EVALUATION OF THE *DOKTOR MUDA* PROGRAMME ON THE ORAL HEALTH OF SECONDARY SCHOOL CHILDREN IN KELANTAN

SITI KAMILAH BINTI MOHAMAD KASIM

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ABSTRACT

Health Promoting School (HPS) concept is a strategy for health promotion by the WHO. In Malaysia, a similar concept was introduced in 1980s known as the *Doktor Muda* Programme (DMP) spearheaded by the Ministry of Health (MOH) and Ministry of Education (MOE). DMP was effective to promote oral health in primary schoolchildren. In 2015, DMP was introduced in secondary schools. However, no evaluation has been conducted on its impacts on oral health. **Objectives:** (i) to compare the impacts of DMP between schoolchildren attending DMP schools and schoolchildren attending non-DMP schools after 6 months in terms children's oral health knowledge (OHK), oral health attitudes (OHA), oral health behaviours (OHB), oral health status (OHS) (oral hygiene, gingival health, caries incidence), and oral health-related quality of life (OHQRoL); (ii) to determine the associated factors for schoolchildren's OHK, OHA, OHB, OHS, and OHRQoL; and (iii) to explore the process implementation of DMP in terms of *Doktor Muda* (DM) selection, training, DMP strengths and weaknesses, and suggestions for improvement from the perspectives of the DMs. **Method:** This study utilised a mixed-method study design with 2 phases. Phase 1 was a quasi-experimental study involving Form 1 schoolchildren (12-13 years) in Kota Bharu and Pasir Mas Districts, Kelantan in 2018. The intervention group (IG) comprised DMP schools and the control group (CG) comprised non-DMP schools, matched by location. The sample size for the IG and CG was 270 and 265, respectively. Study tools included a validated questionnaire, O'Leary plaque index, the Gingival Index for Schoolchildren (GIS), the International Caries Detection and Assessment System (ICDAS), and the Malay Child Oral Impacts on Daily Performances (Malay Child-OIDP) index. Baseline data were collected prior to the DMP intervention, and again after 6 months. In Phase 2, focus group discussions (FGD) were conducted among DMs from the DMP schools. Quantitative data were analysed using SPSS software using descriptive, univariate and multivariate analyses. The qualitative data were transcribed verbatim and analysed using the framework method analysis.

Results: The baseline and follow up response rate was 97.6% and 90.9%, respectively. There were no significant between-group differences in mean OHK and OHB increment scores after 6 months. However, the mean OHA increment score was significantly higher in the CG ($p<0.001$) after 6 months. Both groups had a significant decrement in mean plaque score after 6 months but no between-group difference was observed. The mean increment in score of GIS in the IG was significantly higher compared to the CG ($p<0.001$) after 6 months. A significantly lower proportion of schoolchildren in the IG experienced caries increment compared to schoolchildren in the CG after 6 months ($p<0.05$). In terms of OHRQoL, a lower proportion of schoolchildren in the IG experienced an increment in mean OIDP total score than schoolchildren in the CG after 6 months but no between-group difference in mean OIDP increment scores. The associated factors for OHK increment are gender and school location; for OHA increment are location, gender, type of school and OHK; for plaque score is school location; for GIS increment is type of school; for cavitated caries (tooth) is OHA increment; for cavitated surfaces are mother's education level and OHA increment; for OIDP increment is OHK increment; and for at least 1 OIDP present are gender, mouth-rinsing behaviours, flossing frequency, and cavitated caries increment. From the FGDs, DMs perceived that their appointment was made by teachers, training was quite insufficient, with mixed feedback on support and materials provided. However, DMs perceived the programme improved their OHK and OHB including that of their peers. Recommendations for improvement included a dedicated health advisor, increase number of DMs, and longer time for DMP activities. **Conclusion:** The DMP in secondary school has some positive impacts on caries and OHRQoL after 6 months. Further improvements in DMP implementation are recommended to improve the effectiveness of DMP on schoolchildren's oral health.

Keywords : *Doktor Muda* Programme, oral health knowledge, oral health attitudes, oral health behaviour, oral health-related quality of life

ABSTRAK

Sekolah Mempromosi Kesihatan (SMK) merupakan satu strategi untuk mempromosikan kesihatan yang disarankan oleh WHO. Di Malaysia, konsep yang sama telah dilaksanakan di sekolah pada 1980an yang dikenalpasti sebagai Program Doktor Muda (PDM) yang merupakan kerjasama antara Kementerian Kesihatan Malaysia (KKM) dan Kementerian Pelajaran Malaysia. PMD berkesan dalam mempromosikan kesihatan mulut bagi pelajar sekolah rendah. Pada tahun 2015, PDM diperkenalkan di sekolah menengah. Namun begitu, tiada penilaian dilakukan terhadap impak kepada kesihatan pergigian. **Objektif:** (i) untuk membandingkan potensi impak PDM di kalangan pelajar yang bersekolah di sekolah yang mempunyai PDM (kumpulan intervensi) dan pelajar yang bersekolah di sekolah tanpa PDM (kumpulan kawalan) selepas enam bulan dari segi pengetahuan, sikap dan amalan berkaitan kesihatan mulut, kebersihan mulut, kesihatan gusi, kejadian karies, dan kualiti hidup yang berkaitan dengan kesihatan mulut (KHBKM) (ii) untuk mengenalpasti faktor yang berhubungkait dengan pengetahuan, sikap, dan amalan berkaitan kesihatan mulut, kebersihan mulut, kesihatan gusi, kejadian karies, dan KHBKM dan (iii) untuk meneroka pelaksanaan proses PDM dari segi pemilihan Doktor Muda (DM), latihan diterima oleh DM, kekuatan dan kelemahan PDM, dan cadangan penambahbaikan dari perspektif DM. **Kaedah:** Kajian ini melibatkan 2 fasa, Fasa pertama merupakan quasi-eksperimen melibatkan pelajar Tingkatan 1 (12-13 tahun) di Daerah Kota Bharu dan Pasir Mas, Kelantan pada tahun 2018. Kumpulan intervensi (KI) terdiri daripada sekolah menengah dengan PDM dan kumpulan kawalan (KK) terdiri daripada sekolah menengah tanpa PDM yang dipadankan dengan lokasi. Saiz sampel kajian untuk KI dan KK, masing-masing adalah seramai 270 dan 265 pelajar. Kajian ini menggunakan borang kaji selidik yang telah divalidasi, Indeks Plak O'Leary, *the Gingival Index for Schoolchildren* (GIS), *the International Caries Detection and Assessment System* (ICDAS), dan *Malay Child Oral Impacts on Daily Performances*.

Data pada permulaan kajian dikumpulkan sebelum pelajar terlibat dengan PDM dan selepas 6 bulan. Di dalam fasa ke 2, *Focus Group Discussion* (FGD) telah dijalankan di kalangan DM. Data kuantitatif dianalisa menggunakan perisian SPSS bagi analisa deskriptif, univariat dan multivariat. Data kualitatif, verbatim ditranskrip dan dianalisis menggunakan kaedah *framework* analisa. **Keputusan**: Respon keseluruhan di peringkat permulaan ialah 97.6% dan 90.9%. Tidak terdapat perbezaan yang signifikan dari segi purata kenaikan tahap pengetahuan dan amalan berkaitan kesihatan mulut selepas 6 bulan. Namun begitu, purata kenaikan tahap sikap berkaitan kesihatan mulut adalah jauh lebih tinggi dalam KK (p <0.001). Kedua-dua kumpulan menunjukkan penurunan ketara dalam purata skor plak selepas 6 bulan tetapi tiada perbezaan di antara kumpulan yang dilaporkan. Skor purata kenaikan GIS bagi KI jauh lebih tinggi berbanding dengan KK (p<0.001). Dari segi kesan ke atas karies, peratus pelajar dalam KK mengalami kenaikan karies yang ketara berbanding pelajar dalam KI selepas 6 bulan (p <0.05). Bagi KHBKM, sebahagian kecil pelajar di dalam KI mengalami peningkatan di dalam skor OIDP berbanding dengan KK selepas 6 bulan.Nnamun, tiada perbezaan di antara kumpulan diperhatikan. Faktor yang berhubung kait dengan kenaikan tahap pengetahuan berkaitan kesihatan mulut ialah lokasi sekolah dan jantina; kenaikan tahap sikap berkaitan kesihatan mulut ialah lokasi, jantina, jenis sekolah dan tahap pengetahuan berkaitan kesihatan mulut; plak adalah lokasi sekolah; peningkatan GIS adalah jenis sekolah; karies berkaviti adalah peningkatan dalam tahap sikap berkaitan kesihatan mulut; karies berkaviti berdasarkan permukaan gigi adalah tahap pendidikan ibu dan tahap sikap berkaitan kesihatan mulut; dan kenaikan OIDP ialah tahap pengetahuan berkaitan kesihatan mulut. Faktor yang berhubung kait dengan adanya sekurang-kurangya 1 OIDP adalah jantina, tabiat berkumur dengan air selepas makan, frekuensi menggunakan floss dan peningkatan dalam karies berkaviti. Hasil dari FGD, DM menyatakan yang pemilihan sebagai DM dilakukan oleh guru, latihan tidak mencukupi, dan maklumbalas yang bercampur tentang

sokongan dan bahan yang disediakan. DM merasakan bahawa program ini telah meningkatkan pengetahuan dan sikap mereka berkaitan kesihatan mulut dan termasuk di kalangan rakan sebaya. DM mencadangkan supaya menempatkan penasihat kesihatan, meningkatkan jumlah DM, dan memperuntukkan lebih masa untuk menjalankan aktiviti DMP. **Kesimpulan**: PDM di sekolah menengah mempunyai impak yang positif sedikit terhadap karies dan KHBKM selepas 6 bulan. Penambahbaikan dalam cara pelaksanaan PDM bagi meningkatkan keberkesanannya terhadap kesihatan mulut pelajar sekolah.

Kata kunci: Program Doktor Muda, pengetahuan berkaitan kesihatan mulut, sikap berkaitan kesihatan mulut, tingkah laku berkaitan kesihatan mulut, kualiti hidup yang berkaitan dengan kesihatan mulut

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LIST OF SYMBOLS AND ABBREVIATIONS

CG	:	Control group
DMP	:	*Doktor Muda* Programme
FGD	:	Focus group discussion
GIS	:	Gingival index for schoolchildren
HPS	:	Health Promoting School
ICDAS	:	The International Caries Detection and Assessment System
IDC	:	Incremental Dental Care
IG	:	Intervention group
MOH	:	Ministry of Health
MOE	:	Ministry of Education
MSE	:	Mouth self-examination
MYR	:	Malaysian ringgit
NPP	:	Nutrition promotion programme
OHA	:	Oral health attitudes
OHB	:	Oral health behaviours
OHE	:	Oral health education
OHK	:	Oral health knowledge
OHP	:	Oral Health Programme
OHS	:	Oral health status
OHRQoL	:	Oral health related quality of life
SOC	:	Sense of coherence
SOHP	:	School oral health programme
PWI	:	Performance with impact
QoL	:	Quality of life
WHO	:	World Health Organisation

LIST OF APPENDICES

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Appendix 4 : Permission to conduct the study was also granted by Kelantan Education Department

Appendix 5 : Permission by the Malaysian Dental Council for conducting oral examination for the researcher (SK)

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CHAPTER 1: INTRODUCTION

1.1 Introduction to health promoting school (HPS)

World Health Organisation's Global School Health Initiative, launched in 1995, seeks to mobilise and strengthen health promotion and education activities at local, national, regional, and global levels. The initiative was designed to improve the health of children, school personnel, families and other members of the community, through schools (Petersen, 2004).

World Health Organisation (2019) defines HPS as one that constantly strengthens its capacity as a healthy setting for living, learning and working (World Health Organization, 2019b).

HPS is a place where all members of the school community work, learn, live and play together to promote the health and well-being of students, staff, parents, and the community. Many schools have successfully implemented the HPS concept and a strong network has been developed for mutual support and sharing of the resources (Canterbury District Health Board, 2019; KwaZulu-Natal Department of Health, 2001).

Schools can make a substantial contribution to a student's health and well-being. This has been increasingly recognised by many international initiatives including those from the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the U.S. Centers for Disease Control and Prevention (CDC), and the International Union for Health Promotion and Education (IUHPE) (International Union For Health Promotion and Education, 2009). A range of strategies and programmes has evolved in the last twenty years with diverse names such as Health Promoting Schools, Comprehensive School Health, Child-Friendly Schools, and the Focusing Resources on

Effective School Health (FRESH) initiative (International Union For Health Promotion and Education, 2009). However, these strategies share the connecting thread of a whole school approach and recognition that all aspects of the life of the school community are potentially crucial in the promotion of health. It has become clear that these approaches should be done more than offering health education classes in the curriculum if we want the schools to fulfil their potential in promoting the health of all students.

There is a developing understanding of the interlinked relationship between school education and health. Besides, there is growing evidence that effective schools where young people feel connected, can influence health and inequalities in health (International Union For Health Promotion and Education, 2009).

1.2 Introduction to study area

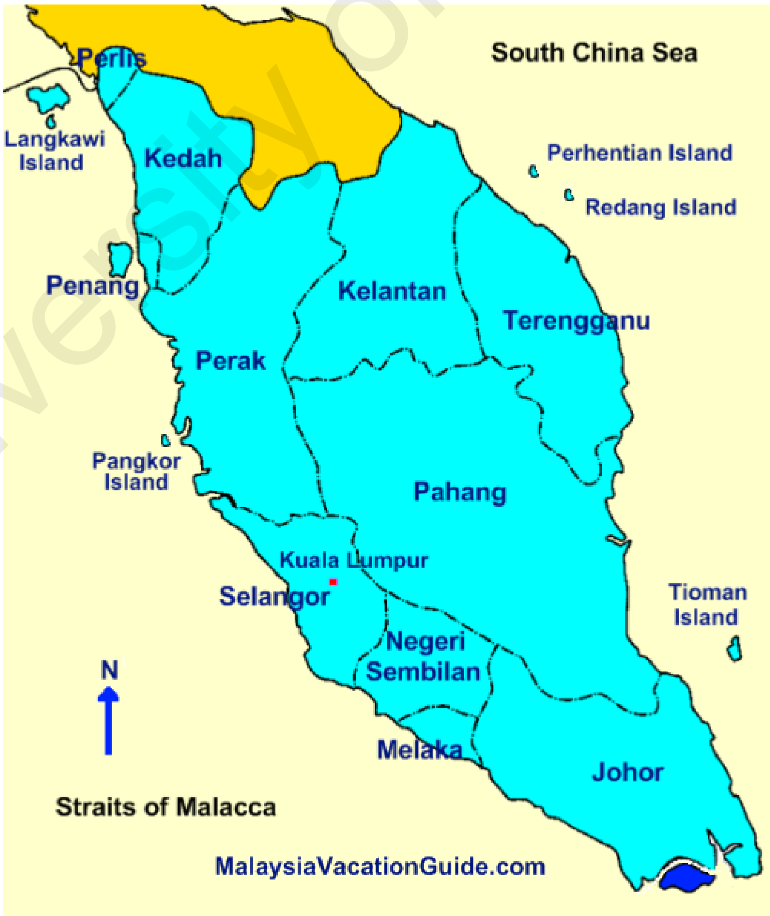

Figure 1.1: Map of Peninsular of Malaysia

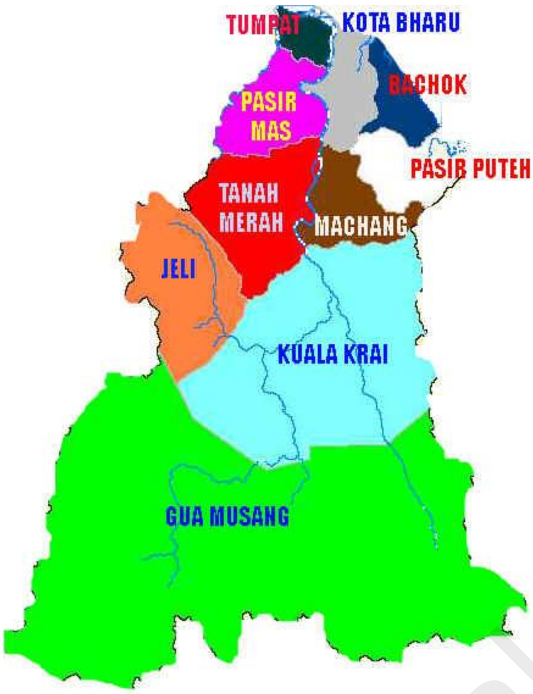

Figure 1.2: Districts in State of Kelantan

The total number of states and federal territories in Malaysia are 15; 13 states and 2 federal territories. The present study was conducted in the state of Kelantan. Kelantan is located in the Northeast of Peninsular Malaysia, facing the South China Sea and bordering with Thailand to the north (Figure 1.1). Kelantan has an area of 1,684,323 hectare (Kelantan State Government, 2018). It has a population of more than one million people with ethnic composition comprises of Bumiputera (93.2%), Chinese (3.0%), India (0.3%), other races (0.6%) and foreigners (2.9%). The ethnic Bumiputera was further sub-categorised into Malay (98.8%) and other Bumiputera (indigenous) (1.2%) (Kelantan State Government, 2018).

The state of Kelantan has 10 districts as illustrated in Figure 1.2 above. All districts are provided with physical infrastructure such as electricity, roads, and piped water supply. The percentage of homes with piped water supply facility was 65.4% in 2016. All households received electricity supply (Department of Statistics Malaysia, 2017). Majority of Kelantan's population (64.1%) received internet services in 2018 (Kelantan State Government, 2018).

Kota Bharu is the capital city of Kelantan. Kota Bharu's urban development began in 1844 as a royal settlement. It now serves as a major centre for administration, trade, finance, culture, and education. Kota Bharu covers an area of 115.64 sq km with a population of more than 300 thousands. Pasir Mas is one of the 10 districts in Kelantan located in the northern part, bordering with Tumpat on the North, Tanah Merah in the south, Kelantan River and Kota Bharu in the East, and Golok River, Thailand to the West.

In 2016, the main source of household income in Kelantan was paid employment (52.9%), followed by self-employment (20.3%), current transfer received (i.e. pension, other periodic payments and remittance from other households) (18.0%), and income from properties and investment (8.9%). The median monthly household income in Kelantan was MYR 3,079 in 2016 (1 MYR = 0.186 GBP). Meanwhile, the median monthly household income in the urban area was MYR 3,635 and in the rural area was MYR 2,635. Kota Bharu recorded the highest median monthly household income of MYR 3,677, followed by Tumpat (MYR 3,105). The lowest median income was recorded in Jeli (MYR 2,377), while Pasir Mas had the third lowest median income (MYR 2,543) (Department of Statistics Malaysia, 2017).

Those who live in Kota Bharu and affluent areas in other districts have higher socioeconomic status than those who live in suburban or rural areas. In comparison to Kota Bharu district, the majority of population in other districts have very low to medium income levels based on the Household Income and Basic Amenities Survey Report 2016 (Department of Statistics Malaysia, 2017). Differences in income levels, employment, and education exist within districts. The incidence of poverty in Kelantan was 0.4% in

2016. The incidence of poverty in the rural and urban areas was 0.6% and 0.3%, respectively (Department of Statistics Malaysia, 2017).

Kelantan population's broad socioeconomic status is one of the main reasons why the state had been chosen as the study area for the present study. As a result, school-based health (and oral health) intervention could be assessed not only in terms of its overall impact, but also on its effect across the different socioeconomic spectrum. Although the piped water supply was available to 65.4% of the population in 2016, the percentage who received fluoridated water supply was only 37.0% (Kelantan Oral Health Division, 2017). Therefore, school-based interventions to improve oral health if properly carried out would have been more effective in areas without water fluoridation.

1.3 Background of study – The *Doktor Muda* Programme (DMP) in Kelantan

In Malaysia, schoolchildren start primary school at the age of 7 (Year 1) until 12 years (Year 6). Traditionally, oral health education (OHE) is delivered to schoolchildren by the school dental service of the Oral Health Programme, Ministry of Health (MOH) once a year through the Incremental Dental Care (IDC) programme (Oral Health Division, 2006). The same service visits schoolchildren in secondary schools (13 – 17 years). Each visit consists of delivering OHE, dental check-up, providing preventive measures such as fissure sealants and fluoride varnish, and providing simple treatment.

Realising the limitations of the traditional approach to disseminate health education on general and oral health, a pilot HPS programme known as the *Doktor Muda* Programme (DMP) was introduced in the late 1980s in a few primary schools in the country (Health Promotion Unit, 2015).

DMP is a smart partnership between the MOH and the Ministry of Education (MOE) (Ministry of Health, 2012). It embraces the HPS concept introduced by the WHO

(World Health Organization, 2003a). The programme is paralleled with the WHO recommendation in which community-based oral health programme is incorporated into a wider health agenda (Petersen & Kwan, 2004). The DMP is basically a health promotion programme implemented by schoolchildren, where a selected group of schoolchildren known as *Doktor Muda* (DMs) or 'Junior Doctors' are empowered with health knowledge and skills to deliver health education to their friends and conduct health promotion related activities at school. DM acts as an agent of change to promote health and oral health of the schoolchildren (Health Promotion Unit, 2015).

The health education syllabus in DMP comprises broad topics on oral health, mental health, personal hygiene, and environmental hygiene, prevention of disease, injury prevention, and safety, healthy nutrition and diet, healthy teenagers, and healthy lifestyle. Each topic has several subtopics. DMs continuously delivered health education throughout the school year (Health Promotion Unit, 2015).

In Kelantan, there were 418 primary schools in 10 districts in 2017 and 174 secondary schools. The number of secondary schools in Kota Bharu district was 48 with 41,309 schoolchildren. In Pasir Mas district, there were 25 secondary schools with 17,699 schoolchildren (Kelantan Education Department, 2017).

The DMP was first introduced in Kelantan in a primary school in 1991 (Health Promotion Unit, 2017). By the year 2000, the number of primary schools with DMP increased to 69 and then to 352 schools in 2018. In 2018, the number of trained DMs was 8,385 with DM to schoolchildren ratio of 1:1800 (Ministry of Health & Ministry of Education, 2018b).

The DMP was introduced in the secondary school in Kelantan in 2014 where one school had been chosen to implement the DMP. From 2014 to 2018, the number of secondary schools with DMP in Kelantan was 71 with 2,286 trained DMs (Ministry of Health & Ministry of Education, 2018a).

The DMP in secondary schools has six (6) objectives, but only four (4) objectives are concerned with the health of the schoolchildren. The 4 objectives are (Health Promotion Unit, 2015):

- Inculcate self-health care skills in daily life;
- Increase level of knowledge & skills on healthy lifestyles;
- Avoid risk behaviours of chronic diseases; and
- Nurture the nature of volunteerism in the student.

1.4 Problem statement

The Kelantan people are well known for consuming high quantity of sugary foods and drinks compared to other states in Malaysia. A study showed that the amount of sugars consumed by schoolchildren in Pasir Mas, Kelantan was very high at 93 grams per person daily (Nurrul Ashikin Abdullah, 2010). Another study in 2010 on the dietary habits and caries severity of adults in Kelantan showed that the majority of Kelantan population (81.2%) consumed sugary food and beverages more than three times a day. Meanwhile the estimated daily intake of sugars from all sources was 81.6 grams per adult in Kelantan (Oral Health Division, 2014).

Worsening the situation of high sugar intake among Kelantan people, they are also experiencing fluoridated water supply problems. Although the piped water supply reached 65.4% of the population in 2016, only 37.0% received fluoridated water supply (Kelantan Oral Health Division, 2017).

As a result, caries experience among the schoolchildren is high. In Kelantan, the 12- year-old caries free prevalence was lower than the Peninsular of Malaysia's average.

The prevalence of caries free teeth was 49.5% in 2017, much lower than the Peninsular of Malaysia's average (72.2%). The mean DMFT score was 1.44 compared to 0.56 in Peninsular Malaysia. Meanwhile, for 16-year-old schoolchildren, the prevalence of caries free teeth in Kelantan was the second lowest (26.6%) after the state of Sabah (21.7%). The mean DMFX for 16-year-old was 2.97 which was higher than the national level of 1.34 (Ministry of Health, 2016).

As for gingival health, the 2016 Annual Report from the Oral Health Programme reported that the proportion of secondary schoolchildren in Kelantan with healthy gingiva was 56.9% assessed using the Gingival Index for Schoolchildren (GIS). This prevalence was much lower than the national level of 70.0% (Oral Health Programme, 2018a). The data indicated that schoolchildren in Kelantan did not brush their teeth frequently compared to the national average.

In Malaysia, primary and secondary schoolchildren's oral healths are under the care of the Oral Health Programme, MOH through the IDC programme. In 2016, the IDC programme national coverage was 92.4% for secondary schools, and in Kelantan the coverage was 94.7% in 2016 (Ministry of Health, 2016).

Apart from the IDC programme, the DMP in secondary schools in Kelantan have been introduced in 2014 with the aim to promote the health and oral health of 13-17 year old schoolchildren. It is regarded as an important programme which acts as a safety net against poor health among schoolchildren in Kelantan. In Malaysia, the evaluation of DMP in primary schools had been conducted by Zamros Yuzadi Mohd Yusof (2013) after the programme had been implemented for 6 years. The results showed positives impacts of the DMP on the oral health behaviours, oral health status, and OHRQoL of 11-12 year old schoolchildren (Zamros Yuzadi Mohd Yusof, 2013).

However, it is uncertain if the DMP in secondary schools has similar effects on older age group schoolchildren as evaluation of DMP in secondary schools has never been done before. As far as oral health is concerned, it was not known whether the DMP in secondary schools has any additional effect on secondary schoolchildren's oral health status over and above that caused by the IDC programme or other factors. Moreover, it was unknown whether the time and cost invested by the MOH and MOE for the DMP have been worthwhile. Therefore, based on these arguments, it was proposed that the effect of DMP on the oral health of secondary schoolchildren should be evaluated.

In Kelantan, DMP in secondary schools has been introduced since 2014. However, no evaluation has been done to assess its potential impacts on the oral health of the secondary schoolchildren and whether it is feasible in the secondary school environment. Therefore, it is timely that a pluralistic evaluation approach is carried out to assess the potential impacts of the DMP on the schoolchildren oral health including a process evaluation on the feasibility of the programme in the secondary school environment.

1.5 Rationale of study

Since the DMP has been expanded in secondary school in Kelantan in 2014, there has been no evaluation was done to assess its potential effectiveness and whether the DMP is feasible in secondary school environment. The DMP in secondary schools could be seen as a safety net to prevent poor health and promote school health including oral health. Therefore, evaluation of the DMP is vital to provide evidence of the effectiveness and ways to improve the programme further. Because of the above, the potential impact of DMP on the schoolchildren oral health is paramount.

The outcome of this present study would be used to inform policymakers, and stakeholders namely the planners, managers, sponsors, teachers, the school community, parents, and schoolchildren on the oral impacts of DMP in secondary schools. The outcomes would provide useful information on the effectiveness and worthiness of the programme to improve schoolchildren's oral health and to justify future funding. Finally, decisions on how to improve the DMP implementation could also be based from the study findings.

1.6 Conceptual framework of study

This study seeks to explore the possible impacts of the DMP on the oral health outcomes of the schoolchildren in terms of immediate impact, intermediate impact, and health impact.

The conceptual framework for this study recognised the schoolchildren-based outcomes (dependent variables) in term of immediate impacts, intermediate impacts and health impacts as the potential outcomes of the DMP. This study was conducted to assess and compare the quantitative outcomes, i.e. oral health knowledge (OHK), oral health attitudes (OHA), oral health behaviours (OHB), oral health status (oral hygiene, gingival health and caries incidence), and oral health related quality of life (OHRQoL) between 12-13 year old schoolchildren in DMP and non-DMP secondary schools after 6 months.

The shorter-term evaluation of 6 months between baseline and follow-up would allow shorter-term outcomes to be assessed. This will give early indications of its potential oral health impacts and provide immediate feedback to improve the implementation process of the DMP if necessary. Effects on gingival health, caries incidence and OHRQoL were also assessed mainly due to the low coverage of water fluoridation, and higher consumption of sugars on daily and poorer tooth brushing behaviour as indicated in previous study (Kelantan Oral Health Division, 2017; Nurrul Ashikin Abdullah, 2010; Oral Health Programme, 2018a).

This study also involved qualitative evaluation, i.e. process evaluation of the DMP from the perspectives of the DMs. The conceptual framework of this study is shown in Figure 1.3 below.

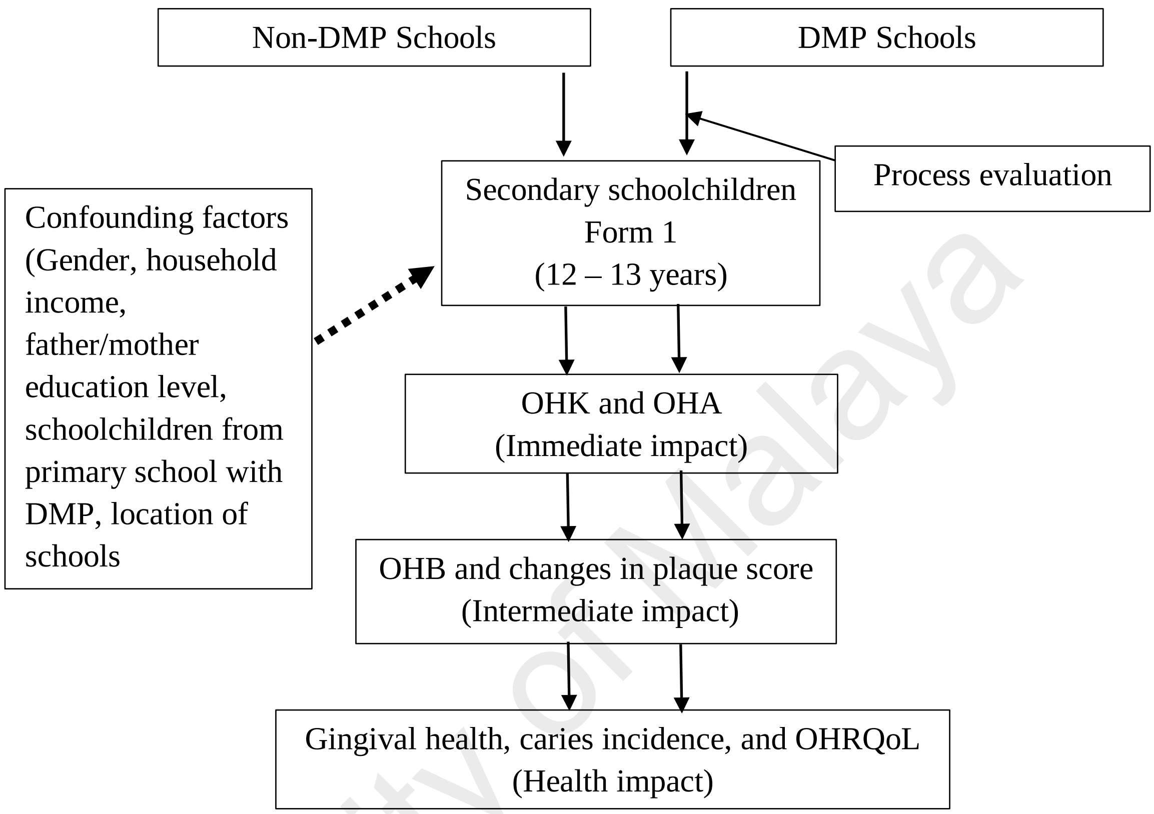

Figure 1.3: Conceptual framework of the study

1.7 Research questions

Research questions in this study were very important. Would the DMP have any impact on secondary schoolchildren in terms of OHK, OHA, OHB, oral hygiene level, oral health status (gingival health and caries incidence), and OHRQoL compared to schoolchildren from non-DMP schools after 6 months of exposure to the DMP?

In addition to exposure to the DMP in secondary schools, other confounding factors must also be observed. Were there any other factors associated with the schoolchildren's OHK, OHA, OHB, oral hygiene level, oral health status (gingival health and caries incidence), and OHRQoL?

Lastly, process implementation of DMP in secondary schools should also be explored. How was the process implementation of the DMP in terms of DM selection, training, strengths, and weaknesses? How could the DMP be improved further in secondary school?

1.8 Aim of study

To evaluate the potential impacts of a health-promoting school model for secondary schools in Malaysia, i.e. the *Doktor Muda* Programme (DMP) on secondary schoolchildren's levels of oral health knowledge, attitudes, behaviour, oral hygiene level, oral health status (gingival health and caries incidence), and oral health-related quality of life after 6 months.

1.8.1 Specific objectives

The objectives of the study were:

1. To compare the potential impacts of DMP between schoolchildren who attended DMP schools (intervention group) and schoolchildren who attended non-DMP schools (control group) after 6 months of implementation in terms of:
    a) Levels of oral health knowledge and attitudes (immediate impact)
    b) Levels of oral health behaviour and oral hygiene (intermediate impact)
    c) Oral health status, i.e. gingival health and caries incidence (health impact)
    d) Oral health-related quality of life (health impact)
2. To determine the associated factors in relation to schoolchildren's oral health knowledge, attitudes, behaviour, oral health status, and OHRQoL.

3. To explore the process implementation of the DMP in terms of DM selection, training, strengths and weaknesses of DMP, and suggestion for improvement from the perspectives of the DM.

1.8.2 Null hypothesis (H0)

There were no significant differences in OHK, OHA, OHB, oral hygiene level, oral health status (gingival health and caries incidence), and OHRQoL between schoolchildren attending DMP schools and schoolchildren attending non-DMP schools after 6 months.

1.8.3 Alternative hypothesis (H1)

Schoolchildren attending DMP schools had significantly better OHK, OHA, OHB, oral hygiene level, oral health status (better gingival health and lower caries incidence), and OHRQoL compared to schoolchildren attending non-DMP schools after 6 months.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The *Doktor Muda* Programme (DMP) was introduced in schools in Malaysia with students' involvement as *Doktor Muda* (DM). A DM refers to a school child who is empowered with health knowledge and skills to deliver health education and conduct health-related activities at school. The DM acts as an agent of change for healthy behaviours in school. The DMP is a smart partnership between the MOH and the Ministry of Education (MOE). The DMP is also part of the Health Promoting School (HPS) concept introduced by WHO in 1995 (World Health Organization, 2019a).

The relevant studies on the effect of the health promoting school on OHK, OHA, OHB, oral health status (plaque score, gingival health, and caries incidence) as well as OHRQoL were searched through UM library (http://www.diglib.um.edu.my) from BioMed Central (2012-2015), CINAHL® Complete @EBSCOhost, Dentistry & Oral Sciences Source @EBSCOhost, MEDLINE Complete @EBSCOhost, and ProQuest Dissertations & Theses Global databases. In addition to the stated databases, related studies were also searched through google scholar website (scholar.google.com).

This chapter will start with the information related to HPS such as rationale, evidence of effectiveness of HPS, and the effect of HPS on OHK, OHA, OHB, oral hygiene improvement, oral health status (gingival health and caries incidence), and OHRQoL.

The second part of the chapter will explain on methods of assessment of oral health status namely the O'leary Index (O'Leary, Drake, & Naylor, 1972), the Gingival Index for Schoolchildren (GIS) (Oral Health Division, 2013), and the International Caries Detection and Assessment System (ICDAS) (Ismail, Sohn, Tellez, Amaya, Sen, Hasson et al., 2007). In addition to that, the Child Oral Impacts on Daily Performances (Child-OIDP) index as a measure for assessing OHRQoL will also be explained (Gherunpong, Tsakos, & Sheiham, 2004a).

In addition, this chapter will also describe the implementation of the DMP in secondary schools from the point of view of DMs. A focus group discussion (FGD) as a method of qualitative data collection (Krueger, 1988) and the framework used for the evaluation of the DMP, namely the Precede-Proceed model (Green & Kreuter, 1991), will also be reviewed in this chapter.

2.2 The Health Promoting School Concept

The WHO defined a health-promoting school (HPS) is one that constantly strengthens its capacity as a healthy setting for living, learning, and working (World Health Organization, 2019b). Schools can provide a supportive environment for promoting the oral health of schoolchildren and the school staff, and offer an extensive network and channel to the local community. Health promotion activities can be targeted at home and throughout the community by school personnel. Through this interaction, the link between the community and homes are essential in promoting health (Alrmaly & Assery, 2018).

Education has the power to improve not only the economic prosperity of a country, but that it has a significant effect on health outcomes. The provision of good and appropriate education can improve health outcomes, and demonstrating that active health promotion in schools can improve both educational and health outcomes for young people. There is evidence that health promotion in schools can support and provide added values to schools as they strive to meet a whole host of social aims through their curriculum and a whole-school approach (St Leger & Young, 2009).

