PRESCHOOL CHILDREN'S TOOTHBRUSHING BEHAVIOUR AND ASSOCIATION WITH THEIR ORAL HEALTH

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PRESCHOOL CHILDREN'S TOOTHBRUSHING BEHAVIOUR AND ASSOCIATION WITH THEIR ORALEALTH

ABSTRACT

Toothbrushing is an important yet neglected behaviour that has affected oral health of preschool children (4-6 years). Factors like dietary habit, socioeconomic status and oral conditions also affect oral health of preschool children. Despite intervention efforts, recent investigations reported high prevalence of early childhood caries (ECC) and oral diseases among this age group across different populations. Therefore, it is imperative to understand the relationship between toothbrushing behaviour and oral health status of preschool children to prevent oral diseases, hence improve their oral health. The aim of the current study was to evaluate toothbrushing behaviour of preschool children, assess their oral health status and determine their association. It was a single visit cross-sectional study. A written informed consent was obtained from the parents/guardians of 92 eligible participants. Preschool children's toothbrushing behaviour was evaluated from parental responses (questionnaire) followed by observation (video recording) of their toothbrushing. The extent of parents/guardians' involvement in their children's toothbrushing was also observed and scored according to the formulated criteria. The oral health status was assessed in terms of pre and post brushing plaque scores (used Mira-2-tone for plaque identification), gingival index and dental caries status. The data from assessment of toothbrushing behaviour and oral health status was analyzed using SPSS. A novel 'Behavioural Observation Research Interactive Software' (BORIS) was used to

analyse toothbrushing videos. Another advanced Smart PLS 3 software was used to perform a second-generation multivariate analysis to create models that depicted the association between children's toothbrushing behaviour and oral health status with and without confounding variables. The impact of other factors was also analyzed as confounders. About two-third of participants were of Malay ethnicity. Slightly more than half (53%) were girls and 38% were 4years old. Majority (90%) of parents/guardians had tertiary level education. The descriptive statistics revealed that there was a difference in the recorded values of both methods (quantitative and qualitative) of toothbrushing behaviour. About 35% of parents reported that their children used pea sized toothpaste but only 28% were observed. Fifty one percent were observed to brush for 1-2mins, however the reported data suggested only 40% to brush for 30sec-1min. A difference of 30% was recorded between reported (80%) and observed fluoride toothpaste (F lesser than 1000ppm) use. Almost 30% were observed to use fluoridated toothpaste (F greater than 1000ppm) and 20% non-fluoridated toothpaste. Slightly more than half of parents/guardians reported to guide their children occasionally but only 11% were observed to supervise them. The mean plaque score reduction after observed toothbrushing was 10.80 (2.46), mean pre-brushing plaque score was 90.3 (10.2), mean gingival index was 0.89 (0.65) and mean dental caries status dfs (1-6) was 18.87 (12.39).Toothbrushing behaviour contributed to plaque score change (86%), dental caries status (73%), gingival index (66%) and pre-brushing plaque score (31%). The significant confounding variables had a small influence on oral health of preschool children.

Preschool children had inadequate toothbrushing behaviour and poor oral health status with a statically significant association between them.

Keywords: Early childhood caries (ECC), oral health, plaque score, preschool children, toothbrushing behaviour.

AMALAN MEMBERUS GIGI KANAK-KANAK PRASEKOLAH DAN PERKAITAN DENGAN KESIHATAN MULUT MEREKA

ABSTRAK

Memberus gigi adalah amalan yang sangat penting namun sering diabaikan yang telah mempengaruhi kesihatan mulut kanak-kanak prasekolah (4-6 tahun). Faktor seperti tabiat pemakanan, status sosioekonomi dan keadaan mulut juga mempengaruhi kesihatan mulut kanak-kanak prasekolah. Walaupun terdapat langkah intervensi yang dijalankan, penyelidikan baru-baru ini melaporkan prevalensi karies awal kanak-kanak (ECC) dan penyakit mulut yang tinggi berlaku dalam kalangan kumpulan umur ini di pelbagai populasi. Oleh itu, ia adalah penting untuk memahami hubungan antara amalan memberus gigi dan status kesihatan mulut kanak-kanak prasekolah untuk mencegah penyakit mulut, sekaligus meningkatkan kesihatan mulut mereka. Tujuan kajian ini dilakukan adalah untuk menilai amalan memberus gigi kanak-kanak prasekolah, menilai status kesihatan mulut mereka dan menentukan hubungan antara kedua-duanya. Ia adalah kajian keratan rentas lawatan sekali. Rekod kebenaran bertulis diperoleh daripada ibu bapa / penjaga 92 peserta yang layak. Tingkah laku memberus gigi kanak-kanak prasekolah dinilai daripada respon ibu bapa (soal selidik) diikuti dengan pemerhatian (rakaman video) berus gigi mereka. Tahap penglibatan ibu bapa / penjaga dalam sesi memberus gigi anak-anak mereka juga diperhatikan dan

dinilai mengikut kriteria yang dirumuskan. Status kesihatan mulut dinilai dari segi skor plak sebelum dan selepas memberus (perwarna Mira-2 digunakan untuk mengenalpasti plak), indeks gingiva dan status karies gigi. Data dari penilaian tingkah laku memberus gigi dan status kesihatan mulut dianalisis menggunakan SPSS. Sebuah novel *'Behavioral Observation Research Interactive Software*' (BORIS) digunakan untuk menganalisis video tingkah laku memberus gigi. Satu lagi laya tun perisian Smart PLS 3 digunakan untuk melakukan analisis multivariat generasi kedua dan membuat model yang menggambarkan perkaitan antara tingkah laku memberus gigi kanak-kanak dan status kesihatan mulut kanak-kanak prasekolah dengan dan tanpa pemboleh ubah yang mengelirukan. Kesan faktor-faktor lain juga dianalisis sebagai pembaur. Kira-kira dua pertiga peserta adalah etnik Melayu. Lebih daripada separuh (53%) adalah kanak-kanak perempuan dan 38% berumur 4 tahun. Majoriti (90%) ibu bapa/penjaga mempunyai pendidikan peringkat tinggi. Statistik deskriptif menunjukkan bahawa terdapat perbezaan nilai yang dicatat dari kedua-dua kaedah (kuantitatif dan kualitatif) tingkah laku memberus gigi. Terdapat 35% ibu bapa melaporkan anak mereka menggunakan ubat gigi berukuran saiz kacang pea tetapi hanya 28% yang diperhatikan. Lima puluh satu peratus diperhatikan memberus selama 1-2 minit, namun data yang dilaporkan mencadangkan hanya 40% untuk memberus selama 30 saat - 1 min. Perbezaan 30% dicatatkan antara penggunaan ubat gigi fluorida yang

dilaporkan (80%) dan diamalkan(F<1000ppm) dan hampir 30% diperhatikan menggunakan ubat gigi fluorida (F> 1000ppm) dan 20% ubat gigi bukan fluorida. Lebih kurang separuh daripada ibu bapa/penjaga dilaporkan membimbing anak-anak mereka sekali-sekala tetapi hanya 11% yang diperhatikan untuk mengawasi mereka. Pengurangan skor plak min setelah memberus gigi yang diperhatikan adalah 10.80 (2.46), purata skor plak pra-memberus adalah 90.3 (10.2), purata indeks gingival adalah 0.89 (0.65) dan purata status karies gigi (1-6) ialah 18.87 (12.39). Tingkah laku memberus gigi menyumbang kepada perubahan skor plak (86%), status karies gigi (73%), indeks gingival (66%) dan skor plak pra-memberus gigi(31%). Faktor-faktor pembaur ketara yang mempunyai kesan kecil terhadap kesihatan mulut kanak-kanak prasekolah. Kanak-kanak prasekolah mempunyai tingkah laku memberus gigi yang tidak mencukupi dan status kesihatan mulut yang buruk dengan hubungan yang signifikan secara statistik antara mereka.

Keywords: Karies awal kanak-kanak, kanak-kanak prasekolah, kesihatan mulut, skor plak, amalan memberus gigi.

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LIST OF SYMBOLS AND ABBREVIATION

ADA	American Dental Association
BORIS	Behavioural Observation Research Interactive Software
dfs	Decayed filled surfaces
DV	Dependent variable
DRF	Data recording form
ECC	Early childhood caries
FDI	Federation of National Dental Associations
ICC	Intra class correlation
ICDAS	International Caries Detection and Assessment System
IV	Independent variable
min	Minute
n	Sample size
NOHPS	National Oral Health Survey of Preschool children
PIS	Patient information sheet
PLS	Partial least Square
PPM	Parts per million
SPSS	Statistical package for the social science
sec	Second

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Study background

According to a recent definition by FDI, oral health is multifaceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow, and convey a range of emotions through facial expressions with confidence and without pain, discomfort, and disease of the craniofacial complex (Glick et al., 2016). Poor oral health not only encourages dental biofilm synthesis on tooth surfaces and causes oral diseases (Ceyhan et al., 2018), but also it is an indicator for general health disorders including oral lesion, which can be the first sign of HIV infection or aphthous ulcer, which may indicate Coeliac disease or Crohn's diseases (Petersen, 2003).

Preschool children are at high-risk for developing oral diseases including early childhood caries (ECC) due to their poor oral health (Jain et al., 2018). Dental biofilm is a layer of microorganisms that is formed on the tooth surfaces (Marsh, 2004; Socransky and Haffajee, 2002). It thickens with the passage of time, and if left undisturbed it makes the oral tissues vulnerable to oral diseases (Chandki et al., 2011). Gingivitis is also among these frequent oral diseases that are found in the preschool children and has direct association with dental plaque (Aranza and Pena, 2011). ECC is the 12th most prevalent disease, that has increased dental, medical, social and economic costs around the globe (Phantumvanit et al., 2018). It progresses more rapidly in primary dentition than dental caries in

the permanent dentition due to its complex aetiology (Kassebaum et al., 2017; Vos et al., 2016). The process of early childhood caries involves, increase in the acidogenic and acid tolerating species of bacteria within the dental plaque (Marsh, 2006). Previously, studies had reported that preschool children had 99% visible plaque on their teeth, 77% had gingivitis and ECC was also prevalent among them (Feldens et al., 2006). According to the latest report of National Oral Health Survey of Preschool Children, the prevalence of ECC among Malaysian preschool children was 71.3% with 25.2% having dental plaque that had affected male population more than females (NOHPS,2015). The factors associated with the poor oral health of preschool children included their improper oral hygiene behaviour, poor dietary habits (ADA, 2014; Thosar et al., 2015), low socioeconomic status (Pitts et al., 2012) and concurrent oral conditions (Chen et al., 2017).

Toothbrushing effectively disturbs the dental biofilm (plaque) formed on the tooth surfaces (Coutinho et al.,2007). High traces of plaque deposits found on tooth surfaces of preschool children were due to their poor toothbrushing habits, this resulted in the development of oral disease.(Ceyhan et al., 2018). In addition, their unawareness regarding significance of proper oral health increased the risk of development of oral diseases (Soltani et al., 2017).

1.2 Problem statement and Rationale of study

Maintenance of good oral health among preschool children is not only essential but a difficult task to achieve for both parents and oral health professionals (Winnier et al., 2015). The possible reasons for poor oral health maintenance among preschool children include; negligence of oral health, frequent snacking on sugary diet, bottle feeding (Harris et al., 2004; Soumya et al., 2017) and their lack of dexterity and manual skills that are required for proper toothbrushing (Muller-Bolla and Courson, 2013). Prevention and early intervention can decrease the progression of oral diseases (Larson, 2003). In the past few decades, reduction in the prevalence of oral diseases among Malaysian preschoolers has been noticed, but at a very slow rate. Currently, more than 50% of preschoolers have oral diseases that requires urgent intervention, affecting rural areas and male population more (NOHPS,2015). Therefore, it is imperative to know about oral health behaviour and routine oral hygiene practices of preschool children. Efforts in aspects such as proper toothbrushing techniques and nurturing habits among children is essential to improve the oral health of preschool children. Thus, educating parents and caregivers need to be given utmost priority. Our study will focus on the toothbrushing behaviour and its associated factors among children of 4-6 year of age and determine its relationship with their oral health status. To date, to the best of our knowledge no such type of study has been conducted in Malaysia on this age group of children.

1.3 Research questions

1. What is the toothbrushing behaviour of preschool children investigated using quantitative and qualitative methods?
2. What is the oral health status of preschool children in terms of plaque scores, gingival index and dental caries status?
3. Is the toothbrushing behaviour associated with the plaque score in preschool children?
4. Is the toothbrushing behaviour associated with the gingival index in preschool children?
5. Is the toothbrushing behaviour associated with the dental caries status in preschool children?

1.4 Aim of the study

The aim of the study was to evaluate the toothbrushing behaviour among preschool children (4-6 years) and determine its association with their oral health status.

1.5 Specific objectives

The objectives of this study are as follow:

1. To assess the toothbrushing behavior of preschool children using a:
   i. Qualitative method (Video recording)
   ii. Quantitative method (Questionnaire)

2 To assess the oral health status of preschool children in terms of:

a. Plaque scores

b. Gingival index

c. Dental caries status

3 To determine the association between toothbrushing behavior of the preschool children and plaque scores.

4 To determine the association between toothbrushing behavior of the preschool children and gingival index.

5 To determine the association between toothbrushing of preschool children and dental caries status.

1.6 Research Hypothesis

Research hypothesis: There is an association between toothbrushing behaviour of preschool children and oral health status in terms of plaque scores, gingival index and dental caries status.

Null hypothesis: There is no association between toothbrushing behaviour of preschool children and oral health status in terms of plaque scores, gingival index and dental caries status.

1.7 Research conceptual framework

As shown in the Figure 1.1, the toothbrushing behaviour of preschool children (4-6years) was used as an independent variable in the present study

and was assessed using observation (video recording) and a quantitative response through questionnaire. The parameters for assessment of toothbrushing behaviour and resources of data are listed below:

I. Toothbrush
   a. Type
   b. Type of grip

II. Toothpaste
   a. Type
   b. Amount

III. Toothbrushing
   a. Frequency
   b. Duration
   c. Technique
   d. Pattern

IV. Post-brushing mouth rinsing

V. Parental guidance

Oral health status of preschool children was used as a dependent variable, which was evaluated in terms of plaque scores, gingival index and dental caries status. The data for gingival index, plaque scores (before and after toothbrushing) and dental caries status (recorded after cleaning and polishing the teeth) was obtained from oral examination.

Once, the assessment was completed the association between toothbrushing behaviour and oral health status was determined. (Figure 1.1).

