

Review Article

Does Sugar in Infant Formula Cause Early Childhood Caries?

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Abstract

A downward trend in early childhood caries (ECC) has been seen in the United States. However, that trend has mainly taken place in certain segments of the population. ECC is a particularly virulent form of tooth decay that affects infants, toddlers, and preschool children. It is caused by the frequent and long-term exposure of a child's teeth to liquids containing sugars. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) supplies baby formula to low-income, postpartum mothers. All formulas are regulated by the Food and Drug Administration (FDA), but there is no regulation of the sugar amount and no requirement that it be listed on the ingredient panel. As a result, sugar content varies significantly between different brands of formula, with some formulas even containing sucrose and/or corn syrup. WIC has different recommendations for different states, and every 1-2 years takes bids from the formula companies to get WIC to use their products. WIC allows each state to decide which formula to recommend, and the sugar content doesn't seem to be one of the issues considered. WIC and FDA can play important roles in the fight against ECC. The FDA must ban certain types of sugar from baby formula and regulate the type and amount of sugar present in formulas. WICs across the country must become more vigilant regarding the sugar content of the formulas that they recommend, and they should not permit those formulas with high sugar content to be purchased with their vouchers.

Keywords

- Early childhood caries
- Formula
- Breastfeeding
- Sugar Eg: Structured clinical interview
- Psychometrics
- Blood pressure

ABBREVIATIONS

ECC: Early Childhood Caries; WIC: Special Supplemental Nutrition Program for Women, Infants, and Children; FDA: Food and Drug Administration; AAP: American Academy of Pediatrics

INTRODUCTION

At a recent dental conference, the Centers for Disease Control and Prevention presented data that shows a downward trend in untreated early childhood caries (ECC) in the United States [1]. However, that trend is only pertinent to a certain socioeconomic group of children. Poverty has an especially strong correlation with ECC, as the percentage of young children with untreated tooth decay rises as family income declines [2-4]. The Third National Health and Nutrition Examination Survey (NHANES III) estimates that 25% of children have 80% of the decay, and that this decay is experienced mainly by low-income children aged 2 to 5 years [5]. Furthermore, disadvantaged children by poverty level, minority status, and social conditions tend to experience higher rates of dental caries, more extensive destruction of their dentition when affected, higher rates of untreated diseases, and higher frequency of dental pain than affluent children [2,5].

ECC or Baby Bottle Decay is caused by the frequent and long-term exposure of a child's teeth to liquids containing sugars. Among these liquids are milk, formula, fruit juice, and soda. The sugars in these liquids pool around the infant's teeth and gums, feeding the bacteria that cause plaque. Every time a child

consumes a sugary liquid, acid attacks the teeth and gums. After numerous attacks, tooth decay can begin. ECC is a particularly virulent form of tooth decay that affects infants, toddlers, and preschool children. *Streptococcus mutans* is the specific pathogenic bacteria identified in the initiation of dental caries. *Streptococcus mutans* metabolizes ingested carbohydrates to form an acid that causes demineralization of the tooth surface [2,3].

ECC is recognized by the Academy of Pediatric Dentistry as a widespread chronic disease that can be devastating to a small child. Those experiencing caries as infants or toddlers have a much greater probability of developing subsequent caries in both their primary and permanent dentitions. Still another immediate consequence of untreated dental decay or severe ECC is pain, which can diminish the quality of life of a small child by inhibiting his/her ability to eat, speak, play, and communicate [4,6,7].

Past studies have supported the notion that breastfeeding reduces the chance of ECC in small children. For example, two dentists, Dr. Brian Palmer and Dr. Harold Torney, have done extensive research on human skulls (from 500-1000 years ago) in their study of tooth decay in children. The children whose skulls were studied were most likely breastfed for an extended length of time. This research led them to conclude that breastfeeding does not cause tooth decay [8] (Palmer 2002). Before the use of formula, dental decay in baby teeth was rare [9].

The US government's Office on Women's Health identifies

the major benefits of breastfeeding for the infant in terms of nutrition and growth benefits and enhanced immune systems and resistance to infection. Although the promotion of breastfeeding over formula use has been recommended nationally and internationally, 47% of infants born annually in the United States use formula as participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) [10,11].

WIC is a federal program that provides federal grants to states to provide nutritional education and supplemental foods to low-income, breastfeeding and non-breastfeeding, postpartum women and their infants and children up to age five who may be at nutritional risk. WIC also promotes breastfeeding and recommends it over formula, but it does supply formula to low-income mothers and mothers on Medicaid. [10-12].

