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UDUL: NON-MILK EXTRINSIC SUGAR (NMES) INTAKE AND EFFECTS ON DENTITION IN CHILDREN AGED 4 TO 6 YEARS IN DATUK SIMON FUNG KINDERGARTEN, KINGFISHER.

JAZAH: DEGREE OF BACHELOR OF FOOD SCIENCE WITH HONOURS.

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DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE DEGREE BACHELOR OF FOOD SCIENCE WITH HONOURS

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2009

DECLARATION

I hereby declare that the materials in this thesis are original except for quotations, excerpts, summaries and references, which have been duly acknowledged.

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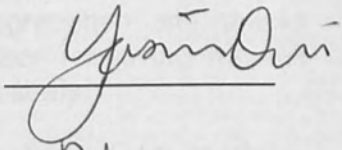

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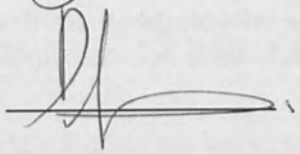

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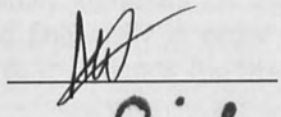

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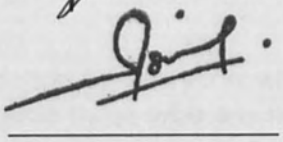

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ABSTRACT

The study of Non-Milk Extrinsic Sugar (NMES) intake in Malaysia is somewhat hampered by the lack of data on NMES content of Malaysian food. The objective of this study was to identify NMES consumption patterns, to examine the relationship between NMES consumption and dental caries experiences, taking into account confounding factors and identify patterns of dental caries among subjects. The study was divided into two components: (1) food frequency questionnaire (FFQ) to measure NMES intake and (2) dental examination by a qualified dentist on preschoolers (n=30, 18 males, 12 females; mean age 5.1±0.69 years) attending Datuk Simon Fung kindergarten, Kingfisher. Subjects came from middle to upper-middle class families. The FFQ consisted of 25 food and beverage items with considerable amounts of NMES commonly consumed by children. The mean intake of NMES among subjects is 3.18g/day. There were 13 types of food items that were commonly consumed by the subjects. There was no significant difference in mean intake of NMES among male and female and among caries and non-caries subjects. There was no association between NMES consumption and caries (r_s=0.043, p=0.823), filled teeth (r_s=-0.091, p=0.634) or crowned teeth (r_s=0.054, p=0.778) among the subjects. From the 30 subjects, 22 were identified having dental caries while 8 were non-caries. The findings clearly indicate the need for studies quantifying NMES content for Malaysian food. There was also a need to repeat such studies in a sample of medium to low income households.

ABSTRAK

PENGAMBILAN GULA EKSTRINSIK BUKAN SUSU DAN KESAN-KESANNYA KEPADA GIGI KANAK-KANAK PRASEKOLAH YANG BERUMUR 4 HINGA 6 TAHUN DI TADIKA DATUK SIMON FUNG, KINGFISHER.

Kajian mengenai pengambilan gula ekstrinsik bukan susu ('NMES') kurang dijalankan di Malaysia disebabkan tiada data tentang kandungan 'NMES' dalam makanan Malaysia. Objektif kajian adalah untuk mengenalpasti amalan pengambilan makanan yang mengandungi NMES, mengkaji hubungan di antara pengambilan 'NMES' dengan pembentukan karies gigi, mengambil kira faktor ancaman dan mengenalpasti keadaan karies di kalangan subjek. Kajian terbahagi kepada 2 komponen:. (1) borang kekerapan pengambilan makanan ('FFQ') untuk merekodkan pengambilan NMES dan (2) pemeriksaan gigi oleh seorang doktor gigi terhadap kanak-kanak prasekolah (n=30, 18 lelaki, 12 perempuan; min umur 5.1±0.69 tahun) yang menghadiri Tadika Datuk Simon Fung, Kingfisher. Subjek berasal daripada kumpulan sosioekonomi sederhana dan ke atas. Borang kekerapan pengambilan makanan terdiri daripada 25 jenis makanan bergula yang kerap dimakan oleh kanak-kanak. Min pengambilan NMES di kalangan subjek ialah 3.18g/day. 13 jenis yang dikenal pasti paling kerap diambil oleh subjek. Tidak terdapat perbezaan signifikan dalam min pengambilan NMES antara subjek lelaki dan perempuan dan yang mempunyai karies dan bukan karies. Daripada jumlah subjek seramai 30 orang, 22 subjek dikenalpasti mempunyai karies gigi manakala 8 subjek tiada karies. Tidak terdapat hubungan di antara pengambilan 'NMES' dengan gigi karies (r_s=0.043, p=0.823), gigi tampal (r_s=-0.091, p=0.634) atau gigi mahkota (r_s=0.054, p=0.778) di antara subjek. Keputusan kajian menunjukkan keperluan data yang mengatakan kuantiti kandungan 'NMES' dalam makanan di Malaysia. Dicadangkan agar kajian akan datang dijalankan di sampel kumpulan sosioekonomi sederhana dan ke bawah.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbols and abbreviations