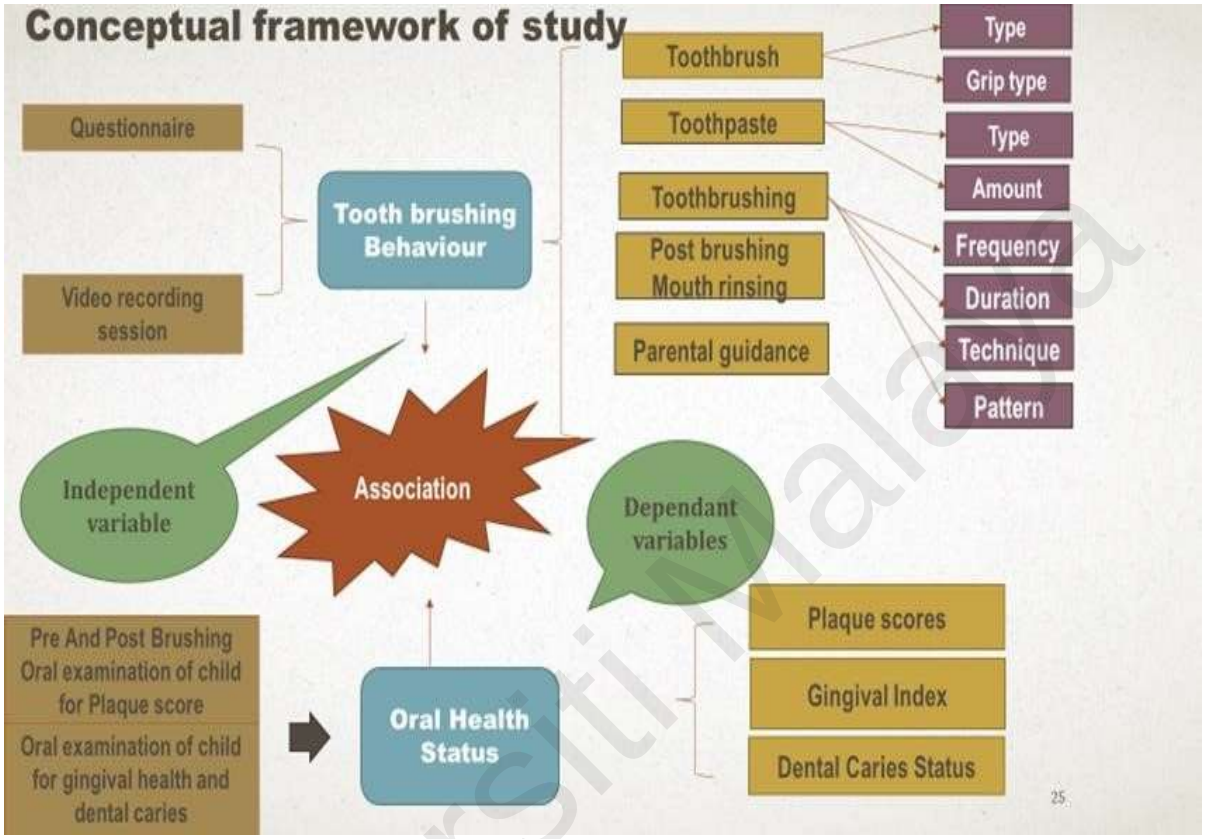


Figure 1.1: Conceptual framework of the study

1.8 Significance of the study

This study will provide an insight about toothbrushing behaviour of children of age group 4-6 years and its impact on their oral health. It will benefit dental practitioners, parents and guardians to focus, develop and incorporate proper

toothbrushing behaviour in daily routine of the preschool children to prevent and control oral diseases among them.

CHAPTER 2: LITERATURE REVIEW

2.1. Human behaviour

Health behaviour can be defined as actions and habits that relate to health maintenance, restoration and improvement (Gochman, 1997).

2.1.1 Oral health behaviour

The oral health behaviour is one of the important human behaviour related to the oral health (Branden et al., 2013). It describes the complex effect of oral hygiene habits (toothbrushing), nutritional preferences and the pattern of a person's utilization of dental services on the individual's oral health. (Lalani et al., 2015).

2.1.2 Toothbrushing behavior

Toothbrushing (oral hygiene) is an essential component of oral health behaviour (Lalani et al., 2015). It should be incorporated into our daily routine for the maintenance of good oral health (Sgan and Harold, 2005). Toothbrushing not only disturbs the dental plaque (biofilm) (Nightingale et al., 2014), but also toothbrush acts as a tool for fluoride application on tooth surfaces (Polk et al., 2014). Factors affecting toothbrushing behaviour includes; lack of awareness, stressful life, large families, low parents' education and poor living standards (Marsham et al., 2016)/

2.1.2.1 Toothbrushing behaviour among preschool children

Preschool children are at a high risk for developing oral diseases (Anil and Anand, 2017). Adoption of correct toothbrushing behaviour; supervised toothbrushing, twice a day for two or more minutes with fluoride toothpaste (F greater than 1000ppm) and minimal mouth rinsing after toothbrushing can reduce the risk of development of oral diseases (Marshman et al., 2016). Moreover, starting toothbrushing at an early age decreases the level of S. Mutans which is one of the risk factors associated with the development of ECC among preschool children (Habibian et al.,2002). Majority of preschool children have inadequate toothbrushing behaviour (Ceyhan et al., 2018; Martin et al., 2019). It is due to its long tedious and repetitive procedure (Ganesh et al., 2012) and absence of manual dexterity required for adequate plaque removal (Muller-Bolla and Courson, 2013). Moreover, the unawareness of preschool children towards proper oral health behaviour is another reason for their poor oral health (Harris et al., 2004).

2.1.2.1.1 Type of toothbrush

A toothbrush is an oral hygiene instrument used to clean the teeth, gums, and tongue. To achieve appropriate cleaning the toothbrush must be of correct design, dimensions and size that can easily fit and access all the tooth surfaces of the preschool children's mouth. A toothbrush with a head size of 15 to 19 mm is suitable for preschool children (Thosar et al., 2015). The toothbrush should have soft bristles to prevent gingival trauma and damage (ADA,2014). Two types of children's toothbrushes are available; manual and powered toothbrushes.

According to two different systematic reviews, a powered toothbrush was the preferred toothbrush among preschool children, because of its oscillatory motion that not only fascinated and motivated them to brush properly but also the oscillations compensated for their inadequate toothbrushing skills (Yaacob et al., 2014;Niederman, 2003). Additionally, powered toothbrush had better plaque removing capability compared to manual toothbrush (Shin et al., 2016). However, a recent study opposed the aforementioned ability of powered toothbrush and stated that both toothbrushes (power and manual) have equal plaque removing capability and that the effective plaque removal was dependent on motor skills of the 5 to 11years old children rather than the oscillation of powered toothbrush. They further argued that children having good handwriting and aptitude for playing music were better at plaque removal because of their developed motor skills (Gallie, 2020). The concept of integration of music to the toothbrush; musical toothbrushing was another attraction for the preschoolers to brush their teeth with music which compelled them to remove plaque better than manual toothbrush. However, this captivation reduced with passage of time and eventually, the plaque removing ability (Ganesh et al., 2012). Toothbrush function is not only to mechanically remove food debris and plaque from the tooth surfaces, but also it acts as an instrument for fluoride application (Polk et al., 2014). Other brushing aids including neem sticks and fingers are also used for toothbrushing by some Indian preschool children (Manya et al., 2017).

2.1.2.1.2 Type of toothbrush grip

For toothbrush to remove plaque efficiently, toothbrush holding style should also be adequate. Beals et al (1999) investigated five different types of toothbrush grip, distal oblique and power grip which used the palm of the hand. While oblique, precision and spoon grip relied on the fingers (Beals et al., 1999). Majority of preschool children preferred distal oblique grip (Lakshmi et al., 2018). Although, toothbrush holding style is inherent, but distal oblique grip type removed plaque more effectively compared to other grip types used by the preschool children (Sharma et al., 2012).

2.1.2.1.3 Type of toothpaste

A toothpaste is a mild abrasive agent containing all the necessary ingredients for maintaining oral hygiene (Maldupa et al., 2012). It has anticariogenic and antiplaque properties that can be beneficial in reduction of plaque deposition and development of ECC (Pitts et al., 2012). A variety of toothpastes are available with a range of fluoride content. About 75% of toothpastes available in the Malaysian market were adult toothpastes, while 25% were marked as children's toothpaste. Among these 48% were labelled as fluoridated toothpastes (Anis et al., 2019). According to the latest recommendations, fluoride toothpaste containing more than 1000ppm of fluoride should be used by the preschool children (Walsh et al., 2010; Wright et al., 2014, Malaysian Dental council, 2009). Nevertheless, low fluoride containing children's toothpaste (500-

600ppm) was still popular and perceived as good for children by many parents (Ekambaram et al., 2011). However, two systematic reviews revealed that unlike high fluoride containing toothpaste (1000-1500ppm), low fluoride toothpaste (<600ppm) prevented surface caries only and also it did not reduce the risk of fluorosis (Santos et al., 2013) probably, because of the inadvertent habit of toothpaste swallowing among children below 6 years of age and occasional supervision of their toothbrushing (Tay et al,2009). Almost 50% of toothpastes available in the Malaysian market were non-fluoridated (Anis et al., 2019) and were used by many preschool children, which was less effective against dental caries (Martin et al., 2019). This may be attributed to the increase activities of anti-fluoridation lobbying; which had instilled false fear among parents regarding fluoride over dosage and overexposure with fluoride toothpaste use and they made them belief that non-fluoridated toothpaste was made of natural ingredients (SYABAS, 2018; Kanduti et al.,2016;Basch et al., 2019). Moreover, some Malaysian Muslim clerics had negative viewpoint regarding fluoride in terms of its side effects and halal status, which was merely because of their inadequate knowledge regarding fluoride and its recommendations (Nazita et al., 2013).

2.1.2.1.4 Amount of toothpaste

A recommendation of 'pea sized toothpaste amount' in children with age group of 4 to 6 years is to avoid side effects such as; fluorosis which can occur in

children who unconsciously swallow the toothpaste (ADAa, 2014).However, there are little chances of development of mild fluorosis with the use of pea sized amount of toothpaste (Wright et al., 2014). On the other hand, fruity flavour of children (fluoride) toothpaste further increases the chances of toothpaste swallowing among preschool children (Nascimento et al., 2013). Moreover, Malaysian preschool children were also reportedly using more than the recommended pea sized toothpaste, which further increased the risk of fluorosis in them (Tay et al., 2009).

2.1.2.1.5 Toothbrushing technique

Toothbrushing is an age-related ability (Pujar and Subbareddy, 2013; Wambier et al., 2013). The motor skills required for the proper toothbrushing in children are not developed until the age of 8 years, therefore, complicated toothbrushing techniques cannot be followed with the needed accuracy for effective plaque removal (Patil et al., 2014). Horizontal scrubbing is a simple and less complicated toothbrushing technique that is preferred by the preschool children (Deinzer et al., 2019; Ceyhan et al., 2018).

2.1.2.1.6 Toothbrushing Pattern

The preschool children are likely to brush without any pattern, in a non-systematic manner (Sandstrom et al, 2011). Systematic pattern of toothbrushing ensures that all the areas of the mouth are cleaned (Dean et al., 2011). Consequently, following

systematic pattern of toothbrushing is suggested for maximum plaque removal in the preschool children (Bain et al., 2018). Recently, a two-index value that described different parameters of toothbrushing pattern in detail was developed; Toothbrushing Systematic Index (TSI). The data from the video observations were used, including the areas of plaque score change between the tooth surfaces, number of tooth surfaces cleaned, toothbrushing duration and brushing time per area. These data were fed into two algorithms that converted the behaviour into two index value. The value tending towards 0 described poor toothbrushing systematics, whereas value tending towards 1 described fine to excellent brushing systematics. The index can be used in many clinical studies to assess the toothbrushing pattern in detail (Schlueter et al., 2018).

2.1.2.1.7 Toothbrushing duration

Toothbrushing is a tedious and repetitive procedure for preschool children to be performed for at least two minutes (Ganesh et al., 2012). However, the two minutes toothbrushing duration is recommended to remove ample amount of plaque from teeth (Pujar and Subbareddy, 2013). The shorter toothbrushing duration (45 sec) among preschoolers (Das and Singhal, 2009) is one of the reasons that they are at a high risk for the development of ECC (Kowash et al., 2017).

2.1.2.1.8 Toothbrushing frequency

It is recommended to brush twice a day for adequate plaque control and maintenance of good oral health (ADA,2014a; Kumar et al., 2016). In comparison, preschool children who brushed frequently tend to have low chances of ECC than children who brushed once a day and those who did not brushed their teeth at all (Jain et al., 2018). Among many, one justification of parents infrequent toothbrushing for their children was household engagements or no family support (Avenetti et al., 2020). In a study on preschool children of United Arab Emirates, less than half of the children brushed frequently (38%) and almost 20% never brush their teeth and more than 70% had ECC. Thus, suggesting a relationship between toothbrushing frequency of preschool children and ECC (Kowash et al., 2017). According to a meta-analysis, infrequent toothbrushing effected deciduous dentition more than permanent in terms of development and progression of ECC (Kumar et al., 2016). Moreover, parents toothbrushing frequency influences the toothbrushing frequency of their children (Bozorgmehr et al., 2013; Mannaa et al, 2013).

2.1.2.1.9 Post-brushing mouth rinsing

Multiple mouth rinsing eliminates soapy taste of toothpaste and prevents fluoride overdosage by ingestion (Van et al., 2004). Many preschool children rinsed their mouth multiple times after toothbrushing (Martin et al., 2019). This reduced the fluoride effect from the mouth, which was necessary for the prevention of ECC.

Studies had shown that in order to prevent ECC, presence of constant concentration of fluoride in the oral cavity was necessary. Increase mouth rinsing (volume, duration, frequency) reduced the level of salivary fluoride concentration after 5 min of dentifrice application (Duckworth et al., 1991; Sotthipoka et al., 2018). Therefore, it is advisable for preschool children to rinse briefly after toothbrushing or spit the toothpaste content without rinsing to retain the fluoride effect (Chestnutt et al., 1998). The concept of minimal mouth rinsing to retain fluoride effect in the mouth includes; rinsing with a slurry of fluoride toothpaste and saliva or mouth rinsing with mouthwash containing fluoride (Pitts et al, 2012) has been replaced by 'spit and do not rinse'. This has been adopted in Britain (Wanless,2014) and Ministry of Health Malaysia.

2.1.2.1.10 Parental guidance

Despite of the ignorant attitude of preschool children towards their oral health, (Rong et al., 2003) the observation of parents/guardians practicing good oral health behaviour had high impact on their oral health (Gradella et al., 2011). Although, some parents/guardian may not consider oral health as important as other basic needs of life (Bozorgmehr et al., 2013), mostly due to their lack of understanding and poor oral health knowledge (Gao et al., 2014; Martin et al., 2019). Moreover, more than half of parents thinks toothbrushing their children teeth is a struggle and it is difficult to continue it for two minutes. (Collett et al., 2016). Malaysian parents reported to supervise their children every day, (41%)

although nearly half of them (46%) never guided their children during toothbrushing session (Tay et al., 2009). The parents/guardians of Malaysia had good oral health knowledge, (Mani et al., 2010; Mani et al., 2012) but their children had poor oral health because of their poor practice (Najlaa et al., 2015). The failure of implementation of oral health knowledge may be attributed to several reasons including failure of parents to tackle their child behaviour, workload and no knowledge about supervised toothbrushing (Marshman et al., 2016). Parents/guardians' guided toothbrushing was associated with better children oral health status (Hamilton et al., 2018). A toothbrushing technique (Fones' brushing method) was taught in a study to three groups of preschool children using: puppet show, single session of guided toothbrushing and five sessions of guided toothbrushing respectively. The group of children with five supervised toothbrushing sessions showed a significant improvement compared to the other groups in terms of plaque score after 24 and 46 days. Thus, emphasizing on importance of supervision during toothbrushing (Hamilton et al., 2018). An improvement in the toothbrushing skills of preschool children were recorded with supervised tooth brushing during a national Supervised Teeth Brushing Program (STBP) conducted on 3-4-year-old children of Southern Israel (Dekel et al., 2019).