Even though the rates of breastfeeding initiation and duration among WIC participants have increased dramatically over the past ten years, WIC participants still lag twenty percentage points behind those mothers that do not use WIC. Even when controlling for socioeconomic status, geography, race/ethnicity, age of the mother, and birth weight of the baby, this statistic still holds true. Moreover, even though the WIC program promotes breastfeeding, in the end the actual results show it as reducing breastfeeding. [11,12].

Breastfeeding provides important nutrition that supports infants' growth and development. It also benefits mothers' health. Currently, the American Academy of Pediatrics (AAP) recommends that infants be fed mother's breast milk exclusively for the first six months of life. "Exclusive" breastfeeding means that the infant does not receive any additional foods or fluids. Beyond the period of 6 months of exclusive breastfeeding, the AAP also suggests feeding infants mother's breast milk for up to 1 year of age in combination with solid foods." [13]. Although many people agree that breastfeeding is ideal, it just does not work for every mother. Some families need to use formula exclusively, while others use formula in addition to breastfeeding. The selection of formula is very important to the mother because of its nutritional value for her baby, and because the high cost of certain formulas can preclude her from purchasing them. [12].

All formulas are regulated by the Food and Drug Administration (FDA), and they must meet the following requirements by WIC: 1) complies with the definition in section 201(z) of the Federal, Drug and Cosmetic Act (21USC. 321(z)) and meets the requirements under section 412 of the Federal Drug Act (21USC.350a) and regulations at 21 CFR parts 106 and 107; 2) iron fortified, 3) supplies 67 calories per 100 milliliters at standard dilution, and 4) a nutritionally complete formula not requiring any additional ingredient other than water prior to serving it in a liquid state [12].

WIC and the FDA can play an important role in the fight against Baby Bottle Decay. However, WIC has different recommendations for different states, and these recommendations are made as a result of bids by the formula companies every 1-2 years to get WIC to use their products [12]. This is important because the sugar content differs by formula, and the amount of sugar is often not clearly reported.

A child frequently being given a bottle or "sippy" cup with

milk or a sweetened liquid at bedtime or before or after meals is particularly at risk of decay. The sweetened liquid pool around the tooth surfaces, combined with bacteria present in the mouth, leads to the demineralization and breakdown of the enamel surface of the tooth and, consequently, tooth decay [3,4].

Oral health is well established as an essential component of general health and well-being [15,16]. When David Satcher was the Surgeon General of the United States, he focused national attention on oral health in "Oral Health in America: A Report of the Surgeon General" [15]. Even though strategies to manage dental caries in young children have had limited success, reducing inequalities and identifying 'windows of opportunity' where interventions may have the greatest long-term benefits in promoting oral health and reducing inequalities must continue [15], especially in untreated preschool children.

DISCUSSION & CONCLUSION

Breastfeeding a child has been well documented as having short- and long-term medical, nutritional, and neurodevelopment advantages and should be considered an important component of a child's development, not a lifestyle choice [13,17]. Despite the American Academy of Pediatrics recommending exclusive breastfeeding for 6 months, with continued breastfeeding until age 1 or even beyond as foods are introduced, breastfeeding rates have remained low (31% at 6 months and 6% at 12 months)[13]. A best-fitting discrete time survival analysis model demonstrated that older women and women of Mexican ethnicity, who had previous breastfeeding experience and were supported by family or friends who had breastfed, were more likely to breastfeed at each monthly interval [10,12].

The WIC program distributes about half the infant formula used in the United States at no cost to low-income families and families receiving Medicaid [12]. This is a matter of concern as it is known that feeding with infant formula results in worse health outcomes than breastfeeding for infants [10,12]. Because WIC provides free formula to clients, it should not be surprising that WIC clients are more likely to choose receiving formula vouchers over breastfeeding and therefore are less likely to breastfeed than those who do not participate in the WIC program [10,12]. Women receiving services from the WIC program often stop breastfeeding earlier than recommended, but little is known regarding the variables that predict the timing of breastfeeding cessation over the 12-month postpartum period [10,12].

