

Determination of sugar types and content in formulated milk of infants and children in Malaysia

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Abstract

High sugar intake contributes to an increased risk of non-communicable diseases such as diabetes, obesity, hypertension, and dental caries. Infants and young children who drink formulated milk have been exposed to free sugars early in their life. Objectives: To determine the amount of free sugar in different brands of formulated milk that are available in Malaysia and to compare the recommended serving size of the formulated milk according to the guideline of daily free sugar intake by WHO for infants and children. Methods: High-Performance Liquid Chromatography (HPLC) was used to determine the sugar amount in five different brands of age-specific formulated milk (0-9 years old). The sugar amount for each sample was determined by 1:100 dilution of milk and HPLC for 8 minutes. Percentage of free sugar intake per day was calculated based on the HPLC result and the recommended serving size per day was compared to the nutritional label of the formulated milk and further compared to the recommended calorie intake by WHO. Results: The total free sugar for all samples were ranged from 0.08% - 23.28% out of the total calories for each age. One out of the 20 aged-specific formulated milk exceeded the WHO recommendation of free sugar intake per day. Conclusion: The amount of sugar in formulated milk should be monitored by health policy as some of the formulated milk has exceeded the recommended free sugar intake by WHO.

Keywords: Formulated milk, sugar content, free sugar, infants and children

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INTRODUCTION

Non-communicable diseases (NCDs) such as diabetes mellitus, obesity, and hypertension are accounted for 68% of world's death in 2012 (WHO, 2014). In recent years, these diseases have increased due to the ageing population, globalization, urbanization and most importantly because of lifestyle changes. By 2020, it is predicted that seven out of every 10 deaths in the world are caused by these diseases (WHO, 2013). World Health Organization (WHO) concerns are focusing on preventable modified risk factors in order to reduce the incidence of NCDs worldwide. Poor dietary intake and reduced physical activities are common causes of NCDs. Increased intake of free sugar in the diet may contribute to an increased overall energy intake, therefore reducing the intake of food containing more nutritionally adequate calories and leading to an unhealthy diet, weight gain and increased risk of NCDs. Diet with high sugar intake is also associated with an increased risk of dental caries (WHO, 2015).

Carbohydrate is the primary source of energy and an important mediator for hormonal regulation in the body (Tornheim & Ruderman, 2011). Carbohydrate can be divided into monosaccharide, disaccharide, oligosaccharide and polysaccharide. "Free sugars" is defined by WHO as all monosaccharides and disaccharides that are being added to foods and beverages by the manufacturer and consumer, as well as sugars that are naturally presented in honey, syrups and fruit juices concentrates (Ministry of Health Malaysia, 2017).

The life-course epidemiology of chronic diseases suggested that the accumulation of the risk factors such as tobacco use, physical inactivity and unhealthy diet throughout the life course may increase the risk of chronic diseases (Nicolau *et al.*, 2007). High consumption of sugar may affect the health status of the children which may progress to chronic severe diseases as they get older (Lucase *et al.*, 1994). Therefore, these risks should be controlled very early in life.

During the first six months of life, the primary nutrition for infants at this age solely depends on human or formulated milk as their digestive tract is still developing. Formulated milk is a product from cow milk or other animals or a mixture of other nutritional ingredients which helps in the development of infants and children. Formulated milk can be in the form of powder, liquid or concentrated liquid. Formulated milk contains carbohydrate, water, energy, fat, protein, minerals and vitamins in different portions compared to breast milk (Martin *et al.*, 2016). Previous studies showed that human and formulated milk are different in terms of nutrition and biological constituents (Institute of Medicine (US) Committee, 2004; Hernell, 2011). Some formulated milk may have extrinsic sugars that are not presented in human milk and the actual sugar content, in terms of both type and proportion, of infant formula is not widely known.

The main aims of this study were to investigate the sugar amount in 20 aged-specific formulated milk available in Malaysian market by using high-performance liquid chromatograph (HPLC) and to compare with recommended free sugar intake per day by WHO. This study also aimed to identify the total carbohydrate intake of all the

formulated milk brands available in Malaysia and to compare with suggested calories intake per day by WHO.