HPS follows the principles and actions called for in the Ottawa Charter for health promotion (World Health Organization, 1986). According to the WHO (2019), a HPS should adhere to the following:

- foster health and learning with all the measures;
- engage with education officers, teachers, teachers' unions, health providers, students, parents and community leaders in orders to make the school a healthy place;
- strive to provide a healthy environment, school health education, and school health services along with school and community projects and outreach, health promotion programmes for staff, nutrition and food safety programmes, opportunities for physical education and recreation, and programmes for counselling, social support and mental health promotion;
- implement policies and practices that respect the well-being and dignity of individuals, provides various opportunities for success, and acknowledges good efforts and intentions as well as personal achievements; and
- strive to improve the health of school members, families and community members as well as students; and work with community leaders to help them understand how the community contributes to, or weakens, health and education.

The concept of HPS embraces the WHO's holistic vision of health and considers positive and negative influences on health. It focuses evenly on lifestyles and the physical, social, and psychological conditions that affect health. It combines prevention, the need to focus on priorities and the importance of measurable outcomes, in which the prevention alone is insufficient. Therefore, HPS goes beyond the prevention model, enabling the full potential of school organisational to be healthy places where to live, learn and work (World Health Organization, 1999).

The HPS focuses on (World Health Organization, 2019b):

- caring for oneself and others
- making healthy decisions and take control of living conditions
- creating conducive conditions for health (through policies, services, physical/ social conditions)
- building capacities for peace, protection, education, income, food, stable ecosystem, social justice, equity, sustainable development.
- preventing major causes of death, illness/disease and disability: helminths, tobacco use, HIV/AIDS/STDs, inactive lifestyle, alcohol and drugs, violence and injuries, unhealthy eating habits.
- influencing behaviour related to health: knowledge, beliefs, skills, attitudes, values, support.

2.3 Rationales and need for the HPS Concept

Oral health is the basis of general health and well-being. A healthy mouth enables an individual to speak, eat, and socialise without having active disease, discomfort, and embarrassment.

Unlike healthy mouths, oral disease can cause pain and tooth loss affecting the appearance, quality of life (QoL), nutritional intake and consequently the growth and development especially in children (Kwan, Petersen, Pine, & Borutta, 2005). Therefore, the burden of oral disease is considerable. Caries and gum disease are among the most prevalent diseases in human population, which affected more than 80% of schoolchildren in some countries (World Health Organization, 2003a).

Oral disease is a diet and lifestyle-related disease (Sheiham, 2001). Many oral health problems can be prevented and their early onsets are reversible. However, in some countries there are a large number of teachers, parents, and children who have limited knowledge on the causes and prevention of oral disease (Rajab, Petersen, Bakaeen, & Hamdan, 2002). The problems are further aggravated by the high intake of sugary snacks and high carbonated beverages in children and adolescents (Currie, Hurrelman, & Settertobulte, 2000).

Given the many risk behaviours that come from the school age year, schools have a strong influence in the development and well-being of students (Currie et al., 2000). The need for oral health promotion at schools is evident, and it can easily be integrated into general health promotion, activities, and school curriculum. Children can be provided with skills that will enable them to make healthy decisions, to practice healthy lifestyles, and to deal with conflicts effectively.

When children grow and become teenagers, they show some levels of increasing autonomy where their decisions, behaviours, and relationships can increasingly determine their health. In addition to the personal preferences and relationships that young people make, the environment in which they live is a strong determinant of their health. The conditions of their homes, schools, workplaces, and communities can encourage or minimise their health (World Health Organization, 1999).

Healthy behaviours and lifestyles developed at a younger age have been shown to be more sustainable into adulthood, partly because the health messages and activities can be reinforced throughout the school years (Kwan et al., 2005). Therefore, the HPS is an excellent platform to nurture healthy habits and skills in schoolchildren that enable them to make healthy decisions and practice a healthy lifestyle.

The health promotion activities can be targeted at home and throughout the community by the school personnel. This school-home-community interaction is an important aspect of a health-promoting school. An effective school oral health programme is one of the most cost-effective interventions a nation can make to simultaneously improve education and oral health (Alrmaly & Assery, 2018).

Alrmaly & Assery, (2018) stated that the need for promoting oral health through schools are due to the following reasons:

i. dental caries and periodontal diseses are prevalent oral diseases in developing countries: although the dental caries in schoolchildren has declined in many industrialised countries in the past decades, dental caries has increased in many developing countries, especially those where preventive programme has not been established (Blumenshine, Vann Jr, Gizlice, & Lee, 2008).

ii. increasing incidence of oral lesions and conditions: quality of life can be affected due to the teeth appearance caused by defects and colour of the tooth enamel. Enamel defects are rising in some countries. In Malaysia, it has been reported that over 75% of 12-year-old children have some forms of opacities and enamel defects, regardless of whether they live in fluoridated areas or not (World Health Organization, 2003a).

iii. increasing incidence of dental trauma: injuries tend to be more prevalent in boys. Regulatory measures, environmental changes, and education play crucial roles in the prevention of injuries and accidents in children's environments (World Health Organization, 2002).

iv. knowledge of oral health among teachers and parents: many studies have shown that mothers with lower levels of education also have lower levels of oral health-related knowledge. The improvement in oral health among children over the past decades has been attributed to an increased awareness of oral health, widespread use of fluoride toothpaste, improved tooth brushing habits, oral health awareness among parents and teachers (Sufia, Khan, & Chaudhry, 2009; Szatko, Wierzbicka, Dybizbanska, Struzycka, & Iwanicka-Frankowska, 2004).

Mother's low education levels, her age, rural domicile of the mother, presence of plaque on the child's teeth, infrequent tooth cleaning, and frequent sugar consumption by the children have been associated with poor oral health of the children (Petersen, Nyandindi, Kikwilu, Mabelya, Lembariti, & Poulsen, 2002; Sufia et al., 2009).

v. cost and consequences of oral problems: oral disease is one of the most causally diet and lifestyle-related diseases. The cost of treating dental decay alone can easily burden a country's total healthcare budget. However, the cost of neglect is also high in terms of its personal, financial, and social impacts (Kwan et al., 2005). In most developing countries, investment in oral health care is low.

vi. oral health in school education and learning: children with chronic dental pain are easily distracted, unable to focus, and may have problems with schoolwork completion. They may also experience a drop in school performance, which negatively impacts their self-esteem (Jackson, Vann Jr, Kotch, Pahel, & Lee, 2011).

vii. growth and development: the experience of pain, endurance of dental abscesses, problems with chewing and eating, embarrassment about the missing, discoloured, shape, and damaged teeth can adversely affect children's daily lives and well-being (Petersen, 2004).

viii. successful prevention through school-based effort: many oral health problems can be prevented and their early onset reversible. However, in some countries, a large number of teachers, parents, and children have limited knowledge of the causes and prevention of oral disease. A school is a closed environment that focuses on a large number of individuals from same age group who regularly attend the institution. For this reason, it has been considered appropriate to develop health and oral hygiene programmes with children in age groups that are favourable to adopt preventive measures (De Farias, de Araujo Souza, & Ferreira, 2009).

ix. lifestyle at school age: schoolchildren's dietary behaviour, as related to oral health and practices of oral health counselling, requires special attention. The dietary factors have been found to influence schoolchildren's oral health. There is convincing evidence for an association of the frequency and amount of sugar intake and dental caries. High consumption of sweets is also common among schoolchildren (Sousa, Santos, Costa, Carvalho, & Pereira, 2019).

x. integration of general health, oral health, and school curriculum: Many risk behaviours stem from the school-age years. Schools have strong influences on development of well-being children. The need for oral health promotion at schools is evident, and it can be easily integrated into general health promotion, activities, and school curricula. Schoolchildren can be provided with skills that enable them to make healthy decisions, to practice a healthy lifestyle, and to deal with conflicts. Healthy behaviours and lifestyles that developed at a young age are more sustainable where messages can be reinforced throughout the school years (Kwan et al., 2005).

2.4 The effectiveness of HPS Projects in promoting schoolchildren's health

The schoolchildren are considered to be an important target group for inculcating healthy habits to last for a lifetime (Singla, Acharya, Chakravarthy, & Singla, 2014). WHO in 2006 stated that the HPS project has been effective to improve young people's health and health-related behaviours (World Health Organization, 2006). These findings are supported by findings in a study in Canada in 2010 which stated that HPS has managed to bring about positive changes in youths' lifestyles (Deschesnes, Trudeau, & Kébé, 2009).

The study by Lee et al. (2008) which assessed the students' perceptions, knowledge and health behaviours between schools that adopted the HPS framework and schools that had not taken the HPS framework showed that students in the HPS were found to be significantly better in personal hygiene practice, health and hygiene knowledge, and access to health information (Lee, Wong, Keung, Yuen, Cheng, & Mok, 2008).

The HPS plays an important role in promoting students' health literacy, behaviours, and academic achievements. The school-based health promotion interventions can be particularly valuable in developing countries facing with the challenges of high burden of disease and low health literacy (Mukamana & Johri, 2016). The literature review by Mukama and Johri (2016) focusing on school-based health promotion interventions and their impacts in developing countries. They found that school-based interventions could be classified into two main categories: those who target environmental determinants such as social and physical environments at school, family, and community levels and those targeting individual determinants of health such as knowledge, skills, and health behaviours. The findings suggested that a comprehensive approach that addresses environmental and individual health determinants can cause long-term behaviour changes and significantly enhanced health and educational outcomes (Mukamana & Johri, 2016).

A systematic review was conducted by Dongxu and Stewart in 2012 to evaluate the effectiveness of a nutrition promotion programme using the HPS approach and to indicate areas where further research were needed as well as to recommend for future practice in related fields. The evidence from the systematic review indicated that nutrition promotion programmes (NPP) using the HPS approach could increase participants' consumption of high-fibre foods, water, milk, vegetables, fruits, and healthier snacks. Such programmes could also reduce participants' 'breakfast skipping' habit, as well as reduce intakes of low-nutrient dense foods, fatty foods, creamy foods, red food and sweet drinks consumption, and eating disorders. HPS could also help in improving food safety behaviour and to develop hygienic habits. Despite the effectiveness of the HPS in improving dietary habits, they recommended that more professional training for teachers in the HPS approach, longer intervention periods, improved follow-up evaluations, further qualitative studies, and adequate funding are required in future school-based nutrition promotion programmes (Wang & Stewart, 2013).

Another study was conducted to demonstrate the effectiveness of HPS framework in promoting nutrition knowledge and healthy eating behaviours among Chinese middle school students, their parents, and school staff. The comparison was made between three schools which randomly assigned to school using HPS framework, school with improved health education (HE) and school did not received any intervention (control school). The results showed that school with HPS framework and health education can increase nutrition knowledge among Chinese middle school students, their parents, and school staff. However, the school with HPS framework was more effective than health education only. The concluded that the HPS had a positive impact on students' eating behaviours (Dongxu, Stewart, Yanfei, & Chun, 2015).

The investments in schools are expected to yield gains for communities, nations and individuals is the form of an improved social and economic development, increased productivity and enhanced QoL (Singla et al., 2014).

A recent study reported in 2019 assessed the impacts of two school-based OHE programmes on the oral health knowledge, behaviours, and oral hygiene of 9-year-old children in Turkey. The two groups of student received the same content of oral health education intervention including the supporting materials. Difference professions delivered the messages. One group received the OHE from a dentist, and another group received the OHE intervention from their teachers. They found that, teacher was more effective for teaching correct brushing techniques (p<0.001) compared to the dentist after 6 months (Eden, Akyildiz, & Sönmez, 2019). This finding shows that, among other things, students were more easily influenced by close people around them, including their teachers, and friends.

The child oral health promotion programme called the 'MaliMali' ('smile' in Tongan) is a school-based programme in the Kingdom of Tonga. It was reported that the programme was feasible and acceptable to the children in the Kingdom of Tonga. The programme promotes oral health and provides accessible and improved oral healthcare in the school setting, consistent with the oral-health promoting school framework. The MaliMali programme is applied in-group setting, therefore the individual cost is less and the overall cost was more effective (Takeuchi, Kawamura, Kawamura, Endoh, Uchida, Taguchi et al., 2017).

2.5 The *Doktor Muda* Programme (DMP)

In late 1980's, the DMP was introduced as a health programme to promote the overall health of primary schoolchildren and now it is introduced into secondary schools. All the basic health information will be presented through a planned module that includes schoolchildren's understanding, skills, and experience in health-related topics. The aim of the DMP is to produce health-conscious DMs who will serve as agents of change to promote good health behaviours to their peers, school members, family members and the community. The rationale for the establishment of the curriculum guidelines for DMP club is in line with the concept of healthy-setting for the purpose of enhancing health knowledge and adopting healthy lifestyles (Ministry of Health & Ministry of Education, 2013).

The objectives of the curriculum guidelines for the DMP club are (Ministry of Health & Ministry of Education, 2013):

i. to produce insightful schoolchildren who will become important human capital for the nation
ii. enable schoolchildren to help themselves, friends, and family members to adopt and practice healthy lifestyles
iii. allow schoolchildren to be guided and act as a role model towards healthy lifestyles
iv. allow schoolchildren to assist health personnel and the school staff in carrying out health activities in school
v. strengthen the involvement of teachers and schoolchildren in improving school health
vi. encourage parents/guardians to pay attention to the health of their schoolchildren
vii. enhancing collaborations between the MOH and the MOE to promote healthy lifestyles amongst schoolchildren

The DMP is a child-to-child school-based health promotion programme where a selected number of schoolchildren known as DMs are trained and empowered with health knowledge and skills to give health education to their peers and conduct health-related activities at school (Ministry of Health, 2012). They act as a role model for healthy behaviours and lifestyles. The selection and training of students from Form 1 to Form 6 are conducted by the teacher trainers who are trained by health education officers from the State Health Department. The teacher trainer acts as a moderator and a supervisor for the DMP activities. At school, DMs are trained using a modular curriculum in a range of health topics based on seventeen scopes including personal hygiene, environmental hygiene, oral health, mental health, prevention of infectious disease, safety and injury prevention, diet and healthy nutrition, healthy lifestyles, and healthy teenagers. Once trained, the DMs will deliver health education to peers throughout school year.

The DMP has been actively implemented in primary schools, where in year 2000 the total number of primary schools with DMP were 151 and increasing to 3,286 primary schools with DMP in 2018 (Ministry of Health & Ministry of Education, 2018b). Meanwhile, the DMP in secondary school was first implemented in 2014 with 30 secondary schools with DMP and the number had increased to 577 for whole Malaysia. Until last year (2018), the total number of trained DMs in secondary schools were 19,876 for whole Malaysia (Ministry of Health & Ministry of Education, 2018a).

The DMP has 17 scopes and 20 packages of activities as delivery modules for this programme. The 17 scopes of the DMP in secondary schools are as follows (Ministry of Health & Ministry of Education, 2013):

- Scope 1 : Healthy Like Me
- Scope 2 : I have Attractive Personality
- Scope 3 : Charming Smile
- Scope 4 : *Lirikan Mata* (eye movement)
- Scope 5 : Be Resilient
- Scope 6 : Move Your Body
- Scope 7 : Eat Healthily
- Scope 8 : Acting Wisely
- Scope 9 : I Love Myself
- Scope 10 : It’s All Dead Poison
- Scope 11 : Set Establishment
- Scope 12 : Instinct
- Scope 13 : Keep Alive, Get Started Now

- Scope 14 : Medicines, Use of Pain
- Scope 15 : First Aid
- Scope 16 : *Lihatlah Keindahan Alam* (Look at the beauty of nature)
- Scope 17 : *Satu Ikrar Sejuta Harapan* (One pledge, a million's hope)

The scope number 3 is related to oral health. In this scope, there are 4 units to be delivered as oral health education namely mouth malodour, malocclusion, dental trauma/injury and how to detect abnormalities in the mouth through extra and intra oral self-examinations. These 4 units cover in term of the causes, treatment and how to prevent the occurrence of oral health problem/ diseases.

The activities carried out under DMP in secondary school include individual advice, health talks, health-related demonstrations, health exhibitions, small group discussions, video show, preparation of health educational materials, creating and managing a health corner, helping a health staff on provision of treatment, measurement of body mass index (BMI), health-related activities at home, outside the school activities and to monitor the achievement of DMP (Ministry of Health, 2012). The activities that are conducted will focus on how to deliver the health messages, their attractiveness (creative and innovative), easy to understand and to remember, and 'fun'. In details, the activities covering all the 17 scopes are:

i. C.S.I (Check, search, investigate); the activities can be a treasure hunt by putting topic/information from DMP module in every checkpoint.
ii. Flash mob; music, dance, health massage, performance.
iii. Melody and lyric; compose health-theme song, performance
iv. DM *robik*; appoint the instructor, come out with aerobics, performance
v. Share the moments; identify school corner to display positive health-related behaviours and update regularly every month

vi. The actor; preparation of scripts, storyboards, actors. To perform in genre such as documentary, short story, drama, parody.

vii. Send it right (S.I.R); the health activities by identifying a target group and prepare the health messages. The activities are conducted virtually through phone or internet.

viii. Master chef; planning and teaching how to prepare healthy food

ix. Respect; visits to institutions, e.g. old folks home, community welfare home, and orphans).

x. The apprentice; DMs are given a sum of money and run an activity that can generate profit

xi. Talent time; individual or group performances. DMs perform in acting, singing, sketching, dancing, rhyme, debate, coral speaking, forum etc.

xii. I feel you; identify the health problems of schoolchildren (peers). DMs are divided into groups according to the schoolchildren's health problems and identify the health problems.

xiii. Demonstration of cardiopulmonary resuscitation (CPR), mouth self-examination (MSE); to show and promote those activities.

xiv. Camping

xv. Special project which will be notified from time to time

In addition, through DMP initiatives, DMs monitor their peers for healthy school environment and prevention of endemic diseases such as dengue and malaria from occurring.

The DMs keep a record of health problems such as cases of diarrhoea, vomiting, and flu-like symptoms involving schoolchildren, and involve in school health activities such as campaigns on anti-smoking and drug abuse. On school health day, DMs help teachers to record students' health report card for height, weight, eye test, health inspection, and personal hygiene.

Other activities include organising health quizzes, drawing competitions, essay writings, and public speaking competitions. The DMs are also trained to treat minor injuries using the first aid kit. Outside school activities include visits to the local clinic, hospital, community health centre, and undertaking health campaigns at community level. DMP exhibitions and competitions on various health promotion initiatives are also carried out.

2.6 The impacts of Health Promoting School on oral health knowledge (OHK), oral health attitudes (OHA), and oral health behaviours (OHB) of schoolchildren

Oral health is an essential component of general health. It has also become clear that the causative or risk factors of oral disease are often the same as those implicated in major general diseases (Nishida, Uauy, Kumanyika, & Shetty, 2004). Oral diseases are related to lifestyles and reducing oral diseases relies much on changing lifestyles and behaviours. Changes for the better behaviours can and do occur, but they require expertise and commitment within health promotion fraternity (Petersen & Kwan, 2004).

Schools are an ideal setting where health promotion strategies can be used to improve the oral health of children and indirectly can be channelled to target community to promote oral health (World Health Organization, 2003a). Oral health promoting schools that incorporate health education, promotion, prevention, and curative services are effective in lowering the burden of oral disease among children. It is also reported that along with this, HPS led to a significant improvement in tooth brushing behaviour (Saheer, Kousalya, Raju, & Gubbihal, 2015; Singla et al., 2014).

A study conducted in China with objectives to assess oral health outcomes of school-based OHE programme on children, mothers, and schoolteachers and to evaluate the methods applied and materials used. They applied the WHO, HPS to primary schoolchildren. After 3 years, the results showed a significant improvement in the intermediate oral health outcomes was reported, such as tooth brushing frequency, flossing frequency, intake of sweet food and drinks and between-meal snacking (Petersen, Peng, Tai, Bian, & Fan, 2004).

A local study on DMP in primary schools in Negeri Sembilan in 2013 showed that the DMP had positive effects on improving OHK, OHA, OHB, OHS, and OHRQoL of 11-12 year old children after 6 years of implementation (Zamros Yuzadi Mohd Yusof, 2013). This study reported that DMP gradually helped children to inculcate positive hygiene behaviours including regular tooth brushing and flossing at school as well as at home (Zamros Yuzadi Mohd Yusof, 2013).

In accordance to a research conducted in 2006 with the objectives were to develop and evaluate a teaching programme based on the national curriculum for use in a primary school setting. The content in a teaching programme were teeth and their function, dental diseases, and how to take care of teeth (prevention of dental disease). The main outcome following the teaching programme in the schools showed an improvement on the knowledge of schoolchildren towards dental health (Chapman, Copestake, & Duncan, 2006).

A study was conducted in Bangalore city to assess the effectiveness of an OHE programme on oral hygiene knowledge, practices, plaque control, and gingival health of 13-15 year old schoolchildren. Three schools were randomly selected and assigned to Group I (lecture using PowerPoint presentation), Group II (lecture using PowerPoint presentation with tooth brushing demonstration), and Group III (not received aby intervention, Control group). They found that a programme with active involvement of schoolchildren with reinforcement OHE improved oral hygiene knowledge, practices and gingival health, and decreased plaque levels (D'Cruz & Aradhya, 2013).

A study was conducted in Brazil involved children aged 10.5±1.3 years. This study was to evaluate the oral health of children who was participated in a preventive/educational programme that introduced in Brazil last 8 years. The results showed that most children performed brushing before sleeping. They concluded, the preventive/educational programme in 2003 was effective, since most of children remains without tooth decay (Leite, Souza, Rocha, Siqueira, Buzalaf, & Sampaio, 2015).

Other study that shows the improvement in tooth brushing habits due to the effectiveness of a health promotion programme was reported in Kingdom of Tonga. Part of this study was on tooth brushing habit that involved children aged 5-14 years. The intervention for this part was visited to kindergartens and primary schools to educate the children on oral hygiene (Takeuchi et al., 2017).

The findings from these 2 studies, i.e. Leite et al., (2015) and Takeuchi et al., (2017) were supported by the meta-analysis and systematic review that conducted in year 2017. They concluded that the past oral health education and promotion programme are effective and positive impacts on attitudes, dental visits, as well as brushing and flossing behaviour during 3 months post-interventions among children (Ghaffari, Rakhshanderou, Ramezankhani, Noroozi, & Armoon, 2018).

A study was conducted in 2012 to determine the prevalence of caries, gingivitis, and orthodontic irregularities in schoolchildren and to assess the efficacy of a health education programme in relation to the plaque and gingivitis control as well as caries treatment in Serbia. The intervention programme included was an oral hygiene education and the application of prophylactic measures. After 6 months, reductions in gingivitis, number of carious teeth, and an improvement in oral hygiene was noted. They concluded that health education programmes contributed to the improvement in oral health and increased motivation for self-care in schoolchildren (Lalić, Aleksić, Gajić, Milić, & Malešević, 2012).

A quasi-experimental study was conducted in a neighbour country, Indonesia to identify the relationship between the school oral health programme (SOHP) and the behaviour in students in 1st and 2nd grades. There were correlations between students in the SOHP and positive changes in dental health behaviours among the students after one month (Muhammad, Darwita, & Setiawati, 2018).

Another quasi-experimental study reported in 2019 which aimed to determine the effect of OHE using a combined training on adopting dental caries preventive behaviours in elementary school students. They found that, at baseline no significant differences were found between the experimental group and the control group in terms of mean scores of knowledge, attitudes, and behaviours. However, after 2 months of exposure to combined training, the intervention group showed significantly higher mean scores in the outcomes (p<0.05). The combined training was conducted by giving a lecture using PowerPoint, a demonstration, and a role play based on the findings at the baseline (Rashidi Birgani & Niknami, 2019).

2.7 The impacts of Health Promoting School on oral hygiene, gingival health, and caries incidence in schoolchildren

The local study on the DMP as part of the HPS concept also reported that the prevalence of intervention children with bleeding gums and plaque or calculus as the causes of oral impacts were significantly lower than that in the control group. This retrospective study was aimed to compare the impacts between schoolchildren who attended DMP schools (IG) and schoolchildren who attended non-DMP schools (CG) after 6 years of implementation in term of schoolchildren's levels of OHK, OHA, OHB, OHS and OHRQoL the study involved schoolchildren age 11-12 year old (Zamros Yuzadi Mohd Yusof, 2013).

The study was conducted in Karnataka, India with aimed to evaluate the oral hygiene related knowledge and plaque scores of 12 year-old schoolchildren before and after receiving health education. The schoolchildren were randomly allocated into 3 groups, i.e. Group I (audio-visual aids), Group II (chalk and blackboard), and Group III (no health education). They found that the reduction in plaque scores and the improvement in oral hygiene seen in the intervention group (IG) compared to the control group (CG) were most likely due to the information children received during the educational session and this information contributed to their improved oral hygiene measures (Hebbal, Ankola, Vadavi, & Patel, 2011).

Another study was conducted in India to determine the effectiveness of school dental health education (SDHE) which was conducted at repeated and different intervals in improving OHK, OHB, oral hygiene status, and the gingival health. The study involved schoolchildren aged 12 to 13 years. The intervention group was divided into 2, i.e. active group receiving the OHE in 3-week interval and another group receiving OHE in 6-week interval. In addition, 1 group was dedicated as a control group which did not receive any intervention programme. They concluded that the SDHE conducted at 3-week interval was more effective than the 6-week interval in improving the OHK, OHB, oral hygiene status, and gingival health of the schoolchildren (Shenoy & Sequeira, 2010).

A study was conducted in 2013 to assess the impact of oral health promotion (OHP) integrated with a HPS initiative on the health outcomes of secondary school students. They reported that the changes were more favourable in IG with respect to bleeding on probing, suggested there was a positive effect on students' oral hygiene status even though it was only weak effect (Mbawalla, Masalu, Masatu, & Åstrøm, 2013).

Many studies mainly focus on prevention of dental caries or periodontal disease but not include a component on preventing mouth malodour. A study conducted in Japan with aim to develop an oral health education programme that included oral malodour prevention and to test the effects of the programme in Japanese senior high school students by comparing the changes of oral health outcomes between IG and CG. Students in the IG received a new oral health education programme, particularly targeting oral malodour. After 1 year, they found that the IG had a significantly higher proportion of students with improved or maintained good oral health status, i.e. dental plaque, gingivitis, tongue coating, and oral malodour (Ueno, Shinada, Zaitsu, Yokoyama, & Kawaguchi, 2012).

The HPS that incorporated with OHE and promotion programmes were effective against caries, plaque, and gingival bleeding scores in children. A study conducted by Cueto, Barraza, Muñoz, and Chang (2016) to evaluate the oral health status of children who were beneficiaries of HPS programme in Chile. In the Chile, children were exposed to a promotional-preventive dental programme which consisted of the following:

i. Visit of an educator from module programme to the school to encourage participation and attendance of children to the programme and meet with parents, guardians, and children,
ii. Received education in oral health consisting of six units (mouth, cavities, healthy eating, habits, dental trauma and my dentist) through classes, videos, hands-on activities, games and songs, in a specially equipped classroom
iii. Oral hygiene techniques are taught and practiced in a tooth brushing room

iv. Received clinical care using the four- and six-hands technique to treat as many teeth as possible in one session and keep full treatment time to a minimum (i.e. sealant application, various fillings, tooth polishing, supragingival scaling, topical fluoride application, extractions, pulpotomies and orthodontics, periodic check-up)

v. The same professionals who worked on the programme offered health fairs at public squares, schools, and common places to reach the entire community

The IG in this study comprised children aged 7 to 13 year who entered Paediatric Dentistry Centre of Reference Simon Bolivar centre and the CG comprised children aged 13 years who just entered the centre. They reported that the proportion of caries-free children in the IG was slightly greater than the CG (Cueto, Barraza, Muñoz, & Chang, 2016).

Previously in year 2009, a study was conducted to assess of the outcome of an oral health promotion programme in schoolchildren over a 3-year period in Yichang City, China suggested that the school-based oral health promotion was an effective way to reduce new caries incidence, improved oral hygiene and establish positive oral health behavioural practices in the targeted schoolchildren (Bao-Jun, Han, Min-Quan, & Bin, 2009).

Another study in 2016 was conducted to evaluate the long-term effectiveness of a school-based child oral hygiene programme on oral heath after approximately 10 years of implementation. The study involved schoolchildren aged 10-11 years. In the IG, schoolchildren received instructions on how to practice daily flossing and brushing under the supervision of a school nurse for one semester. They found that, the mean value of overall plaque score was lower in the IG than the CG, the percentage of pocketing ≥2 in the IG was lower than the CG and the IG had lower DMFT and DMFS values. They concluded that the longitudinal follow-up study demonstrated a highly targeted oral hygiene programme can display positive long-term effectiveness on oral health (Lai, Fann, Yen, Chen, Lai, & Chiu, 2016).

Watt and Marinho (2005) reviewed and summarised study findings on oral health promotion effectiveness in relation to oral hygiene and gingival health. From the studies reviewed, they concluded that reductions in plaque and gingival bleeding were achieved in short-term in the majority of the studies reviewed (Watt & Marinho, 2005).

Another systematic reviewed paper showed that oral health education was effective in reducing caries increment, plaque, bleeding on probing of the gingiva, and as a result improving the gingival health. In addition, the review also recommended that an oral prophylaxis component in oral health education programmes would bring a higher quantum of improvement in gingival health (Nakre & Harikiran, 2013).

A study was conducted in a deprived area in Brazil to assess whether the oral health of 12-year-old children in supportive schools (where health promoting policies had been developed), was better than that of children in non-supportive schools. They reported that the children in supportive schools had better oral health than those in non-supportive schools in term of percentage of caries free and fewer dental trauma (Moysés, Moysés, Watt, & Sheiham, 2003). Furthermore, various studies showed that the school-based oral health promotion was an effective way to reduce new caries incidence, improve oral hygiene and establish positive oral health behavioural practices in the targeted schoolchildren (Al-Jundi, Hammad, & Alwaeli, 2006; Bao-Jun et al., 2009).

Another study found that the mean dmft value in schools that benefited from an oral health promotion programme tended to decrease compared to schools without the oral health promotion program (Tubert-Jeannin, Leger, & Manevy, 2012).

There was a study to assess the cost-effectiveness of an experimental caries-control regimen in a randomised control trail (RCT) in Finland. The study involved children aged 11-12 years. The IG was offered an individually designed patient-centered regimen for caries control. Meanwhile, the CG received a standard dental care. The IG was cared for by dental hygienists. The hygienists carried out preventive procedures and provided information and instructions on eating, snacking, and oral hygiene. Hygienists also conducted a clinical examination during every dental visit to assess the activity of the initial caries lesions and the child practical brushing skills. They concluded that the IG had been more cost-effective than the standard dental care (Hietasalo, Seppä, Lahti, Niinimaa, Kallio, Aronen et al., 2009). Takeuchi et.al, (2017) stated that a programme that was applied in a group setting had little individual cost. Based on their study on the 'MaliMali' Programme, despite the cost to purchase fluoride, materials for fluoride mouthrinsing and toothbrushes were lower than the treatment cost (Takeuchi et al., 2017).

2.8 The impacts of Health Promoting School on oral health-related quality of life of Schoolchildren (OHRQOL)

A study on the DMP in primary school which aimed to compare children's OHRQoL in schools with 6 years' implementation of the DMP showed that the DMP had some positive impacts on 11–12 year old children's OHRQoL (Yusof & Jaafar, 2013).

A study was conducted in 2019 to test the effectiveness of a school-based intervention to enhance the sense of coherence (SOC) and OHRQoL of socially vulnerable Brazilian children. The intervention schools focused on making the school environment a place for developing children's SOC through the involvements of teachers, school staff, and children. The teachers were trained to deliver the intervention programme. They found that children from the SOC-based intervention group had reported fewer impacts on their OHRQoL than the control group (Tomazoni, Vettore, Baker, & Ardenghi, 2019).

Another study in 2015 stated that students who attended the school-based oral health programme had a more positive impact on their OHRQoL, especially in their daily activities, with an insignificant effect on OHK or practices (Alsumait, ElSalhy, & Amin, 2015).

In the same year, a cross-sectional study was conducted in Yogyakarta, Indonesia to assess the association between the performance of school-based dental programme (SBDP) and OHRQoL in schoolchildren aged 12 years. This study also taking into accounts the sociodemographic factors and untreated caries. The results showed that the SBDP performance was related to their Child-OIDP scores. Specifically, poor performance in SBDP was significantly associated with a lower QoL in the children (Amalia, Schaub, Stewart, Widyanti, & Groothoff, 2017).