2.1.2.2 Interventions to improve toothbrushing behaviour of preschool children

The restricted ability of preschool children related to their poor toothbrushing behaviour makes them prone to oral diseases. Therefore, several intervention programmes had been designed to improve toothbrushing behaviour of the preschool children. A playful learning intervention was an educational programme intended to improve oral hygiene of Brazilian 3-5-year-old preschool children. The children had three sessions in an interval of 4 days, in the first session they were taught about oral health knowledge, followed by demonstration of toothbrushing on dolls and finally children were made to practice on their own teeth. They were provided with toothpaste containing disclosing agent and were asked to clean the highlighted areas on the tooth surfaces. Such programmes had positive impact on oral health if they were conducted frequently (Sigaud et al., 2017). Darwita et al (2016) used periodic dental evaluation card (KGMS) to improve toothbrushing behaviour of mothers and children. Among the two groups; intervention group received dental education and charting of caries risk of children every week, which resulted in the improvement of oral health knowledge and reduction in plaque when compared to control group (Darwita et al, 2016). Another intervention study with '21-day Brush Day and Night (BDN) programme' was conducted on the school staff and school children of ten countries. The information regarding oral health knowledge and behaviour was collected by a self-reported questionnaire at baseline (T0), 21 days after the first intervention (T0D21), 6–12 months after the first intervention (T1), and 21 days after the second intervention (T1D21). Clinical evaluation of caries (DMFT) and plaque (Visible Plaque

Index) was performed at T0 and T1. An improvement in the oral health knowledge and behaviour of school children was observed in particularly in the toothbrushing frequency (Melo et al., 2018). According to the 'Health Belief Model (HBM)-based research, children's oral health behaviour can be determined by their guardian's oral health knowledge. A study was conducted using this model on grade 1 to 10 school children of Lao People's Democratic Republic (Lao PDR). They concluded that children toothbrushing frequency was associated with the ECC and guardian's self- efficacy in making their children to brush twice daily (phanthavong et al, 2019).

2.1.3 Toothbrushing recommendations

According to the current recommendations, toothbrushing should start with the eruption of first primary tooth (Thosar et al., 2015). An appropriate size toothbrush (15-19mm head size), with soft bristles (manual or electric toothbrushes) should be used and replaced frequently (ADAc, 2007; Thosar et al., 2015). The recommendation for amount of toothpaste for children below 6 years is pea sized toothpaste with a fluoride content greater than 1000ppm (Wright et al., 2014; ADAa, 2014; Malaysian Dental Council, 2009). The children should brush for at least 2min for effective plaque removal (ADA,2014). Parents/guardians are required to supervise their preschool children's toothbrushing twice a day (ADA, 2014). Excessive mouth rinsing after toothbrushing should be avoided, as it reduces the fluoride effect in the mouth (Pitts et al., 2012). Parents/guardians must be encouraged to supervise their

children during toothbrushing to ensure proper cleaning and minimize swallowing of toothpaste (Martin et al., 2019).

2.2 Oral health

Oral health plays an important role in the wellbeing of a person (Glick et al., 2016). It has significant impact on general health like diabetes, digestive disease, stroke, cardiovascular disease etc. (Nazir, 2017; Sheiham, 2005). Factors like improper oral hygiene, poor dietary habits (Tang et al., 2014), low socioeconomic status (Chandki et al., 2011; Chen et al., 2017; Soltani et al., 2017) and oral conditions like low saliva production can affect oral health. Diet potentiates caries process, if toothbrushing is not done regularly (Palmer et al., 2010). Dental biofilm is a colourless, sticky bacterial film which adheres to the tooth surface, bacterial composition inside this biofilm maintains a microbial homeostasis. Oral diseases including plaque induced gingivitis and ECC (Murakami et al., 2018; Meyer and Enax, 2018) are originated as a consequence of disturbance in this homeostasis inside the oral cavity (Marsh, 2006).

2.2.1 Oral health of preschool children

2.2.1.1 Global trends

Worldwide, studies had shown that ECC is highly prevalent among preschool children (Chen et al., 2017; Gao et al., 2014). The information on ECC prevalence was more with the countries having increased number of practitioners, they showed that ECC was more prevalent in countries with high economic growth (El Tantawi et al., 2018) and in the South

East Asian countries (Duangthip et al., 2017). It commonly effects males more than females (Shalan, 2018). Feldens et al, (2006) recorded high scores of visible dental plaque (99%) and poor gingival health (77%) among preschool children of Brazil (Feldens et al., 2006). In severe forms of ECC, children had low weight and slow growth because they had difficulty in eating (Sheiham, 2005). ECC has increased the societal costs and affected quality of life of preschool children and their parents greatly, but it is treated infrequently in many countries. Proper understanding about causes of ECC, preventive strategies including improvement in dietary habits and development of correct toothbrushing behaviour with use of fluoride products among preschool children can reduce prevalence of ECC. Also, management of ECC at an early stage and according to the needs of the preschool children is required (Tinanoff et al, 2019). World Health Organisation in their recent meeting emphasized on the development of strategies for prevention of ECC, which would be based on WHO Guidelines. These strategies are incorporated into existing primary healthcare systems and focus on the behaviour modification of families and communities. Dental professionals and other communities related to health promotion were trained to detect ECC at an early stage and individual fluoride administration is carried out (Phantumvanit et al., 2018).

2.2.1.2 Oral health of Malaysian preschool children

According to NOHPS latest report (2015), oral hygiene was found to be poor among preschool children of rural areas and males, probably because more males were examined. (NOHPS,2015). A variation in good oral hygiene was also observed among different

ethnicities living in Malaysia, it was lower in other Bumiputera ethnic group than Indian/Pakistani ethnic groups Preschool children studying in government kindergartens had poor oral hygiene compared to private kindergartens. The report also stated that the prevalence of substantial plaque was highest in Perlis than other states of Malaysia effecting male population more. The prevalence of ECC was found to be 71.3% among 5-year-old children of Malaysia, the highest rate was recorded in the state of Kelantan, rural areas, government kindergartens and other Bumiputera ethnic groups (NOHPS,2015). A National Oral Health Plan 2011-2020 (NOHP 2011-2020) was, therefore developed by the Oral Health Division, Ministry of Health, Malaysia. This plan aimed to reduce the prevalence of ECC among preschool children to 50% by the year 2020 (Jaafar, 2011).

2.3 Assessment of toothbrushing behaviour (reported and observed) and its association with oral health

Toothbrushing behaviour has great impact on oral health status of preschool children. A study was conducted on 2 to 4 years old Brazilian children and their mothers. The toothbrushing behaviour reported by mothers varied from the observed behaviour in terms of frequency of habits (Martins et al., 2011). Another study was conducted on preschool children and their parents in Shiraz, Iran. The toothbrushing habits were found to be unsatisfactory, more than half of children started toothbrushing at an age of 2 years which was associated to their father's education and nearly quarter of them brushed infrequently which was associated with the number of children in the family and mother's occupation

(Shaghaghian et al., 2017). Another study on Iranian preschool children belonging to high socioeconomic status revealed that frequency of snack consumption, supervision during toothbrushing, maternal caries and the mother's education was related to the oral health of preschool children (Noaman, 2019). Boustedt et al, (2020) concluded in their study that high caries risk was associated with brushing less than twice a day and improper toothbrushing technique, therefore, parents should supervise their children (Boustedt et al., 2020).

2.4 Summary of Literature Review

Previous studies conducted on the toothbrushing behaviour of preschool children assessed only one or two parameters of toothbrushing behaviour in a study e.g. toothpaste amount (Sotthipoka et al., 2018). As all the toothbrushing parameters are related , their impact on the oral health of preschool children cannot be assessed accurately unless all these parameters are recorded. Such investigations were mostly based on self-reporting, where parents reported about their children's oral habits. These questionnaires reflected more parental knowledge than their children's oral health behaviour (Elidrissi & Naidoo, 2016; Soltani et al., 2017). Other studies used the observation of preschool children's toothbrushing. The participants' consciousness of being observed and the change of environment reduced the chances of capturing natural behaviour (Gardner,2000). Moreover,

manual analysis of toothbrushing videos is a tiring procedure that tend to have chances of human error.

CHAPTER 3*:* Methodology

3.1 Study Design

It was a single visit cross-sectional study designed to assess toothbrushing behaviour and determine its association with the oral health status of preschool children during their onetime participation in the study. The data collection was completed in a duration of one year (March 2018-19).

3.2 Ethical considerations

The ethical approval for this study was obtained from medical ethics committee, Faculty of Dentistry, University of Malaya [Reference number DF CD1707/0039(L)] (Appendix A).

3.3 Study Population and Sampling

3.3.1 Reference population

All the children of age group 4-6 years accompanied by parents/guardians.

3.3.2 Participant's recruitment for the study

The recruitment of participants for the study were done by advertising the nature of the study on various social networking groups and placing posters in different areas within the Faculty of Dentistry (e.g. reception, outpatient clinic entrance and waiting area of Paediatric dental clinic). The interested parents/guardians who fulfilled the inclusion

criteria of the study were then given appointments for the conduct of the study. All study participants were required to register at the outpatient clinic, Faculty of Dentistry, University of Malaya.

3.3.3 Sampling frame

The preschool children of age group 4-6 years accompanied by their parents/guardians either attending outpatient clinic, faculty of dentistry or children of staff members of University of Malaya, who were invited to participate in the study.

3.4 Sample size calculation

A latest version of G-power sample size calculator (3.0.1.9.2) was used to calculate the study sample size. It had a type I error of 0.05 and power was maintained at 90%. A correlation value of 0.3 (between toothbrushing duration and plaque score) was taken from a previous study with similar methodology (Sandstrom, Cressey et al., 2011). The resultant sample size calculated was 92 preschool children (Table 3.1).

Table 3.1: Sample size calculation

Article	α	Power	ρ	n
Sandstrom, Cressey et al. 2011	0.05	0.90	0.3	92

3.5 Sampling design

3.5.1 Sampling method

A convenience sampling technique sampling technique was used for the participants selection until the required sample size was achieved**.**

3.5.2 Inclusion criteria

The inclusion criteria for recruiting study participants is as follow:

1. Malaysian citizens.
2. New patients reporting to Paediatric Dental Clinic, University of Malaya or children of staff members of University of Malaya.
3. Children were of age group of 4-6 years.
4. Children with no current tooth infection and had not taken antibiotics in the last one month.
5. Children with no systemic illness.
6. Children accompanied by parent/guardians who was involved in the upbringing of the child.
7. The parents/guardians who could read and write English or Bahasa Melayu.

3.5.3 Exclusion criteria

1. Participant who were non-Malaysian citizens.
2. Children whose parents/guardians informed that their children did not brush their teeth.
3. Preschool children who had acute odontogenic infection and had taken antibiotics in the last one month.
4. Preschool children with any type of systemic illness.
5. Preschool children who were accompanied by parents/guardians who did not spend much time with them.
6. Parents/guardians who were unable to read and write in English or Bahasa Melayu.

3.6 Study variables

There were three types of variables used in the study namely; independent variable, dependent variable and confounding variable. These are explained below:

3.6.1 Independent variables

Toothbrushing behaviour was the independent variable of our study which was assessed by the following parameters:

I. Toothbrush

a. Type

b. Type of grip

II. Toothpaste
   a. Type
   b. Amount
III. Toothbrushing
   a. Frequency
   b. Duration
   c. Technique
   d. Pattern
IV. Post brushing mouth rinsing
V. Parental guidance

3.6.2 Dependent variable

Oral health status of preschool children was the dependent variable of present study. It was evaluated in terms of plaque score (pre and post brushing), gingival index and dental caries status.

3.6.3 Confounding variables

According to the literature, dietary habits and socioeconomic status of preschool children also effect oral health of preschool children. Therefore, these two factors were included in the study as confounding variables.

3.7 Study instruments

The following tools and instruments were used in the study:

3.7.1. Data Recording Form

A data recording form (DRF) was designed and used by the researcher for record keeping purpose. It consisted of four parts, (A) charting for gingival index, (B) charting for children's plaque scores before and after toothbrushing, (C) charting for dental caries status of the child and (D) charting for toothbrushing parameters. (Appendix D).

3.7.2. Patient Information Sheet

A patient information sheet (PIS) was provided in two convenient languages English and Bahasa Melayu. It consisted of details about the study (purpose, procedure and benefits) and was given to the parents/guardians of eligible children before participating in the study (Appendix B). It was approved by the Faculty of Dentistry, University of Malaya.

3.7.3. Consent letter

The eligible parents/guardians were given a written informed consent form. It requested parents/guardians for their permission (for themselves and their preschool children) to participate in the study. It was also prepared in two languages and was approved by the Medical Ethics Committee, Faculty of Dentistry, University of Malaya. (Appendix C)

3.7.4. Questionnaire

A simple structured questionnaire was designed to explore parents/guardian's oral health knowledge and understand their child's oral health behaviour. The questionnaire was adapted from a previous published study (Buhari et al., 2016). It was drafted in English and then translated to Bahasa Melayu, the local and national language of Malaysia by a language expert. It comprised four sections (Table 3.2). Stepwise construction of questionnaire is shown in the Figure 3.1. (Appendix E).