METHOD

Five formulated milk brands were randomly selected from the list of formulated milk that were available in Malaysia. For the purpose of reporting, the selected brands were renamed as Brand A, Brand B, Brand C, Brand D and Brand E. A total of 20 samples of age-specific formulated milk brands from these five different brands were included in this study.

A High-Performance Liquid Chromatography (HPLC) method was chosen because of its specificity, linearity, accuracy, precision and sensitivity for the quantitative determination of different monosaccharides and disaccharides in formulated milk (Sexton, 2004). The sample was analyzed by using HPLC 1200 series Agilent technologies with Chemstation for LC 3D System. Ohaus analytical balance was used to measure the quantity of milk powder and sugar standard. The column used for standard sugar carbohydrate kit was obtained from Sigma-Aldrich which contained 10 different types of sugar includes glucose, galactose, fructose, maltose, lactose, sucrose, arabinose, xylose, ribose and mannose. Acetonitrile HPLC grade with 99.9% purity was obtained from R&M Chemicals (Ever Gainful Enterprise Sdn Bhd).

All 10 different sugar standards were prepared at 1.0mg/mL in 70% acetonitrile (ESA - A Dionex Corporation, 2016). Additional standards were prepared at concentrations of 0.1mg/mL, 0.01 mg/mL, and 0.001 mg/mL to form the calibration curve. For the sample, 1 mg of milk powder from the 20 milk samples was prepared in 1mL of distilled water. The sample was diluted twice; 1mL sample of 10mL of distilled water and 1mL sample of 10mL dilution with 70% acetonitrile (ESA - A Dionex Corporation, 2016). The sample was then filtered twice with 0.2µm Whatman membrane syringe filter and inserted into the vial. After all the preparations were done, all standard sugar and 20 age-specific formulated milk were placed into the HPLC 1200 series Agilent Technologies. The sample was run for 8 minutes under specific parameters which were the column of Zorbax 4.6x150mm 5µm, the temperature was set at 35°C, mobile phase of 65% aqueous acetonitrile, flow rate of 1.0mL/min, and injection volume of 10µL. In addition, wavelength of 190-210nm was chosen as carbohydrates was detected within this range (Sexton, 2004).

The results were calculated based on the area and equation from calibration curve to find the specific concentration of free sugar in one sample. Amount of sugar from each age-specific formulated milk was taken from the HPLC reading in grams. The total free sugar intake per day was then calculated based on the sugar content in milk powder (in grams from HPLC reading), recommended serving size and frequency of serving for formulated milk and then was compared with the free sugar intake and calories recommended by WHO. The calculation formulae used were as following:

Total free sugar intake per day (g) =

Sugar content (HPLC reading) (g) x serving size * x frequency of feeding per day*

Percentage of free sugar intake per day (%) =

$\frac{\text{Total free sugar intake per day (cal)**}}{\text{Recommended calories intake per day by WHO}} \times 100 \%$

*serving size and frequency of feeding per day are based on recommended value from the manufacturer on the nutrition label of the formula milk

** total free sugar intake per day (g) x 4 cal

RESULTS

Percentage of free sugar intake per day (%)

In formulated milk for the age 0-5 months (Fig. 1), the highest percentage of free sugar intake among girls and boys was 2.64% and

2.83%, respectively, of total calories intake in Brand A1. Meanwhile, the lowest percentage of free sugar intake among girls and boys was 0.11% and 0.12%, respectively, of total calories intake in brand D1. All five brands did not exceed the 10% free sugar intake recommended by WHO.