Table 2.1 shows the summarised studies from year 2003 onwards on the effect of HPS and school-based OHE and promotion programmes on oral health parameters.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Can a School-Based Intervention Improve the Oral Health-Related Quality of Life of Brazilian Children?. Tomazoni, F., Vettore, M., Baker, S., & Ardenghi, T. (2019).	To test the effectiveness of a school-based intervention to enhance the SOC and OHRQoL of socially vulnerable Brazilian children **Cluster-randomized trial** 3 months	5 primary schools in Brazil 165 in the IG 191 in the CG 356 children, aged 8 to 14 year old	IG: 7 sessions of SOC based activities (focused on making the school environment a place to develop children's SOC through involving teachers, school staff, and children). Trained teachers delivered the intervention.	i. Children from the SOC-based IG group reported fewer impacts of their oral health on their daily lives (Child Perceptions Questionnaire mean, 7.22) than those from the CG group (9.14). ii. The IG reported greater improvement of SOC at 2 weeks (SOC mean, 52.98) and 3 months (52.75) than the CG (52.21 and 51.65, respectively).	The intervention was effective in improving SOC and OHRQoL among socially vulnerable Brazilian children. Moreover, SOC was a relevant predictor for oral symptom and functional status in this population

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Comparison of Two School-Based Oral Health Education Programs in 9-Year-Old Children. Eden, E., Akyildiz, M., & Sönmez, I. (2019).	To evaluate the effectiveness of two school-based OHE programs on the oral health knowledge and behaviour and oral hygiene of 9-year-old children in Turkey. **Prospective study** 6 Months	1,053 schoolchildren Aged 9 years	i. Group I received OHE given by dentists at classroom ii. Group II received OHE given by schoolteachers at classroom	i. at baseline, tooth brushing frequency are similar in both groups ii. frequency tooth brushing frequency are significantly improved after 6 months in both groups ($p<0.001$) iii. teacher education was more effective for teaching correct tooth brushing techniques ($p<0.001$) iv. significant decrease in plaque accumulation after 6 months in both groups.	Both OHE programme were found to generate improvement in knowledge and behaviour of children on oral health and plaque control in short-term.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
Effect of Oral Health Education on Adoption of Dental Caries Preventive Behaviors among Elementary Students Using Combined Training. Rashidi Birgani, H., & Niknami, S. (2019).	To determine the effect of oral health education using combined training on adopting dental caries preventive behaviours among elementary students. **Quasi-experimental study** 2 months	i. 60 students in experimental group ii. 60 students in control group students in 5^{th} and 6^{th} grade 120 students	Lecture, PowerPoint, demonstration, and role-playing were used based on results at baseline. Educational intervention was conducted for the experimental group through 2 educational sessions at the school during one week.	i. There was no significant difference between experimental and control groups before the intervention ($p>0.05$). ii. After 2 months, there was a significant difference between the experimental and control groups in mean scores of knowledge, attitude, and behavioural ($p<0.05$).	Combined training can increase knowledge, change attitudes, and improve the adoption of dental caries preventive behaviours that affect oral and dental health of students.
The Relationship of Oral Health and Behavioral Change in Elementry Students. Muhammad, R., Darwita, R. R., & Setiawati, F. (2018).	To identify the relationship between the SOHP and the behaviour in students in first- and second-grade **Quasi-experimental study** 1 month	i. 80 students from 1^{st} grade ii. 90 students from 2^{nd} grade aged 6-9 year old 170 students	SOHP intervention (education about brushing teeth properly, mass teeth brushing, dental health education, and independent plaque screening by students.)	i. A significant relationship (p=0.001) was identified through a comparative analysis of plaque, behaviour, knowledge, attitude and action scores from before and after intervention. ii. the results of the correlation analysis between plaque and behaviour scores after intervention was p=0.001	There is a correlation between participation in the SOHP and changes in dental health behaviour among the study subjects.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Evaluation of the child oral health promotion 'MaliMali' Programme based on schools in the Kingdom of Tonga. Takeuchi, R., Kawamura, K., Kawamura, S., Endoh, M., Uchida, C., Taguchi, C., et al. (2017).	To explore: i. whether the programme was accessible to Tongan schoolchildren ii. the impact of the programme on decayed, missing, and filled teeth (DMFT) scores and tooth brushing habits (effectiveness) iii. factors that affected the adoption programme (adoption) iv. whether implementation was consistent with the programme model (implementation) v. the long-term sustainability of the programme (maintenance) **Programme Evaluation** 10 years after implementation of the programme	Participants under 18 year old i. For caries increment (prevalence of caries, 12-year-old): In 2001: 78 In 2011: 223 ii. Tooth brushing habit: In 2008: 829 children (5-14 year-old)	i. Visit kindergartens and primary schools to educate students on oral hygiene (i.e. distributing leaflet and providing verbal instruction about snacks and beverages), tooth brushing with fluoride dentifrice and fluoride mouth rinsing. ii. Dental examination and provide fissure sealant for the first permanent molars.	The oral health of Tongan children has improved, with decreased in mean DMFT index and increase in tooth brushing.	The evaluation found the “MaliMali” Programme to be feasible and acceptable to children and schools in the Kingdom of Tonga. The programme promotes oral health and provides accessible and improved oral health café in the school setting, consistent with the oral health-promoting promoting framework.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Long-term effectiveness of school-based children oral hygiene program on oral health after 10-year follow-up. Lai, H., Fann, J. C. Y., Yen, A. M. F., Chen, L. S., Lai, M. H., & Chiu, S. Y. H. (2016).	To evaluate the long-term effectiveness of a school-based child oral hygiene program on oral heath after approximately 10 years of follow-up. **Prospective cohort study** 10 years	120 schoolchildren (IG) and 120 classmates (CG) matched by gender 10–11 years 240 schoolchildren	IG: instructions on how to practice daily flossing and brushing under the supervision of school nurses for one semester	i. The mean value of overall plaque score in the IG (16.9%) was lower than that of the CG (32.6%); ii. The percentage of pocketing (CPI ≧ 2) in the IG (75.0%) was lower than that of the CG (90.8%); iii. The IG had lower DMFT values and DMFS score than the CG (4.1 and 6.6 versus 6.2 and 11.0). iv. Moreover, the IG had significantly better dental knowledge and habits and dental conditions than the CG.	This longitudinal follow-up study demonstrated that a highly targeted oral hygiene program could display positive long-term effectiveness.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
Evaluation of an Oral Health Promotion and Preventive Programme: A Case-Control Study. Cueto, A. U., Barraza, A. S., Muñoz, D. A., & Chang, S. (2016).	i. to evaluate the oral health of children who were beneficiaries of a promotion and preventive programme ii. to estimate the factors relating to their oral condition **Case Control** 6 years	all children admitted to the Paediatric Dentistry Centre of Reference Simon Bolivar between 2003 and 2009 with complete clinical records 7 to 13 year old, 512 children.	i. promotional-preventive dental programme: • the visit of an educator from the module to the school to encourage participation and attendance in the programme and meet with parents, guardians and children) • receive education in oral health consisting of six units (mouth, cavities, healthy eating, habits, dental trauma and my dentist) through classes, videos, hands-on activities, games and songs, in a specially equipped classroom • oral hygiene techniques are taught and practiced in a tooth brushing room	The main finding is that this programme does not successfully control the local risk factors of caries. The factors that jointly explain the presence of caries-free children were: non-participation in the programme, attending public school and the presence of sealed teeth.	The HPS programme in Chile reported that the proportion of caries-free children in the intervention group was slightly greater than control group.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
			• receive clinical care using the four- and six-hands technique to treat as many teeth as possible in one session and keep full treatment time to a minimum (i.e. sealant application, various fillings, tooth polishing, supragingival scaling, topical fluoride application, extractions, pulpotomies and orthodontics, periodic check-ups) • The same professionals who work on the programme offer health fairs at public squares, schools, etc., to reach the entire community		

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Evaluation of a program of oral health promotion in public daycare centers: Longitudinal study. Leite, D. F. B. M., Souza, N. L., Rocha, Í. M., Siqueira, M. d. F. G., Buzalaf, M. A. R., & Sampaio, F. C. (2015).	To evaluate the oral health of children who participated in a preventive/educational program applied in eight years before **Longitudinal study** 1 year follow up	3 day-care centres 33 children with a mean age of 10.5±1.3 years	Preventive/educational measures were performed addressing the importance of oral health, aetiology, prevention of dental caries, and orientation with respect to the ideal time to clean the oral cavity, especially at night before sleeping. For this, posters, flyers, macro model, and illustrative albums were used.	For night hygiene, it was observed that most performed brushing before sleeping and had no dental caries in 2011 (73.7%, p=0.02). Considering the presence of dental erosion in permanent teeth, there was association with erosive diet (soft drinks and juices) (p=0.001).	The preventive/ education program performed in 2003 was effective, since most of children remains without tooth decay.
Long-Term Effects of School-Based Oral Health Program on Oral Health Knowledge and Practices and Oral Health-Related Quality of Life. Alsumait, A., ElSalhy, M., & Amin, M. (2015).	To evaluate the effects of exposure to the SOHP during primary school years on the current OHK and practices and OHRQoL **Cross-sectional study**	i. 189 participants had attended the SOHP ii. 111 had not attended the SOHP 17.6–24.3 years, 300 participants	Attended the SOHP.	i. The daily activities of the non-SOHP attendees were twice as likely to be affected by dental health issues compared to those of the SOHP attendees (OR = 2.28, 95% CI = 1.41–3.68, p<0.001). ii. The SOHP attendees were 3 times as likely to describe their OH status as good/very good/excellent than the non-SOHP attendees (OR = 2.85, 95% CI = 1.31–6.18, p=0.008).	The SOHP attendees had a better OHRQoL and overall self-satisfaction with their oral health than the non-SOHP attendees with insignificant differences between the 2 groups in OHK and practices.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
The implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach: a systematic review. Wang, D., & Stewart, D. (2013)	i. To evaluate implementation and effectiveness of NPP using the HPS approach. ii. To indicate areas where further research is needed. iii. To make recommendations for practice in this field. Design: Searched through electronic databases included: CINAHL, Cochrane Library, Health Reference Center, Informit Search, MEDLINE, ProQuest, PsycINFO, PubMed, ScienceDirect, Scopus, Social Services Abstracts and Web of Science. Inclusion criteria were:	Setting: school Subjects: students, parents and school staff.	• NPP using HPS approach	All studies described intervention delivery and 6 reported on process evaluation. In intervention schools, school environment, and ethos were more supportive, appropriate curriculum was delivered and parents and/or the community were more engaged and involved. Students participated in interventions at differing levels, but the majority was satisfied with the intervention. The evidence indicated that NPP using the HPS approach can increase participants' consumption of high-fibre foods, water, milk, vegetables, fruits, and	More professional training for teachers in the HPS approach, longer intervention periods, improved follow-up evaluations, further qualitative studies, and adequate funding are required for future school-based nutrition promotion programmes

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
	(i) controlled or before-and-after studies evaluating a nutrition intervention and involving the HPS approach, either fully or in part; (ii) provision of information about components and delivery of the intervention; and (iii) report on all evaluated outcomes.			healthier snacks. It can also reduce participants' 'breakfast skipping', as well as reduce intakes of low-nutrient, dense foods, fatty foods, creamy foods, red food and sweet drinks consumption, and eating disorders. It can help to develop hygienic habits and improved food safety behaviours.	
Effectiveness of oral health education programs: A systematic review. Nakre, P. D., & Harikiran, A. G. (2013).	i. Collect and collate all information on oral health education programmes ii. Assess the programs based on various coding criteria iii. Assess effectiveness of these oral health education programmes on OHS and OHK, OHA and OHB. Design: Searched of all published articles in Medline was done using the keywords "oral health education, dental health education, oral health promotion	i. Articles on oral health programs with an OHE component ii. Articles published after the year 1990 iii. Articles published in English	OHE, dental health education, oral health promotion	Out of total of 40 articles 13 articles evaluated the effectiveness of the programme through improvement in knowledge, 4 through change in attitude, 15 through improvement in oral health related practices, 8 through improvement in gingival health, 11 through reduction in plaque, 8 through reduction in bleeding on probing, 9 evaluated the caries increment and 9 used other outcome variables to evaluate the effectiveness of the program	Oral health education is effective in reducing caries increment, plaque, bleeding on probing of the gingiva, and as a result improving the gingival health.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Oral health impacts of the health promoting school: The Doktor Muda programme. Zamros Yuzadi Mohd Yusof. (2013).	i. to compare the impacts between schoolchildren who attended DMP schools (IG) and schoolchildren who attended non-DMP schools (CG) after 6 years of implementation in term of schoolchildren's levels of OHK, OHA, OHB, OHS and OHRQoL ii. to determine associated sociodemographic and related factors in relation to schoolchildren's OHK, OHA, OHB, OHS and OHRQoL iii. to explore other associated environmental factors which might influence the programme implementation and outcome **Retrospective cohort study** 6 years of implementation	1224 students from 16 DMP schools 2061 students from non DMP schools 11-12 years old	IG: Year Six (11-12 year olds) and had exposure for past 6 years since Year One CG: Year Six with no previous exposure to DMP	i. The IG a higher mean OHB score than the CG (p<0.001) ii. The IG significant lower in mean DMFT and DMFS incremental score than the CG (p<0.05)	The HPS known as DMP in Malaysia showed: i. positive impacts in improving OHK, OHA, OHB, OHS as well as OHRQoL ii. the prevalence of intervention children with bleeding gums and plaque or calculus as causes of oral impacts were significantly lower than that in the control group.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Health promoting schools and children's oral health related quality of life. Yusof, Z. Y., & Jaafar, N. (2013).	To compare children's OHRQoL in schools with 6 years of implementation of a health promoting school model in Malaysia, i.e. the DMP and in schools without the DMP. **Cross-sectional study (Evaluation)** After 6 years implementation of DMP	Year 6 (11–12 year old) children; 1282 from DMP (intervention) and 2173 from non-DMP (control) schools. The sample comprised 3455	School with DMP in primary school	IG: i. mean total impact score was 7.10 ii. Significantly less DMP children had oral impact on cleaning teeth (*p*=0.034). iii. Significantly more DMP children reported having 'very little' and 'little' levels of impact intensity on cleaning teeth (*p*=0.037) and emotional stability (*p*=0.020) iv. Significantly less DMP children reported having 'very severe' level of impact intensity on speaking (*p*=0.038) v. Significantly less DMP children reported bleeding gums (*p*=0.016) and presence of plaque/ calculus as causes of impacts (*p*=0.032).	This study showed that the health promoting school model, i.e. the DMP for primary schools in Malaysia had some positive impacts on 11–12 year old children's OHRQoL.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Changes in adolescents' oral health status following oral health promotion activities in Tanzania. Mbawalla, H., Masalu, J. R., Masatu, M., & Åstrøm, A. N. (2013).	To assess the impact of oral health promotion integrated with a HPS initiative on the oral health outcomes of secondary school students **Cluster randomized trial** 2 years	Urban: 2 IG (schools) 3 CG (schools) Rural: 3 IG (schools) 2 CG (schools) 732 students in secondary school	OHE attended by school teacher and students (The key oral hygiene messages included: brush with fluoride toothpaste, brush for 3 min at least twice a day and replace toothbrush when bristles start to get out of shape)	i. Mean number of teeth with plaque decreased significantly in IG and CG. ii. Mean number of teeth with bleeding decreased (0.5 vs 0.3, $p<0.05$) in IG, whereas no change was observed in the control schools (0.4 vs 0.5, $p=0.051$).	The health outcomes of secondary school students reported that the changes were more favourable in IG with respect to bleeding on probing, suggested there was positive effect on students' oral hygiene status even though it was only weak effect.
Impact of oral health education on oral hygiene knowledge, practices, plaque control and gingival health of 13-to 15-year-old schoolchildren in Bangalore city. D'Cruz, A., & Aradhya, S. (2013).	To assess effectiveness of an OHE programme on oral hygiene knowledge, practices, plaque control and gingival health of 13- to 15-year-old school children in Bangalore city **Randomised control trial** 9 months	Three schools were randomly selected and assigned to experimental I, experimental II and control groups. 13- to 15-year-old schoolchildren 450 schoolchildren	OHE was provided by the investigator: i. Group I :lecture using a PowerPoint presentation ii. Group II: lecture using a PowerPoint presentation with tooth brushing demonstration. CG: not received any intervention	9 months post-intervention, there was significant improvement in oral hygiene knowledge and practices in experimental groups. There were significant reductions in mean plaque index and gingival index scores in the experimental groups. The control group did not show any significant improvement	Active involvement of schoolchildren with reinforcement of OHE can improve oral hygiene knowledge, practices, and gingival health and decrease plaque levels.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
Addressing children's oral health inequalities: caries experience before and after the implementation of an oral health promotion program. Tubert-Jeannin, S., Leger, S., & Manevy, R. (2012).	i. To evaluate the dental status of 5-year-oldchildren in Clermont-Ferrand (France) in 2009; ii. To measure changes in children's dental status between 2003 and 2009 iii. To estimate the impact of an oral health promotion programme implemented in 9 schools since 2005 **Retrospective cohort** 6 years	i. 5-year-olds attending public schools in deprived areas (oral health promotion) ii. 6 schools randomly selected schools in Clermont-Ferrand (non- oral health promotion) 5 year old, 620 schoolchildren	i. Schools with oral health promotion programme ii. school without oral health promotion	i. The mean dmft was 1.18 (SD2.61); 27.6% had at least one tooth affected ii. The only difference observed was increased in the 'f' (p<0.001) iii. In deprived areas, mean dmft increased in schools without the oral health promotion programme (p=0.04).	The oral health promotion programme has done little to reduce disparities in oral health, even if dental status improved in four schools.
Effects of an oral health education program targeting oral malodor prevention in Japanese senior high school students. Ueno, M., Shinada, K., Zaitsu, T., Yokoyama, S., & Kawaguchi, Y. (2012).	i. to develop an oral health education programme that included oral malodour prevention ii. to test the effects of the program in Japanese senior high school students by comparing the changes of oral health outcomes between the intervention and control groups **Intervention study** 1 year follow up	i. 163 Grade 1 ii. 135 Grade 2 senior high school students 298 students	A novel OHE programme, which incorporated prevention of oral malodour, was developed and conducted on all Grade 1 students (IG) and Grade 2 students (CG) did not receive the programme.	The IG compared with the CG, had a significantly higher proportion of students who improved or maintained good oral health status (i.e. dental plaque, gingivitis, tongue coating, and oral malodour).	An OHE programme focusing on the prevention of oral malodour is effective for promoting oral health among Japanese senior high school students. Therefore, embedding such a programme in the school oral health curriculum would be beneficial for adolescents.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
The efficacy of the interventional health education program for oral health improvement in schoolchildren. Lalić, M., Aleksić, E., Gajić, M., Milić, J., & Malešević, Đ. (2012).	To determine the prevalence of caries, gingivitis and orthodontic irregularities in schoolchildren and to assess the efficacy of health education program in relation to the plaque and gingivitis control as well as caries treatment. **Program evaluation** 6 months follow up	i. 56 second grade students with early mixed dentition ii. 56 seventh grade students with permanent dentition, from elementary school "Borislav Petrov Braca" in Pancevo. 112 participants	The Interventional Program included oral hygiene education and the application of prophylactic measures (At the school, during the classes, previously trained dental students disclosed dental plaque of schoolchildren and explained them the nature and consequences of the presence of plaque on teeth and gums)	After six months of conducting the program, reduction of gingivitis and number of carious teeth in DMFT/dmft as well as oral hygiene improvement were achieved in both age groups.	Oral hygiene, dental status and the prevalence of orthodontic anomalies in schoolchildren indicate the necessity to intensify preventive measures. Health education programs contribute to improvement of oral health and increase motivation for self-care in children.
Evaluation of knowledge and plaque scores in school children before and after health education. Hebbal, M., Ankola, A. V., Vadavi, D. V., & Patel, K. (2011).	To evaluate the oral hygiene related knowledge and plaque scores of 12-year-old schoolchildren in Belgaum city before and after health education. **Randomised control trial** 2 months	3 schools, 12-year-old school children in Belgaum city, India 150 children	Three health educational groups: i. group I (audio-visual aids), ii. group II (chalk and blackboard) and iii. group III (no health education)	Baseline: The mean knowledge score before intervention in group I was 7.94, in group II was 7.86 and in group III was 7.74, no significant in plaque score After intervention ; The mean knowledge score was 14.42 in group I, 12.7 in group II and 9.58 in group III (p<0.001), the mean plaque scores were 0.627 in group I, 0.8826 in group II and 1.0156 in group III.	Health education by audio-visual aids could be an effective preventive measure against plaque-related oral diseases.

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Effectiveness of a school dental education program in improving oral health knowledge and oral hygiene practices and status of 12- to 13-year-old schoolchildren. Shenoy, R. P., & Sequeira, P. S. (2010).	To determine the effectiveness of school oral health education, conducted at repeated and differing intervals, in improving oral health knowledge, practices, oral hygiene status, and the gingival health of schoolchildren belonging to two socioeconomic classes. **Community intervention study** 36 weeks	6 schools in Mangalore, India (3 schools for each socioeconomic group) 400 children 11-13 year old	i. Social class I-schools 1A, 1B, 1C; ii. social class V- schools 2A, 2B, 2C. • Active group (AG): 1A and 2A (programme at 3-week interval) • Control group (CG): 1B&1C and 2B&2C (No programme) • After 18 weeks: changing to: i. New AG: 1B&2B (programme at 6-week interval) ii. CG: 2A iii. Residual control: 1C&2C (no programme)	Plaque and Gingival score reductions were highly significant in intervention schools, and were not influenced by the socioeconomic status.	The OHE programme conducted at three-week intervals was more effective than that conducted at six-week intervals in improving oral health knowledge, practices, oral hygiene status, and gingival health of schoolchildren.
Factors influencing the adoption of a health promoting school approach in the province of Quebec, Canada. Deschesnes, Trudeau, & Kébé, (2009)	To examine a prediction model that integrated three categories of predictors likely to influence adoption of the Quebec Healthy Schools approach, i.e. attributes of the approach, individual and contextual characteristics. **Cross-sectional study**	141 respondents representing 96 schools participated in a postal survey	Adopt the Quebec Healthy Schools approach	Participants having a good or very good knowledge were more likely to adopt Healthy School than those with a superficial knowledge (79.3 versus 21.1%).	HPS has managed to bring about positive changes in youths' lifestyles

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
Assessing the effectiveness of a school-based oral health promotion programme in Yichang City, China. Bao-Jun, T., Han, J., Min-Quan, D., & Bin, P. (2009).	To assess the outcome of oral health promotion in schoolchildren **Cluster randomised control trial** 3 years	7 intervention schools and 8 control schools were randomly selected. 6-7 year old student After 3 years, 661students in intervention school and 697 in control schools	(i) a 30-min OHE instruction for children delivered by school teachers biweekly for 3 years. (ii) a 30-min OHE instruction for mothers once a year (iii) an OHE booklet for use by the children (iv) annual presentation of OHE posters, both in the classroom and the schoolyard; (v) contests on OHK, painting oral health situations, and on brushing teeth; (vi) a tour of the dental hospital once during the 3 years to familiarize the children with the clinical practice (vii) an oral examination by local dentists in the classrooms once a year, (viii) provision of fluoride toothpaste (ix) provision of preventive and curative care	i. The primary outcomes were a 3-year net caries increment (DMFT⁄DMFS) in the permanent dentition and changes in children oral hygiene status. ii. The secondary outcomes were the increments of children (%) with certain oral care habits and the variable ‘restoration, sealant, and decay’ during the 3-year study period.	The school-based oral health promotion was an effective way to reduce new caries incidence, improve oral hygiene and establish positive oral health behavioural practices in the targeted schoolchildren

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
Can the concept of Health Promoting Schools help to improve students' health knowledge and practices to combat the challenge of communicable diseases: Case study in Hong Kong? Lee A., Wong M.C., Keung V.M. et al. (2008).	To examines the differences in student perceptions, knowledge and health behaviours between those schools that have adopted the HPS framework and those that have not adopted. **Cross-sectional study**	i. Health school with award (HSA) : 5 primary schools and 7 secondary schools ii. Non HSA school: 8 primary school and 7 secondary school 2700 students	• The HPS framework to promote better health and hygiene. • Built on the concept of 'the' HPS framework, the Hong Kong Healthy Schools Award scheme includes "Personal Health Skills" as one of its key aspects to improve student hygiene knowledge and practices. A self-administered questionnaire	• Students in the HSA category were found to be better with statistical significance in personal hygiene practice, knowledge on health and hygiene, as well as access to health information. • HSA schools were reported to have better school health policy, higher degrees of community participation, and better hygienic environment.	Students in schools that had adopted the HPS framework had a more positive health behaviour profile than those in non-HPS schools.
The efficacy of a school-based caries preventive program: a 4-year study. Al-Jundi, S. H., Hammad, M., & Alwaeli, H. (2006).	To test the efficacy of a school-based caries preventive programme. **Randomised control trial** 4 years	i. Study group (SG): 436 children ii. Control group (CG): 420 children From 1st and 6th grade 856 children	i. The SG received a preventive program which consisted of intensive oral hygiene instructions sessions, and supervised daily tooth brushing using fluoridated tooth paste in schools ii. CG received only oral hygiene instructions sessions	i. the caries status of the children in the SG was better than that of the CG. The difference was statistically significant (*p*=0.001). ii. the estimates of relative risk values: children in CG are 3.1 (6th grade) and 6.4 (1st grade) times at higher risk of having dental caries than those in the SG	This study proves that supervised daily tooth brushing using fluoridated toothpaste is successful in controlling dental caries in children

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
An oral health education programme based on the National Curriculum. Chapman, A., Copestake, S. J., & Duncan, K. (2006).	To develop and evaluate a teaching programme based on the national curriculum for use in a primary school setting. **Community intervention study** 7 weeks	Manchester (n = 58) and North London (n=30). 7 and 8 years 88 children	Teaching programme: i. *Teeth and their function (d*ifferent layers of teeth, different types of teeth, and using teeth for eating) *ii. What can go wrong with our teeth? (*decay, toothache, tooth loss and erosion) *iii. How to take care of our teeth (*diet, importance of regular tooth brushing, tooth brushing technique, and dental visits	Following the teaching programme, children in both schools showed a significant improvement in dental health knowledge (p<0·001).	The dental profession's oral health messages were easily integrated with the aims of the National Curriculum. Development and assessment of a more widely available teaching resource would be useful for encouraging the teaching profession to take on oral health education without more costly input from dental professionals.
Does oral health promotion improve oral hygiene and gingival health?. Watt & Marinho, (2005).	i. To search and critically assess on: a) Oral health promotion systematic reviews on the effectiveness of interventions in reducing plaque and gingival bleeding. b) controlled trials published subsequent to the oral health promotion reviews on the effectiveness of interventions in reducing	Reports on systematic reviews and controlled trials (randomized or quasi randomized) which specifically stated that they assessed reductions in dental plaque levels and ⁄ or (gingival bleeding) gingivitis and compared health	Health education and promotion interventions that included school or community based programs ⁄campaigns, professional instruction, self-instruction manuals ⁄ leaflets, home-visits, self assessments	Reductions in plaque and gingival bleeding were achieved in the short-term in the majority of studies reviewed paper. Future studies should use longer follow-up periods to assess whether short-term beneficial changes	Reductions in plaque and gingival bleeding were achieved in short-term in the majority of the studies reviewed

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
	plaque and gingival bleeding. ii. To summarize qualitatively the evidence on the effectiveness of OHP interventions in relation to plaque control and gingival bleeding Design: Searched the following databases in The Cochrane Library, Issue 1, 2004 for relevant systematic reviews: the Cochrane Database of Systematic Reviews (CDSR), the Database of Abstracts of Reviews of Effects (DARE), the Health Technology Assessment Database (HTA), and the NHS Economic Evaluation Database (NHS EED), the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE (through PubMed) without date limits or language restriction, in April 2004	education ⁄ health promotion interventions not involving clinical professional input or the use of pharmacological interventions		are sustained. Better quality evaluation was required of other forms of oral health promotion action to promote periodontal health	

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	Objectives, study design and follow up	Sample attribute, age, number	Intervention	Outcome	Conclusion
Effect of a school-based oral health education programme in Wuhan City, Peoples Republic of China. Petersen, P. E., Peng, B., Tai, B., Bian, Z., & Fan, M. (2004).	i. To assess oral health outcomes of a school-based OHE programme on children, mothers and schoolteachers in China, ii. to evaluate the methods applied and materials used **Community intervention study** 3 years	3 experimental and 3 control schools in Hongshan District, Wuhan City, Central China, 803 children for both groups	The WHO Health Promoting Schools Project applied to primary schoolchildren in with a 3-year follow-up.	DMFT/DMFS increments were comparable; the f/F components were higher in experimental schools than in control schools. The gingival bleeding score was, similarly, significantly lower. More children in experimental schools adopted regular oral health behaviour, i.e. tooth brushing, recent dental visits, use of fluoride toothpaste, with less frequent consumption of cakes/biscuits compared to controls. In experimental schools, mothers showed significant beneficial oral health developments, while teachers showed higher OHK and more positive attitudes.	I. The HPS that incorporated with oral health education and promotion programmes were effective against caries, plaque, and gingival bleeding scores in children. ii. The significant improvement in the intermediate oral health outcomes was reported, such as tooth brushing frequency, flossing, intake of sweet food and drinks and between-meal snacking

Table 2.1 Studies from year 2003 onwards on the effect of health promoting schools and school-based oral health education and promotion programmes on oral health parameters (continued)

Title and Authors	**Objectives, study design and follow up**	**Sample attribute, age, number**	**Intervention**	**Outcome**	**Conclusion**
Associations between health promoting schools' policies and indicators of oral health in Brazil. Moysés, S. T., Moysés, S. J., Watt, R. G., & Sheiham, A. (2003).	To assess whether the oral health of 12-year-old children in supportive schools, where health promoting policies had been developed, was better than that of children in non-supportive schools. **Cross-sectional study**	1823, 12-year-old schoolchildren from 33 public school in Curitiba, Brazil	Implementation of comprehensive HPS activities	i. Schools with a comprehensive curriculum were more likely to have a higher percentage of caries-free children (β = 6.27, p=0.02) and fewer children with dental trauma (β = −5.04, p=0.02). ii. The commitment towards health and safety at school was strongly associated with dental trauma, as 9.7% fewer children had dental trauma (p=0.00) in schools that demonstrated a commitment towards health and safety.	Children in supportive schools had better oral health than those in non-supportive schools.

2.9 Natural history of oral diseases

2.9.1 Gingivitis

Gingivitis is an inflammation of the gingiva that does not cause a clinical attachement loss (American Academy of Pediatric Dentistry, 2018).

Clinical and experimental studies had shown that the most important etiological factor in gingivitis is bacterial plaque at the gingival margins (Carranza Jr, 1966; Waerhaug, 1966).

In 1950's, Hine showed that neglected tooth brushing can cause gingivitis (Hine, 1950). Fifeteen years later, Löe, Thelade and Jensen (1965) demonstrated that the withdrawal of tooth brushing in young age with clinically normal gingiva and excellent oral hygiene resulted in the accumulation of plaque on tooth surfaces. Subsequently, gingivitis was seen clinically after ten to twenty-one days, and the inflammation was associated with the degree of plaque accumulation. However, when tooth cleansing was reinstitued, healthy gingival condition was re-established clinically within a week (Löe, Theilade, & Jensen, 1965). Therefore, gingivitis is reversible.

An experimental study was conducted with 21 individuals in Sweden in1968, where oral hygiene was abolished on the buccal and inter-proximal tooth surfaces on one side of the mouth in mandibular premolar and molar areas. The other teeth surfaces acted as controls and were subjected to comprehensive oral hygiene measures. After fifeteen to seventeen days, gingivitis had developed in the non-cleansing sides of the majority of the subjects (Zachrisson, 1968). However, the condition was reversed following toothbrushing.

Gingivitis is a reversible disease and the therapy for gingivitis is aimed primarily at reducing etiological factors to minimise or eliminate inflammation, thereby enabling gingival tissues to heal. An appropriate supportive periodontal maintenance that includes personal and professional care is essential to prevent recurrence (American Academy of Pediatric Dentistry, 2018).

Treatment for individuals with chronic gingivitis is initially directed at reducing oral bacteria in calcified and non-calcified deposits. Patients with chronic gingivitis, but without significant calculus, changes in gingival morphology, or systemic diseases that can affect oral health, may respond to therapeutic regimens consisting of a good personal plaque control alone (Löe et al., 1965). However, many patients lacked the motivation or skills to achieve and maintain plaque-free state for a significant period of time (Guerra, Johnston, & Radike, 1979).

There were clinical trials that showed that a self-administered plaque control programme alone, without regular professional reinforcement, was inconsistent in providing long-term inhibition of gingivitis (Agerbaek, Melsen, Lind, Glavind, & Kristiansen, 1979; Listgarten, Schifter, & Laster, 1985; Suomi, Greene, Vermillion, Doyle, Change, & Leatherwood, 1971).

Many patients with gingivitis have calculus or other local factors such as defective dental restorations that can interfere with personal oral hygiene and the ability to remove plaque. An acceptable therapeutic result for these patients is usually obtained when personal plaque control measures are taken in conjunction with professional plaque and calculus removal, and other local contributing factors (Lövdal, Arno, Schei, & Werhaug, 1961).

Removal of dental calculus is achieved by scaling and root planning procedures using hand, sonic, or ultrasonic instruments. The objective of scaling and root planning is to remove plaque and calculus reducing subgingival bacteria below threshold that can initiate clinical inflammation (American Academy of Pediatric Dentistry, 2018).

2.9.2 Caries

A lay person commonly termed dental caries as tooth decay (Featherstone, 2008). Dental caries is a transmissible bacterial disease process caused by acids from bacterial metabolism diffusing into enamel and dentine and dissolving the minerals to form cavities (Featherstone, 2008).

Dental caries is a diet-related disease. There was an extensive scientific evidence to show that free sugars are the primary causative factor in the development of dental caries (Sheiham & James, 2015). The WHO (2015) indicated that sugars intake more than 10% of the total energy intake inducing high caries rate despite of fluoride use in drinking water and toothpaste (World Health Organization, 2015).

Sheiham in 1967 reported that only 2.0% of Nigerians in urban and rural areas had dental caries when their average of free sugar intake was about 2g/day per person (0.4% energy) (Sheiham, 1967).

In addition to high sugar intakes, bacteria also play an important role in caries. At least two major groups of bacteria, i.e. streptococci and lactobacilli species, can produce organic acids during the metabolism of fermentable carbohydrates that demineralise enamel structures (Krasse, 1988; Loesche, 1986; Marsh, 1994).

Water fluoridation can reduce the incidence of new dental caries. A study conducted in Ireland showed that a fluoridated water system supplying 73.0% of the population for over 50 years showed significant caries-reducing effects. The number of DMFT in fluoridated and non-fluoridated areas were 13.3 and 16.0 in 35- to 44-year-olds, respectively (Whelton, Crowley, O'Mullane, Woods, McGrath, Kelleher et al., 2007).

Caries to be visible in the mouth takes a long time. A study was conducted to look at the natural history of dental caries using the International Caries Detection and

Assessment System (ICDAS). It was found that the development of caries, i.e. a non-cavitated lesion (ICDAS II Code 2) takes between 18 to 40 months (Gussy, Ashbolt, Carpenter, Virgo-Milton, Calache, Dashper et al., 2016). Another study reported that caries lesions were progressing faster within 2 years, where most of the lesions had ICDAS 2, 3, and 4 (Ferreira Zandoná, Santiago, Eckert, Katz, Pereira de Oliveira, Capin et al., 2012).

The American Academic of Paediatric Dentistry (2016) stated that a recall appointment every 3 to 6 months was sufficient to assess the progression of caries (American Academy of Pediatric Dentistry, 2016b). A more recent randomised control trial (RCT) conducted in Iran to evaluate an intervention programme to prevent childhood caries found that a 6-month period was shown to be sufficient to observe a significant finding on new caries incidence among the children (Basir, Rasteh, Montazeri, & Araban, 2017). This evidence indicates that caries lesions may develop over a shorter period of time if the risk factors are present consistently in high quantities.

The earliest clinical sign of active dental caries lesion in the mouth is the appearance of a “white spot lesion”. This is the first sign that can be seen by the human eye, and by this time the decay process had taken place over some months (Featherstone, 2008). At this stage, prior to cavitation, the therapeutic intervention that can arrest or reverse the process is by remineralisation (Featherstone, 2000). When demineralisation results in the loss of mineral deep into enamel or exposed dentine, it can be detected radiographically, visually, or by optical methods such as laser-induced fluorescence (Stookey, 2000; Tranæus, Al-Khateeb, Björkman, Twetman, & Angmar-Månsson, 2001).

The main point is that if the carious lesion is non-cavitated, and especially if it is in enamel, it can be reversed or arrested chemically by remineralisation (Featherstone, 2008).

Remineralisation is a natural repair process for subsurface non-cavitated carious lesion (Ten Cate & Featherstone, 1991). Remineralisation is a simple in concept, where calcium and phosphate, mainly from saliva, but probably from other topical sources permeate into tooth with the help of fluoride and build up existing crystalline residues, rather than forming new crystal (Featherstone, 2000). New crystalline surfaces, it is made up of well-formed mineral veneers that may be similar to fluoroapatite, depending on the amount of fluoride available (Figure 2.1) (Featherstone, 2008). The crystalline surface is now less soluble than the original carbonated hydroxyapatite mineral and it is more difficult for acid to dissolve in future. Fluoride speeds up the remineralisation process, which consumed during reminiralisation and forms an important part of the new veneer on the crystal surface (Ten Cate & Featherstone, 1991). This is one of the main mechanisms of action of fluoride in the inhibition and reversal of caries process.

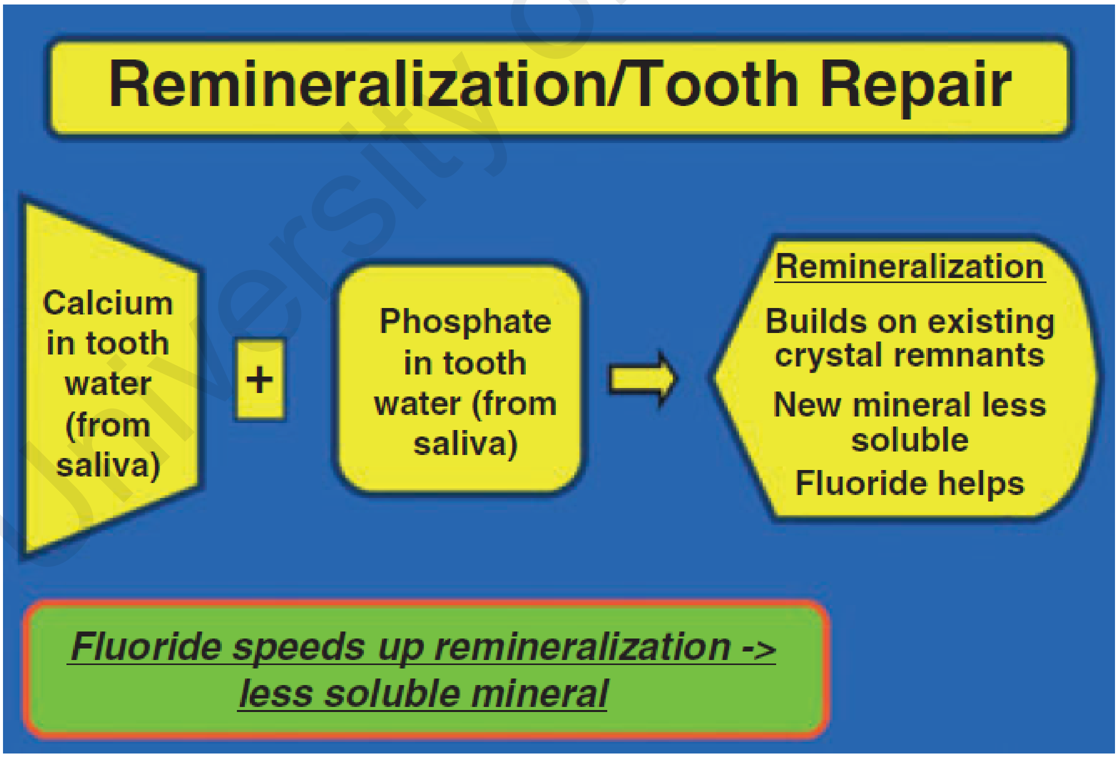

Figure 2.1. Outline of the remineralisation process (Featherstone, 2008)

Dental caries is a dynamic process in the mouth. The cycle of demineralisation and remineralisation continues in the mouth as long as there are cariogenic bacteria, fermentable carbohydrates and saliva present. Whether the process of demineralisation and remineralisation is carried out at any time is determined by the balance between pathological and protective factors (Figure 2.2).