Table 3.2: Sections of Questionnaire

Section	Name	No. of questions
A	Demographic information of parents/guardians	4
B	Demographic information of child	5
C	Child's feeding habits	7
D	Child's oral health practice	10

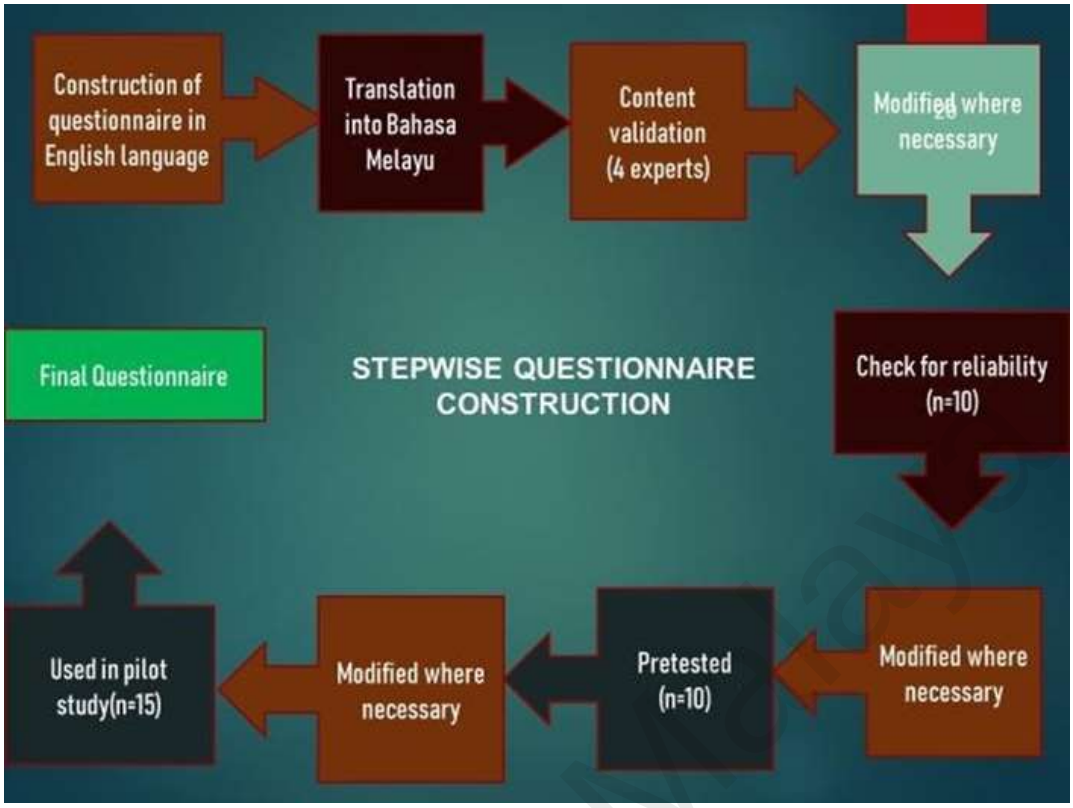


Figure 3.1: Stepwise construction of Questionnaire

3.7.5 Behavioural Observation Research Interactive Software (BORIS)

This is an innovative tool which was previously used to study animal behaviour. The present study was among the pioneer studies in the field of dentistry to use it for studying human behaviour (Friard and Gamba., 2016). The pre-recorded videos are uploaded in the software as an individual ethogram. The behaviour is then defined and coded as point or state event. The modifiers are then used to add attributes to the behaviour for example toothbrushing duration can be

either <30s or 1min or 2min or more. The video is then played and controlled using a toolbar according to desire. BORIS can be switched on and off to a frame-by-frame mode during observations and slowed down to a desired percentage of the original tempo. This feature makes it possible to analyse each step in the video easily, with more detail and focus on a display (e.g. toothbrushing strokes, toothpaste amount etc.). When viewing toothbrushing videos, each key pressed results in the insertion of a behavioural display at the time in which it occurs in the video. The occurrence of a behaviour in an individual can be reviewed using a graphical representation or by generating a time-budget analysis.

As shown in the screenshot below (Figure 3.2) the data extraction from the video of patient 2. A video of a child, brushing her teeth is visible. To the left, a box titled 'Ethogram' is visible. All the toothbrushing parameters, its descriptions, event type and codes assigned to each parameter are enlisted in this table. Below 'ethogram', is another box titled 'subject', It has information about the participant in the video. To the right, another table can be seen, recording all the parameters time to time.

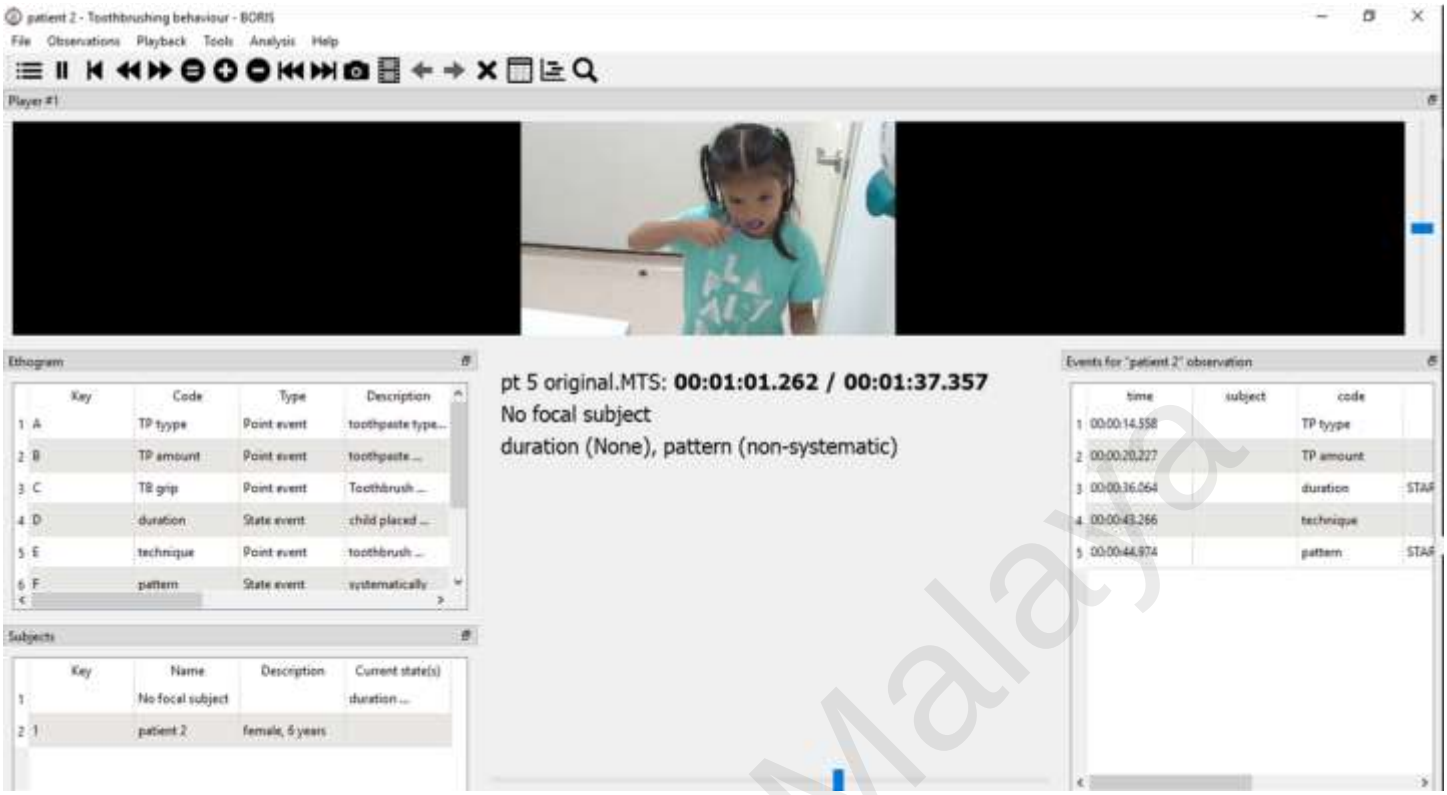


Figure 3.2: Data extraction from BORIS software

The video recorded toothbrushing behaviour was studied with this software to extract information according to the following parameters:

i. Toothpaste type: The type of toothpaste selected by the child/parent based on the fluoride content.

ii. Toothpaste amount: The amount of toothpaste dispensed on the toothbrush by the child was categorised according to toothpaste length on brush.

iii. Toothbrush grip type: The type of toothbrush grip was recorded according to the toothbrush grasp by the child.

iv. Toothbrushing duration: The duration of toothbrushing was noted from the time children placed their toothbrush on teeth until they finished and kept the brush aside.

v. Toothbrushing technique: It was recorded based on the direction of toothbrush strokes.

vi. Toothbrushing pattern: It was based on the systematic nature of toothbrushing.

vii. Post-brushing mouth rinsing: The number of times a child rinsed their mouth after brushing their teeth.

viii. Parental guidance: The parents/guardians were scored for their involvement in the toothbrushing session according to the criteria.

3.7.6 The Plaque Control Record

The plaque identification was performed using "The Plaque Control Record" (O' Leary et al.,1972) on both buccal and lingual sides of all the teeth. A plaque disclosing solution (Mira -2- Ton) was used for identifying plaque on the tooth surfaces. All teeth were scored. Each tooth was scored on four surfaces; mesial,

distal, facial and lingual depending upon the presence of plaque on them. Later, these scores were totalled and divided by the number of teeth present in the mouth and then multiplied by 100 to get a percentage. The calculated percentage was then averaged and categorised according to the scoring enlisted below in Table 3.3.A total of 80 tooth surfaces (primary teeth) per child were scored. The plaque scores recorded before and after toothbrushing were used to calculate plaque score change, by subtracting the post brushing plaque score from the pre-brushing plaque score.

Table 3.3: Plaque Scoring Criteria

Plaque score (%)	Category
0-10	Excellent/ very good
11-25	Good
26-35	Fair
>35	Poor

3.7.7 Loe and Silness gingival index

Gingival index was calculated using the Loe and Silness Gingival Index (Loe,1963). The six index teeth (55,52,64,75,72,84) were scored for four surfaces per tooth namely; mesial, distal, facial and lingual depending upon the extent of gingival inflammation as shown in Table 3.4. For individual tooth score, the scores of four surfaces were totalled up and divided by the number of surfaces (4). For mouth score (individual child score), all the tooth scores were totalled and divided by the number of index teeth (6). The mouth score was

calibrated accordingly to grade gingivitis; 0 = normal gingival; 0.1-1.0 = mild gingivitis; 1.1-2.0 = moderate gingivitis and 2.1-3.0 = severe gingivitis. Total 24 tooth surfaces were examined in each child for gingivitis. The missing teeth in this index were not replaced.

Table 3.4: The criteria for Gingival index

Score	Criteria
0	Absence of inflammation
1	Mild inflammation: Slight change in colour and texture. There is no bleeding on probing
2	Moderate inflammation: Moderate glazing, redness, edema and hypertrophy. There is bleeding on probing.
3	Severe inflammation: Marked redness and hypertrophy, a tendency to spontaneous bleeding and ulceration.

3.7.8 International Caries Detection and Assessment System II (ICDAS)

The dental caries status was assessed according to the latest criteria "International Caries Detection and Assessment System" (ICDAS II). A two-coded ICDAS II was used with first digit indicating the type of restoration (Table 3.5A) and second digit indicating tooth decay as shown in Table 3.5B. ICDAS II coding was used for the assessment of dental caries (tooth surfaces) because it provides information about cavitated and non-cavitated lesions and restored surfaces, which is not possible with DMF index. ICDAS codes 1-3 refer to enamel caries and codes 4-6 refer to dentine caries. However, for analysis purposes, the codes

were converted to dfs index such that . the sum of both categories ($dfs_{(1-6)}$) was used for determining the association between toothbrushing behaviour and oral health status of the preschool children.

Table 3.5 A: ICDAS II digit I coding criteria (type of restoration)

Code	Criteria
0	Sound
1	Partial sealant
2	Full sealant
3	Tooth coloured restoration
4	Amalgam restoration
5	Stainless steel crown
6	Porcelain/gold/ PFM crown or veneer
7	Lost/broken restoration
8	Temporary restoration
97	Tooth missing due to caries
99	Tooth unerupted

Table 3.5 B: ICDAS II-digit II coding criteria (Type of tooth decay)

Code	Criteria
0	Sound tooth surface
1	First visual change in enamel
2	Distinct visual change in enamel
3	Localized enamel breakdown
4	Underlying dark shadow from dentine
5	Distinct cavity with visible dentin
6	Extensive

3.7.9 Parental guidance criteria

To evaluate the extent of parents/guardians' guidance during preschoolers toothbrushing, a scale was compiled after observing them during the pilot study. The details of the criteria are given in Table 3.6.

Table 3.6: Parental Guidance Score

Code	Criteria
0	Parents/guardians were not involved at all during the child's toothbrushing session.
1	Parents/ guardians only observed during the child's toothbrushing session
2	Parents/guardians provided verbal guidance only during child's toothbrushing session.
3	Parents/guardians brushed for their child and did not permit the child to brush themselves.
4	Parent/guardians brushed for their child after the child had attempted to brush independently.
5	Parent/guardians observed and used a verbal and hands-on approach to assist child during toothbrushing.

3.7.10 Toothbrushes

The toothbrushes used in the study were kept standardized. Colgate children soft toothbrushes were used which included two age group ranges (2-5years and 5-9 years) (Figure3.3). Both had oval shaped head, measuring 25mm and 27mm long and 5mm and 7mm wide respectively. It had nylon bristles set in a row of

four and extra soft round ended filaments. The handle was slightly curved and ergonomically designed with both hard and soft components.

Figure 3.3: Children's Colgate Toothbrushes provided during toothbrushing session

3.7.11 Toothpastes

All the participants were provided with a range of toothpastes commonly available in the Malaysian market and children had to select from them. The variety of toothpastes selected was based on those commonly reportedly used by the participants in the pilot study. At the time of the study very limited

toothpastes had 1000ppm F(Anis et al., 2019). Colgate Maximum Cavity Protection (1450ppm F) being adult toothpaste, Colgate children toothpaste (600ppm F), Darlie children toothpaste (600ppm F) and Kodomo Lion children toothpaste (500ppm F) were also included as children's toothpaste. Pureen was the non-fluoridated toothpaste among the variety (Figure 3.4).

Figure: 3.4 Toothpastes provided during the toothbrushing session

3.8 Calibration of study instruments

1. Questionnaire

Content validation of questionnaire was performed by a panel comprising four experts from the Department of Paediatric Dentistry and Community Dentistry. The values for reliability of questionnaire (test-retest coefficient) calculated were 0.7-0.8. The result of pretesting questionnaire conducted on 10 parents/guardians (not involved in main or pilot study) indicated a good reliability thus, minor changes in only two sections were needed in terms of rephrasing of some terminologies.

2. Plaque control record

The two-way intraclass correlation coefficient values (ICC) were calculated using findings from the 15 participants during the pilot study and was calibrated between the researcher and a gold standard, one of the supervisors who is specialist paediatric dentist. The calculated values for the inter-rater calibration of pre- and post-brushing plaque score were 0.85 and 0.78 respectively. The intra-rater calibration for pre-brushing plaque score was 0.97 and post- brushing plaque score was 0.99. These values represented a good calibration.

3. Loe and Silness gingival Index

The two-way intraclass correlation coefficient values (ICC) were calculated using findings from the 15 participants during the pilot study and was calibrated between the researcher and a gold standard, one of the supervisors who is specialist paediatric dentist. The ICC values calculated for inter-rater calibration of gingival index was 0.87 and intra rater calibration of dental caries status was 0.97.

4. International Caries Detection and Assessment System II (ICDAS)

The two-way intraclass correlation coefficient values (ICC) were calculated using findings from the 15 participants during the pilot study and was calibrated between the researcher and a gold standard, one of the supervisors who is specialist paediatric dentist. The ICC values calculated for inter-rater calibration of dental caries status was 0.88 and intra rater calibration of dental caries status was 0.9.

5. Behavioural Observation Research Interactive Software (BORIS)

A Cohen's kappa calibration for BORIS represented excellent agreement between the two raters with the value of 0.9. It was calibrated using findings from 15 videos during the pilot study, between the researcher and trained software expert.

6. *Parental guidance criteria*

A kappa score for parental guidance was calculated to be 0.8 representing a good level of agreement between the two raters. It was calibrated using findings from 15 videos during the pilot study, between the researcher and gold standard; specialist paediatric dentist.

3.9 Conduct of the study

3.9.1 Pilot study

A pilot study was conducted on 15 preschool children and their parents/guardians. During this study all the procedure and study parameters were tested to eliminate unanticipated problems, parents/guardians were observed and criteria for parental guidance was developed, assessment of commonly used toothpastes was done to ensure that they were provided for the main study and study instruments were calibrated.