%	percentage
&	and
±	plus minus
NMES	Non-Milk Extrinsic Sugar
COMA	Committee on Medical Aspects of Food Policy
WHO	World Health Organization
DRI	Dietary Reference Intake
USDA	United States Department of Agriculture
NDNS	National Diet and Nutrition Survey
MAFF	Ministry of Agriculture, Food and Fisheries
HNRC	Human Nutrition Research Centre
FAO	Food and Agricultural Organization
UK	United Kingdom
US	United States
MOH	Ministry of Health
DSF	Datuk Simon Fung
FFQ	Food Frequency Questionnaire
BMI	Body Mass Index
RNI	Recommended Nutrient Intake
SD	Standard Deviation
NSM	Nutrition Society of Malaysia
n	sample size

LIST OF UNITS

Units	
kcal	kilocalorie
kg	kilogram
g	gram
mg	milligram
cm	centimetre

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Oral health is an integral component of general health and is essential for well being. Diet and nutrition impact on many oral diseases, in particular dental caries. It is well established that a good diet is essential for the development and maintenance of healthy teeth, but healthy teeth are important in enabling the consumption of a varied and healthy diet throughout the life cycle (Moynihan, 2005). Dietary sugars are the most important dietary cause of dentition problems in children. Both the frequency of consumption and the total amount of sugars are important in the aetiology of dentition (WHO, 2003; Sheiham, 2001).

1.2 Background of the study

Total sugar in the diet is the sum of natural sugar and added sugar. Natural sugars include all sugars occurring naturally occur in foods. Consequently, diets high in natural sugar could be expected to result in good diet quality in children. Added sugars are those added in the processing, cooking, or preparing of food and those added at the table. Much added sugar in the diet comes from foods that are also high in fat such as pastries and candies (Sigman-Grant & Morita, 2003).

Non-Milk Extrinsic Sugars (NMES) are those sugars located outside of cellular structures, present in natural or unprocessed form, such as honey and table sugar and excludes all milk sugars (Department of Health, 1989). NMES are chemically indistinguishable from other sugars, harmful to dentition and considered more cariogenic than intrinsic and milk sugar. NMES include those added sugars and syrups added to foods by food manufacturers, cooks and consumers during processing and preparation to alter the flavour, taste, or texture of the food. Specifically, added sugars include white and brown sugar, corn syrup, malt syrup, fructose sweetener, fruit-juice concentrate, honey, molasses, anhydrous dextrose, and crystal dextrose. NMES are found in a wide range of foods, the main sources in the diet being table sugar, confectioneries, soft drinks, fruit juices, candies, biscuits and cakes (USDA/DHHS, 2000).

The Committee on Medical Aspects of Food Policy (COMA) panel reported that due to their location within the structure of the food, intrinsic sugars are not a threat to dental health. Foods which contain intrinsic sugars tend to require more mastication which mechanically stimulates saliva flow thereby increasing the ability to neutralize plaque acid. Although lactose in milk resides extracellularly, it is considered less cariogenic than glucose, fructose, sucrose and maltose when in extrinsic form; therefore, milk sugars are not included in the NMES category (Department of Health, 1989). Milk also contains factors (calcium phosphate and casein) that protect against demineralization of enamel (Dairy council, 2001).

Dentition begins at approximately six weeks in uterus and continues into late adolescence. Dental disease has wide ranging effects. A healthy mouth is necessary for nutrition and communication, which affects growth and development. Severe dental caries can cause chronic pain and systemic infection. Children suffering from this condition are often malnourished, because it is painful to eat, they are frequently absent from school, may have difficulty sleeping and socializing, and have low self esteem (Schafer & Adair, 2000).

