cao, D., & Liu, L. (2023). Dietary sugar consumption and health: umbrella review. *BMJ (Clinical research ed.)*, *381*, e071609. https://doi.org/10.1136/bmj-2022-071609

Ianelli, V. (2021). Making Sense of 'Stages' and 'Steps' on Baby Food Labels. *Verywell Family*. https://www.verywellfamily.com/baby-food-stages-and-steps-2634465

Isaacs, A., Neve, K., Hawkes, C. Why do parents use packaged infant foods when starting complementary feeding? Findings from phase one of a longitudinal qualitative study. *BMC Public Health,* 22(1), 2328. https://doi.org/10.1186/s12889-022-14637-0

Institute for the Advancement of Food and Nutrition Sciences. (n.d.). *A partnership for public health: USDA Global Food Database.* https://iafns.org/our-work/research-tools-open-data/bfpd/#:~:text=The%20goal%20of%20%22A%20Partnership%20for%20Public%20Health%3A,private%20label%20data%20provided%20by%20the%20food%20industry

Levay, A. V., Chapman, G. E., Seed, B., & Wittman, H. (2018). It's just the right thing to do: Conceptualizing a theory of change for a school food and beverage sales environment

intervention and implications for implementation evaluation. Evaluation and program planning, 70, 73–82. https://doi.org/10.1016/j.evalprogplan.2018.04.011

Lott, M., Callahan, E., Welker Duffy, E., Story, M., Daniels, S. (2019). Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Technical Scientific Report. Healthy Eating Research. https://healthydrinkshealthykids.org/app/uploads/2019/09/HER-HealthyBeverageTechnicalReport.pdf

Lurie, P., Hill, A., Vasan, A. (2023). Citizen petition requesting that the U.S. Food and Drug Administration develop voluntary, measurable added sugars reduction targets for processed, packaged and prepared food and beverages. *Center for Science in the Public Interest.* https://www.cspinet.org/sites/default/files/2023-04/CSPI_NYC%20DOHMH_added%20sugars%20reduction%20petition_4.24.23.pdf

Maalouf, J., Cogswell, M. E., Bates, M., Yuan, K., Scanlon, K. S., Pehrsson, P., Gunn, J. P., & Merritt, R. K. (2017). Sodium, sugar, and fat content of complementary infant and toddler foods sold in the United States, 2015. *The American journal of clinical nutrition*, *105*(6), 1443–1452. https://doi.org/10.3945/ajcn.116.142653

Malito, A. (2017). *Grocery stores carry 40,000 more items than they did in the 1990s.* Marketwatch. https://www.marketwatch.com/story/grocery-stores-carry-40000-more-items-than-they-did-in-the-1990s-2017-06-07

Maslin, K., & Venter, C. (2017). Nutritional aspects of commercially prepared infant foods in developed countries: a narrative review. *Nutrition research reviews*, *30*(1), 138–148. https://doi.org/10.1017/S0954422417000038

McCann, J., Beckford, K., Beswick, H., Chisholm, M., & Woods, J. (2022). Toddler foods and milks don't stack up against regular foods and milks. *Nutrition journal*, *21*(1), 12. https://doi.org/10.1186/s12937-022-00765-1

Micha, R., Peñalvo, J., Cudhea, F., Imamura, F., Rehm, C., Mozzaffarian, D. (2017). Association Between Dietary Factors and Mortality from Heart Disease, Stroke, and Type 2 Diabetes in the United States. *JAMA*. 7;317(9):912-924. doi: 10.1001/jama.2017.0947.

Mintel. Feeding babies and toddlers - US. (2017). https://store.mintel.com/report/us-baby-food-and-drink-market-report

Musicus, A. A., Roberto, C. A., Moran, A. J., Sorscher, S., Greenthal, E., & Rimm, E. B. (2022). Effect of Front-of-Package Information, Fruit Imagery, and High-Added Sugar Warning Labels on Parent Beverage Choices for Children: A Randomized Clinical Trial. *JAMA network open*, *5*(10), e2236384. https://doi.org/10.1001/jamanetworkopen.2022.36384

Musicus, A. A., Hua, S. V., Moran, A. J., Duffy, E. W., Hall, M. G., Roberto, C. A., Dillman Carpentier, F. R., Sorscher, S., Wootan, M. G., Smith Taillie, L., & Rimm, E. B. (2022). Front-of-package claims & imagery on fruit-flavored drinks and exposure by household demographics. *Appetite*, *171*, 105902. https://doi.org/10.1016/j.appet.2021.105902

National Academies of Sciences, Engineering, and Medicine, Health and Medicine Division, Food and Nutrition Board, & Committee to Review WIC Food Packages. (2017). *Review of WIC Food Packages: Improving Balance and Choice: Final Report*. National Academies Press (US).