3.9.2 Data collection

The eligible preschool children along with their parents/guardians were briefed about the study and provided with patient information sheet (English or Bahasa) for further explanation. A written informed consent was then signed by parents/guardians for themselves and their children. After this, parents/guardians were requested to fill the questionnaire about oral health behaviour of the preschool children. During this time preschool children were examined orally for gingival index and pre-brushing plaque score using dye for identification (Mira-2-ton) (Figure 3.5). Then, both (children and parents/guardians) were invited to the children's toothbrushing session at a mock setup

that consisted of a washbasin, a mirror, disposable cup, a stool for participant's convenience and a range of toothpastes, as shown in the Figure 3.6. The children were provided toothbrushes suitable for their age. Complete confidentiality and a comfortable surrounding space were ensured. This session was video recorded with a Handycam (Sony, HDR-CX405 HD) which was mounted on a tripod stand located behind the mirror and was partially hidden. They could select the toothpaste either of their choice or the one they used at home and were instructed to brush as they did at home. Once they had completed toothbrushing, the child was re-examined for post-brushing plaque score using the same dye reapplication. The dental caries status was recorded after oral prophylaxis. At the end, both were taught about proper oral health care using videos and model demonstrations and made to practice as well (Figure 3.7). The children were also given small gifts as token of appreciation. Qualitative (video recording) and quantitative data (questionnaire) were collected on the same day. The results obtained from both the aforementioned methods were combined as part of the evaluation of data (mixed mode)

Figure 3.5: Oral examination of child

Figure 3.6: Toothbrushing station

Figure 3.7: Oral care education and learning station

3.10 Data analysis

a) SPSS (version 26)

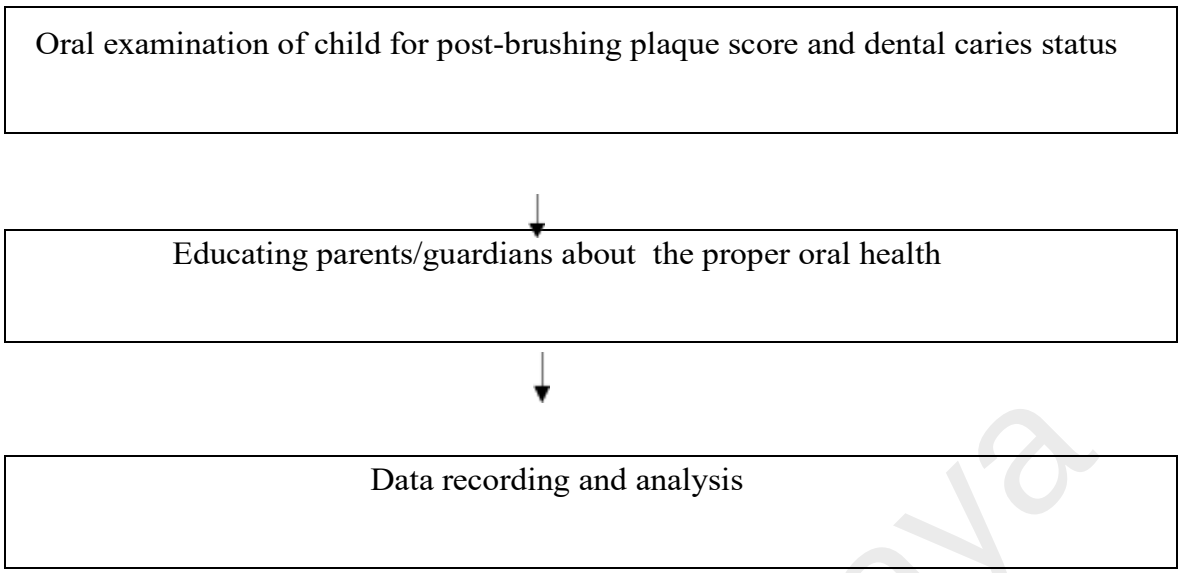
Descriptive statistics of SPSS were used for evaluation of toothbrushing behaviour and oral health status of the preschool children. The categorical data was represented in terms of frequency and percentages and continuous data was represented by Mean and standard deviation. The SPSS was also used for calibration of study parameters. Moreover, demographic information and confounding variables were also analysed in terms of frequency and percentages. A significance level of 0.05 was used.

b) Smart PLS version 3.2.9

Another innovative and advanced statistical tool was used for determining the association between toothbrushing behaviour and oral health status of preschool children (Ringle et al., 2016). A second-generation multivariate analysis was performed to create two models, first without confounding variables and second with confounding variables. Each model had an outer/measurement and inner/structural model. The outer/measurement model explained the influence of each factor (e.g. electric toothbrush) on its respective latent variable (e.g. toothbrush type). The number denotes the strength of the contribution, The higher the number, the stronger the contribution. It explains each factor using the term multicollinearity; a condition in which two or more factors are correlated and was determined by Variance Inflation Factor (VIF). All the variables contributing to the toothbrushing behaviour were checked for highly correlated variables. The variables of outer model were divided into formative

constructs; group of factors contributing to form the respective latent variable and reflective constructs; factors that are formed by their respective latent variable. The inner/structural model represented the relationship between toothbrushing behaviour (IV) and oral health status (DV) and was explained in terms of coefficient of determination, path analysis and bootstrapping. The coefficient of determination (R^2) was interpreted as the proportion of the variance in the dependent variable that is predicted by the independent variable. The path analysis (β) determined the causal linkage between toothbrushing behaviour and oral health status and bootstrapping; which is a test for estimation of sample distribution using random sampling method (p-values). The flow chart of the study is shown below in Table 3.7.

TABLE 3.7: Flow chart of the study



CHAPTER 4: RESULTS

4.1. Main study findings

4.1.1 Demographic characteristics of preschool children

A total of 92 preschool children (4-6 years) participated in the study along with their parents or guardians. Girls were slightly greater in number than boys. About two third of the participants were Malay however, a discernible percentage (34%) also belonged to other ethnicities (Chinese, Indian and others). Among the three age groups of preschool children; age group 4 years was higher in proportions than 5- and 6-year old. Majority (90%) of parents/guardians accompanying children had tertiary level of qualification. Only one- fifth of parents/guardians were working in the health-related departments, 33% were employed in the non-health related sectors, 23% were studying and almost 30% were home makers. Slightly less than half of preschool children had large families with more than two siblings and spent most of their time with their mothers (50%) than fathers (12%), relatives (15%) and caregivers (23%). Nearly half of the preschool children were the eldest child of the family although, the middle and last child accounted for 23% and 31% respectively. The demographic characteristics of the participants are given in the Table 4.1.

Table 4.1: Sociodemographic information of preschool children

Variables		Number of participants (n=92) (n=%)
Age	4 years	35(38)
	5 years	27(29.3)
	6 years	30(32.6)
Gender	Girl	49(53.3)
	Boy	43(46.7)
Ethnicity	Malay	61(66.3)
	Chinese	22(23.9)
	Indians	9(9.8)
	others	2(2.2)
Parents Education	Primary level	2(2.2)
	Secondary level	7(7.6)
	Tertiary level	83(90.2)
Parents occupation	student	21(22.8)
	Housewife	27(29.3)
	Health sectors	14(15.7)
	Other sectors	20(21.7)
	Business owner	10(10.9)
Number of children in family	One	15(16.3)
	Two	35(38.0)
	>two	42(45.7)

4.1.2 Evaluation of toothbrushing behaviour of preschool children

The toothbrushing behaviour was evaluated quantitatively (questionnaires) and qualitatively (video recording). The findings are explained accordingly in the following subsections (Table 4.2):

4.1.2.1 Reported behaviour (questionnaire)

Nearly 40% parents/guardians reportedly started toothbrushing for their children at an age of 1-2 years and a quarter of them started by the age of 3-4

years. Although, a small proportion of children (17%) started toothbrushing at an age of 6 months to 1 year, and one-tenth started brushing even before the age of 6 months. About half of the preschoolers brushed twice a day and 12% brushed more than twice a day. A small number (8.7%) of children reportedly brushed once a day, whereas 11% did occasionally once in 2 to 3 days and 18% rarely brushed. More than half of parents/guardians changed their children's toothbrush when bristles frayed, 26% replaced their toothbrushes every 2 to 3 months and 16% replaced them after every 15 days. A few (4.3%) also reported to change their children's toothbrush every month and two (2.2%) parents/guardians had not changed their children toothbrush yet. More than 80% of parents/guardians reported that their children did not shared toothbrush with their siblings, of which 11% of children did not share their toothbrushes because they had no siblings. However, four (4.4%) children shared toothbrush with siblings. The percentage of preschoolers undergoing dental check-up was 35%, only 30% visited the dentist for toothache and more than 30% (32) never visited the dentist.

4.1.2.2 Observed behaviour (video recording)

Some aspects of toothbrushing behaviour were observed through video recording including toothbrushing technique, pattern, toothbrush grip type and post brushing mouth rinsing. Among the four different toothbrushing techniques more than two-fifth (41.3%)

of preschool children were observed to use horizontal scrubbing technique followed by rotational (22%) and vertical (16%). About one-fifth of them brushed superficially without any defined strokes. Slightly more than half of preschoolers brushed in a non-systematic pattern and only forty-five (48.9%) brushed systematically covering most of the tooth surfaces. The preferred toothbrush grip type was distal oblique (34%) followed by oblique (27%), power (15%), precision (14%) and spoon (6%). More than 70% preschool children were observed to rinse once after toothbrushing however, 22% rinsed multiple times and 5% did not rinse.

Figure4.1: Different toothbrush grip types

4.1.2.3 Comparison of toothbrushing behaviour variables assessed by both (quantitative and qualitative) methods

A few toothbrushing variables were assessed by the both methods. Among toothbrush types used by the preschool children, children's manual toothbrush was reportedly preferred (67%) over children's electric toothbrush (23%). Nevertheless, almost one-tenth (9.8%) of the preschool children brushed with fingers or other objects including neem sticks. In terms of observation, toothbrush type was standardized, and only children's manual toothbrush was provided to the children during the toothbrushing session. Although, the proportion of preschool children reportedly using F lesser than 1000ppm (30%) was more than that observed, the reported values of those using fluoridated (F greater than 1000ppm; 1450ppm) and non-fluoridated toothpastes were lower than the observed values. A smear sized toothpaste amount was reportedly used by 30% of preschool children but 47% were observed to do so. The pea sized and full-length toothpaste amounts were used by reportedly more preschool children compared to those observed in the videos. Only nine (9.8%) parents/guardians reported half-length of toothpaste amount used by their children whereas fourteen (5.2%) were actually observed using this amount. About 38% preschoolers reportedly brushed for 1-2mins but, nearly half of them were observed to do so. The reported values for toothbrushing duration of 30s-1min was more (40%) than that was observed (14%). Almost, 15% of preschool children reportedly brushed for less than 30 sec but only one-fifth of them actually performed. Double the number of preschool children were observed to brush

for more than 2mins than was reported. According to the reported values, only 43% of preschool children were supervised daily and 52% were occasionally supervised by their parents/guardians during toothbrushing. However, on observation 46% were not supervised at all, 18% parents/guardians brushed for their children and did not allow them to brush for themselves. 8.7% were provided verbal guidance only and toothbrushing was performed by parents/guardians after allowing them to brush independently in 6.5% of children. Only ten (10.9%) parents/guardians guided their children with both verbal and hands-on approach.

Table 4.2: Reported and observed toothbrushing behaviour (IV) of preschool children

Variables (n=92)		**Reported n(%)**	**Observation n (%)**
Child started Toothbrushing	< 6 months	9(9.8)	NR
	6 mon-1 year	16(17.4)	
	1-2 years	37(40.2)	
	2-3 years	7(7.6)	
	3-4 years	23(25)	
Toothbrushing frequency	Once a day	8(8.7)	NR
	Twice a day	46(50)	
	>2 times a day	11(12)	
	Once in 2-3 days	10(10.9)	
	Rarely	17(18.5)	
Toothbrush type	Powered Toothbrush	21(22.8)	Not assessed as it was kept fixed by the researcher
	Manual Toothbrush	62(67.3)	
	Finger or other object	9(9.8)	
Frequency of Toothbrush change	Once in 15 days	15(16.3)	NR
	Once in month	4(4.3)	
	Every 2-3 months	24(26.1)	
	Once bristles frayed out	47(51.1)	
	Has not changed yet	2(2.2)	

Table 4.2: continued			
Variables (n=92)	**Reported n(%)**	**Observation n (%)**	**Variables (n=92)**
Toothpaste amount	Smear	28(30.4)	43(46.7
	Pea	32(34.8)	26(28.3)
	Half length	9(9.8)	14(5.2)
	Full length	23(25)	9(9.8)
Toothbrushing Duration	< than 30 sec	13(14.1)	18(19.6)
	30sec-1min	37(40.2)	13(14.1)
	1-2 min	35(38.0)	47(51.1)
	>2min	7(4)	14(15.2)
Toothpaste type	fluoridated(F greater than1000ppm)	11(12)	28(30.4)
	Fluoridated (F less than1000ppm)	74(80.4)	46(50)
	Non- fluoridated	7(7.6)	18(19.6)
Parental guidance	Yes occasionally	48(52.2)	
	No	4(4.3)	
Toothbrushing technique	Horizontal	NR	38(41.3)
	Rotatory motion		21(22.3)
	Vertical		15(16.3)
	Other method		18(19.6)
Toothbrushing pattern	Systematic	NR	45(48.9)
	Non-systematic		47(51.1)
Toothbrush grip type (Child grip) (n=78)	Oblique	NR	21(26.9)
	Distal Oblique		27(34%)
	Precision		11(14.10)
	Power		14(15.2)
	Spoon		5(6.4)
Post-brushing mouth rinsing	Do not rinse	NR	5(5.4)
	Once		67(72.8)
	Multiple times		20(21.7)
Visit to dental clinic	Yes, for dental check-up	32(34.8)	NR
	Yes, for tooth ache	28(30.4)	
	No	32(34.8)	

Table 4.2: continued

Variables (n=92)	Reported n(%)	Observation n (%)	Variables (n=92)
Parental guidance during toothbrushing (observation)	Parents/guardians were not involved at all during the participant's child's toothbrushing session.	NR	42(45.7)
	Parents/ guardians only observed during their child's toothbrushing session		9(9.8)
	Parents/guardians provided verbal guidance only during child's toothbrushing session.		8(8.7)
	Parents/guardians brushed for their child and did not permitted the child to brush themselves.		17(18.5)
	Parent/guardians brushed for their child after the child has attempted to brush independently.		6(6.5)
	Parent/guardians observed and used a verbal and hands-on approach to assist their child during toothbrushing.		10(10.9)

4.1.3 Assessment of oral health status of preschool children

Oral health of preschool children was assessed in terms of plaque score, gingival index and dental caries status. Each is explained as follows:

a) Plaque score:

As shown in Table 4.3A, the pre and post brushing plaque scores among preschool children were categorised as poor. Although, a mean change in plaque score of 10.8(2.4) was observed (Table 4.3B), the traces of plaque were recorded on more than 35% of tooth surfaces even after toothbrushing.

b) Gingival index

About 28 (30%) preschool children had healthy gums free of gingivitis. Nearly half of the preschool children had mild and almost one fifth had moderate gingivitis. No record of severe gingivitis among preschool children was documented (Table 4.3A). The mean gingival index (Table 4.3B) of 0.8 (0.6) was recorded among preschool children.

c) Dental caries status

As shown in Table 4.3A, majority of preschool children had early childhood caries (ECC) with more than half having enamel caries and slightly less than 40% having dentine caries. The mean value for dentine caries was more than that of enamel caries (Table 4.3B). the classification of enamel and dentine caries is explained in chapter 3, section 3.7.4, page 34.