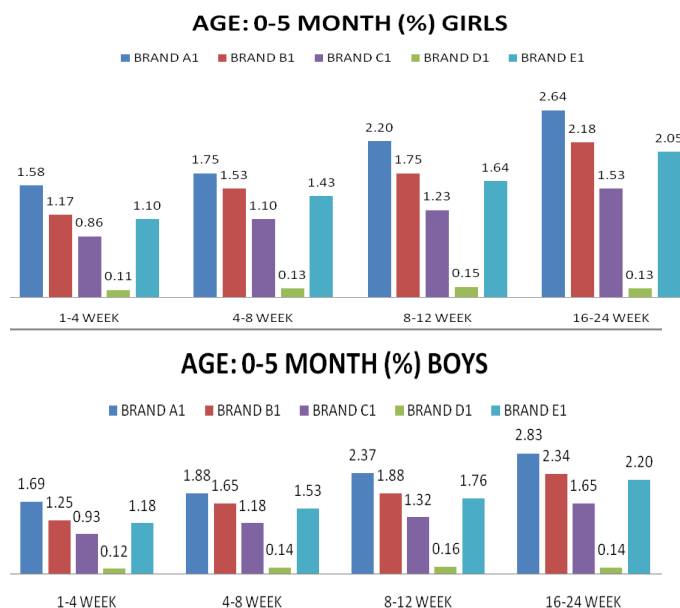


Fig. 1 Percentage of free sugar intake in 0-5 months age-specific formulated milk among (a) girls and (b) boys.

For the of age 6-11 months (Fig. 2), the highest percentage of free sugar intake among girls and boys was 23.28% (6-8 months girls) and 25.40% (6-8 months boys) of total calories intake in brand B2. Meanwhile, the lowest percentage of free sugar intake among girls and boys was 0.13% and 0.14% of total calories intake in brand D1. Brand B2 exceeded 10% free sugar intake recommended by WHO.

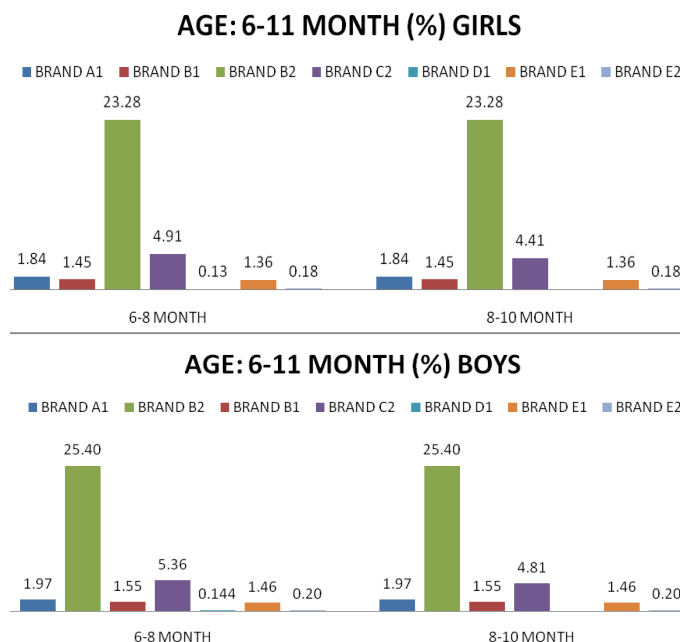


Fig. 2 Percentage of free sugar intake in 6-11 months age-specific formulated milk among (a) girls and (b) boys.

For the age of 1-3 years old (Fig. 3), the highest percentage of free sugar intake among girls and boys was 20.96% and 22.87% of total calories intake in brand B2. The lowest percentage of free sugar intake among girls and boys was 0.08% and 0.09% of total calorie intake in brand C3. Brand B2 exceeded 10% of free sugar intake recommended by WHO.