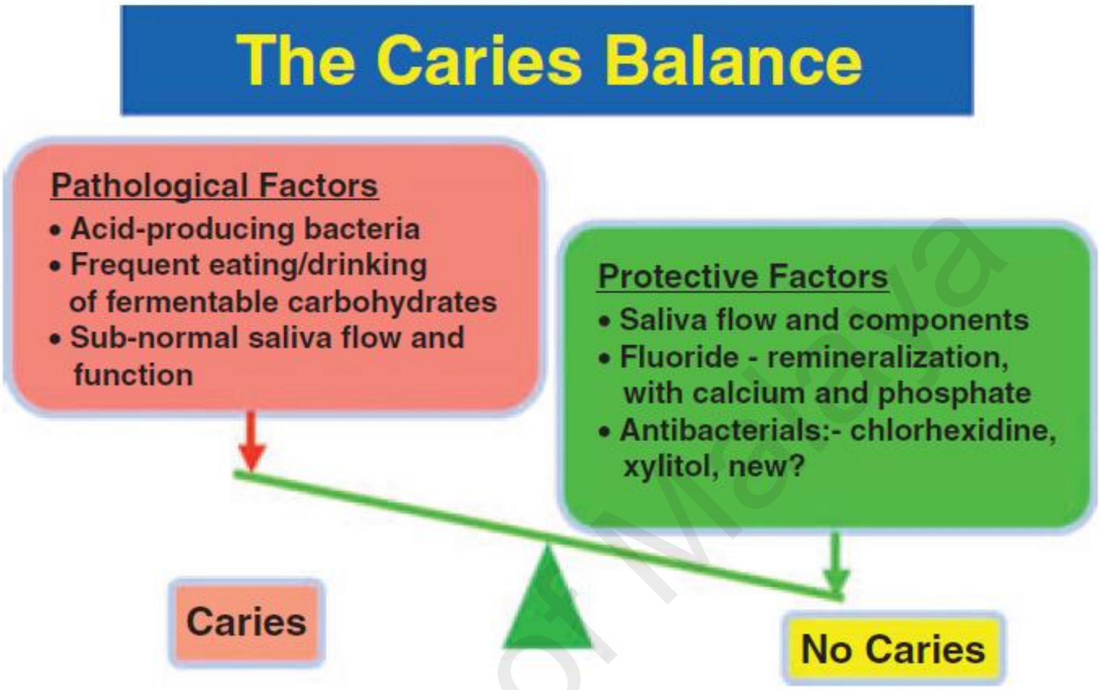

Figure 2.2. The caries balance concept. The key pathological and protective factors determine which side of the balance changes and whether the caries process progresses, reverses, or is in balance (Featherstone, 1999, 2000, 2004).

An extreme example for impairment in saliva production can be observed when a person becomes xerostamic due to a radiation therapy in head and neck cancer. The salivary gland function could be severely impaired and as a result can cause rampant caries in months if aggressive preventive measures are not taken (Lockhart, 1986).

Brushing teeth twice a day with fluoride toothpaste can balance and eliminate future carious lesions (Twetman, Axelsson, Dahlgren, Holm, Källestål, Lagerlöf et al., 2003). A study that conducted in China showed that daily toothbrushing with fluoridated toothpaste was effective in reducing the development of new dental caries (Rong, Bian, Wang, & De Wang, 2003).

When the bacterial challenge is high, it is difficult for fluoride to overcome the challenges and caries could progress (Featherstone, 2008).

2.10 The indices for measuring plaque score

Oral hygiene is an important prerequisite for oral health. Poor oral hygiene leads to dental plaque-collections, which in turn can cause gingivitis and eventually may lead to periodontal disease (Lisigarten, 1988). This is the reason why many clinical studies have been focusing on the role of oral hygiene in the prevention and control of oral disease.

Plaque is a soft and sticky film that builds up on the teeth and contains millions of bacteria. The bacteria in plaque cause tooth decay and gum disease if they are not removed periodically through brushing and flossing (American Dental Association, 2011).

A number of plaque indices have been developed to assess the levels of individual plaque control and these have been widely used in epidemiological studies. Some of the most well-known indices which have been used in various studies are listed below:

i. Oral Hygiene Index (OHI) (Greene & Vermillion, 1960)

This index is composed of the combined Debris Index and Calculus index, each of this index is in turn based on 12 numerical determinations representing the amount of debris or calculus found on the buccal and lingual surfaces of each of three segments of each dental arch. The maxillary and mandibular arches are composed of three segments. Each segment is examined for debris or calculus. From each segment, one tooth is used for calculating the individual index, for that particular segment. The tooth used for the calculation must have the greatest area covered by either debris or calculus.

ii. Simplified Oral Hygiene Index (OHI-S) (Greene & Vermillion, 1964)

This index differ from the OHI in terms of the tooth surface scored (6 rather than 12). The criteria used for assigning scores to the tooth surfaces are the same as those use for the OHI. The selection of tooth surfaces were the six surfaces examined for the OHI-S are selected from four posterior and two anterior teeth.

iii. Silness-Loe Index (Silness & Löe, 1964)

The measurement was based on recording both soft debris and mineralized deposits on the following teeth. Each of the four surfaces of the teeth (buccal, lingual, mesial, and distal) is given a score from 0-3.

iv. Quigely Hein Index- Modified (Turesky, Gilmore, & Glickman, 1970)

A score of 0 to 5 is assigned to each facial and lingual non-restored surface of all the teeth except third molars. An index for the entire mouth is determined by dividing the total score by the number surfaces examined.

v. The Plaque Control Record (O'Leary et al., 1972)

It is a simple method of recording the presence of plaque on individual tooth surfaces. The tooth surfaces are mesial, distal, buccal, and lingual surfaces. A disclosing solution is painted on all exposed tooth surfaces. After the patient has rinsed, the operator examines each stained surface for soft accumulations of plaque at the dentogingival junction. When found, they are recorded by making a dash/red colour in the appropriate spaces on the record form. Those surfaces, which do not have soft accumulations at the dentogingival junction, are not recorded. After all teeth are examined and scored, the index is calculated by dividing the number of plaque containing surfaces by the total number of available surfaces.

The Plaque Control record was used to record the plaque distribution in a patient. It is used to motivate patients to improve their oral hygiene. The charted form of Plaque Control record allows the patient to visualize their own plaque distribution and help to monitor progress in plaque control (Figure 2.3). The same areas/surfaces with plaque present after a few visits can also be recorded. Thus, a special instruction can be given to patients toward improving their performance in those areas/surface.

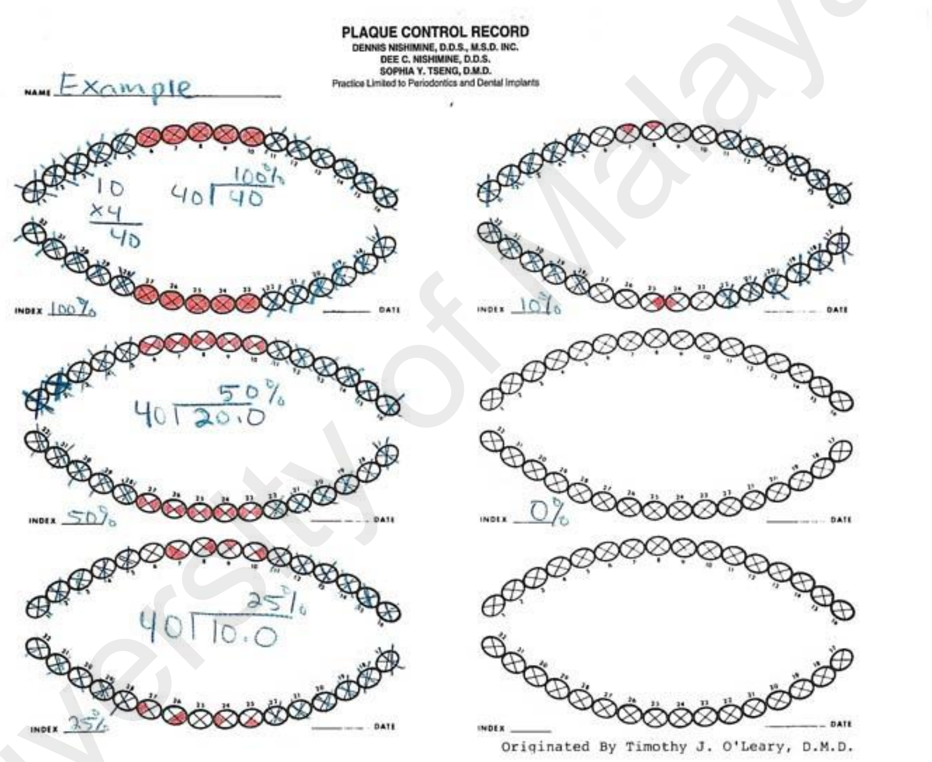

Figure 2.3 Example of Plaque Control Record (www.pinsdaddy.com)

2.11 The Gingival Index for Schoolchildren (GIS) as a measure in assessing the gingival health status among schoolchildren.

The Gingival Index system was introduced for the assessment of the gingival condition which clearly distinguished between the quality of the gingiva (the severity of the lesion) and the location (quantity) as related to the four (buccal, mesial, distal, lingual) areas which make up the total circumference of the marginal gingiva (Löe & Silness, 1963).

The Gingival Index does not consider periodontal pocket depths, degrees of bone loss or any other quantitative changes of the periodontium. The criteria are entirely confined to the qualitative changes in the gingival soft tissue (Löe, 1967). In this index, the score is recorded as below:

0 = normal gingival

1 = mild inflammation – slight change in colour, slight oedema and no bleeding on probing

2 = moderate inflammation – redness, oedema, glazing and bleeding on probing

3 = severe inflammation – marked redness and oedema, ulceration and tendency to spontaneous bleeding.

In Malaysia, the gingival status is one of the indicators of oral health status used in the incremental dental care (IDC) programme in schools. Previously, the delivery of oral health care for schoolchildren was guided by the "Guideline on Oral Healthcare for Schoolchildren," which "gingivitis-free mouth" was assessed using six (6) surfaces of six (6) index teeth as illustrated in Figure 2.4 below (Oral Health Division, 2006). Using this index, a marked difference was observed between the data on gingival status of schoolchildren obtained from national surveys namely the National Oral Health Survey for Schoolchildren 2007 for children aged 12 years (2010), and the National Oral Health Survey for Schoolchildren 2007 for children aged 16 years (2010) (Oral Health Division, 2013). To address the issue, a study to compare gingivitis free status using 6 surfaces (as using in IDC programme) versus the 12 surfaces (which modified index) of 6 index teeth was undertaken in July 2011 (Oral Health Division, 2013).

From the study, the twelve (12) surfaces index was found to be more sensitive in detecting gingivitis. However, it is time consuming on the population level. The biggest difference was found in the lower left incisor tooth, therefore seven (7) surfaces index was tested. This modified seven (7) surfaces index was able to detect 99.14% of the gingivitis cases in the population and was comparable with the results of the twelve (12) surfaces index.

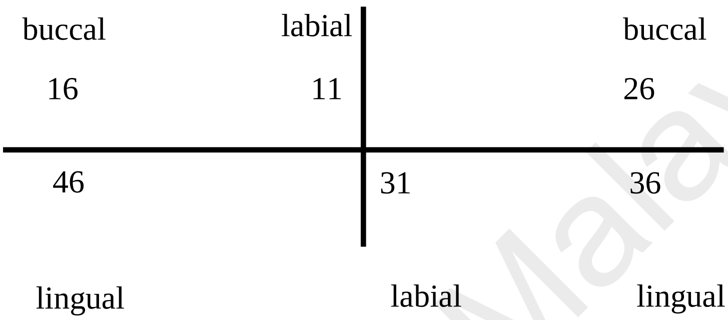

Figure 2.4 Illustration of the surfaces of the index teeth for the assessment of gingivitis-free mouth.

The scoring criteria for gingivitis-free mouth score is shown below (Oral Health Division, 2006):

0 = absence of both gingivitis and calculus

1 = presence of gingivitis with or without calculus or presence of calculus with or without gingivitis

The seven (7) surfaces index was subsequently named The Gingival Index for Schoolchildren (GIS) to evaluate the gingival status of the schoolchildren (Figure 2.5). The use of the index in the Malaysian school IDC programme started in 1 January 2014. Gingivitis-free mouth refers to the absence of gingivitis and calculus (Oral Health Division, 2013). The scoring criteria are roughly the same as the Gingival Index by Löe (1967). However, the scoring criteria are easier to suit the use of dental therapist as well as dental officers in the IDC programme. The scoring only observed the presence of healthy gum, the presence of gingivitis and calculus. The details of scoring criteria are as follows:

0 = no gingivitis, no calculus

1 = no gingivitis with calculus

2 = gingivitis, no calculus

3 = gingivitis with calculus.

The examination procedures using the GIS is described below (Oral Health Division, 2013):

i. examine only fully erupted teeth

ii. do not examine teeth which have been indicated for extraction

iii. alternative teeth, if an index tooth is missing or not fully erupted, examination was carried out to the adjacent tooth.

iv. visually examine the index teeth for obvious presence of calculus and/or gingivitis. A cotton pallet may be used to remove food debris. When in doubt, record the lower score.

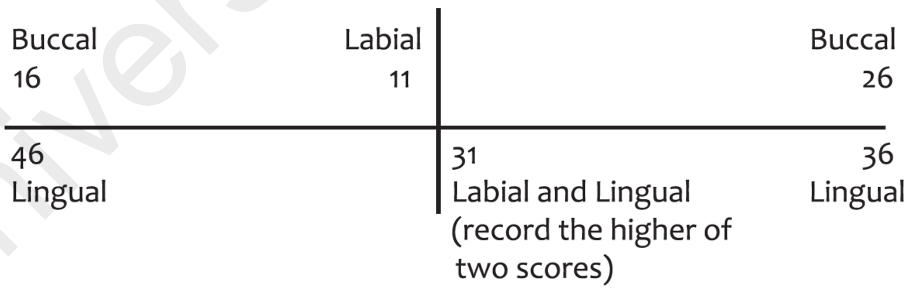

Figure 2.5 Illustration of index surfaces of the index teeth for The Gingival Index for Schoolchildren (GIS)

The highest score of the index teeth will be the overall score schoolchildren. However, if there were a combination of score 1 and 2 among the index teeth, the GIS score of 3 would be taken.

2.12 The International Caries Detection and Assessment System (ICDAS) as a measure for assessment of caries activity

Dental caries is a complex multifactorial disease of the calcified tissues of the teeth, caused by interaction of various factors including the host (tooth), agent (bacteria), substrate, and time. ICDAS is a clinical scoring system for use in clinical practice, dental education, research, and epidemiology, and provides a framework to support and enable personalized total caries management for improved long-term health outcomes (Gugnani, Pandit, Srivastava, Gupta, & Sharma, 2011).

The understanding of the caries process has continued to advance with the vast majority of evidence supporting caries as a dynamic process, influenced by numerous modifiers who tend to push the mineral equilibrium in one direction or another, i.e. towards remineralization or demineralization (Holt, 2001).

The ICDAS was developed to bring forward the current understanding of the initial process and progression of dental caries to the field of epidemiological and clinical research (Shivakumar, Prasad, & Chandu, 2009). This system allows the severity and incidence of the caries in its continuum to be recorded. The ICDAS I was developed in 2002 and was later modified to ICDAS II in 2005. The ICDAS I and II criteria incorporate concepts from the research conducted by Ekstrand et al., (1995).

2.12.1 ICDAS: The scoring system

The primary requirement for ICDAS system is the examination of clean and dry teeth. Drying the tooth surface is the key for detection of non-cavitated lesion. The ICDAS detection for coronal caries are range from 0 to 6 depending on severity of the lesion. Below table 2.2 shows the basic of the ICDAS code.

Table 2.2: ICDAS II codes and criteria (Gugnani et al., 2011)

Code	Description
0	Sound surfaces: No evidence of caries after 5 seconds air drying
1	First visual change in enamel: Opacity or discoloration (white or brown) is visible at the entrance to the pit or fissure seen after prolonged air drying
2	Distinct visual change in enamel visible when wet, lesion must be visible when dry
3	Localized enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying
4	Underlying dark shadow from dentine
5	Distinct cavity with visible dentine
6	Extensive (more than half the surface) distinct cavity with visible dentine

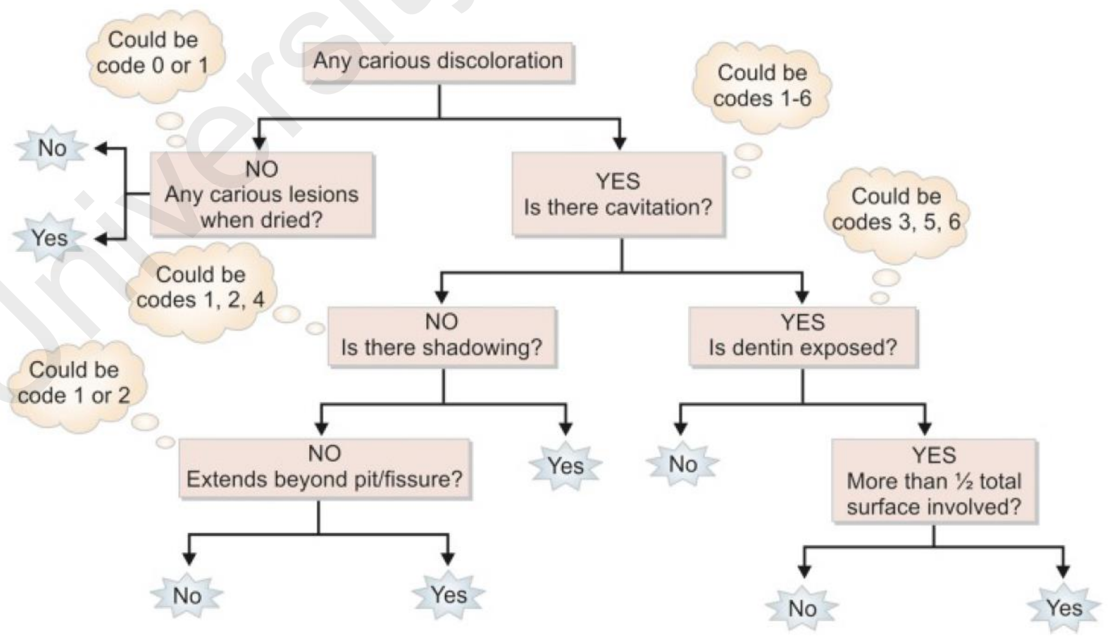

Figure 2.6 Flow chart of a simple decision tree for ICDAS (Banting, Eggertsson, & Ekstrand, 2005)

Previously, the epidemiological surveys have mainly focused on DMFT/DMFS to evaluate the prevalence of caries. However, such studies rely on recording of cavitated lesions only. While ICDAS allows the recording of both cavitated and non-cavitated lesions in a continuum. Various studies have evaluated the feasibility of using ICDAS II in epidemiological surveys by comparing it with the WHO criteria (Braga, Oliveira, Bonini, Bönecker, & Mendes, 2009; Mendes, Braga, Oliveira, Ferreira Antunes, Ardenghi, & Bönecker, 2010).

A few studies have also shown good inter- and intra-examiner reproducibility and the accuracy of ICDAS II in detecting occlusal caries, especially in the outer half of the enamel. One study was performed in 2010 to evaluate intra- and inter-examiner reproducibility of ICDAS II on occlusal caries diagnosis when different time intervals were allowed to elapse between examinations. The weighted kappa values for intra- and inter-examiner reproducibility were 0.76 to 0.93 and it was observed that the time span did not have a major impact on assessing intra- and inter-examiner reproducibility (Jablonski-Momeni, Ricketts, Weber, Ziomek, Heinzel-Gutenbrunner, Schipper et al., 2010).

The ICDAS system allows us to record the severity and incidence of the caries in its continuum. It is certainly leading to a paradigm shift in the concept of recording both the cavitated and non-cavitated lesions. In current scenario, the use of sharp explorer should certainly be discouraged for detection of dental caries as it may damage the intact enamel covering the early demineralisation. As a consequence of this changing trend to record the non-cavitated lesions in the daily practice, ICDAS would certainly promote preventative therapies worldwide that encourage the remineralisation of non-cavitated lesions resulting in inactive lesions and the preservation of tooth structure, function and aesthetics and a much decreased DMF all-over (Gugnani et al., 2011).

2.13 The Child Oral Impacts on Daily Performances (Child-OIDP) Index as a measure for assessing OHRQoL

The OHRQoL instrument was developed to measure subjective oral impacts on daily performances and quality of life (Adulyanon & Sheiham, 1997). This index enables important information on functional and social dimensions of dental diseases to be collected. The information was important to reflect the perceived of oral health need by individual's perspective and how it is influence their quality of life. The Child-OIDP is one of the most widely used OHRQoL instruments to be used in children (Gherunpong et al., 2004a). It had been chosen as the instrument to evaluate children's levels of OHRQoL. The Child-OIDP index was developed and successfully tested on 11–12 year old schoolchildren in Thailand in year 2004 (Gherunpong, Tsakos, & Sheiham, 2004b). In this index, if the oral impacts on daily performances were severe, their effects on QoL would also be severe. The development and evaluation process was conducted on non-random sample in U-thong District, Thailand. The psychometric properties evaluated in this study refer to face, content and concurrent validity and internal and test-retest reliability. Throughout the development process, the OIDP index was modified and its psychometric properties evaluated. The final test revealed excellent validity and reliability with kappa value of 0.93. The index showed very significant associations with perceived oral treatment need (p<0.001) and perceived oral health problems (p<0.001). The validity and reliability of the index was confirmed by similar results in the re-evaluation study. This study has demonstrated that the CHILD-OIDP index is a valid, reliable and practical measure of oral health-related quality of life in 12 year old Thai children (Gherunpong et al., 2004a).

The Child-OIDP index is used to measure oral impacts on eight performances namely eating, talking, cleaning teeth, relaxing, emotional stability, smiling, doing schoolwork, and socialising. The calculation for Child-OIDP index score is by multiplying the frequency (0 to 3) and severity of impact (0 to 3), the maximum score per performance is 9. By adding all the performance scores results to the sum impact score. Then, the sum is divided by 72 (maximum possible score) and multiply by 100 to give the percentage score.

The score in OIDP can be described as in terms of prevalence score by individual performance and total impact score (mean score and standard deviation; median and interquartile). The OIDP can be presented in terms of impact intensity, from no impact (0) to very severe impact (9). The extent of impact is explained from the number performance with impact (Gherunpong et al., 2004b; Yusof & Jaafar, 2013)

A local study in 2013 on the DMP in primary school reported that the prevalence of impact in each of the eight performances in the intervention group was consistently lower than those of the control group (Yusof & Jaafar, 2013).

On the other hand, a study was conducted in 2007 to compare psychometrically the self-administered Child-OIDP index with the original interviewer administered Child-OIDP. The results showed that the self- and interviewer-administered Child-OIDP did not differ in recording any of the eight performances ($p \geq 0.206$). For validity of the criteria, the correlation coefficients of the Child-OIDP with self-perceived measures were not different between the two modes of administration ($p \geq 0.118$). Furthermore, the Cronbach's alpha values for the two groups were similar ($p = 0.466$). This study demonstrated that the self-administered Child-OIDP performed the same as the original interviewer administered mode, while at the same time reducing administrative burden.

This provides support for the use of the self-administered Child-OIDP (Tsakos, Bernabé, O'Brien, Sheiham, & de Oliveira, 2008).

The Child-OIDP was translated and cross-culturally adapted into Malay by Yusuf and Jaafar (2012). The Malay version was tested for reliability and validity on a non-random sample on 11–12 year old schoolchildren. Psychometric analysis of the Malay Child-OIDP involved face, content, criterion and construct validity tests as well as internal and test-retest reliability. The standardised Cronbach's alpha was 0.80 and the weighted Kappa was 0.84 (intraclass correlation = 0.79). This study indicated that the Malay Child-OIDP index is a valid and reliable instrument to measure the oral impacts of daily performances in 11–12 year old schoolchildren in Malaysia (Yusof & Jaafar, 2012).

The Child-OIDP was cross-cultural translation and adaptation into many languages to meet local needs i.e. English, French, Hindi, Arabic, Brazil, Persian, Spanish, Swedish, and many more (Castro, Cortes, Leão, Portela, Souza, Tsakos et al., 2008; Dhawan, Singh, Agarwal, & Aeran, 2019; Dorri, Sheiham, & Tsakos, 2007; Montero, Bravo, & Albaladejo, 2008; Ostberg, Andersson, & Hakeberg, 2008; Tubert-Jeannin, Pegon-Machat, Gremeau-Richard, Lecuyer, & Tsakos, 2005; Yusuf, Gherunpong, Sheiham, & Tsakos, 2006; Zaghloul, Amer, & Ahmed, 2019).

2.14 Associated Factors in relation to schoolchildren's oral health knowledge, attitudes, behaviour, oral health status, and OHRQoL.

A qualitative study conducted in 2015, to explore parents' perceptions of the barriers and facilitators that influenced oral health behaviours of children. The six focus group interview was conducted involved 39 parents of 7-year old children in Netherland. The results identified many influences on children's oral health behaviours, operating at child, family, and community levels. Perceived controls on children's tooth brushing behaviour were primarily located within the direct family environment, including parental knowledge, perceived importance, and parental confidence in tooth brushing, locus of control, role modelling, parental monitoring, and supervision, parenting strategies and tooth brushing routines, and habituation. The consumption of sugary foods and drinks was influenced by both the direct family environment and factors external to the family, including the school, the social climate, commercials and television, supermarkets and affordability of foods (Duijster, delon de Jong-Lenters, Verrips, & van Loveren, 2015). This study also stated that most parents whose children had caries experience did not believe that oral hygiene effort could prevent their child from experiencing tooth decay. They often associated childhood dental caries to causes beyond the parent's and child's control, such as chance, genetics or health problems in childhood (Duijster et al., 2015).

A study conducted in India involving schoolteachers to deliver dental health education programme for 6-12 year old schoolchildren in Mysore City. The results suggested that the implementation of preventive dental health education programme through school teachers resulted in the enhancement in the knowledge, attitudes and practices towards oral health and also improvements in dental caries, oral hygiene, and gingival health status of the schoolchildren in the study group (Naidu & Nandlal, 2017).

A study was conducted on Iranian children in 2012 to investigate whether an intervention targeting parents and school staff can improve the oral health behaviours and oral health status of schoolchildren aged 11 – 12 years. The school was randomly allocated into three different groups, i.e. comprehensive, student, and control. The comprehensive group consisted of strategies to encourage children, their parents, and school staff to increase the frequency tooth brushing, and flossing. Meanwhile, the student group was only targeted the children and the control group not received any intervention. A significant improvement in OHB, and OHS among schoolchildren was observed in the comprehensive group. They concluded that promising results were seen when the oral health-education targets both school and home setting (Yekaninejad, Eshraghian, Nourijelyani, Mohammad, Foroushani, Zayeri et al., 2012).

A study was conducted in Mangalore, India for 36-week duration with the objective to improve the oral health knowledge and oral hygiene practices and status of 12-13 year old schoolchildren. They found that the socioeconomic status influenced the oral hygiene aids used and the frequency of change of toothbrush (Shenoy & Sequeira, 2010).

A cross-sectional study by Åstrøm and Mbawalla (2011) to evaluate the factors associated with the health and oral health behaviours among adolescents in Tanzania, found that good hygiene behaviour was most frequently reported in females, non-smokers, students having good school connection, access to hygiene facilities at school, and high life satisfaction. Meanwhile for snacking, it occurred more frequently in students who received food at school and low perceived behavioural control with respect to avoiding snacking (Åstrøm & Mbawalla, 2011).

A study in 2018 to assess the association between lifestyle habits and gingivitis severity in young Saudi Arabian males (13-15 year olds) reported that gingivitis severity significantly increased with smoking when sugary drinks were used, indicating the effect of unhealthy lifestyles on gingival health, and the need to promote healthy lifestyle habits in this age group (El Tantawi & AlAgl, 2018).

A study was conducted in 2015 in Yunnan, China involving 12 year-old children reported that caries experience in China was associated with gender. They reported that girls had higher decayed and filled teeth compared to boys with significant findings (Shinan, Biao, Juan, Lo, & Chun-Hung, 2015).

A study in Kerala, India was conducted to assess the prevalence of dental pain and its impact on daily life and to explore its relationship with oral health behaviours and clinical oral health status among 10-15 year old schoolchildren attending oral health promoting schools. They conducted multiple linear regression (MLR) and found that the severity and impact of dental pain was associated with gender, deciduous dental caries experience, consumption of sweets and frequency of tooth brushing (Saheer et al., 2015).

Another study in India published in 2019 with the aim to find the status of oral hygiene in school-going adolescents and the associated risk factors. The cross-sectional study was conducted among students of standard 7th, 8th, and 9th. It was found that, good oral health was strongly associated with gender, the practice of oral hygiene, and awareness towards oral hygiene. The chances of good oral health increase with the satisfactory practice of oral hygiene and awareness towards oral health. In general, females had better oral health awareness and better OHB than males (Burman, Dasgupta, Banerjee, Sembiah, Bandyopadhyay, & Paul, 2019).

2.15 The Focus Group Discussion as a Method of Data Collection

The term ‘qualitative research’ refers to a wide range of methodological approaches that aim to generate an in-depth understanding of people’s experiences (Gussy, Dickson-Swift, & Adams, 2013). Krishna, Maithreyi and Surapaneni (2010) stated that qualitative research is the kind of research that generates in-depth of understanding rather than quantifiable measurements (Krishna, Maithreyi, & Surapaneni, 2010).

The focus group discussion (FGD) is a type of data collection used in the qualitative study. A FGD is a good way to gather together people from similar backgrounds or experiences to discuss a specific topic of interest. The group of participants is guided by a moderator or group facilitator, who introduces topics for discussion and helps the group to participate in a lively and natural discussion amongst themselves (Krueger, 1988). Van Eeuwijk and Angehrn (2017) stated that FGD is qualitative research method and data collection technique in which a selected group of people discusses a given topic or issue in-depth, facilitated by a professional, external moderator (van Eeuwijk & Angehrn, 2017).

The FGD can be used to explore the meanings of survey findings that cannot be explained statistically, the range of opinions or views on a topic of interest and to collect a wide variety of local terms (Morgan, 1988).

The FGD method serves to solicit participants' attitudes and perceptions, knowledge and experiences, and practices, shared in the course of interaction with different individuals. The technique is based upon the assumption that the group processes activated during a FGD help to identify and clarify shared knowledge among groups and communities, which would otherwise be difficult to obtain with a series of individual interviews. The FGD method does not presume that all the knowledge is shared equally among a studied group. The FGD allows the investigator to solicit both the participants' shared narrative as well as their differences in terms of experiences, opinions and worldviews during such 'open' discussion rounds (van Eeuwijk & Angehrn, 2017).

The FGD is closely similar with other methods to gather information in qualitative study namely an individual qualitative interview, and regular meetings. The characteristic differences between FGD, individual qualitative interview, and a regular meeting are summarised in Table 2.3 below.

Table 2.3 Characteristics of different qualitative data collection techniques (van Eeuwijk & Angehrn, 2017)

	FGD	Individual qualitative interview	Regular meeting
Participants	Multiple participants who share one (some) common characteristic(s) that is (are) meaningful from the research perspective.	One individual interviewee who represents a very personal and distinct characteristic of importance from the research perspective.	Multiple participants who gather at the same place and have certain knowledge of the study subject.
Mode of conduct	Semi-structured; carefully planned and cautiously executed.	Ranging from semi-structured to unstructured; well planned and executed	Unstructured, without clear roles assigned to participants; no clear-cut scenario.
Scope insight	Often a large spectrum of opinions, notions, and/or experiences; added focus on social interaction between participants.	Small spectrum of opinions, notions and/or experiences but provides deep individual insights	Often a large but scattered spectrum of opinions, notions, and/or experiences.
Levels of focus	High level of focus on the given topic(s).	Level of focus varies depending on the degree of structuring	Level of focus largely uncontrollable.
Degree of participation	When accurately and adequately moderated, all participants contribute equally to the discussion	The whole interview is dedicated to the knowledge, attitudes, opinions and experiences of one person	Usually, one or a few participants dominate and shape the discussion.

There are 2 specific types of FGD groups (van Eeuwijk & Angehrn, 2017):

i. 'Natural groups': consist of multiple participants who belong to a pre-existing informal or formal group (e.g. family or kin, co-workers, elderly group, women's self-help group, neighbourhood club, teachers' credit association) prior to the study. Conducting a FGD with a natural group may reveal discrepancies and similarities between what people say and how they act, and how other participants react and comment in response. However, the researcher must be aware that power relations inherent to the group's social dynamics (e.g. doctor vs. nurse, parents vs. children, younger vs. older persons, men vs. women, better off vs. less well off), might influence participants' 'public' statements. The data analysis must account for this potential bias.

ii. 'Expert groups': consist of several people who have particularly good and broad expert knowledge and experience of the research topic(s). Such groups (e.g. dental specialist, nurses from health district center, ambulance drivers, or drugstore vendors) tend to be smaller than typical FGDs and are used to solicit large amounts of highly specific information, although participant statements may vary.

Barbour (2005) stated that the FGD could be used in health research. The use of FGD in health research is listed below (Barbour, 2005):

i. exploration: The FGD have been used during the initial phase of studies to develop items for inclusion in surveys. The role of FGD in such an approach is to ensure that the questions being asked are appropriate and easily understood by respondents and that these are contextually relevant. The FGD are also useful in designing culturally sensitive survey methodology. There is a strong case for mixed methods approaches in health services research. Moreover, the two approaches need not be mutually exclusive: a focus on the ultimate goal of informing development of a questionnaire need not compromise the depth or theoretical sophistication of the qualitative component of the study.

ii. monitoring: can be performed in the midst of on-going research activities to control or supervise the corresponding processes and dynamics (e.g. of a health intervention or a community survey) and to understand them better. The recognition of the need to incorporate the patient's voice has given rise to a body of work which relies heavily on the use of focus groups, and which has allowed researchers to carry out studies in partnership with patients, in identifying barriers and seeking to work together to address these.

iii. evaluation: at the end or during the phasing-out stage of a research programme, a FGD with the main target group can be performed to verify, disprove, modify or differentiate the study's provisional findings. An example in Precede-Proceed framework show that an evaluation of a programme can be conducted towards the end of the research to evaluate the outcomes and the impacts of the programme.

iv. gathering and assessing outcomes: after the completion of an investigation or intervention, the FGD may be performed to generate new findings about potential changes or processes within a target community or group and about their effect or impact on the field of health. The FGD could produce additional findings to support the quantitative study.

The FGD session needs to be prepared carefully through identifying the main objective of the meeting, developing key questions, developing an agenda, and planning how to record the session. The next step is to identify and invite suitable discussion participants, and the ideal numbers is between 6 to 8 participants. Prepared the key questions, maintaining a neutral attitude and appearance, and summarising the session to reflect the opinions evenly and fairly. A detailed report should be prepared after the session is finished. Any observations during the session should be noted and included in the report (Stewart & Shamdasani, 1990).

In terms of sampling and recruitment for FGD, the 'purposive' sampling normally conducted for the FGD. The participants are typically selected to participate in a qualitative research based on certain criteria, such as their knowledge, life-experience, particular characteristics or role in a group/community (Khan & Manderson, 1992).

The approaches used to compose a group of FGD, is sufficient homogeneity to acquire comparison between groups and sufficient diversity within groups (Barbour, 2005).

To conduct the FGD, a group of participants is guided by a moderator who introduces topics for discussion and helps the group to participate in a discussion amongst themselves (Krueger, 1988). The role of the moderator is to ensure that the discussion topic is clearly introduced and thoroughly addressed, and that the discussion is balanced and inclusive. Despite this crucial role, the moderator should avoid dominating the group and expressing own judgments. Instead, a moderator should be open, alert, probing and encourage everyone to take part in the discussion. Ideally, the moderator should be able to establish a group dynamic in which participants discuss topics from the discussion guide among themselves, rather than relying on the moderator to address and interview participants, one by one (Silverman, 2006).

The FGD proceeds as follows (Elmusharaf, 2012):

- The discussion starts with an 'ice-breaker' with an introduction of the moderator and each participant. The rule and regulations the FGD are applied.
- Moderator introduces the topic for discussion.
- The questions asked as drafted/guideline of questions to trigger their opinions. Participants are free to give their views. The discussions are held without interrupting the natural flow of the discussion and are stopped when participant gave the same answers or opinions.

The video or audio recording of the session is helpful and a standard way of documenting a FGD, but it requires formal agreement from all participants. It is advisable to enlist a minute taker to write down the most important points made by participants, along with any other ideas or analytical thoughts that come to mind during or right after the discussion (van Eeuwijk & Angehrn, 2017).