Dental diseases include dental caries, developmental defects of enamel, dental erosion and periodontal disease (gum disease). Dental caries occurs due to demineralisation of enamel and dentine (the hard tissues of the teeth) by organic acids formed by bacteria in dental plaque through the anaerobic metabolism of

sugars derived from the diet (Moynihan & Peterson, 2004). These were significant health problem for people of all ages, but the magnitude of the problem is greatest among preschool children (Reich, 2001). Teeth are most susceptible to dental caries soon after they erupt; therefore, the peak ages for dental caries are 4 to 6 years for the deciduous dentition. The two main factors that increase the risk of cavities in preschoolers are the length of time that food is in a child's mouth and the cariogenity of sugar that is in the food. If a food is sticky or is sucked on, it stays in the mouth longer. Foods like sucker sweets are more likely to affect dentition of young children and cause caries.

Preschoolers are characterized by young children aged between 3 to 6 years of age. The preschool age is a period of rapid growth and development. A regular intake of nutritious food is needed throughout the day to give preschool children stamina and help develop cognitive function. Some children in this age group are still fussy, so they need to be offered a wide variety of foods and regular meals and snacks. Meeting nutritional requirements throughout childhood is essential to full intellectual development. Malnutrition impacts child's behavior, performance and overall cognitive development. Children require sufficient energy and essential nutrients each day to concentrate on and accomplish learning tasks. Children's eating habits are strongly influenced by parental interactions and encouragement. Among the shortcomings of diets of preschool children are that they contain too much of sugar containing foods that contribute to dental caries, hyperactive, childhood obesity and diabetes.

The Malaysian Recommended Nutrient Intake, RNI (MOH, 2005) advises that intake of sugar should not exceed 15% of total energy intake. There are no available reports quantitating sugar consumption among Malaysians. However, the subsequent COMA report on dietary reference values stated that NMES should contribute not more than 10 %, or 60 g/day, to energy intake (Department of Health, 1991). WHO (2003) recommends limiting added sugar intake to less than 10% of total energy. WHO report also suggests that sugar-sweetened beverages should be limited for children to reduce chronic diseases. The US Institute of Medicine of the National Academy of Sciences (2002) suggests limiting added sugar intake to 25% or less of total energy in the Dietary Reference Intakes (DRIs) for macronutrients in preschoolers. This limit is based on evidence that added sugar

consumption exceeding 25% of total calories may lead to dental caries, increased blood lipids, obesity, hyperactivity, diabetes and coronary heart disease in preschoolers.

Cultural and social factors such as parents' knowledge and awareness on oral hygiene practice and socio-economic status also play roles in occurrence of dental caries in children. Advocating good oral hygiene practices among children may reduce the development of dental problems. Good oral hygiene practices followed by proper diets are essential for preschoolers. However, dietary intakes and the consumption patterns of sugary foods are the highest determinant of caries risk among children (Moynihan, 2005). Dental caries is associated with both NMES intake and with frequency of consumption (Moynihan & Peterson, 2004). Other than good oral hygiene practices, taking fluoride supplements or using fluoridated toothpaste have a greater role in reduction of dental caries as fluoride is known to protect teeth against caries (Gibson & Williams, 1999).

1.3 Hypothesis and relevance of the study

It is hypothesized that young children with dental defects have higher intakes of NMES containing foods and beverages, than do children without dental defects.

This study is relevant in the continuous efforts by health professionals, school teachers and parents to promote and instill good nutrition and oral health practices among preschoolers. This study also provides a body of evidence on the pattern of NMES intakes and effects on dentition in Malaysian preschool children. Dental diseases are greatest among preschoolers aged between 4 to 6 years due to their early erupted teeth that are more susceptible to the cariogenicity of NMES and children tend to consume more sugary foods. NMES found in a wide range of foods, include confectioneries, soft drinks, fruit juices, biscuits, honey and cakes, all of which are food items liked by children and most adults. This will be a scoping preliminary study as such studies on Malaysians have never been published. There is also no data on NMES content of Malaysian food which would contain NMES, e.g., all the traditional cakes (*kuih*).

1.4 Objective

The objectives of the present study are:

1. To identify sugary foods consumption patterns, with a focus on items high on NMES, among preschool children aged 4 to 6 years attending the Datuk Simon Fong Kindergarten in Kingfisher, Kota Kinabalu.

2. To examine the relationship between NMES consumption and dental caries experiences, taking into account confounding factors like the use of fluoride supplements and teeth brushing.