*O'Leary's and drake method (80 tooth surfaces)
** Loe and Silness gingival index (24 tooth surfaces)
*** ICDAS (88 tooth surfaces)

Table 4.3A: Oral health status of preschool children

Variable	Grading	n (%)
Pre-brushing plaque score*	Poor (>35%)	92(100)
	Fair (26-35%)	0
	Good (11-25%)	0
	Excellent (0-10%)	0
Post-brushing plaque score*	Poor (>35%)	92(100)
	Fair (26-35%)	0
	Good (11-25%)	0
	Excellent (0-10%)	0
Gingival Index**	No gingivitis	28(30)
	Mild gingivitis	46(50)
	Moderate gingivitis	18(19.6)
	Severe gingivitis	0
Dental caries status***	Enamel caries (dfs(1-3))	54(58.7)
	Dentine caries (dfs(4-6))	34(37)
	Enamel + dentine caries (dfs(1-6))	88(95.6)

Table 4.3B: Pre-schooler's oral health status (mean and standard deviation)

Variable	Mean	Standard deviation
Pre-brushing plaque score	90.3	10.2
Post-brushing plaque score	79.5	9.7
Plaque score change	10.8	2.4
Gingival Index	0.8	0.6
Dental caries status		
Enamel caries (dfs(1-3))	8.1	9.3
Dentine caries (dfs(4-6))	10.5	15.5
Enamel + dentine caries (dfs(1-6))	18.8	12.3

4.1.4 Association between toothbrushing behaviour and oral health status

The association was determined between toothbrushing behaviour which was the independent variable (IV) and oral health status, the dependent variable (DV) in the model. Two models were created; first was without

confounding variables, Model I (Figure 4.2) and second, Model II was with confounding variables (Figure 4.3). The association was explained by second generation multivariate analysis using coefficient of determination R^2 (variance), path analysis and bootstrapping.

4.1.4.1 Model I

This model was created without confounding variables (Figure 4.2). It was explained further using two sub models; outer model and inner model. The overall model portrays the association between IV and DV and amount of contribution by each factor of toothbrushing behaviour towards this association using two aforementioned sub models.

Outer model: As shown in the Figure 4.1 below, the part of the model depicting the toothbrushing variables is known as outer/measurement model. As explained in chapter 3 section 3.9b, this model explains the influence of each factor on its respective latent variable. The multicollinearity values determined by Variance Inflation Factor (VIF) were low (<3) for all the variables contributing to the toothbrushing behaviour (Table 4.4) and were reliable to explain the association between IV and DV.

Table 4.4: Collinearity values (VIF) for outer model (without confounding variables)

No.	Variables	Sub-categories (formative only)	VIF values
1.	Toothbrush type	Child's electric toothbrush	2.80
		Child's manual toothbrush	2.80
		Finger or other methods	-

2.	Toothbrush grip type	Distal oblique	1.17
		Oblique	1.06
		Power	1.12
		Precision	1.14
		Spoon	-
3.	Toothbrushing technique	Horizontal	1.83
		Vertical	1.67
		Rotatory	1.53

Table 4.5 shows the influence of formative construct factors on their respective latent variable. It was found that electric toothbrush had more influence than manual toothbrush (0.94) on the toothbrush types variable. Distal oblique grip (1.004) contributed more towards the variable toothbrush grip types followed by 'oblique', 'power' and 'precision'. Among different toothbrushing techniques, the influence of horizontal toothbrushing technique (1.275) was more than rotational and vertical towards the variable toothbrushing techniques.

Table 4.5: Factors weight contribution to the latent variables (without confounding variables)

No.	Variables	Subcategories (Formative only)	Outer weights
		Child's electric toothbrush	1.581

1	Toothbrush type	Child's manual toothbrush	0.94
		Finger or other methods	-
2	Toothbrush grip Type	Distal oblique	1.004
		Oblique	0.5
		Power	0.37
		Precision	0.517
		Spoon	-
3	Toothbrushing Technique	Horizontal	1.275
		Vertical	0.412
		Rotatory	0.473
		Other method	-

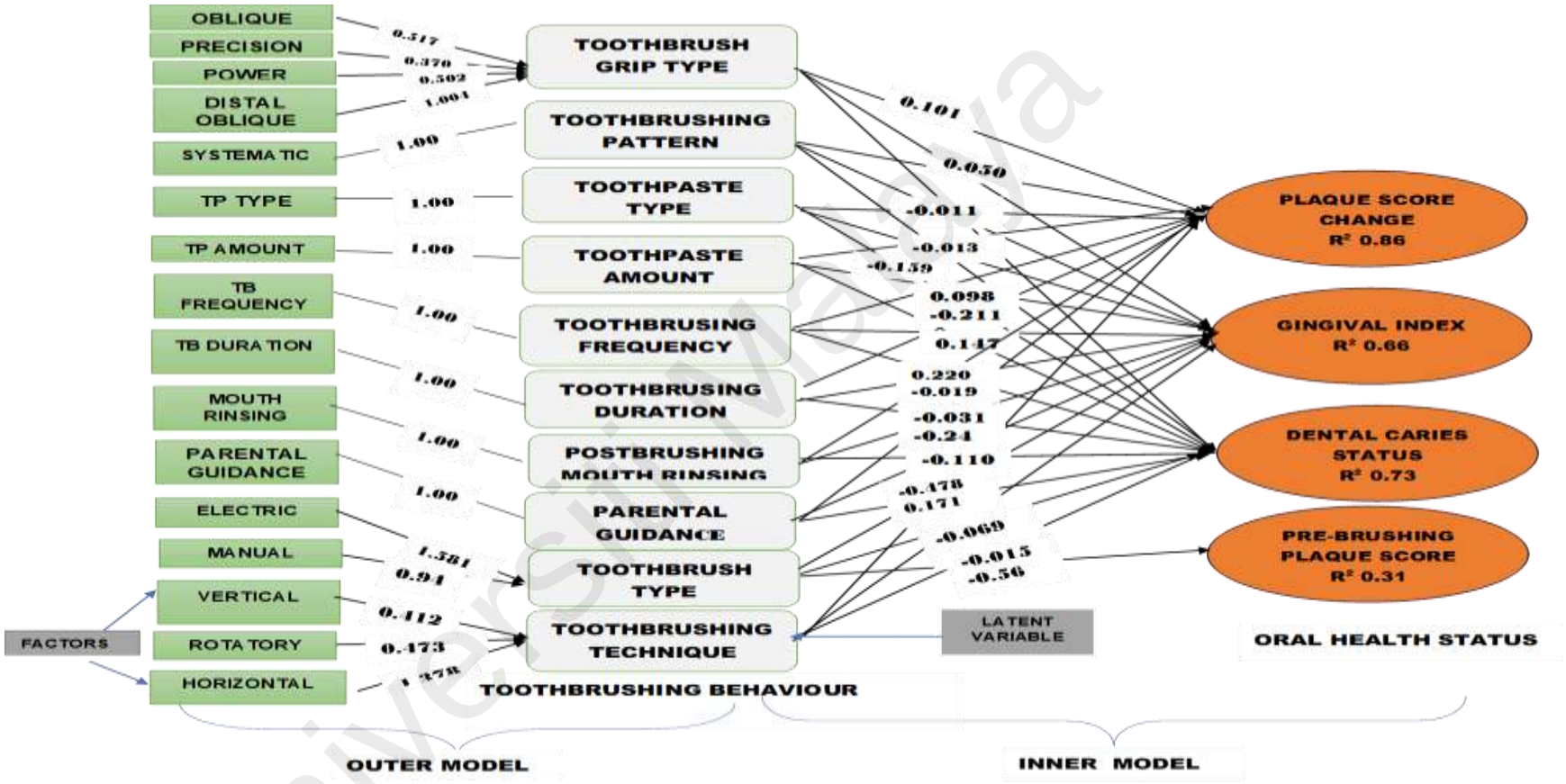


Figure 4.2: Model I depicting association between IV and DV (without confounding variables)

The reflective construct factors included toothbrushing pattern, frequency and duration, toothpaste type and amount, post-brushing mouth rinsing and parental guidance and can be seen in model I (Figure 4.1). All these variables measured one factor, so their value was 1.00. Systematic toothbrushing had more influence than non-systematic toothbrushing pattern. Among five different options of toothbrushing frequency namely; 'twice a day', '>twice a day', 'once a day', 'once in 2-3 days' and 'rarely'. Toothbrushing more than twice a day had the maximum influence on the variable' frequency of toothbrushing' variable. A toothbrushing duration of more than 2 minutes had the highest impact compared to '1-2mins','30s-1min' and 'less than 30sec' on its latent variable. In terms of toothpaste types fluoridated toothpaste (F greater than 1000ppm) had a greater influence than fluoridated (F<1000ppm) and non-fluoridated toothpaste. The full-length toothpaste amount contributed more than 'smear', 'pea' and 'half-length' to its respective latent variable. The 'post brushing mouth rinsing' variable had maximum contribution from factor 'no mouth rinsing' factor than rinsing once or multiple times. The combination of 'verbal and hands on approach of parental guidance' had the maximum influence on its latent variable compared to 'no involvement', 'observation only', 'verbal guidance alone', 'parent brushing for child' and 'parent brushing after child brushed the teeth'. Finally, spoon type of grip, finger or other method among different toothbrush type, other methods among toothbrushing techniques and non-

systematic toothbrushing pattern were removed from the model as it did not show any variance in the values.

Inner model: As discussed in chapter 3 section 3.9b, this section of the model is showing the association between toothbrushing behaviour (IV) and oral health status (DV) of preschool children. Table 4.6 shows the path analysis values (þ). All toothbrushing variables had direct association with gingival index and dental caries status and inverse relation with plaque score change except for toothpaste amount which showed direct relationship. Unlike plaque score change, toothbrush type had direct association with pre- brushing plaque score. However, all toothbrushing variables were not significantly associated with the oral health status. Only significant association was observed between toothbrush type with pre brushing plaque score and gingival index, toothbrush grip type with gingival index, toothpaste type with plaque score change, toothbrushing frequency with gingival index and dental caries status, toothbrushing technique with plaque score change, toothbrushing pattern with dental caries status, post-brushing mouth rinsing with plaque score change and parental guidance with plaque score change, gingival index and dental caries status (Table 4.6).

Table 4.6: The association between IV and DV depicted by Model I (without confounding factors)

No	oothbrushing Variables	Oral health status	B	SE	t value	P Values
1.	Toothbrush type	-brushing plaque score	-0.56	0.06	8.94	0.00*
		Gingival index	-0.24	0.07	3.42	0.00*
		Dental caries	-0.07	0.07	0.94	0.35
2.	Toothbrush grip	Plaque score change	0.10	0.06	1.67	0.10
		Gingival index	-0.06	-0.18	2.64	0.01*
		Dental caries	-0.06	0.07	0.96	0.34
3	Toothpaste type	Plaque score change	0.15	0.07	2.34	0.02*
		Gingival index	-0.06	0.11	0.50	0.62
		Dental caries	-0.21	0.10	2.10	0.04*
4.	Toothpaste amount	Plaque score change	-0.01	0.06	0.23	0.82
		Gingival index	-0.03	0.07	0.46	0.65
		Dental caries	-0.18	0.06	3.32	0.00*
5.	Toothbrushing frequency	Plaque score	0.10	0.06	1.69	0.10
		Gingival index	-0.25	0.09	2.81	0.01*
		Dental caries	-0.20	0.07	2.81	0.01*
6.	Toothbrushing duration	Plaque score change	0.15	0.05	2.86	0.01*
		Gingival index	-0.02	0.09	0.23	0.83
		Dental caries	-0.24	0.09	2.77	0.01*
7.	Toothbrushing technique	Plaque score change	0.18	0.05	3.85	0.00*
		Gingival index	-0.25	0.12	2.04	0.06
		Dental caries	-0.02	0.06	0.25	0.80
8.	Toothbrushing pattern	Plaque score change	0.05	0.07	0.79	0.43
		Gingival index	-0.01	0.11	0.10	0.92
		Dental caries	-0.16	0.08	2.03	0.05*
9 .	brushing mouth rinsing	Plaque score change	0.22	0.06	3.92	0.00*
		Gingival index	-0.03	0.09	0.36	0.72
		Dental caries	-0.11	0.06	1.73	0.09
10.	Parental guidance	Plaque score change	0.34	0.05	6.63	0.00*
		Gingival index	-0.20	0.09	2.11	0.04*
		Dental caries	-0.18	0.07	2.28	0.03*

*Significant at the level of 0.05

The coefficient of determination R^2 (Figure 4.2) was 0.860 for plaque score change. This showed that the variables (toothbrushing technique, duration, post-brushing mouth rinsing and parental guidance) highly explained (86%) variance

in plaque score change. The coefficient of determination R^2 was 0.315 for pre-brush plaque score. This shows that the variable toothbrush type moderately explained (31%) variance in the pre-brushing plaque score. The coefficient of determination R^2 was 0.668 for gingival index. This show that the variables (toothbrushing frequency, toothbrush type, toothbrush grip type, toothbrushing technique and parental guidance) highly explained (66%) variance in the gingival index. The coefficient of determination R^2 was 0.73 for dental caries status. This show that the variables (toothbrushing frequency, toothbrushing pattern, type and amount of toothpaste and parental guidance) highly explained (73%) variance in dental caries status.

4.1.4.2 Model II

The confounding variables: According to the literature, socioeconomic status (Table 4.1) and dietary habits (Table 4.7) were confounders in our study. A correlation analysis was conducted in the latest version of SPSS and only those factors which showed significant correlation with oral health status were included in the model., Socioeconomic status did not have a significant correlation with oral health. Only few dietary parameters showed correlation with oral health (marked by asterisk in Table 4.8. Thus, only the significant confounding factors were included in Model II (Fig 4.3- each single item contributing a weight of 1.00)

Table 4.7: Reported dietary habits of preschool children

Confounding factors	Categories	n (%)
Child feeding type	Solid	22(23.9)
	Bottle feeding	8(8.7)
	Breast feeding	2(2.2)
	Snacks	9(9.8)
	Solid food, bottle feeding, snacks	51(55.4)
Child started solid food	<1-year-old	20(21.7)
	1-2-year-old	62(67.4)
	2-3-year-old	9(9.8)
	3-4-year-old	1(1.1)
Is your child trained to drink in cup?	Yes	91(98.9)
	No	1(1.1)
Introduction of bottle feeding to the child?	6 months -1 year	27(29.3)
	1-2 year	10(10.9)
	Not applicable	8(8.7)
	6 months -1 year	27(29.3)
How often do you give your child breast/formula milk using bottle in a day?	never	1(1.1)
	occasionally	5(5.4)
	once	3(3.3)
	twice	21(22.8)
	Three times	21(22.8)
	>Three times	33(35.9)
	Not applicable	8(8.7)
How often do you give your child juice/sugary drinks (e.g. Milo and Ribena) using bottle in a day?	never	37(40.2)
	occasionally	19(20.7)
	once	3(3.3)
	twice	11(12.0)
	Three times	8(8.7)
	>Three times	6(6.5)
	Not applicable	8(8.7)
How often do you put your child to sleep with the bottle in his/her mouth?	everyday	9(9.8)
	sometimes	20(21.7)
	never	55(59.8)
	Not applicable	8(8.7)

Table 4.8: Confounding factors affecting oral health status of preschool children (p-values)

Variables	Plaque score change	Pre-brush plaque score	Gingival Index	Dental caries
Parent occupation	0.58	0.24	0.54	0.41
Parent education	0.09	0.522	0.39	0.07
Child started bottle feeding	0.06	0.05*	0.01*	0.10
Type of child feed	0.08	0.01*	0.05*	0.09
When did child started solid food?	0.1	0.03*	0.01*	0.01*
Is he cup trained	0.17	0.16	0.15	0.17
Milk per day	0.40	0.04*	0.03*	0.00*
Juice per day	0.06	0.06	0.06	0.08
Sleep with bottle	0.00*	0.01*	0.04*	0.00*

*Significant at the level of 0.05

Outer model: As shown in Figure 4.3, this sub model remained unchanged with the similar finding of outer model shown in Figure 4.2.