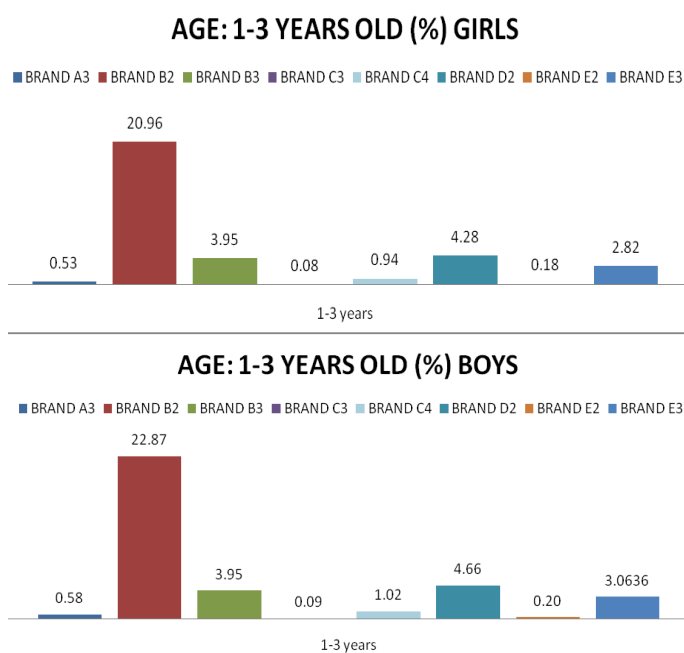


Fig. 3 Percentage of free sugar intake in 1-3 years age-specific formulated milk among girls and boys.

For age 4-6 years old (Fig. 4), the highest percentage of free sugar intake among girls and boys was 1.22% and 1.35% of total calories intake in brand E4. The lowest percentage of free sugar intake among girls and boys was 0.16% and 0.18% of total calories intake in brand A4. All formulated milk samples did not exceed the recommended percentage of sugar intake by WHO.

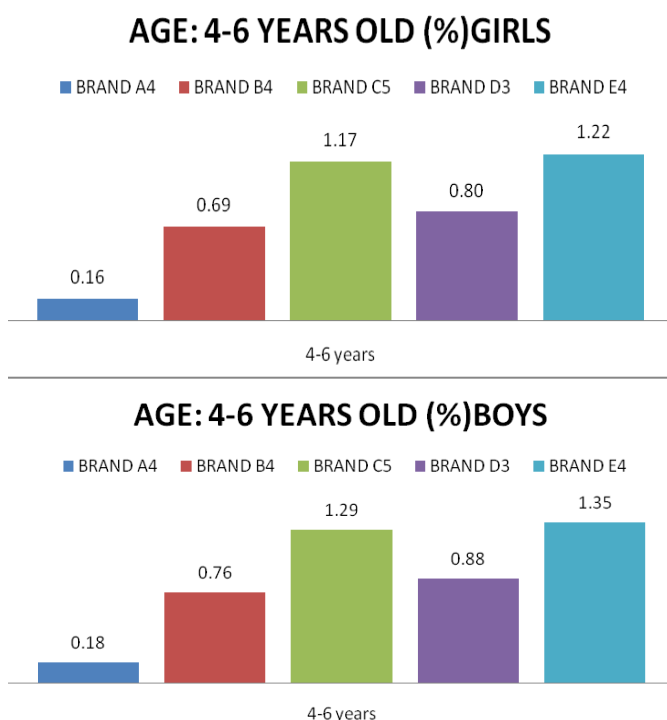


Fig. 4 Percentage of free sugar intake in 4 -6 years aged-specific formulated milk among girls and boys.

For 7-9 years old (Fig. 5), the highest percentage of free sugar intake among girls and boys was 0.88% and 0.95% of total calories intake in brand B4. The lowest percentage of free sugar intake among girls and boys was 0.16% and 0.18% of total calories intake in brand A4. All formulated milk samples did not exceed the recommended percentage of sugar intake by WHO.