National Academies of Sciences, Engineering, and Medicine. 2020. Feeding Infants and Children from Birth to 24 Months: Summarizing Existing Guidance. Washington, DC: The National Academies Press. https://doi.org/10.17226/25747.

Nutrition Coordinating Center. (n.d.). Database licensing. *University of Minnesota.* http://www.ncc.umn.edu/food-and-nutrient-database/

Nutrition Labeling of Food. (21 CFR 101.9(c)(iii)(2016). https://www.ecfr.gov/current/title-21/part-101/section-101.9#p-101.9(c)(6)(iii)

Nutrition Labeling of Food. (21 CFR 101.9(j)(5)(i)) (2016). https://www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-101/subpart-A/section-101.9

Nutritionix. (n.d.) Nutritionix Database. https://www.nutritionix.com/database

Office of Disease Prevention and Health Promotion. 2020. *Healthy People 2030: Reduce consumption of added sugars by people aged 2 years and over – NWS-10.* Retrieved from https://health.gov/healthypeople/objectives-and-data/browse-objectives/nutrition-and-healthy-eating/reduce-consumption-added-sugars-people-aged-2-years-and-over-nws-10

Plum Organics. (2022). Baby. https://www.plumorganics.com/baby-snacks/

Rahkovsky, I. (2012). New food choices free of trans fats better align U.S. diets with health recommendations. Economic Information Bulletin No. (EIB-95). https://www.ers.usda.gov/publications/pub-details/?pubid=44674

Reidy, K., Bailey, R.L., Deming, D., O'Neill, L., Carr, T.B., Lesniauskas, R. Johnson, W. (2018). Food consumption patterns and micronutrient density of complementary foods consumed by infants fed commercially prepared baby foods. *Nutrition Today.* 53(2). DOI: 10.1097/NT.0000000000000265

Ricciuto, L., Fulgoni, V. L., Gaine, P. C., Scott, M. O., & DiFrancesco, L. (2022). Trends in Added Sugars Intake and Sources Among US Children, Adolescents, and Teens Using NHANES 2001-2018. *The Journal of nutrition*, *152*(2), 568–578. https://doi.org/10.1093/jn/nxab395

Roess, A. A., Jacquier, E. F., Catellier, D. J., Carvalho, R., Lutes, A. C., Anater, A. S., & Dietz, W. H. (2018). Food Consumption Patterns of Infants and Toddlers: Findings from the Feeding Infants and Toddlers Study (FITS) 2016. *The Journal of nutrition*, *148*(suppl_3), 1525S–1535S. https://doi.org/10.1093/jn/nxy171

Samuel, L., Ethan, D., Basch, C. H., & Samuel, B. (2014). A comparative study of the sodium content and calories from sugar in toddler foods sold in low- and high-income New York City supermarkets. *Global journal of health science*, *6*(5), 22–29. https://doi.org/10.5539/gjhs.v6n5p22

Schwarzenberg, S. J., Georgieff, M. K., & COMMITTEE ON NUTRITION (2018). Advocacy for Improving Nutrition in the First 1000 Days to Support Childhood Development and Adult Health. *Pediatrics*, *141*(2), e20173716. https://doi.org/10.1542/peds.2017-3716

Sharma, S., Kolahdooz, F., Butler, L., Budd, N., Rushovich, B., Mukhina, G. L., Gittelsohn, J., & Caballero, B. (2013). Assessing dietary intake among infants and toddlers 0-24 months of age in Baltimore, Maryland, USA. *Nutrition journal*, *12*, 52. https://doi.org/10.1186/1475-2891-12-52

Statista. (2024). Dollar sales of the leading baby food and snack brands in the United States in 2017. https://www.statista.com/statistics/186146/top-baby-food-and-snack-brands-in-the-us/

Statista. (2022a). Leading grocery stores in the United States in 2022, by market share. https://www.statista.com/statistics/1450393/leading-grocery-store-by-market-share-us/#:~:text=In%202022%2C%20the%20leading%2010%20grocery%20stores%20in,followed%20by%20Costco%20at%20just%20over%20seven%20percent.