3. To identify the pattern of dental caries among preschool children based on their NMES intake.

CHAPTER 2

LITERATURE REVIEW

2.1 Classification of dietary sugars

In 1989, the Committee on Medical Aspects of food policy (COMA) classified dietary sugars for dental health purposes, distinguishing between sugars naturally integrated into the cellular structure of the food (intrinsic sugars) and those present in free form or added to food (extrinsic sugars). Extrinsic sugars were further divided by COMA into milk sugars, namely those naturally present in milk and milk products (almost entirely lactose) and Non-Milk Extrinsic Sugars (NMES) (Department of Health, 1989).

The NMES include all added sugars, sugars in fresh fruit juices, honey and syrups. The reasoning behind such a differentiation was that NMES were cariogenic, while milk sugars and those of an intrinsic nature had a negligible effect on teeth. Due to the lower cariogenicity of lactose and the cariostatic nature of milk (Dairy Council, 2001), sugars naturally present in milk and milk products are not a threat to dental health. NMES are more readily available for metabolism by oral bacteria than intrinsic sugars and are therefore, more cariogenic and potentially damaging to dental health (Department of Health, 1989).

2.2 NMES

2.2.1 Definitions of NMES

According to the WHO Technical Series Report 797 (WHO, 1990), extrinsic sugars were defined as those added to a food and intrinsic sugars as those "naturally integrated into the cellular structure", as those in fruits and vegetables. The aim of the definition was to differentiate between the array of simple sugars inherent in whole fruits and vegetables, and those of an identical chemical nature that are added to food or are naturally present in juices. The term NMES is synonymous with the term 'free sugars' and included all monosaccharides and disaccharides added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and fruit juices (Kelly *et al.*,2005).

The WHO report added that the physical location of sugars influenced their availability for bacterial metabolism and therefore their influences on caries. Although lactose in milk resides extracellularly, it is considered less cariogenic than glucose, fructose, sucrose and maltose when in extrinsic form; therefore, milk sugars are not included in the NMES category. Cheese and yoghurt without added sugars may be considered safe for teeth. Milk and milk products with added sugars may not considered as protective against decay, and do make a sizeable contribution to NMES. Although honey present in natural form but it do contains considerable amounts of NMES and is a high cariogenic food (Gregory *et al.*, 2000).

The U.S. Department of Agriculture (USDA) has defined NMES as added sugars, sugars and syrups that are added to foods during processing or preparation, and also includes sugars and syrups added at the table. There is no difference in the molecular structure of sugar molecules, whether they are naturally occurring in the food or added to the food. Major sources of added sugars include soft drinks, cakes, cookies, puddings and candies. Specifically, added sugars include white sugar, brown sugar, corn syrup, corn-syrup solids, high-fructose corn syrup, malt syrup, maple syrup, fructose sweetener, liquid fructose, fruit-juice concentrate, honey, molasses, anhydrous dextrose, and crystal dextrose (USDA/DHHS, 2000).

Those sugars extracted from cellular structure of foods, become extrinsic sugars, e.g., sucrose which, once extracted from sugar beet, becomes an extrinsic sugar rather than an intrinsic sugar. Extrinsic sugars particularly sucrose, are frequently incorporates into other foods by adding them to beverages or using them in baking. However, this process does not incorporate the sugar into the cells of the other foods so the sugar does not become intrinsic (USDA/DHHS, 2000).

2.2.2 Estimation of NMES in foods

According to the COMA report on Dietary Sugars in Human Disease, 1989, NMES are chemically indistinguishable from other sugars in foods, so cannot be measured by direct analysis. Instead, they are estimated using data on the amounts of different sugars (that can be measured by analysis) that are present in foods. Different dietary survey researchers have devised a number of different methods for NMES estimation. Each method applies slightly different "rules of thumb" or assumptions about the amounts of different sugars that should be included when estimating the NMES content of different foods.

A study was conducted by Kelly *et al.*, 2005, to identify the different methods to estimate the NMES content of all foods in the food tables, compare the NMES intakes of young English adolescents and to assess the advantages and disadvantages of each method in terms of practicality, degree of complexity and labour intensity. The authors were identified and used three standard methods for NMES estimation. The results of this study indicate that the MAFF method gave significantly higher NMES values (g/100 g) than the NDNS or HNRC methods for every food group. The three methods that were used have shown as below:

A: The method currently used by the Food Standards Agency to determine NMES intake for the National Diet and Nutrition Survey (NDNS) since 1995 and other surveys commissioned by the agency.

B: A method developed by the Ministry of Agriculture, Food and Fisheries (MAFF), used to estimate NMES intakes for earlier NDNS surveys (pre-1995).

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