The usual method used to analyse qualitative data is thematic analysis, grounded theory, and framework analysis (Pope, Ziebland, & Mays, 2006). Data analysis for qualitative study typically consists several step (van Eeuwijk & Angehrn, 2017):

i. Transcribing recorded statements to written document about who said what about a particular question.

ii. Coding the transcription using ‘codes’ (and corresponding ‘sub-codes’ leading to a ‘code path’ or ‘code tree’). Codes are ‘labels’ that summarise or bookmark short fragments of text, and therefore help to sort and structure the data. The several procedures can be used to establish these codes, and it is possible to include different types of codes in one analysis:

   a) Deductive codes – the researcher begin with theory that guide the research. Sometime the theory is a theoretical model, inter-related hypothesis, and question that guide the research. Deductive codes begin with the preliminary that guide research and the researcher expect to test the changes. Those specified before data collection, based on the research question; the Framework Method is a valuable and frequently used (Gale, Heath, Cameron, Rashid, & Redwood, 2013).

   b) Inductive codes – inductive code is a qualitative method of content analysis that researchers use to develop theory and identify themes from a discussion. Those that emerge from the analysed text itself, as in Grounded Theory (Charmaz & Belgrave, 2012).

   c) Codes referring to the group dynamic, which later help to understand how a group opinion was established in the course of interaction, e.g. ‘opposing’, ‘agreeing’, ‘deferring to the opinion of others’, ‘silencing’ or ‘changing mind’ (Barbour

2005). The method of generating categories under which similar themes or categories can be collated (Burnard, Gill, Stewart, Treasure, & Chadwick, 2008).

iii. Reviewing memos produced by the researcher and other members of the research team during the conduct of the study. Such memos often contain reflections on the process of data collection or insights into the research problem.

iv. Analysing and interpreting qualitative data, typically through a two-step approach (Silverman, 2006). First, look at what people in the group literally said, remembering that the group, rather than the individual, is the unit of analysis. This part is rather simple and descriptive. Secondly, interpret what people said in an integrated, theoretical way. This often relies on mapping a problem, identifying patterns, regularities and themes, identifying differences and similarities within the data and between different sources of data and making comparisons between different groups involved in the topic.

v. Establishing validity and reliability through consensus, coherence, triangulation and reflexivity. Conducting a respondent check is a useful first step towards validating the results. It requires presenting the findings to the discussion participants or to the community. It does not require that participants support all results and conclusions made by the researcher (and vice versa), but respondent validation can strengthen or weaken the level of trust in the results, and might bring about new insights and motivate the researcher to refine or modify his/her findings. To successfully establish the reliability of qualitative findings, the researcher is expected to actively think about how his/her own social, economic, ethnic, religious, cultural, personal, and scientific background might influence the chosen scientific approach and mode of interpretation. Finally, contrast qualitative FGD results with findings from other techniques used in the same or similar study, or with another data source, such as literature review. This is called ‘triangulation’ or ‘cross-validation’ (for instance, through the application of interview, observation, self-reporting and/or meta-analysis).

2.16 Precede-Proceed Framework in evaluation of the programme

The challenge of planning and evaluation of public behaviours is more than knowledge, beliefs, and attitudes (motivation) drive. The enabled factors, as well as predisposed behaviours should be sustained over long periods to achieve health benefits. The policies and programmes, regulations and organisation must be reinforced and enabled the communications. The programmes should be adapted to different populations and settings, with sensitivity to their differences.

The Precede-Proceed framework is a comprehensive planning system that starts with extensive research to assess needs at multiple levels with an ecological perspective (Green & Kreuter, 1991).

The Precede model is a framework for the process of systematic development and evaluation of health education programmes. An underlying premise of this model is that health education is dependent on voluntary cooperation and participation of the client in a process which allows personal determination of behavioural practices and that the degree of change in knowledge and health practice is directly related to the degree of active participation of the client. Therefore in this model, appropriate health education is considered to be the intervention or treatment for a properly diagnosed problem in a target population (Green & Kreuter, 1991).

This model is multidimensional, founded in the social and behavioural sciences, epidemiology, administration, and education. As such, it recognizes that health and health behaviours have multiple causations, which must be evaluated in order to assure appropriate intervention. The comprehensive nature of Precede allows for application in a variety of settings such as school health education, patient education, community health education, and direct patient care settings (Green & Kreuter, 1991).

The Proceed is added to the model in the late 1980s based on L. Green's experience with Marshall Krueter in various positions with the federal government and the Kaiser Family Foundation. Proceed is added to the framework in recognition of the need for health promotion interventions that go beyond traditional educational approaches to change unhealthy behaviours.

The components of Proceed take the practitioner beyond educational interventions to the political, managerial, and economic actions necessary to make social systems environments more conducive to healthful lifestyles and a more complete state of physical, mental, and social well-being for all.

The purpose of the Precede-Proceed model is to direct initial attention to outcomes rather than inputs. A study was conducted in Japan using the Precede-Proceed (P-P) Model Modification in a community-based oral health promotion. The aim of this study was to explore whether pathways in the P-P model accurately reflect the status of environmental/behavioural assessment in a Japanese community and to examine whether using the linear structural relations (LISREL) programme would improve the model. They found that after P-P model modification, indirect effects on the quality of life from predisposing, reinforcing, and enabling factors became stronger than those in initial P-P model. The overall fit of the modified P-P model was significantly better than that of the P-P model without modification, which did not accurately reflect the status of environmental/behavioural assessment in the community. They concluded that the modified P-P model reflected the current status of environmental/behavioural assessment in the community and the health education models should be tested rigorously to ensure that they fit the reality of people's behaviours (Kawamura, Komabayashi, Sasahara, Okada, Taguchi, & Ogawa, 2010).

Another study was conducted by Inchley, Muldoon and Currie in 2006 to evaluate the process implementation of the HPS concept in Scotland. The intention of the study was to show how an exploration of the processes involved in developing and implementing HPS at local level was crucial to understand of how schools were progressing, through sustained attention to HPS principles, to influence on intermediate health outcomes such as healthy lifestyles/environments. These findings highlight an important elements at a structural/organisational level that need to be in place to allow HPS to function effectively. The FGD undertaken involved students and teachers in Scotland. The themes arrived from the FGD were as follows:

i. Theme 1: ownership and empowerment: need to empower staff through 'shared ownership' of change and innovation, in a framework enabled each member to take a role in strategic planning and professional decision-making.
ii. Theme 2: leadership and management: every school was required to appoint a project coordinator and usually member of senior management took on related role
iii. Theme 3: collaboration: working partnership or 'inter-sectoral collaboration' was a core principle of the HPS. A collaboration involved external professionals, students, and parental involvement.
iv. Theme 4: integration: new initiatives integrated into the ongoing life of the school were considered important to sustain the programme in the longer term.

From the FGD, they concluded that many factors have the potential to influence the implementation of HPS in school setting. Poor performances were unlikely to yield positive results and could adversely affect the credibility of the approach as a whole. When assessing HPS progress, the focus should be extended beyond narrow behavioural outcomes. The study findings suggested that ownership, leadership, collaboration and integration were important to 'improving schools from within'. However, there needs to be greater recognition of the time it takes to make such changes and support schools was needed to actively engage the school community in pursuing the ideology of HPS. Teachers were mediators of such efforts as the key agents of change in the school environment. Emphasis on changing organisations and supporting teachers should prove more productive than narrow focus on individual behaviours in effectively promoting HPS implementation and facilitating sustainable long-term health improvement (Inchley, Muldoon, & Currie, 2007).

This framework will be applied in the present study to evaluate the DMP. The types of evaluation will consist of: Process Evaluation, Impact Evaluation and Outcome Evaluation. The FGD will be carried out among DMs as part of the process evaluation (phase 7) to assess the implementation of DMP from the students' perspectives. Improvement in OHK and OHA as a result of the programme will also be assessed. Impact evaluation (phase 8) will assess the OHB and oral hygiene status. Outcome evaluation (phase 9) will assess improvement in oral health status and OHRQoL due to the DMP.

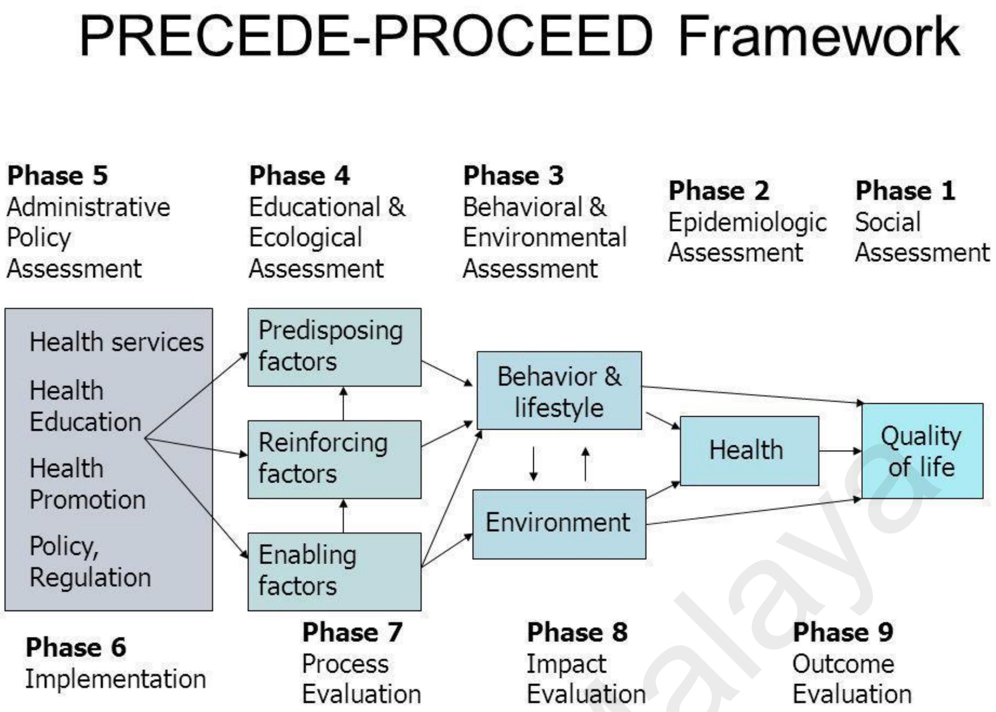

Figure 2.7 Generic representation of the Precede-Proceed Model (Green & Kreuter, 2005)

2.17 Summary

The literature provides evidence on related topics on HPS and the impact of DMP indirectly. Furthermore, the literature has also shown the positive effects of HPS on OHK, OHA, OHB, OHS and OHRQoL outcomes.

With the extension of implementation of DMP in secondary school, perhaps the incidence of dental caries, gingivitis, and plaque score will be reduced. The reduction in these, directly can contribute to improvement in OHRQoL. Therefore, the DMP is important to inculcate the positive attitudes and behaviours towards healthy oral health.

The indices that will be used in the current study are ICDAS (to observe caries activity), the Plaque Control Record (to measure the oral hygiene status), and the GIS index (to measure gingival health).

The literature has shown the effectiveness of HPS in improving on OHK, OHA, OHB, OHS and OHRQoL. Due to the rising healthcare cost, it is worthwhile to spent resources on prevention as this will improve oral health and prevent from poor oral health.

The quantitative and qualitative study has their limitations as well as particular strengths. The combination of qualitative and quantitative methods should be combined in order to compensate for their mutual and overlapping weaknesses. The mixed methods design can provide pragmatic advantages when exploring complex research questions. The qualitative data provide a deep understanding of survey responses, and statistical analysis can provide detailed assessment of patterns of responses.

The FGD is suitable to evaluate the implementation of the DMP in phase 6 and 7 in the Precede-Proceed framework. The FGD may be performed to generate new findings about potential changes or processes within a target community or group and about their effect or impact on the field of health. The FGD could generate additional finding to support the quantitative study.

CHAPTER 3: MATERIALS AND METHODS

3.1 Study design.

This study used a mixed-mode (quantitative and qualitative) study design. The mixed-mode study design was chosen because it involved a procedure for collecting, analysing and "mixing" both quantitative and qualitative data to understand the research questions more comprehensively (McCusker & Gunaydin, 2015). This study comprised 2 phases namely Phase 1 involving a quantitative study (quasi-experimental) and Phase 2 involving a qualitative study (FGD).

3.2 Phase 1: Quantitative study (Quasi-experimental)

Phase 1 involved a study utilising a quasi-experimental study design with matched control on 2 DMP and 2 non-DMP secondary schools. The study involved pre and post clinical examinations and a self-administered questionnaire to be answered at baseline and after 6 months. The study included Form 1 schoolchildren aged 12-13 years in year 2018. Baseline data were recorded in the beginning of the year, and follow up evaluation was carried out on the same cohort after 6 months. The intervention group (IG) comprised secondary schools with DMP and the control group (CG) comprised secondary schools without DMP, matched by location. The IG and CG schools were located in rural and urban areas.

3.2.1 Study population

The study population was Form 1 (12-13 year olds) schoolchildren in the state of Kelantan.

3.2.2 Sample population, sample size, sample selection, and list of secondary schools.

(i) Sample population

The sample population was Form 1 (12-13 year olds) schoolchildren in secondary schools in the districts of Pasir Mas and Kota Bharu, Kelantan. In Kota Bharu district, there were 48 secondary schools with 41,309 schoolchildren, while in Pasir Mas district there were 25 secondary schools with 17,699 schoolchildren (Kelantan Education Department, 2017).

These two districts were chosen for this study because the schoolchildren came from broad socio-economic background from urban and rural areas. The rest of the districts were mostly located in rural areas with few schools implementing the DMP irregularly (personal communication). Secondly, these 2 districts have schools with the most active DMP started much earlier in 2015 compared to other districts in Kelantan (Health Promotion Unit, 2018). Thirdly, secondary schools with DMP in these 2 districts had won several DMP awards at the state and national levels from 2015 to 2017. For example, in 2015, one of the DMP schools (SMK Tanjung Mas) had won first place in teaching aids innovation, exhibition of intervention programmes and community project category at the national level conferences. The same school had also won the 'DMP School Excellence Award' at state level competition in 2016. In 2017, SMK Bunut Susu had won first and second place in the competition held during the Training of Trainers 2017 workshop (Health Promotion Unit, 2017).

Thus, the inclusion of the two districts in our study provided the best opportunity to evaluate the potential impacts of DMP on schoolchildren's oral health if the programme was conducted properly and to assess the DMP implementation issues for future improvement.

(ii) Sample size estimation

Sample size estimation was based on the potential benefits of DMP on the oral health-related parameters of secondary schoolchildren compared to non-DMP schools.

The identified potential benefits of DMP were improvements in oral health knowledge, attitudes, behaviours, oral hygiene level, oral health status, and OHRQoL. For oral health status, the parameters were a reduction in caries incidence and an improvement in gingival health. These two variables were included because of the high sugar consumption among schoolchildren in Kelantan state (Nurrul Ashikin Abdullah, 2010) with limited water fluoridation in the two districts (Kelantan Oral Health Division, 2017).

Findings from a study by Zamros Yuzadi Mohd Yusof (2013) were used as references for the sample size estimation. The study was about the effect of DMP on primary schoolchildren's oral health knowledge, attitudes, behaviours, caries status increment, and OHRQoL.

Estimation of sample size was done using the G Power 3.1 software. For oral health knowledge (OHK), oral health attitude (OHA), and oral health behaviour (OHB) variables, a 5% difference in mean scores between schoolchildren in IG and CG was used. The power was set at 80% with a 5% Type 1 error.

Table 3.1 shows the estimated sample size for the variables. The mean scores of OHK, OHA, and OHB used in the calculation were based on the study findings by Zamros Yuzadi Mohd (2013).

Table 3.1: Estimation of sample size for oral health knowledge, attitude, and behaviour variables

Variable	Mean		Estimated sample size (n)	Effect size descriptor
	CG	IG (5% higher)		
OHK	44.5	46.7	166 (83 per group); ES=0.44	Medium
OHA	49.5	52.0	128 (64 per group); ES=0.48	Medium
OHB	35.1	36.9	190 (95 per group); ES=0.40	Medium

For variables related to oral health status (OHS), the Fisher's Exact test was used to estimate the sample size with 80% power and 5% Type 1 error. The research team estimated that 20% of schoolchildren in the CG would experience caries increment/incidence after 6 months compared to 10% in the IG. The 10% difference between the two groups was based on a study conducted by Hartono et al., (2002). This study stated that the percentage caries increment in experimental schools tended to be lower than the control schools by about 10% (Hartono, Lambri, & van Palenstein Helderman, 2002).

Meanwhile, for the potential impact of DMP on oral hygiene level and gingival health, no reference from a local study was available. Therefore, assumptions were made based on the findings from other related studies (Petersen et al., 2004; Shenoy & Sequeira, 2010; Worthington, Hill, Mooney, Hamilton, & Blinkhorn, 2001). It was assumed that the percentage of children with oral hygiene improvement (plaque level reduction) in the IG would be 30% compared to 10% in the CG (20% difference). Similarly, it was assumed that the percentage of children with improvement in gingivitis (decreasing mean score of GIS after 6 months) in the IG would be 30% compared to 10% in the CG (20% difference). These assumptions were based on the 20% - 25% differences in bleeding scores in the intervention studies quoted above.

For the variable OHRQoL, it was assumed that 20% of children in the IG would experience improvement in OHRQoL (decreasing mean score of Malay Child-OIDP) compared to 10% in the CG (Yusof & Jaafar, 2013). Table 3.2 shows the estimated sample size for the variables caries incidence, oral hygiene, gingival health, and OHRQoL.

Table 3.2: Estimation of sample size for variables oral hygiene level, gingival health, caries incidence, and OHRQoL

Variable	Percentage increment/decrement		Estimated sample size (n)
	Control (CG)	Intervention (IG)	
% with oral hygiene improvement	10%	30%	138 (69 per group)
% with gingival health improvement	10%	30%	138 (69 per group)
% with caries incidence/ increment	20%	10%	428 (214 per group)
% with OHRQoL improvement	10%	20%	428 (214 per group)

The highest number of estimated sample size was 428 (214 per group). This number was increased by 20% to account for dropouts from the study (Wood, White, & Thompson, 2004). Therefore, the final sample size for the study was N= 428 + (0.2*428) = 513 (256 per group).

(iii) Sampling method

The inclusion and exclusion criteria were presented below:

The inclusion criteria

a) For DMP school:

i. National secondary school

ii. The DMP has been running continuously for at least 2 full years at the school before the study began (since 2016). The 2-year period was chosen as an adjustment period for the school to overcome any administrative, materials, and training issues in relation to the DMP.

iii. All Form 1 schoolchildren who started schooling from January 2018.

iv. Form 1 schoolchildren who can read and write.

b) For non-DMP school (control):

i. National secondary school with no DMP.

ii. Located in the same district and nearest to the selected DMP school by location.

iii. All Form 1 schoolchildren who started schooling from January 2018.

The exclusion criteria:

a) For schoolchildren:

i. Schoolchildren with dental anomalies and/or genetic skeletal, which affect the dentofacial shape, surface hardness, and structure of the teeth, e.g. amelogenesis imperfecta, dentinogenesis imperfecta, severe fluorosis, palate, and/or cleft lip

ii. Schoolchildren with chronic medical syndrome, medical conditions, or those on long-term medications which affect oral health.

The number of secondary schools in Pasir Mas and Kota Bharu districts in 2017 was 73 with total number of schoolchildren was 59,008. The number of schoolchildren in Form 1 was 10,838 (Kelantan Education Department, 2017). According to Health Promotion Unit in Kelantan State Health Department, the number of DMP secondary schools in the 2 districts in 2017 was 14 (Health Promotion Unit, 2017). After applying the inclusion and exclusion criteria, the schools eligible to be included in this study are shown in Table 3.3.

Table 3.3: List of eligible secondary schools to be included in this study after applying the inclusion and exclusion criteria.

	Urban	
No	DMP School (IG)	Number of Form 1 children (2017)
1	SMK Tanjung Mas, Kota Bharu	145
	Rural	
2	SMK Bunut Susu, Pasir Mas	139

Only 2 DMP schools were eligible to be included in the study. Four other schools could have been included but did not fulfil the inclusion criteria. SMK Kota in Kota Bharu

district started the DMP since 2015 but was not active each year preceding to our study. SMK Kubang Bemban in Pasir Mas district and SMK Dewan Beta in Kota Bharu district started the DMP in 2016 but were not active in 2017. Another school SMK Meranti in Pasir Mas district started the DMP in 2017 and was still in the adjustment period.

Next, the 2 eligible DMP school was matched (by location) with another non-DMP school located nearest to the DMP school. This was to ensure that the IG and CG had almost similar sociodemographic characteristics. As the number of schoolchildren was adequate to fulfil the sample size requirement, the whole sample population was included in the study. The selected DMP schools and control schools are listed in Table 3.4.

Table 3.4: List of DMP and control schools included in the study.

DMP School (IG)		Non-DMP School (CG)	
DMP School	No. of student	Non-DMP School	No. of student
SMK Tanjung Mas, Kota Bharu (urban)	145	SMK Kota Bharu, Kota Bharu (urban)	150
SMK Bunut Susu, Pasir Mas (rural)	139	SMK Tendong, Pasir Mas (rural)	119
Total	284	Total	269

Figure 3.1 shows the locations of the schools involved in the study where the DMP schools were matched with the nearest Non-DMP schools, respectively.

Figure 3.1: Schools location involved in the study

3.2.3 Study variables

The list of variables used in the present study are listed in Table 3.5

Table 3.5: List of dependent variables used in the study.

No	Conceptual definition	Operational definition	Scale of measurement	Unit
1	Oral health knowledge (OHK)	Improvement in OHK score	Likert scale 0 to 5 1: strongly disagree 2: disagree 3: not sure 4: agree 5: strongly agree	Continuous
2	Oral health attitudes (OHA)	Improvement in OHA score	Likert scale 0 to 4 1: strongly disagree 2: disagree 3: agree 4: strongly agree	Continuous

Table 3.5: List of dependent variables used in the study (continued)

No	Conceptual definition	Operational definition	Scale of measurement	Unit
3	Oral health behaviour	Improvement in OHB score	0: 'less good' 1: 'good'	Continuous
4	Oral hygiene	Reduction in plaque score (O'Leary index)	0: No visible plaque 1: Visible plaque	Continuous
5	Gingival health	Reduction in Gingival Index for Schoolchildren (GIS) score	0: No gingivitis, no calculus 1: No gingivitis with calculus 2: Gingivitis, no calculus 3: Gingivitis with calculus	Categorical and continuous
6	Caries activity	Increment in The International Caries Detection and Assessment System (ICDAS) score	0: Sound tooth surface: No evidence of caries after 5 seconds of air drying 1: First visual change in enamel: Opacity or discolouration (white or brown) is visible at the entrance to the pit or fissure seen after prolonged air drying 2: Distinct visual change in enamel visible when wet, lesion must be visible when dry 3: Localised enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying 4: Underlying dark shadow from dentine 5: Distinct cavity with visible dentine 6: Extensive (more than half the surface)	Categorical and continuous

Table 3.5: List of dependent variables used in the study (continued)

No	Conceptual definition	Operational definition	Scale of measurement	Unit
			distinct cavity with visible dentine	
7	Oral health related quality of life (OHRQoL)	Reduction in Child-OIDP index score	0: none 1: little 2: moderate 3: severe	Continuous

Meanwhile the list of independent variables analysed in MLR and MLogR were:

i. type of school
ii. gender
iii. school location
iv. father's education level
v. mother's education level
vi. carer's education level
vii. household income
viii. availability of dmp in primary school
ix. increment in ohk score
x. increment in oha score
xi. increment in ohb score
xii. increment in total score of gis
xiii. cavitated caries (ICDAS $\geq$3)
xiv. decay teeth (ICDAS >0)
xv. frequency of tooth brushing
xvi. frequency of using fluoride toothpaste
xvii. gargling with water after meal
xviii. conducting mouth self-examination

xix. frequency of using floss

xx. frequency of drinking sweet/carbonated drinks/eating sweet food.

xxi. smoking

3.2.4 Method of data collection

The methods of data collection were:

i. A self-administered questionnaire to assess OHK, OHA, OHB, and OHRQoL. It contains two parts. The first part aimed to assess schoolchildren's OHK, OHA, and OHB. The second part aimed to assess schoolchildren's OHRQoL.

ii. An oral examination to record schoolchildren's OHS at baseline and after 6 months.

Study instruments

(a) A self-administered questionnaire

The study used a self-administered questionnaire which contained two parts.

i. The first part consisted of 3 sections to assess OHK (17 items), OHA (16 items), and OHB (8 items), respectively (APPENDIX A). The development of the first part of the questionnaire is described at the end of the chapter in a pilot study.

ii. The second part of the questionnaire consisted of the Malay Child-OIDP index (Yusof & Jaafar, 2013) to evaluate schoolchildren's OHRQoL. The index has been cross-culturally adapted from English Child-OIDP index (Yusuf, Gherunpong, Sheiham, & Tsakos, 2006) and validated for use by 11 – 12 year old children in the Malaysian setting (APPENDIX B).

(b) Clinical examination

The indices used were the following:

i. Plaque score assessment: This was assessed using the O'Leary plaque index (O'Leary et al., 1972) (APPENDIX C). The teeth surfaces were painted with a disclosing solution (Mira-2-Ton, Hager Werken) using a disposable brush, and the student was asked to rinse his/her mouth once. The presence of plaque on the mesial, distal, labial/buccal, lingual/palatal was recorded as:

- ✓ 0 – No visible plaque
- ✓ 1 – Visible plaque

The plaque score calculation: $\dfrac{\text{plaque containing surfaces}}{\text{No of teeth examined x 4}}$ X 100

The oral hygiene status of the schoolchildren was categorised as the following (Nuryastri Md Mustafa, 2018):

0-10% Excellent

11-25% Good

26-35% Fair

>35% Poor

ii. Gingival health assessment: This was assessed using the Gingival Index for Schoolchildren (GIS) (APPENDIX D). This index is only used in Malaysia, where improvements have been made to the previous scale used by OHD, i.e. scale for oral hygiene (OH) and gingivitis-free mouth assessment (Oral Health Division, 2006). The GIS was used by the Oral Health Division to assess the gingival health among schoolchildren in Malaysia (Oral Health Division, 2013). The examination involved assessing the surfaces of index teeth, i.e. 16 (buccal), 11 (labial), 26 (buccal), 36 (lingual), 31 (labial and lingual), and 46 (lingual) as illustrated in Figure 3.2. The examination only involved fully erupted teeth. The teeth indicated for extraction were excluded. If an index tooth was missing or partially erupted, the adjacent tooth was examined.

Example 1: if 16 was missing/ partially erupted, the adjacent 17 was examined. If 17 was missing/ partially erupted, the highest score of the adjacent teeth 15 or 14/ adjacent E (55) or D (54) were obtained.

Example 2: if 11 or 51 was missing/ partially erupted, the contralateral tooth, i.e. 21 or 61 was examined. If 11 or 51 was missing/ not present, and 21 or 61 was missing/ partially erupted, the highest score of the remaining teeth in the same sextant was recorded.

- The assessment involved a visual examination of the index teeth for presence of gingivitis and/or calculus. When in doubt, a lower score was recorded.
- The GIS scores were recorded as the following:

  0 : No gingivitis, no calculus

  1: No gingivitis with calculus

  2: Gingivitis, no calculus

  3: Gingivitis with calculus

- The highest score of the index teeth will be the overall score schoolchildren. However, if there were a combination of score 1 and 2 among the index teeth, the GIS score of 3 would be taken (Table 3.6).

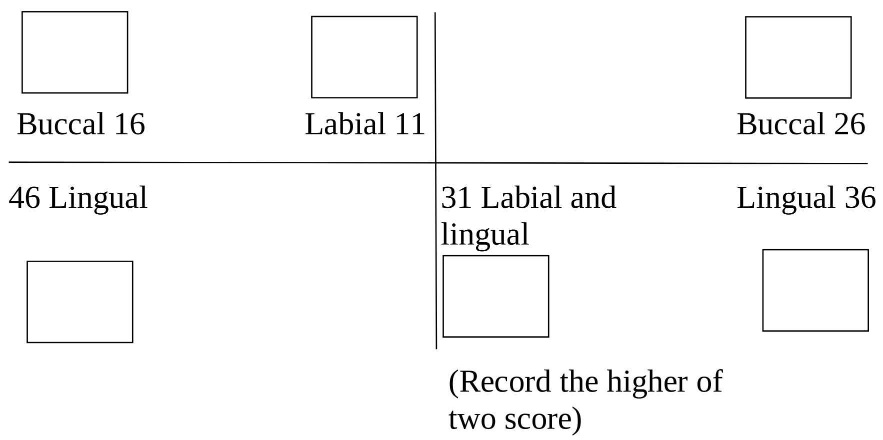

Figure 3.2: The Gingival Index for Schoolchildren (GIS) charting sheet

Table 3.6: The Gingival Index for Schoolchildren (GIS) score table

	Index Teeth						GIS Score
Index Tooth Score	16	11	26	36	31	46	
	0	0	0	0	0	0	0
	1	0	0	1	1	1	1
	0	2	2	0	0	2	2
	0	3	3	0	0	0	3
	1	0	2	2	1	0	3*
	0	1	2	3	3	2	3

iii. Caries status assessment: The International Caries Detection and Assessment System (ICDAS) was used (Pitts, 2004). The ICDAS scores were recorded on a validated ICDAS charting sheet (APPENDIX E). The ICDAS score was charted by surface and tooth.

- The ICDAS scores ranged from 0 to 6. The description for each score is shown below (Gugnani et al., 2011):

  0: Sound tooth surface: No evidence of caries after 5 seconds of air drying,

  1: First visual change in enamel: opacity or discolouration (white or brown) is visible at the entrance to the pit or fissure seen after prolonged air drying,

  2: Distinct visual change in enamel visible when wet, lesion must be visible when dry,

  3: Localised enamel breakdown (without clinical visual signs of dentinal involvement) seen when wet and after prolonged drying,

  4: Underlying dark shadow from dentine,

  5: Distinct cavity with visible dentine, 6: Extensive (more than half the surface) distinct cavity with visible dentin.

- In addition, teeth with no decay or filling, or teeth with filling without decay were considered as sound (ICDAS = 0) (Gugnani et al., 2011; Ismail, Sungwoo, & Woosung, 2011). Only 1-digit caries coding was used in this study.

3.2.5 Calibration and standardisation of examiners

It is necessary to assess the consistency of each individual examiner when examining at different times (intra-examiner reliability), as well as the variations between examiners (inter-examiner reliability) when examining same individuals. Prior to conducting the clinical examinations, the two examiners had undergone calibration and standardisation for caries assessment using the ICDAS (Pitts, 2004), gingival health assessment using the GIS (Oral Health Division, 2013) and oral hygiene assessment using the O'Leary plaque index (O'Leary et., 1972).

The researcher (SK) underwent calibration and standardisation for the GIS and O'Leary index with a periodontal specialist, and ICDAS with a paediatric dental specialist. Later, the second examiner (DO) underwent standardisation for the three indices with the researcher (SK). In this study, the examiners had undertaken inter- and intra-examiner reliability assessment in order to validate findings for the ICDAS, GIS and plaque score chartings.

(i) Conduct of calibration and standardisation exercise

The objective of the calibration and standardisation exercise was to minimise inter-examiner variability in data collection and to ensure uniformity in the interpretation, understanding, and application of all the criteria and codes for all diseases that to be observed and recorded (John, Lee, Prakasam, Eckert, & Maupome, 2013; Rechmann, Jue, Santo, Rechmann, & Featherstone, 2018). This is to ensure each examiner can examine consistently and achieved a reasonable consistency with minimal intra- and inter-examiner variability (World Health Organization, 2003b).

The researcher's (SK) calibration and standardisation for the GIS and O'Leary index were held at the Periodontal Specialist Clinic at Temerloh Dental Clinic in Pahang state. The calibration and standardisation of ICDAS was held at the Paediatric Dentistry Clinic, University of Malaya, Kuala Lumpur.

Prior to the calibration and standardisation exercise, a discussion was held between the researcher (SK) and the specialist on the tools and the charting criteria used. Calibration and standardisation exercise was conducted on five (5) different subjects. For inter-examiner reliability, the researcher (SK) and the specialist took turn to examine the subjects. For intra-examiner reliability, the five subjects were re-examined after one week. This time interval was necessary to prevent recall bias. However, the intra-examiner reliability test was not done for plaque score. This was because plaque score can change easily when a person brushes his teeth or during daily activities, i.e. eating and drinking. Kappa score and Intraclass Correlation Coefficient (ICC) were used to compare agreement between examiners and within examiner. The interpretation of agreement for Kappa (Table 3.7) and ICC (Table 3.8) are shown below. Kappa and percent agreement were compared and Kappa score below 0.60 indicates inadequate agreement among the examiners (Cohen, 1960).

Table 3.7: Interpretation of Cohen's Kappa (Cohen, 1960)

Value of Kappa	Level of agreement
< 0	Less than chance agreement
0.01 – 0.20	Slight agreement

Table 3.7: Interpretation of Cohen's Kappa (Cohen, 1960) (continued)

Value of Kappa	Level of agreement
0.21 – 0.40	Fair agreement
0.41 – 0.60	Moderate agreement
0.61 – 0.80	Substantial agreement
0.81 – 0.99	Almost perfect agreement

Table 3.8. Interpretation of the Intraclass Correlation Coefficient (Koo & Li, 2016)

ICC	Reliability
< 0.5	Poor
0.5 – 0.75	Moderate
0.75 – 0.9	Good
> 0.9	Excellent

(ii) Results of calibration and standardisation exercise

For inter-examiner reliability, the researcher (SK) was calibrated against the benchmark examiner (specialist) for the 3 indices. Repeated assessments were performed after 1-week to determine the intra-examiner reliability. The same procedure for standardisation was carried out for the second examiner (DO). The minimum requirement score set up for this study was >0.60 for Kappa and ≥0.75 for the ICC. Following the exercise, it was noted that all examiners were able to achieve substantial agreement scores, which were more than 0.6 for both the Kappa and ICC scores. The results are shown in Tables 3.9 and 3.10.

Table 3.9: Inter- and intra-examiner reliability analysis for the GIS and O'Leary Index

Dental Officer	GIS				Plaque score (Kappa sore)
	ICC Score		Kappa Score		
	Inter-examiner	Intra-examiner	Inter-examiner	Intra-examiner	Inter- examiner
SK	35 sites of examination				535 sites examined
	0.84	0.83	0.67	0.69	0.75
DO	40 sites of examination				560 sites examined
	0.82	0.96	0.63	0.89	0.83

Table 3.10: Inter- and intra-examiner reliability analysis for the ICDAS

Dental Officer	ICDAS			
	ICC Score		Kappa Score	
	Inter-examiner	Intra-examiner	Inter-examiner	Intra-examiner
SK	482 sites examined			
	0.96	0.81	0.73	0.66
DO	640 sites examined			
	0.97	0.94	0.63	0.66

(iii) Blinding

This study used a double-blinding strategy to some extent in order to reduce bias. First, the schoolchildren were not aware to which group they belonged, i.e. they were not aware if they were in the IG or CG. Second, the second examiner (DO) was blinded to the IG and CG, i.e. she was not aware which schools were in the IG and which schools were in the CG.

3.2.6 Conduct of study

(i) Ethical approval

Ethical approval for the study was granted by the Medical Ethics Committee, Faculty of Dentistry, University of Malaya [Ref: DF CO1709/0069(P)] (Appendix 1). The study was registered with the National Medical Research Register (NMRR) with research identification number of 39026.

(ii) Permission to pre-test the questionnaire

Permissions to pre-test the questionnaire on Form 1 students not involved in the main study in Kota Bharu and Pasir Mas districts were granted by the teacher in-charge of the respective schools. The objectives for conducting a pre-test on the questionnaire were:

(a) to face validate the questionnaire among Form 1 schoolchildren

(b) to assess the psychometric properties of the questionnaire

The development of the questionnaire was described at the end of the chapter.

(iii) Permission to conduct the study in secondary schools in Kelantan

Permission to conduct the study on the actual sample of Form 1 schoolchildren in Kelantan was granted by the Educational Planning and Research Division, Ministry of Education for baseline data collection [Ref: KPM.600-3/2/3 Jld 57 (75), dated 14th November 2017] (Appendix 2), and data collection after 6 months [Ref: KPM.600-3/2/3 Jld 57 (21), dated 11th June 2018] (Appendix 3). Permission to conduct the study was also granted by Kelantan Education Department [Ref: JPKn/SPS/UPP.600-5/4 Jld 9, date 7th January 2018] (Appendix 4).

For conducting oral examinations on Form 1 schoolchildren, the permission was granted by the Malaysian Dental Council [(43) dlm.KKM-60(21/2)/1/2 Jld 3, date 15th February 2018] for the researcher (SK) (Appendix 5) and another one [(8) dlm.KKM-60(21/2)/1/2 Jld 4, date 19th July 2018] for the second examiner (DO) (Appendix 6).

(iv) Data collection

Data collection on the 2 DMP and 2 non-DMP schools took 2 months to complete for baseline and after 6 months each. Baseline data collection took place in February until March 2018, and the 6-month follow up took place in August until September 2018. Permission to conduct the study was granted by the school headmasters after seeing the approval letters from the respective ministry and department.

First, Form 1 schoolchildren from each school were given a consent form for parents to fill at home. The consent form also contained items on parents' education levels and family income. The consent form was returned to the class teacher prior to data collection on the schoolchildren.

On the second visit, schoolchildren with parents' consent were assembled in the Health Education room. They were given a set of questionnaires to answer before undergoing oral examinations. Apart from written instructions, verbal explanations were also given by the researcher to guide the schoolchildren in answering the questionnaire. The schoolchildren had undergone a dental examination twice to examine their OHS. The dental examination was conducted in February 2018 (baseline data) and again in August 2018 (after 6 months).