Inner model: There was no change recorded in the path coefficient values (þ). However, slight change in the variance (R^2) of gingival index, dental caries status and pre-brushing plaque score was noted and alteration in significance of association of some of the toothbrushing variables (toothbrushing frequency, pattern and post brushing mouth rinsing) was also recorded with the inclusion of confounding variables (Table 4.9). The coefficient of determination R2 for plaque score change, pre-brushing plaque scores, gingival index and dental caries were 0.86,0.33,0.69 and 0.76 respectively.

The outcome measures are explained in the subsection ‘Inner Model of Model I’ of this chapter.

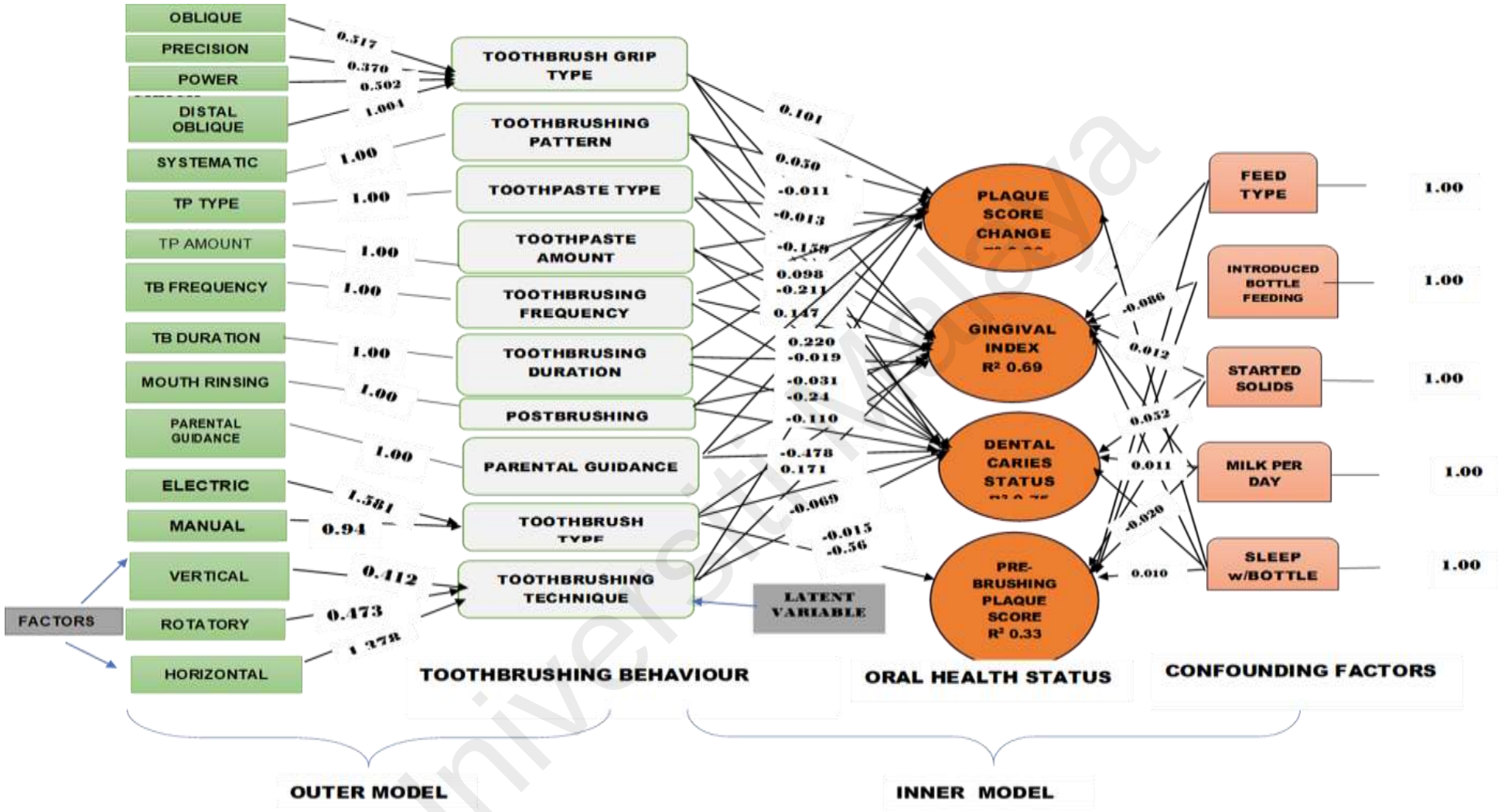


Figure 4.3: Model II depicting association between IV and DV (with confounding variables)

Table 4.9: Association between IV and DV depicted by Model II (with confounding variables)

No.	Toothbrushing Variables	Oral health status	B	SE	t value	P value
1	Toothbrush type	Pre-brushing plaque score	-0.56	0.06	8.94	0.00*
		Gingival index	-0.24	0.07	3.42	0.00*
		Dental caries	-0.07	0.07	0.94	0.35
2	Toothbrush grip	Plaque score change	0.10	0.06	1.67	0.10
		Gingival index	-0.06	-0.18	2.64	0.01*
		Dental caries	-0.06	0.07	0.96	0.34
3	Toothpaste type	Plaque score change	0.15	0.07	2.34	0.02*
		Gingival index	-0.06	0.11	0.50	0.62
		Dental caries	-0.21	0.10	2.10	0.05*
4	Toothpaste amount	Plaque score change	-0.01	0.06	0.23	0.82
		Gingival index	-0.03	0.07	0.46	0.65
		Dental caries	-0.18	0.06	3.32	0.00*
5	Toothbrushing frequency	Plaque score change	0.10	0.05	2.14	0.04*
		Gingival index	-0.29	0.08	3.69	0.01*
		Dental caries	-0.19	0.10	1.88	0.07
6	Toothbrushing duration	Plaque score change	0.15	0.05	2.74	0.01*
		Gingival index	-0.01	0.01	0.09	0.93
		Dental caries	-0.24	0.07	3.39	0.00*
7	Toothbrushing technique	Plaque score change	0.17	0.05	0.33	0.00*
		Gingival index	- 0.22	0.10	2.27	0.03*
		Dental caries	- 0.02	0.04	0.33	0.74
8	Toothbrushing pattern	Plaque score change	0.17	0.05	0.33	0.00*
		Gingival index	- 0.22	0.10	2.27	0.03*
		Dental caries	- 0.02	0.04	0.33	0.74
9	Mouth rinsing	Plaque score change	0.05	0.05	1.00	0.30
		Gingival index	-0.01	0.12	0.06	0.96
		Dental caries	-0.17	0.09	1.84	0.07
10	Parent involvement	Plaque score change	0.35	0.05	6.94	0.00*
		Gingival index	-0.22	0.08	2.61	0.01*
		Dental caries	-0.18	0.09	2.07	0.04*
11	Type of feed	Pre-brushing plaque score	-0.10	0.09	1.12	0.27
		Gingival index	-0.10	0.08	1.26	0.21

TABLE 4.9 'CONTINUED'

12	Child started solid food	Pre-brushing plaque score	-0.08	0.07	1.06	0.30
		Gingival Index	0.05	0.06	0.67	0.51
		Dental caries	0.04	0.06	0.91	0.37
13	Have milk per day	Pre-brushing plaque score	0.01	0.10	0.07	0.94
		Gingival Index	-0.10	0.07	1.49	0.14
		Dental caries	0.04	0.06	0.68	0.50*
14	Child sleep with bottle	Plaque score change	-0.05	0.04	0.16	0.25
		Gingival Index	0.01	0.07	0.09	0.93
		Dental caries	-0.02	0.06	0.34	0.74
		Pre-brushing Plaque score	-0.04	0.11	0.36	0.72
15	Child started bottle feeding	Gingival index	-0.09	0.07	1.21	0.23
		Pre-brushing plaque score	0.02	0.08	0.21	0.83

*significance level at 0.05

4.1.4.3 Comparison of Model I and II

With the addition of confounding variables, a small but significant change was recorded in terms of coefficient of determination (R^2) of gingival index, pre-brushing plaque score and dental caries status. Change in the significance of some of the toothbrushing variables (toothbrushing frequency, pattern and post brushing mouth rinsing) was also observed. Therefore, adapting proper toothbrushing behavior counterbalances the negative impact of poor dietary habit on the oral health status of preschool children.

CHAPTER 5: Discussion

Despite multiple intervention efforts, the oral health of preschool children remained poor (Nakre and Harikiran, 2013). Probably, because ECC is a multifactorial disease and it is difficult to monitor impact of every factor individually on the oral health of preschool children. Although, poor dietary habits and improper toothbrushing behaviour are both two major factors causing ECC, but in absence of proper toothbrushing behaviour and lack of fluoride toothpaste, risk of ECC is increased even more due to the poor dietary habits of preschool children (Palmer et al., 2010). Therefore, in the present study toothbrushing behaviour of preschool children was evaluated in depth and its association with oral health status of preschool children was determined. To the best of our knowledge this type of study has not been conducted on 4 to 6 years old children in Malaysia previously.

The present study had a cross-sectional design conducted for a period of one year, similar to the Iranian study that was conducted on the toothbrushing behaviour of preschool children (Soltani et al., 2017). However, other studies conducted on this topic were either educational programme or longitudinal study (Ceyhan et al., 2018; Wigen and Wang, 2014).

To conduct this study, a separate room was prepared adjacent to the paediatric dental clinic at Faculty of Dentistry, University of Malaya firstly, to facilitate

easy accessibility of adequate number of preschool children who fulfilled the inclusion criteria. Secondly, to ensure that there was no intimidation from the surroundings that could have made children conscious and hesitant to behave naturally. Study conducted in public places including kindergartens (Shaghaghian et al., 2017) reduced the chances of recording real behaviour due to disturbances from the surroundings (Gardner, 2000). Natural behaviour can be more elicited in familiar environment like home (Martin et al., 2019).Therefore, a mock setup similar to home based environment was created to conduct the present study and it was equipped with all the necessary items needed for the toothbrushing as was also reported by Collet in his study (Collett et al., 2016). The Handycam was partially hidden behind the mirror to prevent camera shyness and during video recording the observer either left the room or pretended not to observe the children. Despite these efforts, it may be possible that children and parents or guardians may have acted differently due to change in the environment.

The studies conducted previously on this topic used self-reporting (questionnaire) method which had limited capacity to reproduce the real toothbrushing behaviour (Elidrissi & Naidoo, 2016; Soltani et al., 2017).Whereas, others used observational method that required natural setting to replicate the actual behaviour which was difficult in presence of observers and unfamiliar environments (Gardner, 2000). However, observation was more reliable method than self-reporting for studying behaviour (Collett et al., 2015). In

present study both aforementioned methods were combined (mixed mode) to assess the toothbrushing behaviour of Malaysian preschool children. This way, questionnaire's reporting bias (Martins et al., 2011) and natural environment required by observational method, was overcome by each other to increase the accuracy of obtained toothbrushing behaviour of preschool children.

The pre- and post-brushing plaque scores assessed during the study were beneficial in understanding children's toothbrushing capability. Sandstrom et al (2012) also used the same technique in their study. Unlike our study, in which a trained examiner recorded the plaque score after oral examination, another study used intraoral photographs torecord plaque score before and after toothbrushing (Sandstrom et al., 2011).Photographs are more reliable mode of recording as they can be stored and are re-measurable (Smith et al., 2001). This was probably another limitation of our study. The reapplication of stain after toothbrushing made the plaque remnants on tooth surfaces more apparent to record. In the present study "The Plaque Control Record" was used to record all the teeth and surfaces rather than index teeth and few surfaces (Sandstrom et al., 2011).

The extent of gingivitis was assessed by "Loe and Silness method of gingival index" using a simple probe and mirror. This method was used by other studies on preschool children because it was most reliable and validated scale to measure gingivitis among preschool children (Goswami & Saha, 2017; Gopinath et al., 2015).

The ICDAS II system for dental caries status was used for two reasons. Firstly, this was newer and more accurate method of caries assessment, secondly all the equipment including dental chair needed for its assessment was available and, thirdly the severity of ECC in terms of enamel and dentine lesions could be recorded with this criteria and was not possible with the DMF index. However, for analysis ICDAS codes were converted to the DMF index.

Two advanced and innovative software were used in this study for studying toothbrushing behaviour and determination of its association with their oral health status, respectively. "Behavioural Observation Research Interactive Software (BORIS)" was the advanced software which was specially designed for behaviour evaluation and to the best of the researcher's knowledge, this study was the first in the field of Dentistry to use this software to study human behaviour (toothbrushing behaviour).The data was extracted from toothbrushing videos in the present study using this software. Although, an initial attempt was made to extract the data manually from the videos as was also performed by previous studies (Martin et al 2019; Sandstrom et al., 2011). However, it proved to be tiring and involved possibility of human error because of the haphazard/varied methods of toothbrushing by the children. The data extracted by BORIS was reproducible and reliable. Another advanced software used in the present study for determination of association between toothbrushing behaviour and oral health status of preschool children; Smart PLS 3, is a software with graphical user interface for variance-based structural equation modelling

(SEM) using the partial least squares (PLS) path modelling method. It depicted the association in the form of a monographic model. Other studies reported the use of simple regression analysis (Collett et al., 2016) and ANOVA (Sanstrom et al., 2011). PLS not only provided the information about the association between toothbrushing behaviour and oral health status, but also it provided details of the contribution of each toothbrushing parameter to this association.

According to the Malaysian demographic profile 2019, more than 60% are Malays, almost 21% are Chinese and about 7% Indians. These findings were concurrent with present study ethnic group distribution indicative that our sample was representative of Malaysian population. These findings were also concurrent with the Swedish investigation (Sandstrom et al., 2011).