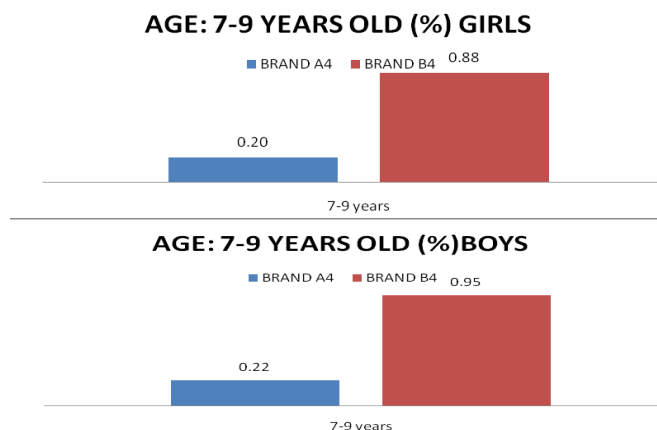


Fig. 5 Percentage of free sugar intake in 7- 9 years aged-specific formulated milk among girls and boys.

DISCUSSION

Milk is an important nutrition source in the growth development of infants and children. It is claimed that in milk, carbohydrates serve as the main energy supply for children as they provide water, protein, mineral and vitamins (Ballard & Morrow, 2013). However, this study found that from all 20 age-specific formulated milk tested, one brand (Brand B2) exceeded the 10% of free sugar intake recommended by WHO. Exposure to excessive sugar intake during childhood is linked with an adverse metabolic consequence in adolescence and adulthood (Johnson *et al.*, 2007). Ironically, the milk that contains calcium and phosphate (Lenton *et al.*, 2015; Rozenberg *et al.*, 2016), which are important for the development of bone and teeth (Rozenberg *et al.*, 2016), also supplies high sugar constituents that are bad for general health and contribute to the development of dental caries (Amid & Woosung, 1999). Therefore, it is crucial for all parents, consumers and caregivers to be aware of the sugar content of their dairy products, especially for their children.

The original method of this study was to compare the sugar content from the HPLC readings with the sugar content on the nutritional label. However, the information from the nutrition label was not labeled as 'sugar', 'free sugar' or any form of 'monosaccharide' or 'disaccharide'. Most of the formulated milk included in this study used the term 'carbohydrate' to include 'free sugar', 'sugar', 'fiber' and 'starch' constituents. Therefore, direct comparison of HPLC reading and the nutritional label on the formulated milk could not be made. This suggested that even though the consumer would want to take into consideration of sugar content before purchasing any product that would not always be feasible. We would like to suggest for more comprehensive sugar labelling on the milk products, particularly those marketed to, or consumed by children. This could only be achieved by ensuring all marketed products to be monitored closely by health policymakers.

Prevention of chronic diseases should start as early as possible in the growth development curve of infants and toddler. The accumulation of risk factors such as tobacco use, physical inactivity and unhealthy diet throughout their life course may increase the risk of chronic diseases (Nicolau *et al.*, 2007). Based on the Malaysian food balance sheet data, the average intake of sugar daily was estimated to be about 86 g/day or 13% of total energy in 1985. This has increased to 104 g/day or 14% of total energy in 2002 (Ministry of Health Malaysia, 2017). It showed that the Malaysian population has exceeded the recommended guideline of total sugar intake per day by WHO (Koletzko *et al.*, 2012). According to WHO (2003), it is advisable to maintain the sugar intake below than 10% of the total energy intake (Ministry of Health Malaysia, 2017). WHO (2015) and Scientific Advisory Committee on Nutrition also recommend a further reduction of free sugars to 5% as there is no harm to further limit free sugar intake (Ministry of Health Malaysia, 2017). Hence, there is a need of drastic change to empower the people to comply with the recommendations by WHO and provide healthier diet choices for better health.

This study randomly selected five formulated milk brands from the list of formulated milk available in Malaysia. Thus, these 20 age-specific formulated milk brands might not represent other brands that available in the Malaysian market. A further extension of this project is to include all brands available in Malaysia and to include other infants and children feeding products such as baby food, ready to drink beverages, and other food supplements, which will be beneficial for future work.

CONCLUSION

The amount of sugar in formulated milk that available in the market should be monitored by health authorities as some of the formulated milk has exceeded the daily free sugar intake recommended by WHO. Careful considerations and monitoring should be in place as excessive added sugar consumption is related to poor health outcomes in children.

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