Baseline clinical examinations were carried out by the researcher (SK) and assisted by the appointed dental assistant (DA) who helped in the charting and holding the torchlight during the examination. The schoolchildren were examined on a portable dental chair in a supine position. The dental examination was carried out with the aid of a torchlight (LED bulb and 50 lumens). The teeth were dried using a manual air blower, i.e. a chip syringe. A disposable dental probe and a mouth (dental) mirror were used to examine the teeth. A dental probe was only used to identify areas with calculus. It was applied gently on the teeth surfaces to ensure that it did not damage nor introduce a cavity into the teeth.

The same procedure was carried out after 6 months. However, after 6 months, the second examination (DO) who was blinded to which group the schoolchildren belonged to carried out the clinical examinations assisted by the appointed dental assistant (DA) who helped in record charting and holding the torchlight. This step was taken to ensure that the expectation bias were reduced by using different examiners at baseline and after 6 months.

(v) Intervention package

Oral health messages are taught under the "charming smile" scope in the syllabus of DMP for secondary schools. This scope covered topics on mouth malodour, MSE, malocclusion, and tooth injury (trauma) (Health Promotion Unit, 2015).

The following are brief descriptions of the topics taught under the "charming smile" scope:

a) Mouth malodour: definition, signs, causes, and how to prevent mouth malodour.
b) MSE: definition, importance of MSE, abnormality need to observe, and step by step how to conduct MSE.
c) Malocclusion: definition of orthodontic treatment, oral condition that requires orthodontic treatment, types of orthodontic treatment and oral hygiene instruction during orthodontic treatment.

d) Tooth injury (trauma): definition of mouth guard, importance of wearing mouth guard, high-risk sports that required wearing a mouth guard, types of mouth guard, how to choose mouth guard, and how to wear a mouth guard to protect teeth.

The schools delivered the oral health messages according to the DMP syllabus in secondary schools after baseline data collection had been conducted and before the 6-month data collection was done. The DMP schools that involved in the present study agreed to conduct these activities as advised. However, the actual month or date when the activities were conducted were based on the schools' decisions and beyond our control.

Figure 3.3 is the flow chart to illustrate the overall conduct of the whole study. Figure 3.4 shows the flow chart of data collection of the study.

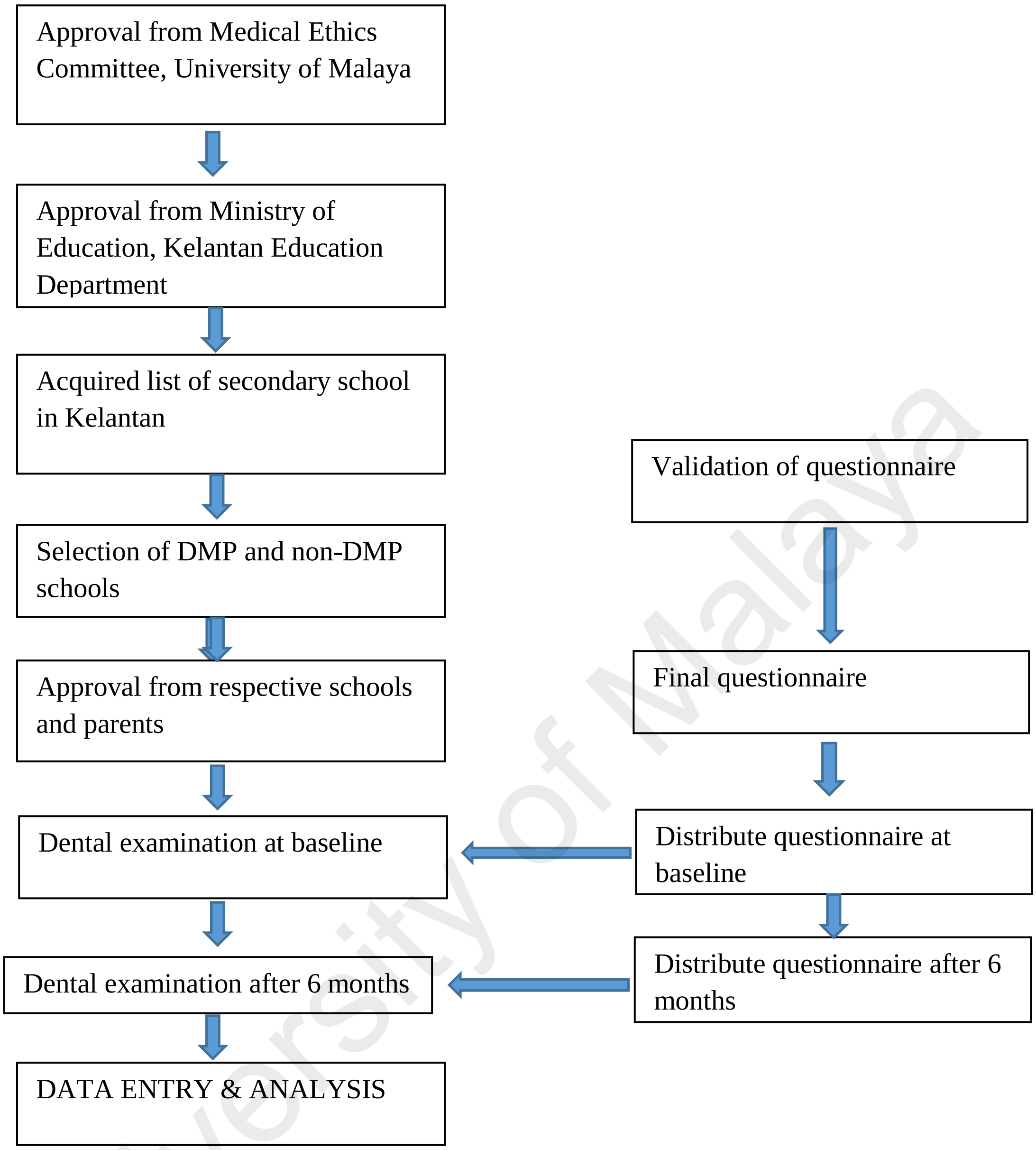

Figure 3.3. Flow chart of the conduct of the study for Phase 1

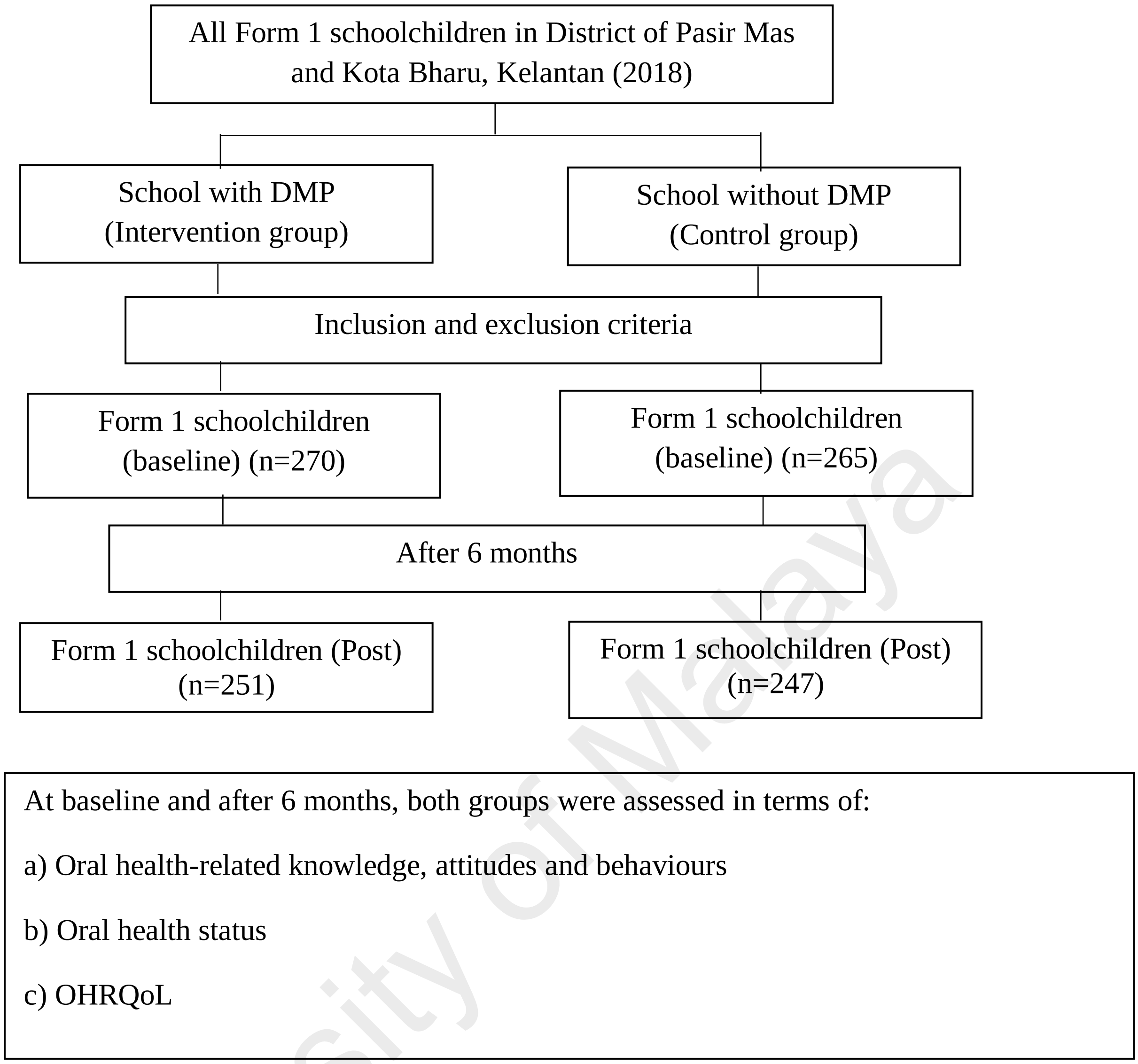

Figure 3.4. Flowchart of data collection of the study

3.2.7 Data analysis for Phase 1

All data from the quantitative study were entered into and analysed using Statistical Package for the Social Science Software (SPSS) version 21.0 for windows. The data on schoolchildren's OHK, OHA, OHB, OHS, and OHRQoL were analysed to answer the objectives number 1 and 2 of this study.

The demographic characteristics of the sample were analysed using descriptive statistics. The Chi-square test was used to analyse significant differences in the proportions between the IG and CG.

(i) Analysis of data on schoolchildren's OHK, OHA, OHB, OHS, and OHRQoL.

Oral Health Knowledge

For OHK sub-scale, there were 17 items in this section, sixteen (16) items were positive statements and 1 item was reversed-scored so that children who answered correctly on that item would score a maximum of 5 points and vice versa (score of 1). Therefore, schoolchildren with good OHK would score highly on the OHK sub-scale (questionnaire on OHK, OHA, OHB in the Malay version is available in Appendix A). Each item was rated on a 5-point Likert scale from 1 = strongly not agree, 2 = not agree, 3 = not sure, 4 = agree, and 5 = strongly agree.

OHK between IG and CG was compared in terms of item and total scores. Item score was described in mean $\pm$ standard deviation (SD) or median and interquartile range (IQR). Total score was obtained by summing up item scores, divided by 85 (total score), and times 100 to give percentage score. Between-group differences in item and percentage scores were assessed using Independent sample t test for normally distributed data, and Mann Whitney test for skewed data.

Next, OHK total score was categorised into good, moderate, and poor levels (Table 3.11). Between-group comparison of OHK levels at baseline and follow up were assessed using Chi-square test. Next, 6-month mean incremental score of OHK was obtained and between-group comparison was assessed using Independent sample t test. At the end, multiple linear regression analysis was carried out to identify factors associated with the 6-month mean incremental score of OHK.

Oral Health Attitudes

For OHA sub-scale, out of sixteen (16) items, two (2) items were reverse-scored so that children with positive attitude on these items would score a maximum of 4 points and vice versa (score 1). Thus, schoolchildren with good level of oral health attitude would score highly on the sub-scale. Each item was rated on a 4-point Likert scale from 1 = strongly not agree, 2 = not agree, 3 = agree, and 4 = strongly agree.

OHA between IG and CG was compared in terms of item and total scores. Item score was described in mean ± standard deviation (SD) or median and interquartile range (IQR). Total score was obtained by summing up item scores, divided by 64 (total score), and times 100 to give percentage score. Between-group differences in item and percentage scores were assessed using Independent sample t test for normally distributed data.

Next, OHA total score was categorised into good, moderate, and poor levels (Table 3.11). Between-group comparison of OHA levels at baseline and follow up were assessed using Chi-square test. Next, 6-month mean incremental score of OHA was obtained and between-group comparison was assessed using Independent sample t test. At the end, multiple linear regression analysis was carried out to identify factors associated with the 6-month mean incremental score of OHA.

Table 3.11: Categorisation of item and total scores of the OHK and OHA sub-scales into good, moderate, and poor levels.

Sub-scale	Items	Score	Category of score	Range of total score (%)
OHK (Score 1-5)	All 17 items	5 (strongly agree)	Good	81 – 100 (Good level)
		4 (agree)	Moderate	61 – 80 (Moderate level)
		1-3 (strongly disagree – not sure)	Poor	20 – 60 (Poor level)
OHA (Score 1-4)	All 16 items	4 (strongly agree)	Good	76 – 100 (Good level)
		3 (agree)	Moderate	51 – 75 (Moderate level)

Table 3.11: Categorisation of item and total scores of the OHK and OHA sub-scales into good, moderate, and poor levels (continued)

Sub-scale	Items	Score	Category of score	Range of total score (%)
		1-2 (strongly disagree – disagree)	Poor	25 – 50 (Poor level)

<u>Oral Health Behaviour</u>

For OHB sub-scale, there were eight (8) items. Schoolchildren were asked to report how often they performed each behaviour and whether they performed the behaviour on a daily, weekly, or monthly basis, e.g. brushing 2x/day. Item D5 (sweet drinks intake) and D6 (sweet food intake) were combined together as one (1) item to assess sweet drinks/food intake. Answers given by the schoolchildren were entered into SPSS and categorised accordingly into 'good' and 'less good' OHB (Table 3.12). Between-group differences were assessed using Chi-square test.

Next, score 1 was given for item with 'good' behaviour and score 0 for item with 'less good' behaviour. Percentage score for OHB was calculated by adding all the items, divided by 7, and times 100. The total score was categorised further as below:

51% – 100% = practicing more good behaviour

0% - 50% = practicing less good behaviour

Apart from score category, 6-month mean incremental score was also obtained based on the percentage score differences between baseline and follow up.

Table 3.12: Categorisation of items of OHB into good, less good, and poor categories of behaviour.

Sub-scale	Item		Category	Category descriptor
OHB	i.	Frequency of tooth brushing	At least twice daily	Good
	ii.	Frequency of using fluoride toothpaste	Less than twice daily	Less good
	iii.	Gargling with water after meal	Yes	Good
	iv.	Conducting mouth self-examination	No	Less good
	v.	Frequency of using floss	At least once daily	Good
			Less than once daily	Less good
	vi.	Frequency of drinking sweet/carbonated drinks/ eating sweet food.	4 times and less	Good
			5 times and more	Less good
	vii.	Smoking	No	Good
			Yes	Poor

[The cut-off points for the categories were based on the literature for tooth brushing and fluoride use frequencies (American Academy of Pediatric Dentistry, 2015, 2016; Davies, Ellwood, & Davies, 2003; Stookey, 2006), sugary food or drinks intake (Moynihan, 2016), (British Association for the Study of Community Dentistry, 2009), and detection of oral cancer through mouth self-examination MOH/K/GIG/6.2007(PT) (Oral Health Division, 2008)].

Between-group comparisons were made at baseline and after 6 months using Independent sample T test for continuous data, and Chi-Squared test for categorical data. Within-group comparisons were assessed using Paired sample T test.

Univariate analysis was conducted to explore the relationships between scores of OHK, OHA, and OHB and categories of independent variables namely demographic characteristics of schoolchildren. The aim of this analysis was to identify significant associations between schoolchildren's demographic characteristics and their OHK, OHA, and OHB scores, respectively.

All total scores were subjected to normality tests to explore their normality distributions. The differences between groups of independent variables were assessed using Independent T test (two-group variable), One-way ANOVA (more than two-group variable) and Mann-Whitney U test for skewed data. In one-way ANOVA test, homogeneity of variance between groups of independent was checked by using Levene's test followed by post-hoct test for significant finding to evaluate relationship between score for three and more specific groups in one variable.

Variables with significant associations ($p<0.10$) with the outcome at the univariate level were further analysed in multi-variate analysis, i.e. multiple linear regression (MLR) statistics for continuous data. The aim was to find significant factors associated with OHK, OHA, and OHB incremental scores respectively after controlling for all significant independent variables at univariate analysis. Generation of MLR models was explored using various methods namely stepwise, forward, backward and enter methods. The final MLR models selected were the ones with the highest adjusted R^2. The model was checked for significant two-way interaction. Addressing the two-way interaction would ensure the final model more accurate and free from influences of a combination of any two factors together (Field, 2009). Finally, the model was checked for statistical assumption namely independent distribution of errors, presence of multicollinearity, model fitness, value of R^2 and diagnostic test.

(ii) Analysis of data on schoolchildren's oral hygiene

The teeth surfaces were painted with a disclosing solution (Mira-2-Ton, Hager Werken) using a disposable brush and the children were asked to rinse their mouth once. The operator examined each stained surface for soft accumulations of plaque at the dentogingival junction. If found, the DA would record the finding by making a dash/red colour in the record form. Those surfaces which did not have soft accumulations of plaque at the dentogingival junction were not recorded.

After all teeth were examined and scored, total score was calculated by dividing the number of plaque containing surfaces by the total number of available tooth surfaces. For example, 30 tooth surfaces containing plaque from total tooth surfaces of 70, the plaque score was calculated by dividing 30 by 70 and multiplied by 100. Then the score was categorised into "excellent" (score = 0-10%), "good" (score = 11-25%), "fair" (score = 26-35%), and "poor" (score >35%) levels. Differences in the proportion of plaque score levels between the IG and CG was analysed using Chi-square test at baseline and after 6 months.

The increment of plaque score after 6 months was measured by comparing the percentage of plaque score at baseline and after 6 months. If there was an increment, a score 1 was recorded, and if there was a decrement or no change in plaque score, a score 0 was recorded. Then, the Chi-square test was used to analyse the differences in proportion of schoolchildren experiencing increment in percentage plaque score between the groups.

Between-group comparison of mean percentage plaque score (mean ± SD) at baseline and after 6 months was assessed using the Independent sample T test. While within-group comparison after 6 months was assessed using Paired sample T test. Mean plaque score increment (mean ± SD) after 6 months was calculated for IG and CG. Between-group comparison of mean plaque score increment was assessed using Independent sample T test.

Univariate analysis between mean percentage plaque score increment with demographic characteristics of the schoolchildren were analysed using Independent sample T test (two-group variable), One-way ANOVA (more than two-group variable) and Mann-Whitney U test for skewed data. Univariate analysis with continuous variables, i.e. OHK, OHA and OHB increments were also carried out.

Variables with $p<0.10$ at univariate analysis were further analysed using MLR statistics to identify significant factors associated with 6-month mean plaque score increment.

(iii) Analysis of data on schoolchildren's oral health status

Gingival health

The comparison of proportions of schoolchildren with overall GIS score 0, 1, 2, and 3 between IG and CG at baseline and after 6 months were assessed using Chi-square test. The differences in proportions of schoolchildren with GIS score 0, 1, 2, and 3 within group at baseline and after 6 months were assessed using Chi-square test.

Other comparison made was in terms of mean total score of GIS at baseline and after 6 months. This score was continuous and different compared to the GIS scores which were ordinal in nature. The score of the index teeth was summed and divided by the total number of index teeth to get the total score of GIS. Next, the proportion of schoolchildren experiencing increment in mean score of GIS was determined by comparing the mean score of GIS at baseline and after 6 months. If there was an increment in the score after 6 months, a score 1 was recorded, and if there was a decrement or no change in mean score of GIS, a score 0 was recorded. Then, Chi-square test was used to evaluate the differences in proportions of schoolchildren experiencing increment in mean score of GIS between the IG and CG.

Next, 6-month mean score of GIS increment was calculated for IG and CG. Between-group comparison was assessed using Independent sample T test, while within-group comparison was assessed using Paired sample T test.

Univariate analyses between mean score of GIS increment and categories of the demographic characteristics of the schoolchildren were carried out using Independent sample T test (two-group variable), One-way ANOVA (more than two-group variable), and Mann-Whitney U test for skewed data. Homogeneity of variance between groups of independent of total score of GIS was checked by using Levene's test followed by post-hock test for significant finding to evaluate relationship between score for variable with three and more specific groups. Univariate analysis with continuous variable was also carried out, i.e. OHK, OHA and OHB increments.

Variables with $p<0.10$ at univariate analysis were further analysed using MLR statistics to identify significant factors associated with 6-month mean increment of total score of GIS.

Caries incidence

The proportions of schoolchildren experiencing increments in ICDAS score after 6 months by group were recorded. Mean ICDAS score was calculated by adding all ICDAS scores on all teeth and divided by the number of teeth present at baseline and after 6 months. The proportions of schoolchildren experiencing increments in ICDAS score was determined by comparing the mean ICDAS score at baseline and after 6 months. If there was an increment, a score 1 was recorded, and if there was a decrement or no change in mean ICDAS score, a score 0 was recorded. The Chi-square test was used to evaluate the differences in proportions of schoolchildren experiencing caries increments over 6 months.

The 6-month caries incidence rate was analysed by teeth for ICDAS >0 (caries) and ICDAS $\geq$3 (cavitated caries). The incidence was compared between IG and CG using Chi-square test. Next, 6-month mean caries increment was calculated for IG and CG. Between-group comparison of mean caries increment was assessed using Independent sample T test, and within-group comparison using Paired sample T test.

Univariate analysis was done between 6-month mean caries increment and demographic characteristic of the schoolchildren using Independent sample T test (two-group variable), One-way ANOVA (more than two-group variable), and Mann-Whitney U test for skewed data. The criteria for caries was ICDAS >0 and ICDAS $\geq$3.

Univariate analysis with continuous variables, i.e. OHK, OHA and OHB increments were also carried out.

Variables with $p<0.10$ at univariate analysis were further analysed using MLR statistics to identify significant factors associated with 6-month mean caries increment among the schoolchildren.

(iv) Analysis of data on schoolchildren's oral health related quality of life.

Oral impacts on daily performances of the schoolchildren in the previous three months were assessed in terms of its prevalence, impact scores, impact intensity, and extent of impact.

Each performance score was calculated by multiplying the frequency (0 to 3) and severity (0 to 3) of impact to give a performance score of 0-9. The prevalence of impact for each performance was measured as the proportion of children with impact score >0 for that performance.

Total impact score was calculated by summing up the scores of the 8 performances, divided by 72 (maximum score), and multiplied by 100 to give a total percentage score. The overall prevalence of impact was measured as the proportion of children with total impact score >0.

The impact intensity of a performance was calculated by multiplying the severity score (0 to 3) and frequency score (0 to 3). The total score (from 0-9) was categorised into 0 (no impact), 1 (very little impact), 2 (little impact), 3 and 4 (moderate impact), 6 (severe impact), and 9 (very severe impact).

The extent of impact was calculated by adding the number of OIDP performances with impacts. It extends from 0 to 8 performances with impacts (PWI).

In each outcome, the IG and CG were compared. Between-group differences in proportion were assessed using Chi square test. For OIDP scores, the schoolchildren's OIDP scores were non-normally distributed. Thus, the analysis was done using non-parametric test. Between-group differences were analysed using Mann-Whitney U Test while within-group differences were assessed using Wilcoxon Signed Ranks Test. McNemar Test was used to assess binomial data. The Marginal Homogeneity test was used for outcome data relating to the number performances with impact (PWI).

Univariate relationships between 6-month mean OIDP score increment, and presence of at least one OIDP impact after 6 months with demographic characteristics of the sample were assessed, respectively. The statistical tests used were Independent sample T test (two-group variable), One-way ANOVA (more than two-group variable), Mann-Whitney U test for skewed data, and Chi-squared test (categorical data). MLR analysis was conducted to evaluate factors associated with mean OIDP score increment after 6 months using the same method as described previously. For factors associated with the presence of at least one OIDP impact after 6 months, MLogR was carried out.

In all analyses, level of significance was set at $p<0.05$. Below is a summary table of the statistic tests used in the present study.

Table 3.13: Summary table of the statistical tests used in the data analysis

No	Item	Analysis
1	Socio-demographic characteristic	Chi-Square test was used to compare proportions of schoolchildren between the IG and CG at baseline and after 6 months
2	Immediate impact: OHK	i. Independent Sample T Test was used to compare between IG and CG on each item score, percentage of total OHK score, and mean increment OHK score except for item no.2 where Mann-Whitney Test was used. ii. Chi-Square test was used to compare proportions of schoolchildren having good, moderate, and poor levels of OHK between the IG and CG at baseline and after 6 months iii. Paired Sample T Test was used to compare OHK score at baseline, after 6 months, and increment score over 6 months within the groups
3	Immediate impact: OHA	i. Independent Sample T Test was used to compare between IG and CG on each item score, percentage of total OHA score, and mean increment score ii. Chi-Square test was used to compare proportion of schoolchildren having good, moderate, and poor levels of OHA between the IG and CG at baseline and after 6 months iii. Paired Sample T Test was used to compare OHA score at baseline, after 6 months and increment score over 6 months within the groups
4	Intermediate impact: OHB	i. Chi-Square test was used to compare percentage distribution of OHB by group at baseline and after 6 months ii. Independent Sample T Test was used to compare percentage of total OHB score at baseline, after 6 months, and mean increment score between IG and CG iii. Chi-Square test was used to compare proportion of schoolchildren practicing more and less good OHB between the IG and CG at baseline and after 6 months

Table 3.13: Summary table of the statistical tests used in the data analysis (continued)

No	Item	Analysis
		iv. Paired Sample T Test was used to compare OHB score at baseline, after 6 months and increment score over 6 months within the groups
5	Intermediate impact: Oral hygiene (plaque score)	i. Chi-Square test was used to compare proportion of schoolchildren with plaque score levels by groups at baseline and after 6 months ii. Chi-Square test was used to compare proportion of schoolchildren experiencing increment in percentage of plaque score after 6 months by groups iii. Independent Sample T Test was used to compare percentage of plaque score at baseline, after 6 months, and mean increment score between IG and CG iv. Paired Sample T Test was used to compare plaque score within the group over 6 months
6	Health impact: Gingival health	i. Chi-Square test was used to compare proportion of schoolchildren with GIS score 0 to 3 at baseline and after 6 months within and between the groups ii. Chi-Square test was used to compare proportion of schoolchildren experiencing increment in mean GIS score after 6 months by groups iii. Independent Sample T Test was used to compare mean score of GIS at baseline, after 6 months, and mean increment score between IG and CG iv. Paired Sample T Test was used to compare mean score of GIS within the group over 6 months
7	Health impact: Caries incidence	i. Chi-Square test was used to compare proportion of schoolchildren experiencing increment in ICDAS score after 6 months by groups ii. Chi-Square test was used to compare 6-month caries incidence rate of ICDAS>0 and ICDAS ≥3 by groups iii. Independent Sample T Test was used to compare mean decayed teeth (ICDAS>0) at baseline, after 6 months, and mean increment score between IG and CG iv. Paired Sample T Test was used to compare mean decayed teeth within the group over 6 months

Table 3.13: Summary table of the statistical tests used in the data analysis (continued)

No	Item	Analysis
8	Health impact: OHRQoL	i. Mann-Whitney Test was used to compare mean each activity, overall activity, and mean increment each activity score at baseline and after 6 months between IG and CG ii. Chi-Square test was used to compare proportion of schoolchildren experiencing increment in mean total OIDP score after 6 months by groups iii. Chi-Square test was used to compare prevalence of impact intensity at baseline and after 6 months by groups iv. Mc Nemar Test was was used to compare frequency distribution of oral condition perceived to have cause overall impact within the group after 6 months v. Chi-Square test was was used to compare frequency distribution of oral condition perceived to have cause overall impact between the groups at baseline and after 6 months vi. Mann-Whitney Test was used to compare mean total OIDP score at baseline, after 6 months, and mean OIDP score increment between IG and CG vii. Wilcoxon Signed Rank Test was used to compare mean total OIDP score within the group over 6 months i. Marginal Homogeneity Test was used to compare number of performances with impact at baseline and after 6 months between IG and CG
9	Associated factors in relation to schoolchildren' OHK, OHA, OHB, OHS, and OHRQoL	i. Univariate analysis ii. Multilinear regression analysis iii. Multiple logistic regression

3.3 Phase 2: Qualitative study

The second phase of this study was a qualitative study. The Focus Group Discussion (FGD) was selected as the method for data collection. The FGD was used to obtain detailed information about personal and group feelings, perceptions and opinions about focused topics. If suitable, FGD could save time and money to gather feedback on groups of individuals compared to individual interviews. FGD could also provide a broader range information about a topic and offer an opportunity for clarifying or supporting the outcomes of quantitative data in the present study. The study population in the FGD was the DM schoolchildren representatives from the selected DMP secondary schools in Table 3.4 above.

3.3.1 Sample selection and conduct of Focus Group Discussion (FGD)

The FGD was conducted on DMs to explore the process implementation of the DMP in terms of DM selection, training, strengths and weaknesses of DMP, and suggestion for improvement from the perspectives of the DM.

DMs from the two DMP schools namely SMK Tanjung Mas and SMK Bunut Susu were invited to participate in the FGD. The FGD was conducted separately for the two schools. The inclusion criteria for DM to participate in the FGD were those DM who were active in the various DMP activities verified by DMP teachers, and appointed as DM for at least 1 year. In this study, two DMs were chosen to represent each academic year. The DMP teacher facilitators of each school helped to select a group of DMs who fulfilled the inclusion criteria above. Although the DMs were of different ages, they were considered as a homogenous group by virtue of their involvement in the DMP activities. Only DMs from the two IG schools were involved in the FGD due to the following reasons:

i. The data obtained from these FGDs would be used to help explain and support the quantitative data findings of the study.

ii. The 2 schools involved were the most active DMP schools in Kota Bharu and Pasir Mas districts where DMP have been running each year at least for the past 3 years. As such, meaningful feedback on the FGD topic guide would only be possible by including the most active DMP schools that implemented the programme as fully as possible.

iii. The selection of participants for the FGD also involved the most active DMs. This was to ensure that the DMs selected were able to provide valuable inputs on the semi-structured questions during the FGD.

The FGD took place on 2 July 2018 at SMK Tanjung Mas, and 4 July 2018 at SMK Bunut Susu. In each school, the FGD consisted of eight (8) DM participants. Each FGD lasted for about 40 minutes to one hour. The discussions were conducted in the Malay language to ensure they were able to give opinions without any difficulties. The researcher (SK) acted as the facilitator as well as the note taker.

A topic guide with open-ended questions was used to obtain the opinions of DMs about the DMP. The researcher, who facilitated the discussion, used this topic guide to ask and probe questions (Wong, 2008). Six (6) open-ended questions were asked in the FGD in relation to the DMP selection process, DM training, DMP implementation, the support and materials provided for the DMP, and DMP perceived benefits, weaknesses and recommendations for improvement (APPENDIX F). The list of open-ended questions are listed below:

i. What are your opinions about the selection process and appointment of DM in your school?

ii. What are your opinions about the training received by the DM?

iii. What are your opinions about the implementation of DMP at your school?

iv. What are your opinions about the support and materials provided by the school for DMP?

v. What are your opinions about the benefits of joining the DMP?

vi. What are your opinions about the weaknesses of the DMP?

vii. In your opinions, what are your recommendations to improve the DMP at your school?

A voice recorder was used to record the FGD and later used for data transcriptions and reference.

The FGD proceeded as follows:

- The discussion started with an 'ice-breaker', i.e. self-introduction by the moderator and each participant. The rules and regulations of the FGD were explained.
- The moderator introduced the topic for discussion.
- The questions were asked to the group one at a time to obtain their feedback. Participants were free to give their views. The discussions were held without interrupting the natural flow of the discussion and were considered completed when no further opinions were put forward by the DMs or repeating answers or opinions were given by the participants. If the discussion was held back by lack of input, the moderator would ask probing questions to guide and promote participations from the DM. The moderator would also monitor the group dynamics such as levels of participation, the presence of dominant participants, levels of interest, and voice tones of the participants.
- Finally, when the FGD was over. The moderator thanked all the participants.

3.3.2 Rigour of data from the FGD

The validity and reliability of qualitative analysis was described as trustworthiness (Elo, Kääriäinen, Kanste, Pölkki, Utriainen, & Kyngäs, 2014). The terms credibility, transferability, dependability, and confirmability are used in qualitative research to explain the reliability and validity of data, and contribute to appraise the findings of qualitative research (Golafshani, 2003).

The rigour of data in the FGD was established by following the criteria for data trustworthiness defined by Lincoln and Guba (1985). The following steps were undertaken to ensure the rigour of data in this study:

i. Credibility: To ensure data credibility was achieved, the following strategies were undertaken, i.e. prolonged engagement, persistent observations, and triangulation (Lincoln & Guba, 1985):

a) Prolonged engagement: a few minutes were spent with the participants to understand and develop good rapport with them. This was to ensure that participants felt comfortable to give their opinions based on the questions asked.

b) Persistent observation: identifying those characteristics and elements that are most relevant to the questions under study. The sessions were observed carefully in terms of group dynamics, i.e. levels of participation in the presence of more senior DM, presence of dominant participants (vocal participants), and level of interest to answer the questions. The group dynamics were monitored by the moderator closely. In addition to this, prolonged engagement with the data involved reading and re-reading of the transcripts, re-analysed, and revised the themes from the FGD.

c) Triangulation: triangulation aims to enhance the process of qualitative research by using multiple approaches (Sim & Sharp, 1998). In this study, triangulation was achieved using different data sources, investigator, and methods of data collection (Lincoln & Guba, 1985).

- Data triangulation: the data were obtained by conducting two sessions of FGD at different places and different times.

- Investigator triangulation: investigator triangulation was achieved by involving two researchers as research team members, and involving them in addressing the organisational aspects of the study and the process of analysis. Data were analysed by two different researchers. The investigator triangulation was done by employing a colleague from the same field, i.e. the researcher (SK) and another researcher in the same department who had experience in qualitative research. Both investigators were supplied with the voice recordings from the FGD and went through the data transcriptions independently. If there were differences in opinions about the emerging themes, these were resolved through discussions. The two researchers held regular meetings during the process of data analysis (after analysing every third data set). In addition, regular analytical sessions were held with the research team.
- Method triangulation: The present study used a mixed-mode (quantitative and qualitative) study design. The mixed-mode study design was chosen because it involved a procedure for collecting, analysing and "mixing" both quantitative and qualitative data to understand the research questions more comprehensively. The findings from the qualitative part in the present study would be useful to support findings from the quantitative part of the study.

ii. Transferability: to ensure the data obtained from the FGD can be generalised to all ages in the secondary school. The DMs involved in the FGD were selected from all Forms (Form 2 to Form 5) and ages (13 – 17 years) in the selected secondary school, except students in Form 1 (12 – 13 years) where only a few were selected as DMs. DMs from both genders were selected to participate in the FGD.

iii. Dependability and confirmability: the accuracy of the data was assured by relying on the audio recorder and field notes during transcription and data checking. All FGDs were performed in the same manner using a focus group guide, which using this method had supported the consistency of data collection.

3.3.3 Analysis of data from FGD

The data from the FGD were analysed as follows:

The framework method analysis was used to analyse the FGD data (Gale et al., 2013). In this method, the semi structured (open ended) questionnaire prepared by researcher (SK) contained specific domains, i.e. selection of DM, training received by DM, the implementation of DMP, support and materials for DMP, benefits of joining the DMP, weaknesses of the DMP, and recommendation for DMP improvement. The procedures for analysing the qualitative data in this study are listed below following the framework method analysis:

i. Transcription: A verbatim (word-for-word) transcription of the FGD data was done into the Malay language and later translated into English. Transcripts were done with large margins and adequate line spacing for later coding and note-making. The transcription was done by the researcher (SK) and an external transcriptor (ET) by sending the audio-recording to the person. All transcriptions were manually checked and thorough discussions between the two parties (SK and ET) were held by comparing the results of each transcription. At the final discussion, it was agreed that there were no differences in the 2 sets of the transcriptions.

ii. Familiarisation: The researcher familiarised herself with the FGD data by listening to the audio recorder immediately after the discussion took place for several times, and also later by reading the transcriptions. The familiarisation process took about 1 week for each FGD. In addition, the transcriptions and contextual or field notes that were recorded during the FGD were read and used to complement the audio-recording to understand the content better. The process continued until the researcher had become familiar with most of the responses and could imagine the possible themes that would emerge from the transcriptions. The whole process took about 2 weeks.

iii. Coding: After data familiarisation, the transcript was read carefully line by line, applying a paraphrase or label (a 'code') that described what the researcher had interpreted from the passage. At this stage 'open coding' takes place, i.e. coding anything that might be relevant from as many different perspectives as possible. Coding aims to classify the data so that they could be compared systematically with other parts of the data set. Coding was done with the help from 2 dental colleagues and another person from the public. Inputs from the public person would offer alternative viewpoints thus ensuring that one particular perspective did not dominate.

iv. Developing a working analytical framework: After coding the first few transcripts, the researcher (SK) and the supervisors met together to discuss and compare the codes that were applied, and agreed on a set of codes to be applied to subsequent transcripts.

v. Applying the analytical framework: The working analytical framework was applied by indexing subsequent transcripts using the existing categories and codes. Each code was assigned with the full name of the code and written directly onto the transcripts.

vi. Charting data into the framework matrix: A spreadsheet was used to generate a matrix and the data were 'charted' into the matrix. The charting involved summarising the data by category from each transcript. The chart included references to interesting quotations.

vii. Interpreting the data: Impressions, ideas and early interpretations of the data also was note down as additional data. Observation during FGD was also note down such as group theme, group dynamics, voice tone, etc. The findings that generated through the process can go beyond description of particular cases to explanation of, for example, reasons for the emergence of a phenomena, predicting how an organisation, or identifying areas that are not functioning well within an organization or system.