The study participants were accompanied by their parents/guardians, majority of whom had achieved university level education and were mostly employed, an indication that their parents/guardians may have adequate oral health knowledge. Two other Malaysian studies also reported the same results (Mani et al., 2010; Mani et al.,2012). In contrast to the present study, another study reported a reduced rate of caries with lower level of parent's education (Nota et al., 2019). The stringent inclusion criteria of our study excluded preschool children with oral and systemic illness since they may have difficulties in the tooth brushing. The antibiotic therapy affects dental plaque, (Walker et al., 1983)

therefore, children with history of antibiotic intake in last one month were also excluded.

The oral health status of preschool children in this study was poor. Studies have shown that southeast Asian countries had the highest prevalence of ECC (Duangthip et al., 2017). Moreover, National Oral Health of Preschool Children (NOHPS,2015) latest survey reported the same findings as our study (NOHPS,2015).Overall toothbrushing behaviour of preschool children was unsatisfactory in terms of toothbrush type, toothpaste type and amount, toothbrushing frequency, duration, technique and pattern, mouth rinsing and parental guidance. Despite of having good oral health knowledge parents/guardians had poor practice (Mani et al., 2010; Mani et al., 2012; Najlaa et al., 2015). This was probably because of their ignorance towards its effectiveness for oral health maintenance, impact of poor oral hygiene on overall health, difficulty in providing equal effort for all the children in large families, challenging behaviour of children and work overload of parents/guardians making it tough to supervise their children every day (Marshman et al., 2016). In the present study, majority of children were reportedly looked after by their mother (80%) followed by father (10%) and relatives/caregivers(10%).

As shown in the Model I, toothbrushing behaviour was associated with the oral health status of Malaysian preschool children. Better oral health status (pre-brushing plaque

score and gingival index) was observed among the preschool who brushed with electric toothbrushes compared to manual toothbrushes. This was concurrent with the findings of two systematic reviews, which justified that the effective removal of plaque was due to the oscillations produced by the electric toothbrush (Yaacob et al., 2014; Niederman,2003). However, a recent study opposed it and stated that both toothbrushes had equal capability to remove plaque and this ability was dependent on children's motor skills rather than oscillations of electric toothbrush (Gallie, 2020). Among five different toothbrush grip types distal oblique was the preferred grip in this study compared to oblique, power, precision and spoon type toothbrush grip. This may be due to the firm palm grasp at the shank area of the toothbrush although, power grip also relies on palm support, but at the level of handle of the toothbrush. Other grip types depend upon fingers for support. Two Indian studies reported the similar findings too (Lakshmi et al., 2018; Sharma et al.,2012). Moreover, the plaque removal efficacy of distal oblique grip was also superior than its counterparts (Sharma et al., 2012) because of the firm grip at shank area, which effectively removed plaque from the tooth surfaces. However, in the present study no significant association was recorded between grip type and plaque score, but instead, it was significantly associated with gingival index which may be due to effective plaque removal from gingival margins using this grip. Also, in the present study only children toothbrush grips were recorded, and grips used by parents/guardians for brushing their children teeth were excluded to determine association of preschool children's toothbrushing behaviour with their oral health status. The use of fluoridated toothpaste by majority of our study participants (92%) synchronized with the findings reported in a previous Malaysian study (Tay et al., 2009). Although, a higher proportion of Malaysian

preschool children were observed to use fluoridated toothpaste than Hispanic preschool children (Martin et al., 2019), the trend of using non-fluoridated toothpaste has remained at 8-10% in our study and in the earlier Malaysian study (Tay et al., 2009). This may be attributed to increased activities of anti- fluoridation lobbying, which had created false beliefs among people regarding fluoride toothpaste use including fear of over exposure and overdosage of fluoride besides the fact that non-fluoridated toothpaste was made of natural ingredients (SYABAS,2018; Kanduti et al, 2016; Basch et al., 2019). Moreover, the inadequate knowledge of some Malaysian clerics regarding fluoride and its recommendations further created negative impact and concern about its side effects and halal status among Muslims (Nazita et al., 2013). While there were no toothpastes with 1000ppm provided to the participants in the present study, fluoridated toothpaste with 1450ppm had a significant effect on dental caries status and plaque score change. This was concurrent with the recent systematic review that discussed the importance of fluoride toothpaste with fluoride content greater than 1000ppm in prevention of ECC (Wright et al., 2014).

In comparison to another Malaysian study, the 'pea sized toothpaste amount' was used more (35%) than their study (19%) and 'full-length toothpaste amount' was used by a quarter of preschoolers of our study than their study (15%). However, more than half (62%) of children in their study reportedly used 'half-length toothpaste amount' than our study (9.8%) (Tay and Jaafar,2008). The observed toothpaste amounts in this study were higher than that observed in the Hispanic population: pea sized (20%), half-length (4.8%) and full length (2.4%) (Martin et al., 2019). The increase in the use of recommended

toothpaste amount for preschool children was indicative of improvement in parents/guardian oral health knowledge and practice. In our study, children using a larger toothpaste amount (full length) had better dental caries status, possibly due to increased content of fluoride (Walsh et al., 2010), although, the recommended pea sized toothpaste amount was to avoid side effects such as fluorosis which can occur in children who inadvertently swallow the toothpaste (ADAa, 2014).

Wright et al, (2014) revealed in their study that although fluoride has anticariogenic property, there are mild chances of development of fluorosis even with using pea sized toothpaste, especially when using toothpaste with greater fluoride content (f >1000ppm; 1450ppm) (Wright et al., 2014).

The findings of toothbrushing frequency in terms of toothbrushing twice a day and once a day in our study were lesser than that reported by another Malaysian and Norwegian investigations (Buhari et al., 2016; Wigen and Wang., 2014). However, our study findings in terms of toothbrushing twice a day and more than twice a day were higher than that reported by Indian study (Pullishery et al., 2013). Reasons explaining preschool children's toothbrushing frequency can be related to their parent's priorities, attitudes and beliefs. For example, parents/guardian's high self-standards and self-efficacy made their children brush their teeth twice a day, on other hand parents with false beliefs about the benefits of twice daily tooth-brushing had infrequent children's toothbrushing routines (Huebner and Riedy, 2010; Phanthavong et al 2019). In the present study, preschoolers who brushed frequently had better gingival index and dental caries status as being

reported and these findings were concurrent with other studies (Huebner and Milgrom, 2015; Jain et al., 2018). This can be attributed to the fact frequent toothbrushing prevents plaque deposition on tooth surfaces responsible for gingivitis and dental caries.

In this study, the reported toothbrushing duration of 1-2 mins was less (40%) than the Hispanic preschool children however, more children were observed to brush for recommended toothbrushing duration in the present study than the Hispanic preschool children (42%). (Martin et al., 2019). The prolonged toothbrushing duration (1-2min) in this study was probably because the preschool children had brushed in accordance with the current recommendation for toothbrushing (ADA,2014) and secondly, they were attempting to do their best, because they were participating in the study or perhaps they had attempted to remove dye from their teeth which was applied for plaque identification. In contrast, previous studies had recorded a shorter toothbrushing duration of less than 2 min among preschool children (Das and Singhal, 2009; Ceyhan et al., 2018; Collett et al., 2016). Also, the present study showed a significant association between plaque score change and dental caries status because toothbrushing duration of 2 mins removed more than half of the plaque deposits (Creeth et al., 2009) which reduced the chances of ECC (Kowash et al., 2017).

The four toothbrushing methods; horizontal, vertical, rotational and no method differs in terms of the toothbrush strokes during brushing. The term 'no method' categorises those haphazard strokes performed superficially and cleaning the

minimal tooth surfaces. The lack of manual dexterity at this young age makes it difficult to replicate rotational and vertical strokes (Muller-Bolla and Courson,2013). For this reason, the preferred toothbrushing technique by preschool children was the horizontal technique (Ceyhan et al., 2018; Patil et al., 2014). Our study also reported horizontal technique by highest proportion of preschool children (41%) for it was a simple and easy method. In this technique the toothbrush head was placed perpendicular to the tooth surfaces and plaque removal is performed with back and forth movements. In the present study, toothbrushing technique was associated with plaque score change, which was possibly because this technique removed plaque effectively as suggested by another study (Patil et al., 2014). Moreover, toothbrushing in a systematic pattern ensures that every quadrant was cleaned, and no tooth surface was left unattended (Dean et al., 2011). The percentage of children brushing systematically in the present study was higher than Swedish children (19%) (Sandstrom et al., 2011). This may be attributed to parents/guardian's awareness that this technique is more thorough in covering all tooth surfaces than the non-systematic approach of toothbrushing. Therefore, systematic toothbrushing pattern is recommended (Bain et al., 2018). The significant association of systematic toothbrushing pattern with dental caries status in this study probably was due to this toothbrushing technique's ability to remove traces of plaque from maximum tooth surfaces when done on a regular basis thus, preventing ECC.

In the present study, majority (94.5%) of preschool children rinsed their mouth after toothbrushing. This percentage was more than that observed by Martin et al. (2019) in their study (65%) (Martin et al., 2019). The elimination of foamy taste of toothpaste and parents/guardians fear of fluoride overdosage of their preschool children by inadvertently swallowing it was the probable reason of multiple mouth rinsing habit in preschool children. Currently, it is recommended to spit and do not rinse or rinse after toothbrushing with either saliva and fluoride slurry or fluoride mouth rinse to retain the antiplaque effect of fluoride in oral cavity for a longer period (Pitts et al., 2012). In our study, the majority of preschool children rinsed only once after toothbrushing but had rinsed multiple times during the course of toothbrushing. This may reflect their parents/guardian's oral health knowledge about mouth rinsing which was acquired previously. Although, evidence was lacking, rinsing multiple times before completing toothbrushing was likely to reduce the fluoride effect of toothpaste in the mouth. The post brushing mouth rinse was significantly associated with plaque score change in this study because of antiplaque effect of fluoride retained with minimal mouth rinsing (Pitts et al., 2012).

On comparison of the present study findings with other studies, parents/guardians reportedly supervising their children during toothbrushing (every day and occasionally) in our study were more (96%) than that reported by another Malaysian study (49%) and the Hispanic study (Martin et al., 2019; Tay et al., 2009), the reported findings were different from observed findings of

our study with almost half of parents/guardians being uninvolved during toothbrushing of their children. The plausible difference in the findings may be because, some parents/guardians had to attend to their other children who also accompanied them to the clinic while the participating preschool child brushed their teeth. In addition, parents/guardians may have been camera shy. Better (significantly associated) oral health status (plaque score change, gingival index and dental caries status) was observed among preschool children with supervised toothbrushing. Several studies had also emphasized on the fact that supervised toothbrushing improved oral health of preschool children (Huebner and Riedy, 2010; Marshman et al., 2016; Collett et al., 2016).

According to literature, dietary habits and socioeconomic status of preschool children are two major factors affecting oral health of preschool children, besides toothbrushing behaviour. Therefore, these were included in the study as confounding variables as shown in Model II. On comparison of Model I and II, a small but significant difference was observed in the variance (R^2) of gingival index, pre-brushing plaque score and dental caries status. This change was recorded with dietary variables only, probably because its impact on oral health was reduced in the presence of proper toothbrushing behaviour (Palmer et al.,2010). Some of the toothbrushing behaviour factors also lost (statistical) significant association with oral health status. This included toothbrushing frequency, it was significantly associated with the dental caries instead of plaque score change and post brushing mouth rinsing significant association to oral

health status was no longer. Possible reason for this was, because frequent sugary snacks and sleeping with milk bottle at this age, a common practice in Malaysia, may have increased the chances of ECC (Jain et al., 2018).

The strengths of our study included, that it was the first study conducted on the toothbrushing behaviour of Malaysian preschool children (4 to 6 years) to the best of our knowledge. Moreover, the ethnic distribution of this study was similar to that provided by the department of statistics of Malaysia, except perhaps for those of lower education. The separate room prepared with mock home-based setup was beneficial in recording toothbrushing behaviour of preschool children with high accuracy. An advanced software "BORIS" was used for the first time in the field of dentistry to study behaviour and extract data which was otherwise manually extracted. Moreover, another advanced software Smart PLS 3 was used to perform partial least square regression analysis and portray it in the form of a model. For recording post-brushing plaque score, the reapplication of dye made the traces of plaque on tooth surfaces apparent to record.

There were certain study limitations that needed to be addressed. Firstly, the small sample size of our study could have affected associations between plaque score and some of the toothbrushing factors, for example, toothbrush grip type, toothbrushing pattern and post brushing mouth rinse. Secondly, the prolonged toothbrushing duration observed among children was possibly due to their

attempt at removing the plaque disclosing stain on their teeth. Thirdly, plaque was recorded by the trained examiner, unlike other studies which took photographs to record plaque scores. Fourthly, the specified time (of day) of oral examination differed among children and may have affected their pre-brushing plaque scores. In addition, the toothbrushing environment provided in the clinic differed from that in their homes and the consciousness of being observed may have influenced their toothbrushing pattern. Finally, the children who used electric toothbrushes at home may have not been familiar with brushing using the manual toothbrushes given to them, thus affecting their post-brushing plaque scores.

The present study signified the role of toothbrushing behaviour in maintenance of oral health status of preschool children. Incorporation of correct toothbrushing habit at an early age will become lifelong habit that will reduce the chances of oral diseases in both dentitions. This study findings will also aid dental practitioners and parents to emphasize on development of correct toothbrushing behaviour as a preventive strategy to reduce prevalence of oral diseases and improve oral health of preschool children.

CHAPTER 6: CONCLUSION

Within the study limitations, the following conclusions can be derived:

6.1 Evaluation of toothbrushing behaviour

The overall toothbrushing behaviour of preschool children OF Klang valley was inadequate in terms of toothbrushing duration, toothpaste type and amount, toothbrushing frequency, technique, pattern and multiple mouth rinsing after toothbrushing. Moreover, the parents/guardians did not supervise their children during toothbrushing every day.

6.2 Assessment of oral health status

The oral health status of preschool children of Klang valley was poor. Majority had high plaque scores. Almost 70% had gingivitis and the prevalence of ECC was also very high (96%) among them.

6.3 Association between toothbrushing behaviour and oral health status

The present study suggested that toothbrushing behaviour was associated with the oral health status of preschool children in terms of plaque scores, gingival index and dental caries status. A better oral health status was recorded among preschool children who brushed twice a day for 2mins, with fluoride toothpaste(F greater than 1000ppm) in a systematic manner, rinsed minimally after toothbrushing and were guided by their parents/guardians during their toothbrushing.

Hence, it can be concluded that toothbrushing behaviour have impact on the oral health status of preschool children. Regardless of other factors, adopting proper toothbrushing behaviour will prevent oral diseases among preschool children and parents/guardians should provide guidance to their children during toothbrushing.

6.4 Recommendations

The low fluoride toothpaste preferably used by preschool children of Malaysia should be discouraged as they are less efficient against ECC. Oral health education of preschool children and their parents/guardians is needed in terms of minimizing the rinsing of mouth after toothbrushing their children teeth, to maintain anticariogenic effect of fluoride in mouth. The encouragement of parents/ guardians to supervise their children daily during toothbrushing is necessary to maintain good oral health of their children.

It is recommended to conduct such studies on large sample size and different areas for in- depth knowledge about toothbrushing behaviour of preschool children of Malaysia. It is also suggested that toothbrushing behaviour should be studied at home for better understanding. Further investigation regarding the best practice of minimal mouth rinsing among preschool children is also recommended.

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