Lactose is the predominant source of carbohydrate in human breast milk, and most infants are born with the ability to digest lactose with an enzyme that they themselves make called lactase [18]. This lactase breaks the molecules apart to enable them to be absorbed. Lactose has some other benefits as well. It assists in calcium absorption from baby formula, and it helps feed the good bacteria that are needed to grow in the baby's intestines [18]. However, only some formulas use lactose as the main source of carbohydrate.

The sweetness of the formula causes babies to crave sweetness, according to a pediatric dentist in Chicago who says that any formula that contains sucrose causes the baby to crave sugar. In fact, sucrose-containing formulas make the baby want to eat more, so they become hypersensitive to sweetness [19]. This

may play a role in childhood obesity. Interestingly, the FDA, while regulating many aspects of formula, does not require that the sugar contents be listed on the formula labels and doesn't place a limit on how much sugar should be allowed [14]. Furthermore, the WIC program allows each state to decide which formula to recommend, and the sugar content doesn't seem to be one of the issues considered [12].

Because infant formulas do not list their sugar contents, an investigative report was done to measure the amount of sugar in seven of the most popular baby formulas [20]. Besides lactose, other commonly used sources of carbohydrate were found to include corn syrup, corn syrup solids, corn maltodextrin (another type of corn sugar), and sucrose (table sugar). These other sugar sources are commonly used because they are much cheaper and much sweeter than lactose [21]. While lactose is a glucose and a galactose molecule joined together, corn maltodextrin and corn syrup are primarily all glucose molecules, and sucrose is a glucose and a fructose molecule joined together. These alternative sugars do not utilize infants' lactase enzyme that is 'ready-to-go'. In addition, it is possible that corn sugar may have a larger impact on infant insulin since it contains twice as much glucose per gram as does lactose.

Almost 40% of a baby's carbohydrate calories come from baby formula (just like breast milk). So a baby who is consuming a formula that contains no lactose but all corn syrup will be consuming 40% of his/her calories as pure glucose [19]. That much glucose is likely to result in higher insulin surges. Even though the pancreas of a baby is very strong and able to handle that much glucose, it is not known what are the long-term consequences of forcing formula-fed babies' pancreases to work harder than breastfed babies' pancreases [19].

There is much research in adults about the damage that large amounts of fructose can have on the body. In adults, consumption of too much fructose can lead to liver damage, insulin resistance, unhealthy fat inside internal organs, and increased risk of obesity and diabetes [19]. However, no one has studied whether these effects also occur in infants, so it is not known what the long-term consequences are of consuming large amounts of fructose in infancy, while infant's tiny organs are still developing [19]. Human breast milk does not contain fructose, but soy- and lactose-free formulas usually contain fructose since they usually contain sucrose [19].

Maltodextrin is another type of corn syrup that is made up

of many longer chains of glucose [19]. In fact, corn maltodextrin would become corn syrup if it were broken down just a little bit more. This means that corn maltodextrin is a little less sweet than corn syrup. However, both corn syrup and maltodextrin are much sweeter than lactose. Maltodextrin is probably preferable to corn syrup since it is less sweet, so the baby won't become trained to love super-sweet flavors [19].

Another carbohydrate is starch, which is usually rice starch. Starch is not used as the only source of carbohydrate, but in certain formulas it is used to thicken the formula so that the baby will be less likely to spit it up. Below is a chart that summarizes the main types of sugars in baby formula (Table 1).

INFANT FORMULAS AND SWEETNERS

Currently there are only three major companies which account for 99 % of the infant formula market in the US, Mead Johnson (52%), Ross (35) %, and Carnation (12%). Each of these companies is a subsidiary of a larger company:

- Enfamil and Gerber infant formulas, produced by Mead Johnson, which is part of Bristol-Myers Squibb.
- Similac infant formula, produced by Ross Laboratories, which is a division of Abbott Laboratories.
- Good Start infant formula, made by Carnation, which is a subsidiary of Nestlé (a company that makes candy) since 1988 [12].

Some of the most popular formulas were found to have some of the highest sugar contents. The highest sugar content was found in Enfamil Premium and Parent's Choice Premium, which contain 13.5 and 12.4 grams per serving, respectively [18]. However, the type of sugar found in these two formulas is lactose, which, as noted above, is the same type that is found in breast milk and has many beneficial effects.