Statista. (2022b). Market value of infant formula and baby food in North America in 2016 and 2025. https://www.statista.com/statistics/249499/north-americas-baby-food-market-sales-value-by-country/

Tedstone, A. Nicholas, J. MacKinlay, B., Knowles, Bethany, Burton, J., Owtram, G. *Food and drinks aimed at infants and young children: evidence and opportunity for action.* (2019, June). Public Health England. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812204/Foods_and_drinks_aimed_at_infants_and_young_children_June_2019.pdf

United States Department of Agriculture. (n.d.). More Key Topics. https://www.myplate.gov/eat-healthy/more-key-topics

United States Department of Agriculture. (2019, July17). What are "added sugars"? https://ask.usda.gov/s/article/What-are-added-sugars

United States Department of Health and Human Services and United States Department of Agriculture. (December, 2020). *2020 – 2025 Dietary Guidelines for Americans*. 9th Edition. Retrieved from https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf

United States Department of Health and Human Services and United States Department of Agriculture. (December, 2020). *2020 – 2025 Dietary Guidelines for Americans*. 9th Edition. Retrieved from https://www.dietaryguidelines.gov/sites/default/files/2020-12/Dietary_Guidelines_for_Americans_2020-2025.pdf

Voices for Healthy Kids. (n.d.). Grant Opportunities. American Heart Association. https://voicesforhealthykids.org/campaign-resources/grants

Vos, M. B., Kaar, J. L., Welsh, J. A., Van Horn, L. V., Feig, D. I., Anderson, C., Patel, M. J., Cruz Munos, J., Krebs, N. F., Xanthakos, S. A., Johnson, R. K., & American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Clinical Cardiology; Council on Cardiovascular Disease in the Young; Council on Cardiovascular and Stroke Nursing; Council on Epidemiology and Prevention; Council on Functional Genomics and Translational Biology; and Council on Hypertension (2017). Added Sugars and Cardiovascular Disease Risk in Children: A Scientific Statement from the American Heart Association. *Circulation*, *135*(19), e1017–e1034. https://doi.org/10.1161/CIR.0000000000000439

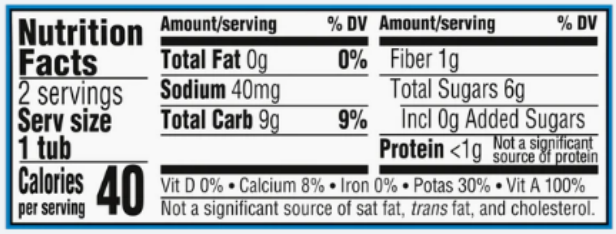
Walker, R., & Goran, M. (2015). Laboratory Determined Sugar Content and Composition of Commercial Infant Formulas, Baby Foods and Common Grocery Items Targeted to Children. *Nutrients*, *7*(7), 5850–5867. MDPI AG. Retrieved from http://dx.doi.org/10.3390/nu7075254

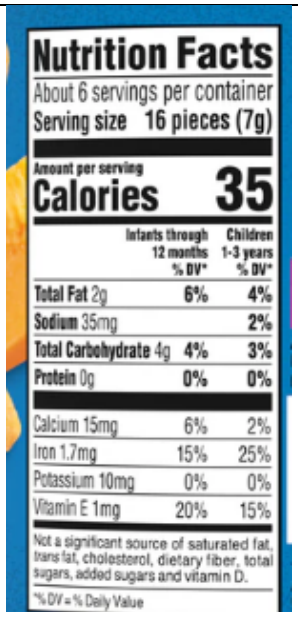
Wang, E.Y., Wei, H., Caswell, J.A. (2016). The impact of mandatory trans fat labeling on product mix and consumer choice: A longitudinal analysis of the U.S. Market for margarine and spreads. *Food Policy.* 64(63-81). https://doi.org/10.1016/j.foodpol.2016.09.004

WIC Works Resource System. (n.d.). Eye on nutrition: iron and vitamin C. United States Department of Agriculture. https://wicworks.fns.usda.gov/resources/eye-nutrition-iron-and-vitamin-c#:~:text=1%20Legumes%20%28beans%2C%20peas%20and%20lentils%29%202%20Peanut,etc.%29%205%20Dark%20leafy%20green%20vegetables%206%20Tofu

Yang, Q., Zhang, Z., Gregg, E., Flanders, WD., Merritt, R., Hu, F. (2014). Added sugar intake and cardiovascular diseases mortality among US adults. *JAMA Internal Medicine.* 174(4):516-524. doi: 10.1001/jamainternmed.2013.13563