The final results of the FGD were presented in tables including the domains, themes, and verbatim explanation to support the emerging themes

3.4 Pilot Study - Development of the questionnaire to evaluate schoolchildren's OHK, OHA, and OHB.

The questionnaire used in the study was adapted from the Malay version questionnaire developed in a local study on the DMP (Yusof & Jaafar, 2013) with a few items added based on the DMP syllabus for secondary schools (Ministry of Health & Ministry of Education, 2013). This questionnaire aimed to measure children's levels of oral health knowledge, attitudes, and behaviour in the main study.

The original questionnaire was aimed for use by 11-12 year old schoolchildren taking into account their cognitive and affective development at this age and based on the curriculum of the DMP module for primary schools (Ministry of Health, 2008).

The original questionnaire has thirty-four (34) items, which covered domains on OHK, OHA, and OHB.

For OHK domain:

a) The original questionnaire have 12 items which covered topics on dental caries, caries prevention, gum disease, fluoride, oral hygiene methods, dental visit, benefits of good oral health, and the effect of smoking on oral health.

b) The number of added items were 8 which covered topics on mouth malodour, mouth self-examination (MSE), malocclusion and the treatment available, and prevention of dental trauma.

c) Total items were 20.

d) The items were a mixed of positive and negative statements to ensure schoolchildren answered based on their OHK and prevented invalid or response bias. An example of a negative statement was "*Berus gigi yang keras lebih baik daripada berus yang gigi lembut untuk membersihkan gigi*" (A hard toothbrush is better than a soft toothbrush to clean the teeth).

For OHA domain:

a) The original questionnaire have 15 items which covered 2 main domains, i.e. the importance of tooth brushing (9 items), and consumption of sweet food and drinks (6 items).

b) One item from the tooth brushing domain was deleted (following the pre-test) because it was considered not relevant to the secondary schoolchildren who have reached the age of adolescence. The question was "*memberus gigi sangat penting kerana ia menyebabkan ibu bapa saya gembira*" (brushing teeth is very important because it makes my parents happy).

c) The number of added items were 6 to assess children's attitudes towards the new items added in the OHK section. Schoolchildren with good knowledge on oral health would be more aware and cautious about the consequences of poor oral health. For example, schoolchildren with good knowledge on mouth malodour would have a high awareness that mouth malodour can cause difficulties to mingle with friends, having low self-esteem and would be more worried.

d) Total items were 20.

e) The items were a mixed of positive and negative statements. A few negative statements were developed related to food and sweet drinks, mouth malodour, MSE, and prevention of tooth injury.

For OHB:

a) The original questionnaire have 7 items which covered topics on frequencies of tooth brushing, using fluoride toothpaste, gargling after meal, flossing, carbonated and sugary drinks consumption, eating sweets/chocolate/ice cream, and smoking status.

b) One new item was added on MSE.

c) Total items were 8.

d) There were changes in the answering options where an open-ended answer option was made. The schoolchildren needed to indicate the frequency of OHB, i.e. daily, weekly or monthly. The OHB items were not developed as a measuring scale because of the unstandardised answer options. As a result, the items were analysed per item and were not treated as a potential scale.

With the additional items, the initial draft Malay questionnaire used in this current study had 48 items altogether (OHK: 20 items, OHA: 20 items, and OHB: 8 items)

3.4.1 Content and face validation of the draft questionnaire

The content validity of the draft questionnaire to assess oral health knowledge, attitudes, and behaviour was verified by two dental public health experts. The experts were in consensus agreement that the questionnaire items addressed relevant oral health topics including items on the oral health syllabus of the DMP in secondary school. During content validation, the questionnaire's applicability, efficiency, clarity, and sensitivity were assessed by the experts:

a) Content validity – refers to the adequacy of the measure to assess the domain of interest, i.e. whether the items were relevant to the topic, the concepts were culturally relevant, acceptable to the society, and conformed to current scientific knowledge;

b) Applicability – the appropriateness of the measure for use by the target group, i.e. were the items applicable to the target group, and were they the appropriate measures for the related domains;

c) Efficiency – relates to user friendliness and feasibility of administration, i.e. were the items free of jargon;

d) Clarity – refers to the use of appropriate language and terminology, i.e. were the items free of basic grammatical errors, not too long, and free of ambiguity.

Following content validation, minor modifications were made to the questionnaire taking into account all inputs from the experts. The experts concluded that all items were deemed relevant to the various topics without duplication. No item was removed at this stage.

Next, the questionnaire was pretested among schoolchildren who were not involved in the final sample. This phase, referred to as face validation, was conducted by the researcher (SK) in Kajang, Selangor in October 2017 involving 25 Form 1 (12-13 years) children. Following the pretest, a discussion with the 25 schoolchildren was held. At the end of the discussion, the researcher (SK) concluded that overall the children understood the purpose, content, wording, general layout, instructions, and flow of the questionnaire. A slight change was made where the words "white thread (*benang putih*)" was replaced with "dental floss (*benang pergigian*)". This change was in accordance to the term "*benang pergigian"* used in the DMP syllabus for secondary school. The researcher also assessed the questionnaire administration in field condition. In terms of timing, the time taken for the children to answer the questionnaire was also acceptable, i.e. 7-10 minutes.

3.4.2 Pilot study of the draft Malay questionnaire on OHK and OHA.

Following the pretest, a pilot study was conducted in SMK Tendong, Pasir Mas, Kelantan in November 2017 involving 150 Form 1 (12-13 years) schoolchildren. The aim was evaluate the psychometric properties of the draft questionnaire before the actual study began. The questionnaire was redistributed to 33 schoolchildren (20% of the initial sample) after 1 week. Following the pilot test, the data were analysed using SPSS version 21 software.

<u>Psychometric analysis of the draft questionnaire</u>

The aim of the psychometric analysis was to establish the validity and reliability of the draft Malay questionnaire as a measuring scale.

First, excluding the OHB items, the remaining 40 items of the draft Malay questionnaire on OHK and OHB were reverse scored where applicable. This enabled a student with good OHK and OHA to score highly on the respective domains.

Next, the 40 items were factor analysed using principal component analysis (PCA). The varimax rotation method with Kaiser Normalization was used for factor loading. The Kaiser-Meyer-Olkin (KMO) test was used to measure the sampling adequacy and Barlett's test of Sphericity to test for sample adequacy and items correlation. For KMO coeeficient, value >0.5 indicates the sample size is adequate for factor analysis (Kaiser, 1974). For Barlett's test of Sphericity, $p<0.05$ indicate the data are acceptable.

Following the factor analysis, each emerging factor was further analysed for internal consistency and test-retest reliability. The reliability test was carried out to ensure the factor items are internally valid and generate consistent scores at two different times. Internal reliability was assessed using Cronbach's alpha coefficient (Cronbach, 1951) and corrected item-total correlation. The value of alpha coefficient indicates the strength of the index to measure the construct of interest. Its value ranged from good-excellent ($\alpha \geq 0.8$), fair-moderate ($0.6 \leq \alpha < 0.8$), poor ($0.5 \leq \alpha < 0.6$), and unacceptable ($\alpha < 0.5$) (George & Mallery, 2010).

The test-retest reliability was measured using intra-class correlation coefficient (ICC) using two-way random effects model (Field, 2009). The test-retest reliability analysis was conducted to assess whether the index would yield consistent scores when distributed at two different times. The values of ICC ranged from 0 (no agreement) to 1 (perfect agreement). The interpretation of reliability using ICC (Koo & Li, 2016) was illustrated in Table 3.8.

<u>Result of pilot study</u>

(a) Results of factor analysis

The factor analysis of the 40-item questionnaire to evaluate schoolchildren's OHK and OHA revealed two factors and were named Factor 1 = OHK and Factor 2 = OHA (Table 3.14). Most items which were originally developed for Factor 1 and 2 had loaded into both factors, respectively.

Two items which were initially developed for Factor 1 (B2 and B6) had loaded into Factor 2. Fourteen items that were initially developed for Factor 2 (C1.a, C1.b, C1.c, C1.d, C1.e, C1.f, C1.g, C1.h, C2.a, C2.b, C2.c, C3.a, C3.b, and C5) had loaded into Factor 1.

The two factors explained 55.5% of the total variance in the data with item loadings ranged from 0.173 – 0.570 for Factor 1 and 0.332 – 0.636 for Factor 2. The KMO values was 0.846 indicated the sample size was adequate for factor analysis (Kaiser, 1974). The Barlett's test of Sphericity was significant (p<0.001) indicating factor analysis was appropriate for the items (Field, 2009).

Table 3.14: Factor analysis of the draft Malay questionnaire to evaluate schoolchildren's OHK and OHA.

Factor/Dimension	Factor 1	Factor 2
OHK (20 items)	B1 (0.381)	B2 (0.223)
	B3 – B5 (0.173 - 0.459)	B6 (0.231)
	B7 – B20 (0.264 - 0.570)	
OHA (20 items)	C1.a – C2.c (0.332 - 0.574)	C2.d – C2.f (0.606 - 0.636)
	C3.a – C3.b (0.444 - 0.558)	C3.c – C4 (0.551 - 0.539)
	C5 (0.415)	C6 (0.355)

(b) Internal and test-retest reliability analysis of OHK dimension

Although item B2 and B6 loaded into Factor 2 and items C1.a, C1.b, C1.c, C1.d, C1.e, C1.f, C1.g, C1.h, C2.a, C2.b, C2.c, C3.a, C3.b, and C5 had loaded into Factor 1, subsequent reliability analyses of the 2 Factors with all their original items included within each factor were carried out. This exploration analysis was done because based on the content validation of these items, the content experts were satisfied that such items belonged to their respective domain for which they were developed. Thus, it was decided that for the reliability analyses all items which were originally developed for their respective factor were analysed together. The two factors with their respective items were Factor 1= OHK (20 items) and Factor 2= OHA (20 items).

The internal consistency reliability analysis was done for the OHK domain. For each analysis, an item would be removed if by doing so would increase the Cronbach's alpha value. Then, the analysis was repeated until the highest Cronbach's alpha value was achieved. After 3 rounds of analyses, three OHK items were deleted namely "Dental plaque can cause gum disease", "Brushing teeth properly improves the health of the gum", and "A person should see a dentist for a dental check-up at least once a year". Table 3.15 shows the Cronbach's alpha and the ICC for the 17 items of the OHK dimension. The corrected item-total correlations ranged from 0.14 to 0.54. Eight items had corrected item-total correlation values above 0.30 and nine items between 0.14-0.30. The overall Cronbach's alpha coefficient was 0.72 (moderate) and the value did not increase if any of the items were deleted. The ICC was 0.78 (nearer to 1).

Table 3.15: The corrected item-total correlation and Cronbach's alpha if item deleted for the 17 items of the OHK dimension.

No	Item/Question	Corrected Item-Total Correlation	Cronbach's Alpha if item deleted
1	Eating too much sugary food can cause tooth decay	0.30	0.71
2	A hard toothbrush is better than a soft toothbrush to clean the teeth	0.23	0.72
3	For adequate fluoride supply, a person must brush teeth at least twice a day using fluoride toothpaste	0.22	0.72
4	Brushing teeth with fluoride toothpaste prevents tooth decay	0.36	0.71
5	Using dental floss to clean the areas between the teeth improves gum's health	0.26	0.72
6	A person can reduce the risk of tooth decay by reducing sugary food every day	0.14	0.73
7	Healthy teeth enhance a person's confidence	0.35	0.71
8	Gum disease can cause teeth to become loose	0.41	0.70
9	Smoking habit is bad for oral health	0.29	0.72

Table 3.15: The corrected item-total correlation and Cronbach's alpha if item deleted for the 17 items of the OHK dimension (continued)

No	Item/Question	Corrected Item-Total Correlation	Cronbach's Alpha if item deleted
10	Smelly breath can be caused by the presence of impacted food and plaque accumulation in between the teeth	0.54	0.70
11	Smelly breath is caused by eating food with peculiar smell such as stinky bean *(petai)* and *jering*	0.28	0.71
12	Smelly breath is caused by infection in the mouth such as tooth decay and gum disease	0.38	0.70
13	Smelly breath is caused by smoking	0.29	0.71
14	Mouth self-examination can help to detect changes in the mouth such as ulcers that do not heal within 2 weeks, white spots, or growths.	0.26	0.72
15	Dental malocclusions such as crowding or rotated teeth require orthodontic treatment (tooth braces)	0.37	0.71
16	A person with abnormal jaws such as jaws that are too big or small can be treated with orthodontic treatment	0.32	0.71
17	Using a of mouth guard is important when doing extreme sports such as cycling or rugby as it can protect the teeth from injury	0.49	0.69
Cronbach's Alpha = 0.72 (moderate)			
ICC = 0.78 (nearer to 1 than 0)			

(c) Internal and test-retest reliability analysis of OHA dimension

The internal consistency reliability analysis was conducted for OHA items. For each analysis, an item would be removed if by doing so would increase the Cronbach's alpha value. Then, the analysis was repeated until the highest Cronbach's alpha value was achieved. After 4 rounds of analyses, 4 items were deleted namely "Sweet food and drinks should not be sold at the school canteen", "Sweet food and drinks are common during growing up", "Smelly breath will make me more worried", and "I do not need a mouth guard when doing extreme sports". Table 3.16 shows the Cronbach's alpha and the ICC for the OHA dimension. The corrected item-total correlation for all items were positive with values ranging from 0.11 to 0.57. Eleven items had corrected item-total correlation values above 0.30. The overall Cronbach's alpha coefficient for OHA domain was 0.75 (moderate) and the value did not increase if any of the items were deleted. The ICC was 0.62 (nearer to 1).

Table 3.16: The corrected item-total correlation and Cronbach's alpha if item deleted for the 16 items of the OHA dimension.

No	Item/Question	Corrected Item-Total Correlation	Cronbach's Alpha if item deleted
1	Brushing teeth is important to me because…		
	a) it prevents my teeth from decay	0.23	0.75
	b) it freshens my breath	0.34	0.74
	c) it prevents my teeth from becoming yellow	0.27	0.74
	d) it is part of the whole body cleanliness	0.52	0.72
	e) it makes my gum healthy	0.33	0.74
	f) it helps improve my appearance	0.58	0.72
	g) it makes my friend to like me	0.33	0.74
	h) it makes my dentist to like me	0.35	0.74
2	Sweet food and drinks …		
	a) are unhealthy for my teeth	0.25	0.74
	b) should be avoided if possible	0.30	0.74
	c) are my choice almost all the time	0.11	0.75
	d) will not harm my teeth	0.31	0.75
3	Smelly breath …		
	a) would make me difficult to mingle with my friends	0.57	0.72
	b) cause me to feel inferior	0.42	0.73
4	I do not have to check my own mouth because I do not have any problems	0.45	0.72

Table 3.16: The corrected item-total correlation and Cronbach's alpha if item deleted for the 16 items of the OHA dimension (continued)

No	Item/Question	Corrected Item-Total Correlation	Cronbach's Alpha if item deleted
5	If I have an irregular tooth arrangement problem, I will get orthodontic treatment (tooth braces)	0.37	0.74
Cronbach's Alpha = 0.75 (moderate)			
ICC = 0.62 (nearer to 1 than 0)			

The reliability analysis results above were discussed further with the statistician and content experts. After a series of discussions, the results above were agreed by the research team and the final Malay questionnaire contains 41 items; 17 items on OHK, 16 items on OHA and 8 items on OHB.

Based on the factor analysis and the reliability analyses, the questionnaire has been successfully developed and empirically verified to be valid and reliable to measure OHK and OHA among Form 1 schoolchildren in the Kelantan state. The OHB items will not be analysed as a scale but will be analysed as individual items.

CHAPTER 4: RESULTS

4.1 Introduction

The results presented in this chapter follow the study objectives, and are divided into immediate, intermediate, and health impacts as well as the results from the FGDs. In general, the details of the results are as follows:

i. response rate and demographic characteristics of the schoolchildren
ii. Objective 1a: levels of oral health knowledge and attitudes (immediate impact)
iii. Objective 1b: levels of oral health behaviour and oral hygiene (intermediate impact)
iv. Objectives 1c and 1d: oral health status (gingival health and caries incidence/increment) and OHRQoL (health impact).
v. Objective 2: associated factors in relation to schoolchildren's oral health knowledge, attitudes, behaviour, oral health status, and OHRQoL.
vi. Objective 3: results from the FGD involving DM schoolchildren.

4.2 Response rate

The number of schoolchildren who fulfilled the inclusion and exclusion criteria and consented to participate in this study was 548. Table 4.1 shows the number of schoolchildren at baseline and after 6 months. At baseline, thirteen (13) schoolchildren were absent on data collection day. Meanwhile, thirty-four (34) schoolchildren did not finish the study due to change of school, two schoolchildren did not attend school for a long period, i.e. on medical leave due to accidents, and one schoolchildren had passed away. Finally, 498 schoolchildren completed the study. The number of schoolchildren in each group exceeded the highest number of estimated sample size for each group, i.e. 214.

Table 4.1: Response rate of the sample by group

		Intervention group	Control group
i.	Initial sample size	276	272
ii.	Schoolchildren who were absent during data collection at baseline	6	7
		Baseline	
iii.	Number of Schoolchildren	270	265
iv.	Response rate	97.8%	97.4%
Overall response rate		535 (97.6%)	
		Follow up	
v.	Number of Schoolchildren	251	247
vi.	Response rate	90.9%	90.8%
Overall response rate		498 (90.9%)	

4.3 Demographic characteristics of the sample

Tables 4.2 and 4.3 show the demographic characteristics of the schoolchildren at baseline and after 6 months. At baseline, mother's education level, household income, and the availability of DMP in primary school were significantly different between IG and CG. The same differences were observed after 6 months.

The majority of schoolchildren in the IG (67.0%) and CG (67.5%) at baseline had mothers with education up to secondary school level, followed by university level, STPM/College level, and primary school level. The percentages were slightly higher after

6 months, respectively. There was a significant difference in mother's education level between groups, where mothers with education level up to STPM/College were significantly higher in CG than in IG (p<0.05).

More schoolchildren in IG (49.6%) and CG (40.8%) at baseline came from poor household income level, followed by low-income level, and medium-low income level. The percentages were slightly higher after 6 months, where the proportion in IG was 51.0% while in the CG, it was 41.7%. Only 8.2% in IG and 15.6% in CG came from medium-high to high household income levels at baseline. Meanwhile, after 6 months, the percentages were 8.0% and 15.4% in IG and CG, respectively. The household income level was based on categories of family income in Peninsular Malaysia, Department of statistics (2016). There was a significant difference between household income and type of school, where the proportion of household income at poor level was higher in IG compared to CG at baseline and after 6 months (p<0.05).

The percentage of schoolchildren with DMP in primary school was significantly higher in CG (61.5% and 62.8%) compared to IG (40.7% and 41.0%) at baseline and after 6 months, respectively (p<0.001).

In conclusion, for demographic characteristics of the schoolchildren at baseline and after 6 months showed no significance changes for both groups, respectively.

Table 4.2 Socio demographic characteristics of the schoolchildren at baseline (N=535)

Variable	Overall N (%)	Intervention n (%) (n= 270)	Control n (%) (n= 265)	*p* value [a]
Gender				
Male	281 (52.5)	142 (52.6)	139 (52.5)	0.974
Female	254 (47.5)	128 (47.4)	126 (47.5)	
Ethnicity				
Malay	532 (99.4)	270 (100.0)	262 (98.9)	0.121
Chinese & other[1]	3 (0.6)	0	3 (1.1)	
District and School location				
Kota Bharu/ Urban	280 (52.3)	144 (53.3)	136 (51.3)	0.641
Pasir Mas/ Rural	255 (47.7)	126 (46.7)	129 (48.7)	
Father's education level (n=451)[∞]				
Primary school	45 (8.4)	24 (8.9)	21 (7.9)	0.107
Secondary school	322 (60.2)	154 (57.0)	168 (63.4)	
STPM/College	35 (6.5)	11 (4.1)	24 (9.1)	
University	49 (9.2)	18 (6.7)	31 (11.7)	
Mother's education level (n=476)[∞]				
Primary school	25 (4.7)	14 (5.2)	11 (4.2)	**0.007**
Secondary school	360 (67.3)	181 (67.0)	179 (67.5)	
STPM/College	39 (7.3)	9 (3.3)	30 (11.3)	
University	52 (9.7)	21 (7.8)	31 (11.7)	
Carer's education level (n=34)[∞]				
Primary school	6 (1.1)	3 (1.1)	3 (1.1)	0.707
Secondary school	20 (3.7)	14 (5.2)	6 (2.3)	
STPM/College	4 (0.7)	2 (0.7)	2 (0.8)	
University	4 (0.7)	2 (0.7)	2 (0.8)	
Household income (n=513)[∞, 2]				
Poor	242 (45.2)	134 (49.6)	108 (40.8)	**0.006**
Low	166 (31.0)	79 (29.3)	87 (32.8)	
Medium-low	42 (7.9)	14 (5.2)	28 (10.6)	
Medium-high	29 (5.4)	8 (3.0)	21 (7.9)	
High	34 (6.4)	14 (5.2)	20 (7.5)	
Appointed as DM				
Yes	4 (0.7)	4 (1.5)	0 (0.0)	0.064
No & unsure	531 (99.3)	266 (98.5)	265 (99.6)	
Availability of DMP in primary school				
Yes	273 (51.0)	110 (40.7)	163 (61.5)	***p*<0.001**
No & unsure	262 (49.0)	160 (59.3)	102 (38.5)	

[∞]Total participant N< 535 due to some schoolchildren did not lived with parents/carers

[a] Chi-Square Test, level of significance was set at $p<0.05$

[1] Other consists of Siamese and Pakistan.

[2] Income level: <MYR 930= poor, MYR 931- MYR 3000 = Low, MYR 3001– MYR 4500 = medium-low, MYR 4501- MYR 6000 = medium-high, >MYR 6001 = high (Charon Wardini Mokhzani, Nov 3, 2016; Economic Planning Unit, December 19, 2016)

Table 4.3 Socio demographic characteristics of the schoolchildren after 6 months (N=498)

Variable	Overall N (%)	Intervention n (%) (n=251)	Control n (%) (n=247)	*p* value [a]
Gender				
Male	259 (52.0)	132 (52.6)	127 (51.4)	0.793
Female	239 (48.0)	119 (47.4)	120 (48.6)	
Ethnicity				
Malay	495 (99.4)	251 (100.0)	244 (98.8)	0.121
Chinese & Other[1]	3 (0.6)	0	3 (1.2)	
District and School location				
Kota Bharu/ Urban	253 (50.8)	131 (52.2)	122 (49.4)	0.532
Pasir Mas/ Rural	245 (49.2)	120 (47.8)	125 (50.6)	
Father's education level (n=423)[∞]				
Primary school	42 (8.4)	24 (9.6)	18 (7.3)	0.136
Secondary school	303 (60.8)	142 (56.6)	161 (65.2)	
STPM/College	33 (6.6)	11 (4.4)	22 (8.9)	
University	45 (9.0)	17 (6.8)	28 (11.3)	
Mother's education level (n=447)[∞]				
Primary school	24 (4.8)	13 (5.2)	11 (4.5)	**0.021**
Secondary school	340 (68.3)	171 (68.1)	169 (68.4)	
STPM/College	36 (7.2)	9 (3.6)	27 (10.9)	
University	47 (9.4)	19 (7.6)	28 (11.3)	
Carer's education level (n=30)[∞]				
Primary school	6 (1.2)	3 (1.2)	3 (1.2)	0.761
Secondary school	17 (3.4)	12 (4.8)	5 (2.0)	
STPM/College	3 (0.6)	2 (0.8)	1 (0.4)	
University	4 (0.8)	2 (0.8)	2 (0.8)	
Household income (n=480)[∞,2]				
Poor	231 (48.1)	128 (51.0)	103 (41.7)	**0.012**
Low	153 (31.9)	73 (29.1)	80 (32.4)	
Medium-low	38 (7.9)	13 (5.2)	25 (10.1)	
Medium-high	25 (5.2)	7 (2.8)	18 (7.3)	
High	33 (6.9)	13 (5.2)	20 (8.1)	
Appointed as DM				0.064
Yes	4 (0.8)	4 (1.6)	0 (0.0)	
No & unsure	494 (99.2)	247 (98.4)	247 (100.0)	
Availability of DMP in primary school				***p*<0.001**
Yes	258 (51.8)	103 (41.0)	155 (62.8)	
No & unsure	230 (46.2)	148 (59.0)	92 (37.2)	

[∞]Total participant N< 498 due to some schoolchildren did not lived with parents/carers

[a] Chi-Square Test, level of significance was set at $p<0.05$

[1] Other consists of Siamese and Pakistan.

[2] Income level: < MYR930 = poor, MYR 931- MYR 3000 = Low, MYR 3001– MYR 4500 = medium-low, MYR 4501- MYR 6000 = medium-high, > MYR 6001 = high (Charon Wardini Mokhzani, Nov 3, 2016; Economic Planning Unit, December 19, 2016)

4.4 Immediate impact

4.4.1 The schoolchildren's levels of oral health knowledge (OHK) (Objective 1a)

Table 4.4 shows item and total scores of OHK domain at baseline. There were no significant differences in OHK item scores between IG and CG at baseline except for the following:

i. Schoolchildren in the IG had a significantly higher mean scores for item number 12 (smelly breath is caused by infection in the mouth such as tooth decay and gum disease) ($p<0.05$) and item number 16 (a person with abnormal jaws such as jaws that are too big or small can be treated with orthodontic treatment) ($p<0.05$), respectively.

ii. Schoolchildren in the CG had a significantly higher mean scores for item number 9 (smoking habit is bad for oral health) ($p<0.05$), and item number 10 (smelly breath can be caused by the presence of impacted food and plaque accumulation in between the teeth) ($p<0.05$).

iii. There was no difference in mean total score between IG and CG. Both groups had a mean score of 78.0 each.

Table 4.5 shows item and total scores of OHK after 6 months. The comparison between IG and CG after 6 months showed:

i. Schoolchildren in the IG had significantly higher mean scores for item number 3 (for adequate fluoride supply, a person must brush teeth at least twice a day using fluoride toothpaste) ($p<0.05$) and item number 4 (brushing teeth with fluoride toothpaste prevents tooth decay) ($p<0.05$).

ii. Schoolchildren in the CG had significantly higher mean scores for item number 8 (gum disease can cause teeth to become loose) ($p<0.05$), item number 9 (smoking habit is bad for oral health) (p<0.05), and item number 11 (smelly breath is caused by eating food with peculiar smell such as *petai* and *jering*) (p<0.05).

iii. The CG had a higher mean total score (82.1; SD =7.5) than the IG (81.3; SD = 9.3), but the difference was not statistically significant.

Table 4.6 shows the proportions of schoolchildren having good, moderate, and poor levels of OHK at baseline and after 6 months. At baseline, no difference was detected between IG and CG. However, after 6 months, 2.8% of schoolchildren in IG had poor level of OHK compared to none in the CG (p<0.05).

Table 4.7 shows the changes in percentage scores of OHK after 6 months for 498 schoolchildren. A comparison was made between groups for mean increment score of OHK. There was no significant difference in mean increment scores of OHK between IG and CG after 6 months. Both groups showed a significant increment in total OHK score after 6 months.

Table 4.4 Mean (±SD) and median (IQR) scores of oral health knowledge (OHK) items by group at baseline (N=535)

No.	Item	Overall (N=535)		Intervention (n=270)		Control (n=265)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
1	Eating too much sugary food can cause tooth decay	3.9 (1.4)	5 (3-5)	3.8 (1.5)	5 (3-5)	3.9 (1.3)	5 (3-5)	0.607[b]
2	A soft toothbrush is better than a hard toothbrush to clean the teeth[∞]	3.7 (1.4)	4 (3-5)	3.8 (1.3)	4 (3-5)	3.6 (1.4)	4 (3-5)	0.129
3	For adequate fluoride supply, a person must brush teeth at least twice a day using fluoride toothpaste	3.7 (1.1)	4 (3-5)	3.7 (1.0)	4 (3-4)	3.8 (1.1)	4 (3-5)	0.166
4	Brushing teeth with fluoride toothpaste prevents tooth decay	3.8 (1.1)	4 (3-5)	3.8 (1.1)	4 (3-5)	3.8 (1.1)	4 (3-5)	0.609
5	Using dental floss to clean the areas between the teeth improves gum's health	4.0 (1.1)	4 (3-5)	4.0 (1.1)	4 (3-5)	4.0 (1.1)	4 (3-5)	0.522
6	A person can reduce the risk of tooth decay by reducing sugary food every day	4.2 (1.1)	5 (4-5)	4.1 (1.2)	5 (4-5)	4.2 (1.1)	5 (4-5)	0.409
7	Healthy teeth enhance a person's confidence	4.5 (0.9)	5 (4-5)	4.5 (0.9)	5 (4-5)	4.5 (0.9)	5 (4-5)	0.536
8	Gum disease can cause teeth to become loose	3.7 (1.1)	4 (3-5)	3.7 (1.1)	4 (3-5)	3.6 (1.1)	4 (3-5)	0.639
9	Smoking habit is bad for oral health	4.3 (1.3)	5 (4-5)	4.1 (1.4)	5 (4-5)	4.4 (1.2)	5 (4-5)	**0.007**
10	Smelly breath can be caused by the presence of impacted food and plaque accumulation in between the teeth	4.2 (1.1)	5 (4-5)	4.2 (1.1)	5 (4-5)	4.3 (1.0)	5 (4-5)	**0.038**
11	Smelly breath is caused by eating food with peculiar smell such as *petai* and *jering*	4.3 (1.0)	5 (4-5)	4.2 (1.1)	5 (4-5)	4.3 (1.0)	5 (4-5)	0.131
12	Smelly breath is caused by infection in the mouth such as tooth decay and gum disease	3.7 (1.1)	4 (3-5)	3.8 (1.0)	4 (3-5)	3.6 (1.1)	4 (3-5)	**0.034**
13	Smelly breath is caused by smoking	4.1 (1.1)	4 (3-5)	4.1 (1.0)	4 (3-5)	4.0 (1.2)	5 (3-5)	0.501
14	Mouth self-examination can help to detect changes in the mouth such as ulcers that do not heal within 2 weeks, white spots, or growths.	3.3 (1.0)	3 (3-4)	3.4 (1.0)	3 (3-4)	3.3 (1.1)	3 (3-4)	0.336

Table 4.4 Mean (±SD) and median (IQR) scores of oral health knowledge (OHK) items by group at baseline (N=535) (continued)

No.	Item	Overall (N=535)		Intervention (n=270)		Control (n=265)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
15	Teeth which are overlapping, rotated, biting the lip, or jutted out will require orthodontic treatment (dental braces)	4.0 (1.1)	4 (3-5)	4.0 (1.0)	4 (3-5)	3.9 (1.2)	4 (3-5)	0.468
16	A person with abnormal jaws such as jaws that are too big or small can be treated with orthodontic treatment	3.4 (1.0)	3 (3-4)	3.5 (1.0)	3 (3-4)	3.3 (1.0)	3 (3-4)	**0.016**
17	Using a mouth guard is important when doing extreme sports such as cycling and rugby as it can protect the teeth from injury	3.7 (1.2)	4 (3-5)	3.7 (1.2)	4 (3-5)	3.8 (1.2)	4 (3-5)	0.488
Percentage of total OHK score		78.0 (10.5)	78.8 (72.9-85.9)	78.0 (10.4)	78.8 (72.9-85.9)	78.0 (10.6)	80.0 (71.8-85.3)	0.990
Minimum possible percentage score = 20								
Maximum possible percentage score = 100								

[a] Independent Sample T Test except item 1 using [b] Mann Whitney Test

∞statement was changed from negative to positive and the score had been reversed

Level of significant is set at $p<0.05$

Table 4.5 Mean (±SD) and median (IQR) scores and of oral health knowledge (OHK) items by group after 6 months (N=498)

No	Item	Overall (N=498)		Intervention (n=251)		Control (n=247)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
1	Eating too much sugary food can cause tooth decay	4.4 (0.9)	5 (4-5)	4.4 (1.0)	5 (4-5)	4.4 (0.8)	5 (4-5)	0.742[b]
2	A soft toothbrush is better than a hard toothbrush to clean the teeth[∞]	3.8 (1.2)	4 (3-5)	3.8 (1.2)	4 (3-5)	3.8 (1.1)	4 (3-5)	0.828
3	For adequate fluoride supply, a person must brush teeth at least twice a day using fluoride toothpaste	4.0 (0.8)	4 (3-5)	4.1 (0.8)	4 (3-4)	3.9 (0.9)	4 (3-4)	**0.020**
4	Brushing teeth with fluoride toothpaste prevents tooth decay	4.0 (0.9)	4 (3-5)	4.1 (0.9)	4 (4-5)	4.0 (0.9)	4 (3-5)	**0.023**
5	Using dental floss to clean the areas between the teeth improves gum's health	4.1 (0.9)	4 (3-5)	4.1 (0.8)	4 (4-5)	4.1 (0.9)	4 (3-5)	0.975
6	A person can reduce the risk of tooth decay by reducing sugary food every day	4.2 (0.9)	4 (4-5)	4.2 (0.9)	4 (4-5)	4.2 (0.9)	4 (4-5)	0.968
7	Healthy teeth enhance a person's confidence	4.5 (0.7)	5 (4-5)	4.5 (0.8)	5 (4-5)	4.5 (0.7)	5 (4-5)	0.577
8	Gum disease can cause teeth to become loose	3.8 (0.9)	4 (3-5)	3.7 (1.0)	4 (3-4)	3.9 (0.9)	4 (3-5)	**0.031**
9	Smoking habit is bad for oral health	4.6 (0.8)	5 (4-5)	4.5 (0.9)	5 (4-5)	4.7 (0.7)	5 (4-5)	**0.025**
10	Smelly breath can be caused by the presence of impacted food and plaque accumulation in between the teeth	4.4 (0.8)	5 (4-5)	4.3 (0.8)	4 (4-5)	4.4 (0.7)	5 (4-5)	0.056
11	Smelly breath is caused by eating food with peculiar smell such as *petai* and *jering*	4.4 (0.7)	5 (4-5)	4.3 (0.8)	4 (4-5)	4.5 (0.7)	5 (4-5)	**0.002**
12	Smelly breath is caused by infection in the mouth such as tooth decay and gum disease	3.9 (0.9)	4 (3-5)	3.9 (0.9)	4 (3-5)	3.8 (0.9)	4 (3-5)	0.178
13	Smelly breath is caused by smoking	4.2 (0.9)	4 (4-5)	4.1 (0.9)	4 (4-5)	4.3 (0.9)	5 (4-5)	0.081
14	Mouth self-examination can help to detect changes in the mouth such as ulcers that do not heal within 2 weeks, white spots, or growths.	3.6 (0.9)	3 (3-4)	3.5 (0.9)	3 (3-4)	3.7 (0.9)	3 (3-4)	0.072

Table 4.5 Mean (±SD) and median (IQR) scores and of oral health knowledge (OHK) items by group after 6 months (N=498) (continued)

No	Item	Overall (N=498)		Intervention (n=251)		Control (n=247)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
15	Teeth which are overlapping, rotated, biting the lip, or jutted out will require orthodontic treatment (dental braces)	4.1 (0.9)	4 (4-5)	4.1 (0.9)	4 (4-5)	4.1 (0.9)	4 (3-5)	0.381
16	A person with abnormal jaws such as jaws that are too big or small can be treated with orthodontic treatment	3.5 (0.9)	3 (3-4)	3.5 (0.9)	3 (3-4)	3.4 (0.9)	3 (3-4)	0.194
17	Using a mouth guard is important when doing extreme sports such as cycling or rugby as it can protect the teeth from injury	4.0 (1.0)	4 (3-5)	4.0 (1.0)	4 (3-5)	4.1 (1.0)	4 (3-5)	0.081
Percentage of total OHK score		81.7 (8.5)	82.4 (76.5-87.1)	81.3 (9.3)	81.2 (76.5-88.2)	82.1 (7.5)	82.4 (77.6-87.1)	0.314
Minimum possible percentage score = 20								
Maximum possible percentage score = 100								

[a] Independent Sample T Test except item 1 using [b] Mann Whitney Test
∞statement was changed from negative to positive and the score had been reversed
Level of significant is set at p<0.05

Table 4.6 Proportion of schoolchildren having good, moderate, and poor levels of OHK at baseline and after 6 months.