In two types of Similac formula, Similac Advance Organic Complete Nutrition and Similac Soy Infant formula, were found the sweetest kind of sugar, sucrose, with the former containing 3.5 grams of sugar per serving and the latter containing 3.8 grams per serving [18,19]. The Similac Soy Infant Formula contains four types of added sugar, including sucrose. In Europe, sucrose has been banned in baby formula, and in many other countries, sucrose is not allowed [18]. The impetus for banning sucrose was concern about child obesity. Enfamil doesn't use sucrose in its infant formulas. Some products have corn syrup

Table 1: The Main Types of Sugars in Baby Formula.

Sugar	Description
Lactose	Galactose + Glucose This is the sugar found in breast milk
Corn Syrup	Short chains of glucose
Corn Syrup Solids	Dehydrated corn syrup
Glucose Syrup	Close to Corn Syrup –but the product is the same
Maltodextrin	Contains longer, more complex chains of glucose
Polydextrose	Is a synthetic sugar fiber, it can provide the bulk, texture, it works well with other intense sweeteners
Sucrose	Glucose + Fructose- These sugars are found in table sugar
Rice Starch	This is added to thicken certain formulas. This is usually a small source of carbohydrates calories

Table 2: Common Baby Formulas and Their Sources of Carbohydrate.

GERBER® Good Start	Ingredient
For Supplementing and Gentle	70% Lactose, 30% Corn maltodextrin
Soothe	70% Corn Maltodextrin, 30% Lactose
Soy	79% Corn Maltodextrin, 21% Sucrose (sugar)
ENFAMIL®	
Newborn	100% Lactose
Infant	100% Lactose
Gentlease	Mostly all Corn Syrup plus a little bit of Lactose from the Cow's Milk protein
ProSobee (Soy based)	100% Corn Syrup Solids
SIMILAC®	
Organic	Maltodextrin, Sugar, and a little bit of Lactose from Cow's milk protein
Advance & Pro-Advance	100% Lactose
Soy Isomil	80% Corn Syrup Solids, 20% Sugar

solids, sometimes used as a carbohydrate in low lactose formulas [18,19].

The corn syrup solids are used to make the taste of the formula closer to the taste of breast milk. Enfamil's Gentlease, and ProSobee each contain approximately 10g of corn syrup solids per 5 oz. For a two-month old consuming 28 oz. per day of formula, this is 56 g of corn syrup solids every day, which is more than the amount of corn syrup in 16 oz. of Coco-Cola. [18]. On the other hand, the three brands that were found to have the least amount of sugar were Gerber Good Start, Similac Advance Complete, and Enfamil Pro-Sobee [18,19].

Below is a summary table of the most common brand-name baby formulas for healthy term babies, and the sources of carbohydrate in each formula (Table 2).

CONCLUSION

As mentioned earlier lactose is the sugar found in breast milk, and it assists in calcium absorption from the baby formula and is easily digestible. In addition, most babies make lactase that breaks the lactose molecules apart to enable it to be easily absorbed.

Other sweeteners are used because they are lower in cost. Sucrose and corn syrups should be banned in babies' formula as sweeteners. The additional sweeteners in formulas cause babies to crave sweetness, and this may cause a baby to eat more and thus may play a later role in childhood obesity. In addition, once a woman starts feeding her infant with formula, she is likely to become dependent on it for the current infant and probably for future babies as well [12,19]. In Europe, sucrose has been banned in baby formulas, and in many other countries sucrose is not allowed [21]. There are other economic and political reasons why marketing infant formulas have become very profitable for formula businesses [12], but the discussion for this paper is focused on sweeteners. Some sweeteners are detrimental to a child's health. The following are recommendations for WIC and the FDA:

1. The FDA must make it mandatory that formula companies list all sweeteners that are contained in infant formulas on

packaging labels. This requirement includes the exact name(s) of the sweeteners and the gram count and purpose of the sweetener. The purpose of the sweetener is important in case a baby is lactose intolerant and requires a sweetener substitute. This information should guide the WIC Program in each state to make the most appropriate selection of baby formula for an infant. The importance of the FDA regulating the sweetener content found in infant formulas cannot be over stated.

2. WICs across the country must become more vigilant with respect to the sugar content of the formulas that they recommend. In addition, for those formulas that, despite having high sugar content, are still recommended by state WIC programs, vouchers should not be allowed to be used to purchase them. Many of the most popular formulas have the highest sugar contents.

3. Lastly, WICs should continue to promote breastfeeding; incorporate education on the harmful effects of the sugar found in some formulas and other sweet drinks; and continue to encourage mothers to reduce the number of sugar drinks and snacks that they give to their child.

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