APPENDIX A: BABY/TODDLER FOOD PRODUCT LABEL EXAMPLES

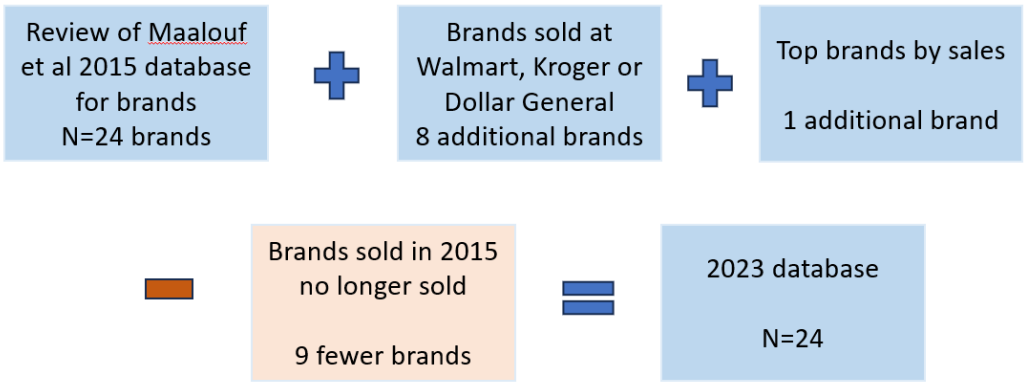
Sample Label	Front of Package	Nutrition Facts Label
Infants 0-12 months		
Children 1-3 years label		

Dual Label (infant through 12 months, and Childre n 1-3 years)		

Images: Gerber.com

APPENDIX B: ESTABLISHMENT OF A 2023 BABY AND TODDLER DATABASE

Brands Included in the 2023 Database



APPENDIX C: DATA FIELDS COLLECTED

Front of Package

Data field	Examples
Product name	Yogurt melts mixed berries
Manufacturer	Gerber
Target eater	8+ months, crawler
Stages (numeric)	Stage 1, stage 2, stage 3, stage 4
Net weight grams	Net weight of package or container in grams
Size	Size in ounces

Nutrition Facts Label

Data field	Examples
Servings per container	8, 4
Serving size	1 cup, 2/3 cup
Calories (per serving)	230, 240
Total fat (% daily value)	12%
Total fat (grams)	8 g
Saturated fat (% daily value)	5%
Saturated fat (grams)	1 g
Trans fat (grams)	0 g
Cholesterol (% daily value)	0%

Cholesterol (mg)	0mg
Sodium (% daily value)	7%
Sodium (mg)	150mg
Total carbohydrates (% daily value)	12%
Total carbohydrates (grams)	37g
Fiber (%daily value)	14%
Fiber (grams)	4g
Sugars (grams)	1g
Added sugars (grams)	1g
Protein (grams)	3g
Vitamin D (%daily value)	10%
Vitamin D (mcg)	2
Calcium (%daily value)	20%
Calcium (mg)	260mg
Iron (% daily value)	45%
Iron (mg)	8mg
Potassium (%daily value)	5%
Potassium (mg)	235mg
Zinc	1mg

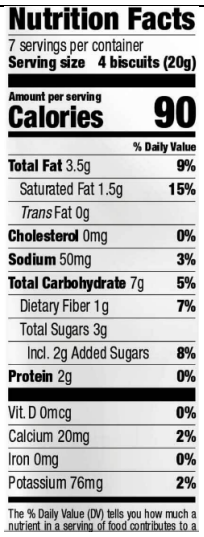
Other

Data field	Examples

Ingredient list	Ingredients: cultured reduced fat milk sugar, raspberry puree, gelatin, tapioca starch
Date collected	11/17/23
Web source url	Lil' Bits Whole Wheat Apple Blueberry Cereal | Gerber

APPENDIX D: PRODUCT IMAGES COLLECTED

	Front of package	NFL	Ingredient list
1	 Yogurt Melties Strawberry, Apple & Yogurt - Beech-Nut (beechnut.com)		Cultured Reduced Fat Milk, Apples, Non Fat Dry Milk, Strawberries, Cane Sugar, Whey Protein Concentrate, Natural Flavors, Fruit Pectin, Dried Beet Juice (For Color), Mixed Tocopherols (To Preserve Freshness). **Contains Milk**
2	 Fruit & Veggie Melties Apple & Pumpkin -Beech-Nut (beechnut.com)		Apples, Pumpkin, Mango, Chicory Root Fiber

3	 Butternut Bliss Dino Biscuits with Hidden Veggies - Beech-Nut (beechnut.com)		WHOLE WHEAT FLOUR, DRIED VEGETABLE POWDER (BUTTERNUT SQUASH, CARROT), SOYBEAN OIL, COCONUT OIL, TAPIOCA STARCH, TAPIOCA SYRUP, SUGAR, NONFAT DRY MILK, BROWN SUGAR, RAISIN PASTE, CORN STARCH, NATURAL FLAVOR, LEAVENING (BAKING SODA, SODIUM ACID PYROPHOSPHATE, MONOCALCIUM PHOSPHATE), SALT, CINNAMON. **Contains Milk, Wheat**

Images: Beechnut.com