Variable	Overall (N=535) n (%)	Intervention (n=270) n (%)	Control (n=265) n (%)	*p* value [a]
At baseline				
Level of OHK score				
Good (score = 81-100)	234 (43.7)	114 (42.2)	120 (45.3)	0.573
Moderate (score = 61- 80)	268 (50.1)	141 (52.2)	127 (47.9)	
Poor (score = 20-60)	33 (6.2)	15 (5.6)	18 (6.8)	
Variable	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
After 6 months				
Level of OHK score				
Good (score = 81-100)	283 (56.8)	142 (56.6)	141 (57.1)	**0.029**
Moderate (score = 61-80)	208 (41.8)	102 (40.6)	106 (42.9)	
Poor (score = 20-60)[b]	7 (1.4)	7 (2.8)	0 (0.0)	

[a] Chi-Square Test
Level of significance is set at $p<0.05$
[b] Post Hoc test was statistically significant

Table 4.7 Changes in percentage scores of OHK after 6 months by group (N=498)

Domain		Overall	Intervention group	Control group	p value [b]	Effect Size	Effect size descriptor
Oral Health Knowledge (OHK)	Baseline Score Mean (±SD)	78.3 (10.4)	78.2 (10.5)	78.5 (10.4)	0.746	-	-
	After 6 months Score Mean (±SD)	81.7 (8.5)	81.3 (9.3)	82.1 (7.5)	0.314	0.1	Small
	Mean increment score (±SD)	3.4 (10.5)	3.2 (11.1)	3.6 (10.0)	0.626	-	-
	p value [a]	$\boldsymbol{p<0.001}$	$\boldsymbol{p<0.001}$	$\boldsymbol{p<0.001}$			
	Effect size	0.4	0.3	0.4			
	Effect size descriptor	Small	Small	Small			

[a] Paired Sample T Test
[b] Independent Sample T Test
Level of significant is set at $p<0.05$

4.4.2 The schoolchildren's levels of oral health attitudes (OHA) (Objective 1a)

Table 4.8 shows item and total scores for OHA by group at baseline. There were no significant differences in OHA item scores at baseline except for 4 items below where schoolchildren in IG had a significantly higher score each than CG:

i. 1. Brushing teeth is important to me because :

(a) it prevents my teeth from decay, (p=0.001)

(d) it is part of the whole body cleanliness, (p<0.05).

ii. 2 (c) Sweet foods and drinks are not necessarily my choice most of the time, (p<0.05)

iii. 5. If I have an irregular teeth alignment problem, I will seek for orthodontic treatment (dental braces), (p<0.001).

vi. The IG had a significantly higher mean total score (83.5; SD =9.8) than the CG (81.6; SD = 10.0) (p<0.05).

Meanwhile, Table 4.9 shows item and total scores of OHA by group after 6 months. Of the 16 items, 7 items showed significant differences between groups. Schoolchildren in the CG had significantly higher mean scores in all the 7 items namely:

i. 1. Brushing teeth is important to me because:

(b) it freshens my breath, (p<0.05)

(d) it is part of the whole body cleanliness, (p<0.05)

(f) it helps improve my appearance, (p<0.05)

(g) it makes my friend to like me, (p<0.05)

ii. 2 (a) Sweet foods and drinks are unhealthy for my teeth, (p<0.05)

iii. 3. Smelly breath:

(a) will make it difficult for me to mingle with my friends, (p<0.001)

(b) will make me feeling inferior, (p<0.05)

iv. The mean total OHA score was higher in CG (88.8; SD =6.4) compared to the IG (86.5; SD = 8.4), and the difference was statistically significant (*p*=0.001).

Table 4.10 shows the proportions of schoolchildren having good, moderate, and poor levels of OHA at baseline level and after 6 months. The results show that:

i. at baseline, more schoolchildren in IG had good level of OHA (80.0%) compared to CG (75.1%), with no significant difference.

ii. However after 6 months, the proportion of schoolchildren with good level of OHA was significantly higher in CG (96.8%) compared to IG (89.6%) (p<0.05).

In Table 4.11, shows the changes in percentage scores for OHA after 6 months for 498 schoolchildren. Mean OHA total score was significantly higher in CG compared to IG (p<0.05) after 6 months. The mean increment score was also significantly higher in CG compared to IG (p<0.05). Within-group comparison of mean OHA total scores between baseline and after 6 months showed that in both groups the mean OHA total scores were significantly higher after 6 months compared to baseline for both groups (p<0.001).

Table 4.8 Mean (±SD) and median (IQR) scores of oral health attitude (OHA) items by group at baseline (N=535)

No.	Item	Overall (N=535)		Intervention (n=270)		Control (n=265)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
1	**Brushing teeth is important to me because…**							
	a) it prevents my teeth from decay	3.5 (0.9)	4 (3-4)	3.6 (0.7)	4 (3-4)	3.4 (1.0)	4 (3-4)	**0.001**
	b) it freshens my breath	3.7 (0.7)	4 (4-4)	3.7 (0.6)	4 (4-4)	3.6 (0.8)	4 (4-4)	0.140
	c) it prevents my teeth from becoming yellow	3.5 (0.9)	4 (3-4)	3.5 (0.9)	4 (3-4)	3.5 (0.8)	4 (3-4)	0.870
	d) it is part of the whole body cleanliness	3.2 (0.9)	3 (3-4)	3.3 (0.9)	4 (3-4)	3.2 (0.9)	3 (3-4)	**0.035**
	e) it makes my gum healthy	3.7 (0.6)	4 (3-4)	3.7 (0.6)	4 (3-4)	3.7 (0.6)	4 (4-4)	0.712
	f) it helps improve my appearance	3.4 (0.8)	4 (3-4)	3.5 (0.8)	4 (3-4)	3.4 (0.8)	4 (3-4)	0.789
	g) it makes my friend to like me	3.4 (0.8)	4 (3-4)	3.5 (0.8)	4 (3-4)	3.3 (0.8)	4 (3-4)	0.053
	h) it makes my dentist to like me	3.4 (0.8)	4 (3-4)	3.4 (0.8)	4 (3-4)	3.3 (0.8)	4 (3-4)	0.084
2	**Sweet foods and drinks …**							
	a) are unhealthy for my teeth	3.4 (0.9)	4 (3-4)	3.3 (1.0)	4 (3-4)	3.5 (0.8)	4 (3-4)	0.065
	b) must be reduced if possible	3.5 (0.8)	4 (3-4)	3.5 (0.9)	4 (3-4)	3.5 (0.8)	4 (3-4)	0.655
	c) are not necessarily my choice most of the time[∞]	2.7 (1.0)	3 (2-4)	2.8 (1.1)	3 (2-4)	2.6 (1.0)	3 (2-3)	**0.014**

Table 4.8 Mean (±SD) and median (IQR) scores of oral health attitude (OHA) items by group at baseline (N=535) (continued)

No.	Item	Overall (N=535)		Intervention (n=270)		Control (n=265)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
	d) will harm my teeth[∞]	3.0 (1.1)	3 (2-4)	3.0 (1.1)	3 (2-4)	3.0 (1.1)	3 (2-4)	0.905
3	**Smelly breath …**							
	a) will make it difficult for me to mingle with my friends	3.2 (1.0)	4 (3-4)	3.2 (1.0)	4 (3-4)	3.2 (1.0)	4 (3-4)	0.869
	b) will make me feeling inferior	3.1 (1.0)	3 (3-4)	3.1 (1.0)	3 (2-4)	3.2 (0.9)	3 (3-4)	0.274
4	I do check my own mouth even though I do not have any problem[∞]	2.9 (1.0)	3 (2-4)	3.0 (1.0)	3 (2-4)	2.8 (1.0)	3 (2-4)	0.052
5	If I have an irregular teeth alignment problem, I will seek for orthodontic treatment (dental braces)	3.3 (1.0)	4 (3-4)	3.4 (0.9)	4 (3-4)	3.1 (1.0)	3 (3-4)	***p*<0.001**
Percentage of total OHA score		82.6 (9.9)	84.4 (78.1-89.1)	83.5 (9.8)	84.4 (78.1-90.6)	81.6 (10.0)	82.8 (75.8-89.1)	**0.028**
Minimum possible percentage score = 25 Maximum possible percentage score = 100								

[a] Independent Sample T Test
[∞]statement is positive and the score had been reversed
Level of significant is set at $p<0.05$

Table 4.9 Mean (±SD) and median (IQR) scores of oral health attitude (OHA) items by group after 6 months (N=498)

No.	Item	Overall (N=498)		Intervention (n=251)		Control (n=247)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
1	**Brushing teeth is important to me because…**							
	a) it prevents my teeth from decay	3.7 (0.6)	4 (4-4)	3.7 (0.6)	4 (4-4)	3.8 (0.5)	4 (4-4)	0.068
	b) it freshens my breath	3.8 (0.4)	4 (4-4)	3.8 (4.6)	4 (4-4)	3.9 (0.1)	4 (4-4)	**0.008**
	c) it prevents my teeth from becoming yellow	3.8 (0.5)	4 (4-4)	3.7 (0.6)	4 (4-4)	3.8 (0.5)	4 (4-4)	0.126
	d) it is part of the whole body cleanliness	3.5 (0.8)	4 (3-4)	3.4 (0.8)	4 (3-4)	3.5 (0.7)	4 (3-4)	**0.015**
	e) it makes my gum healthy	3.8 (0.4)	4 (4-4)	3.8 (0.4)	4 (4-4)	3.8 (0.4)	4 (4-4)	0.899
	f) it helps improve my appearance	3.7 (0.6)	4 (3-4)	3.7 (0.6)	4 (3-4)	3.7 (0.5)	4 (4-4)	**0.047**
	g) it makes my friend to like me	3.6 (0.3)	4 (3-4)	3.6 (0.6)	4 (3-4)	3.7 (0.5)	4 (3-4)	**0.023**
	h) it makes my dentist to like me	3.6 (0.6)	4 (3-4)	3.5 (0.7)	4 (3-4)	3.6 (0.6)	4 (3-4)	0.066
2	**Sweet foods and drinks …**							
	a) are unhealthy for my teeth	3.7 (0.7)	4 (4-4)	3.6 (0.8)	4 (3-4)	3.8 (0.5)	4 (4-4)	**0.018**
	b) must be reduced if possible	3.6 (0.6)	4 (3-4)	3.6 (0.6)	4 (3-4)	3.7 (0.6)	4 (3-4)	0.079
	c) are not necessarily my choice most of the time[∞]	2.6 (1.0)	3 (2-3)	2.6 (1.0)	3 (2-3)	2.6 (0.9)	3 (2-3)	0.939
	d) will harm my teeth[∞]	3.2 (0.9)	3 (3-4)	3.2 (0.9)	3 (3-4)	3.2 (0.9)	3 (3-4)	0.972

Table 4.9 Mean (±SD) and median (IQR) scores of oral health attitude (OHA) items by group after 6 months (N=498) (continued)

No.	Item	Overall (N=498)		Intervention (n=251)		Control (n=247)		*p* value [a]
		Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	Mean (±SD)	Median (IQR)	
3	**Smelly breath …**							
	a) will make it difficult for me to mingle with my friends	3.7 (0.6)	4 (3-4)	3.6 (0.7)	4 (4-4)	3.8 (0.5)	4 (4-4)	***p*<0.001**
	b) will make me feeling inferior	3.5 (0.7)	4 (3-4)	3.4 (0.7)	4 (3-4)	3.6 (0.7)	4 (3-4)	**0.038**
4	I do check my own mouth even though I do not have any problem[∞]	3.0 (0.9)	3 (3-4)	2.9 (0.9)	3 (2-4)	3.0 (0.9)	3 (3-4)	0.121
5	If I have an irregular teeth alignment problem, I will seek for orthodontic treatment (dental braces)	3.4 (0.8)	4 (3-4)	3.4 (0.8)	4 (3-4)	3.4 (0.9)	4 (3-4)	0.849
Percentage of total OHA score		87.6 (7.6)	89.1 (82.8-92.6)	86.5 (8.4)	87.5 (82.8-92.2)	88.8 (6.4)	90.6 (84.4-93.8)	**0.001**
Minimum possible score = 25 Maximum possible score = 100								

[a] Independent Sample T Test
[∞]statement was changed from negative to positive and the score had been reversed
Level of significance is set at $p<0.05$

Table 4.10 Proportions of schoolchildren having good, moderate, and poor levels of OHA at baseline and after 6 months.

Domain	Overall (N=535) n (%)	Intervention (n=270) n (%)	Control (n=265) n (%)	*p* value [a]
At baseline				
Level of OHA score				
Good (score = 76-100)	415 (77.6)	216 (80.0)	199 (75.1)	
Moderate (score = 51-75)	119 (22.2)	54 (20.0)	65 (24.5)	0.264
Poor (score = 25-50)	1 (0.2)	0	1 (0.4)	
Domain	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
After 6 months				
Level of OHA score				
Good (score = 76-100)	464 (93.2)	225 (89.6)	239 (96.8)	
Moderate (score = 51-75)	34 (6.8)	26 (10.4)	8 (3.2)	**0.002**
Poor (score = 25-50)	0	0	0	

[a] Chi-Square Test
Level of significance is set at $p<0.05$

Table 4.11 Changes in percentage scores of OHA after 6 months by group (N=498)

Domain		Overall	Intervention group	Control group	*p value* [b]	Effect size	Effect size descriptor
Oral Health Attitudes (OHA)	Baseline Score Mean (±SD)	82.9 (9.7)	83.6 (9.9)	82.3 (9.4)	0.136	0.1	Small
	After 6 months Score Mean (±SD)	87.6 (7.6)	86.5 (8.4)	88.8 (6.4)	**0.001**	0.3	Small
	Mean increment score (±SD)	4.7 (11.0)	3.0 (11.5)	6.5 (10.1)	$\boldsymbol{p}$**<0.001**	0.3	Small
	p value [a]	$\boldsymbol{p}$**<0.001**	$\boldsymbol{p}$**<0.001**	$\boldsymbol{p}$**<0.001**			
	Effect size	0.5	0.3	0.8			
	Effect size descriptor	Medium	Small	Large			

[a] Paired Sample T Test

[b] Independent Sample T Test

Level of significance is set at p<0.05

4.5 Intermediate impact

4.5.1 The schoolchildren's levels of oral health behaviour (OHB) (Objective 1b)

Tables 4.12 and 4.13 show percentage distribution and total score of OHB items by group at baseline and after 6 months.

At baseline, the percentage of schoolchildren who brushed teeth at least twice daily in IG was significantly higher compared to that in the CG (p<0.05). Significantly more schoolchildren in IG smoked cigarettes compared to those in the CG (p<0.05).

Meanwhile, after 6 months only one item showed a significant difference between groups in favour of the CG. A significantly more schoolchildren in the CG brushed teeth at least twice daily (91.1%) compared to that in the IG (85.3%) (p<0.05).

In term of OHB scores, at baseline, the IG showed a higher mean OHB total score compared to CG but the difference was not significant. However, after 6 months the mean OHB total score was higher in the CG compared to the IG but the difference was not statistically significant.

Table 4.14 shows the proportions of schoolchildren practicing more and less good OHB at baseline and after 6 months. Higher proportions of schoolchildren in both groups were practicing more good behaviours at baseline and after 6 months. However, the difference in proportions between IG and CG were not statistically significant.

Table 4.15 shows the mean decrement in OHB score in both groups. The mean OHB decrement score for the IG was higher than the CG but the difference was not statistically significant. There was a significant within-group difference in OHB scores between baseline and after 6 months in the IG. However, the effect size was small. No significant within-group difference were observed in the CG.

Table 4.12 Percentage distribution of oral health behaviour (OHB) items by group at baseline (N=535)

No.	Item	Overall (N=535) n (%)	Intervention (n=270) n (%)	Control (n=265) n (%)	*p* value [a]
1	Frequency of tooth brushing				
	At least twice daily	475 (88.8)	249 (92.2)	226 (85.3)	**0.013**
	Less than twice daily	60 (11.2)	21 (7.8)	39 (14.7)	
2	Frequency of using fluoride toothpaste				
	At least twice daily	379 (70.8)	201 (74.4)	178 (67.2)	0.071
	Less than twice daily	156 (29.2)	69 (25.6)	87 (32.8)	
3	Gargling with water after meal				
	Yes	493 (92.1)	244 (90.4)	249 (94.0)	0.148
	No	42 (7.9)	26 (9.6)	16 (6.0)	
4	Frequency of flossing teeth				
	At least once daily	214 (40.0)	110 (40.7)	104 (39.2)	0.791
	Less than once daily	321 (60.0)	160 (59.3)	161 (60.8)	
5	Frequency of drinking sweet or bicarbonate drinks or eating sweet foods				
	≤ 4 times daily	457 (85.4)	224 (83.0)	233 (87.9)	0.112
	≥ 5 times daily	78 (14.6)	46 (17.0)	32 (12.1)	
6	Undertaking mouth self-examination in front of a mirror				
	Yes	439 (82.1)	220 (81.5)	219 (82.6)	0.737
	No	96 (17.9)	50 (18.5)	46 (17.4)	
7	Smoking status				
	Yes	36 (6.7)	25 (9.3)	11 (4.2)	**0.024**
	No	499 (93.3)	245 (90.7)	254 (95.8)	
7(a)	If yes, frequency of cigarette smoked (n=36)				
	≥1 stick/day	25 (69.4)	18 (72.0)	7 (63.6)	0.792
	1-5 stick/weekly	9 (25.0)	6 (24.0)	3 (27.3)	
	Irregular	2 (5.6)	1 (4.0)	1 (9.1)	

Table 4.12 Percentage distribution of oral health behaviour (OHB) items by group at baseline (N=535) (continued)

No. Item	Overall (N=535) n (%)	Intervention (n=270) n (%)	Control (n=265) n (%)	*p* value [a]
Percentage of total OHB score				
i. Mean (±SD)	78.9 (17.5)	79.0 (17.1)	78.7 (17.9)	0.933[b]
ii. Median (IQR)	85.7 (71.4-85.7)	85.7 (71.4-85.7)	85.7 (71.4-92.9)	
Minimum possible percentage score = 0				
Maximum possible percentage score = 100				

[a] Chi-Square Test

[b] Independent Sample T Test

Level of significance is set at *p*<0.05

Table 4.13 Percentage distribution of oral health behaviour (OHB) items by group after 6 months (N=498)

No.	Item	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
1	Frequency of tooth brushing				
	At least twice daily	439 (88.2)	214 (85.3)	225 (91.1)	**0.044**
	Less than twice daily	59 (11.8)	37 (14.7)	22 (8.9)	
2	Frequency of using fluoride toothpaste				
	At least twice daily	418 (83.9)	203 (80.9)	215 (87.0)	0.061
	Less than twice daily	80 (16.1)	38 (15.1)	25 (10.1)	
3	Gargling with water after meal				
	Yes	440 (88.4)	228 (90.8)	212 (85.8)	0.082
	No	58 (11.6)	23 (9.2)	35 (14.2)	
4	Frequency of flossing teeth				
	At least once daily	114 (22.9)	53 (21.1)	61 (24.7)	0.342
	Less than once daily	384 (77.1)	198 (78.9)	186 (75.3)	
5	Frequency of drinking sweet or bicarbonate drinks or eating sweet foods				
	≤ 4 times daily	364 (73.1)	192 (76.5)	172 (69.6)	0.084
	≥ 5 times daily	134 (26.9)	59 (23.5)	75 (30.4)	

Table 4.13 Percentage distribution of oral health behaviour (OHB) items by group after 6 months (N=498) (continued)

No.	Item	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
6	Undertaking mouth self-examination in front of a mirror				
	Yes	434 (87.1)	218 (86.9)	216 (87.4)	0.842
	No	64 (12.9)	33 (13.1)	31 (12.6)	
7	Smoking status				
	Yes	23 (4.6)	12 (4.8)	11 (4.5)	0.862
	No	475 (95.4)	239 (95.2)	236 (95.5)	
7(a)	If yes, frequency of cigarette smoked (n=23)				
	≥1 stick/day	19 (82.6)	10 (83.3)	9 (81.8)	0.510
	1-5 stick/weekly	3 (13.0)	2 (16.7)	1 (9.1)	
	Irregular	1 (4.3)	0 (0.0)	1 (9.1)	
Percentage of total OHB score i. Mean (±SD) ii. Median (IQR)		77.0 (16.7) 85.7 (71.4-85.7)	76.7 (17.1) 85.7 (71.4-85.7)	77.3 (16.4) 85.7 (71.4-85.7)	0.658 [b]
Minimum possible percentage score = 0 Maximum possible percentage score = 100					

[a] Chi-Square Test
[b] Independent Sample T Test
Level of significance is set at $p<0.05$

Table 4.14 Proportions of schoolchildren practicing more and less good OHB at baseline and after 6 months.

Domain	Overall (N=535) n (%)	Intervention (n=270) n (%)	Control (n=265) n (%)	*p* value[a]
At baseline				
Level of OHB score				
Practicing more good oral health behaviours (score = 51-100)	503 (94.0)	254 (94.1)	249 (94.0)	0.957
Practicing less good oral health behaviours (score = 0-50)	32 (6.0)	16 (5.9)	16 (6.0)	
Item	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
After 6 months				
Level of OHB score				
Practicing more good oral health behaviours (score = 51-100)	466 (93.6)	233 (92.8)	233 (94.3)	0.494
Practicing less good oral health behaviours (score = 51-100)	32 (6.4)	18 (7.2)	14 (5.7)	

[a] Chi-Square Test

Level of significant is set at $p<0.05$

Table 4.15 Changes in percentage scores of OHB after 6 months of DMP for all groups (N=498)

Domain		Overall	Intervention group	Control group	*p* value [b]	Effect size	Effect size descriptor
Oral Health Behaviour (OHB)	Baseline Score Mean (±SD)	78.9 (17.5)	79.0 (17.1)	78.9 (17.9)	0.933	-	
	After 6 months Score Mean (±SD)	77.0 (16.7)	76.7 (17.1)	77.3 (16.4)	0.658	-	
	Mean increment score (±SD)	-2.2 (18.5)	-2.3 (18.5)	-2.1 (18.6)	0.880	-	
	p value [a]	**0.008**	**0.047**	0.080			
	Effect size	0.1	0.1	0.1			
	Effect size descriptor	Small	Small	Small			

[a] Paired Sample T Test

[b] Independent Sample T Test

Level of significant is set at $p<0.05$

4.5.2 Oral hygiene level (plaque score) (Objective 1b)

Tables 4.16 and 4.17 show proportions of schoolchildren with plaque score levels by group. At baseline, there was a significant association between plaque score level and group (*p*<0.001) with significantly more schoolchildren in the IG (18.1%) had “good” level of plaque score compared to CG (6.8%). In addition, the IG (68.9%) also had a significantly lower proportion of schoolchildren with “poor” level of plaque score than the CG (81.9%). After 6 months, the same scenario was observed where there was a significant association between plaque score level and group (*p*<0.001) with significantly more schoolchildren in the CG (26.7%) had “poor” level of plaque score compared to that in the IG (12.4%). The IG also had a significantly higher proportion of schoolchildren with “good” level of plaque score (55.0%) than that in the CG (32.8%).

Table 4.18 shows proportions of schoolchildren experiencing an increment in the percentage of plaque score after 6 months. Both groups showed high proportions of schoolchildren experiencing decrement or no change in percentage of plaque score after 6 months with no significant difference between groups.

Table 4.19 shows mean increment of plaque scores after 6 months by group. At baseline, the mean plaque score in CG was significantly higher compared to that in the IG (*p*<0.05). After 6 months, the CG still showed a significantly higher mean plaque score compared to that in the IG (*p*<0.05). However, the mean decrement of plaque scores between groups were not significantly different. Both groups showed a significant decrement of plaque score after 6 months with a large effect size in each group.

Table 4.16 Proportions of schoolchildren with plaque score levels by group at baseline (N=535)

	Overall (N=535) n (%)	Intervention (n=270) n (%)	Control (n=265) n (%)	*p* value [a]
Plaque score				
Excellent (0-10%)	11 (2.1)	4 (1.5)	7 (2.6)	
Good (11-25%) [b]	67 (12.5)	49 (18.1)	18 (6.8)	***p*<0.001**
Fair (26-35%)	54 (10.1)	31 (11.5)	23 (8.7)	
Poor (>35%) [b]	403 (75.3)	186 (68.9)	217 (81.9)	

[a] Chi-Square Test
Level of significance is set at $p<0.05$
[b] Post Hoc test was statistically significant

Table 4.17 Proportions of schoolchildren with plaque score levels by group after 6 months (N=498)

	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
Plaque score				
Excellent (0-10%)	115 (23.1)	54 (21.5)	61 (24.7)	
Good (11-25%) [b]	219 (44.0)	138 (55.0)	81 (32.8)	***p*<0.001**
Fair (26-35%)	67 (13.5)	28 (11.2)	39 (15.8)	
Poor (>35%) [b]	97 (19.5)	31 (12.4)	66 (26.7)	

[a] Chi-Square Test
Level of significance is set at $p<0.05$
[b] Post Hoc test was statistically significant

Table 4.18 Proportions of schoolchildren experiencing increments in percentage of plaque scores after 6 months by group (N=498)

	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
Increment in percentage of plaque score	48 (9.6)	25 (10.0)	23 (9.3)	0.806
Decrement/no change in percentage of plaque score	450 (90.4)	226 (90.0)	224 (90.7)	

[a] Chi-Square Test

Level of significance is set at $p<0.05$

Table 4.19 Changes in mean percentages of plaque score at baseline and after 6 months by groups (N=498)

Item		Overall	Intervention	Control	*p* value [a]	Effect size	Effect size descriptor
Plaque score	Baseline score Mean (±SD)	56.9 (26.6)	54.6 (28.0)	59.3 (25.0)	**0.022**	0.2	Small
	After 6 months score Mean (±SD)	25.3 (22.1)	21.9 (19.0)	28.9 (24.4)	**0.005**	0.3	Small
	Mean increment score (±SD)	-31.1 (28.3)	-31.7 (31.0)	-30.5 (25.3)	0.643	-	-
	p value [b]	***p*<0.001**	***p*<0.001**	***p*<0.001**			
	Effect size	1.3	1.4	1.2			
	Effect size descriptor	Large	Large	Large			

[a] Independent Sample T Test
[b] Paired Sample T Test
Level of significance is set at $p<0.05$

4.6 Health impact

4.6.1 Gingival health (Objective 1c)

Table 4.20 shows the proportions of schoolchildren with GIS scores at baseline and after 6 months. At baseline, significantly more schoolchildren in the IG had GIS score 0 (61.0%) compared to those in the CG (42.5%), and significantly more schoolchildren in the CG (34.4%) had GIS score 3 compared to those in the IG (18.7%) (p<0.001). However, no significant difference in the proportion of GIS scores between IG and CG were observed after 6 months.

Table 4.21 shows the proportions of schoolchildren experiencing increments in mean score of GIS after 6 months. Significantly more schoolchildren in IG (51.4%) experiencing increments in mean score of GIS after 6 months compared to CG (30.8%) (p<0.001).

Table 4.22 shows the mean increment score of GIS at baseline and after 6 months. At baseline, the mean score of GIS in the CG was significantly higher (mean = 0.6, SD = 0.7) than in the IG (mean = 0.3, SD = 0.5) (p<0.001). However, no between-group difference in mean score of GIS was observed after 6 months. The mean increment score of GIS in the IG was significantly higher than in the CG and the difference was statistically significant (p<0.001). In the IG, the mean increment score of GIS score was 0.2 (SD = 0.5), while in CG, the mean decrement of GIS score was – 0.2 (SD = 0.5).

Table 4.20 Proportions of schoolchildren with GIS score 0 to 3 at baseline and after 6 months by group (N=498)

	Overall (N=498)			Intervention (n=251)			Control (n=247)				
	Baseline n (%)	After 6 months n (%)	*p* value [a]	**Baseline[1]** n (%)	After 6 months[2] n (%)	*p* value [a]	**Baseline[1]** n (%)	After 6 months[2] n (%)	*p* value [a]	*p* value [a, 1]	*p* value [a,2]
GIS Score											
0 (No gingivitis, no calculus)	258 (51.8)	188 (37.8)		153 (61.0)	90 (35.9)		105 (42.5)	98 (39.7)			
1 (No gingivitis with calculus)	30 (6.0)	120 (24.1)	***p*<0.001**	16 (6.4)	66 (26.3)	***p*<0.001**	14 (5.7)	54 (21.9)	***p*<0.001**	***p*<0.001**	0.652
2 (Gingivitis, no calculus)	78 (15.7)	42 (8.4)		35 (13.9)	20 (8.0)		43 (17.4)	22 (8.9)			
3 (Gingivitis with calculus)	132 (26.5)	148 (29.7)		47 (18.7)	75 (29.9)		85 (34.4)	73 (29.6)			

[a] Chi-Square Test

[1] Comparison between groups at baseline using Chi-Square Test

[2] Comparison between groups at follow up using Chi-Square Test

Level of significance is set at p<0.05

Table 4.21 Proportions of schoolchildren experiencing increments in mean score of GIS after 6 months by group (N=498)

	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
Increment in mean score of GIS	205 (41.2)	129 (51.4)	76 (30.8)	***p<0.001***
Decrement/no change in mean score of GIS	293 (58.8)	122 (48.6)	171 (69.2)	

[a] Chi-Square Test

Level of significance is set at p<0.05

Table 4.22 Mean increment scores of Gingival Index for Schoolchildren (GIS) after 6 months by group (N=498)

Item		Overall	Intervention	Control	*p* value [a]	Effect size	Effect size descriptor
GIS	Baseline score Mean (±SD)	0.4 (0.6)	0.3 (0.5)	0.6 (0.7)	***p<0.001***	0.5	Medium
	After 6 months score Mean (±SD)	0.4 (0.6)	0.5 (0.6)	0.4 (0.6)	0.663	0.2	Small
	Increment score Mean (±SD)	0.0 (0.5)	0.2 (0.5)	-0.2 (0.5)	***p<0.001***	0.8	Large
	p value [b]	0.611	***p<0.001***	***p<0.001***			
	Effect size	-	0.3	0.3			
	Effect size descriptor	-	Small	Small			

[a] Independent Sample T Test

[b] Paired Sample T Test

Level of significance is set at $p<0.05$

4.6.2 Caries incidence (Objective 1c)

Table 4.23 shows the proportions of schoolchildren experiencing increments in ICDAS score after 6 months by group. Over 6 months, the CG (78.9%) had a significantly higher proportion of schoolchildren experiencing increments in ICDAS score compared to IG (70.9%) (p<0.05).

Table 4.24 shows the six-month caries incidence rate by group for ICDAS score>0. Over six months, the IG (16.4%) had a higher proportion of schoolchildren with new caries compared to the CG (15.0%). However, the difference in incidence rate was not statistically significant. The caries cumulative incidences were 0.16 and 0.15 for the IG and CG, respectively. The preventive effect of DMP against caries was not significant with a prevented fraction (PF) of 6.7% in favour of the CG.

Table 4.25 shows the six-month cavitated caries incidence rate by group for ICDAS score 3 and above. Over six months, the CG (7.1%) showed a higher proportion of schoolchildren with new cavitated caries lesion compared to the IG (6.4%). However, the difference in the incidence rate was not statistically significant. The caries cumulative incidences were 0.06 and 0.07 for the IG and CG, respectively. The DMP has a prevented fraction (PF) of 14.3% meaning more than one (1) out of 10 persons would be prevented from developing cavitated caries if enrolled in DMP school compared to control school.

Table 4.26 shows mean increment of decayed teeth (ICDAS score >0) over six months by group. At baseline, the mean decayed teeth in IG was significant higher compared to that in the CG (p= 0.001). After 6 months, both groups showed a significant within-group increment in mean decayed teeth (p<0.001) in each group. No significant difference in mean increment score between IG and CG was observed after 6 months. More importantly, schoolchildren in the IG had a lower 6-month mean caries increment (mean = 2.4, SD = 3.8) compared to CG (mean = 2.7, SD = 3.1) with lower effect size of 0.5 compared to 0.7 in CG.

Table 4.23 Proportions of schoolchildren experiencing increments in ICDAS score after 6 months by group (N=498)

	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
Increment in ICDAS score	373 (74.9)	178 (70.9)	195 (78.9)	**0.039**
Decrement/no change in ICDAS score	125 (25.1)	73 (29.1)	52 (21.1)	

[a] Chi-Square Test

Level of significance is set at p<0.05

Table 4.24 Six-month caries incidence rate (ICDAS >0) by group (N = 10,333)

Study group	Baseline [1] Number of sound teeth	After 6 months [2] Number of teeth with decay n (%)	*p* value [a]	Cumulative Incidence (risk)	Cumulative Incidence Rate (%)	Prevented Fraction (PF)[3] (%)
Intervention	5081	834 (16.4)	0.097	0.16	16.0	6.7
Control	5252	789 (15.0)		0.15	15.0	

[1] No. of teeth at risk of dental caries (with ICDAS code = 0)

[2] No. of teeth with dental caries after 6 months (with ICDAS ≥1) from teeth at risk of caries at baseline (ICDAS = 0)

[3] PF = the difference in cumulative incidence between intervention and control group expressed as a percentage of the cumulative incidence in the control group.

[a] Chi-square test

Level of significance is set at p<0.05

Table 4.25 Six-month cavitated caries incidence rate (ICDAS ≥3) by group (N = 12,665)

Study group	Baseline[1] Number of sound teeth	After 6 months [2] Number of teeth with decay (≥3) n (%)	*p* value [a]	Cumulative Incidence (risk)	Cumulative Incidence Rate (%)	Prevented Fraction (PF)[3] (%)
Intervention	6570	422 (6.4)	0.185	0.06	6.0	14.3
Control	6095	430 (7.1)		0.07	7.0	

[1] No. of teeth at risk of cavitated caries (ICDAS < 3)

[2] No. of teeth with cavitated caries after 6 months (ICDAS ≥3) from teeth at risk of cavitated caries (ICDAS <3)

[3] PF = the difference in cumulative incidence between intervention and control group expressed as a percentage of the cumulative incidence in the control group.

[a] Chi-square test

Level of significance is set at $p<0.05$

Table 4.26 Mean increment of decayed teeth after 6 months by group (N=498)

		Overall	Intervention group	Control group	*p* value [b]	Effect size	Effect size descriptor
Decayed teeth (ICDAS >0)	Baseline Score Mean (±SD)	5.0 (3.4)	5.5 (3.6)	4.5 (3.1)	**0.001**	0.3	Small
	After 6 months Score Mean (±SD)	7.5 (4.6)	7.8 (4.9)	7.2 (4.3)	0.122	0.1	Small
	Increment score Mean (±SD)	2.5 (3.4)	2.4 (3.8)	2.7 (3.1)	0.236	0.1	Small
	p value [a]	***p*<0.001**	***p*<0.001**	***p*<0.001**			
	Effect size	0.6	0.5	0.7			
	Effect size descriptor	Medium	Medium	Medium			

[a] Paired Sample T Test

[b] Independent Sample T Test

Level of significance is set at p<0.05

4.6.3 Schoolchildren's oral health related quality of life (OHRQoL) (Objective 1d)

Scores of the Malay Child Oral Impacts on Daily Performances (Child-OIDP) index are described in terms of prevalence of impacts, impact scores, impact intensity, and extent of impact.

Tables 4.27 and 4.28 show the prevalence and score of OIDP by group at baseline and after 6 months.

Overall, all eight (8) performances experienced impacts within the previous 3 months. The prevalence of impacts at baseline from the highest to the lowest were on eating (18.7%), cleaning teeth (14.2%), emotional stability (11.0%), relaxing (9.5%), smiling (9.0%), speaking (7.9%), socialising (5.8%) and studying (4.7%). Meanwhile after 6 months, overall the highest prevalence of impact was also on eating (22.9%) while the lowest was on smiling (0.2%).

In terms of between the groups, at baseline the highest prevalence of impact was reported on eating in the IG (20.0%) and CG (17.4%), respectively. The same trend was also recorded after 6 months, with eating had the highest impact in IG (23.9%) and CG (21.9%), respectively.

In terms of the impact score, the overall mean impact score was 2.9 (SD = 6.0) at baseline and 3.6 (SD = 7.4) after 6 months. Overall, for each performance at baseline, the highest mean impact score was on eating (mean = 0.5, SD =1.3) and the lowest was speaking (mean = 0.1, SD = 0.6). Meanwhile, after 6 months, the highest mean impact score was on eating (mean = 0.7, SD = 1.6) and the lowest was on studying (mean = 0.1, SD = 0.7).

In terms of impact scores between the groups, no significant differences were observed in the total and performance impact scores between the IG and CG at baseline.

However, after 6 months, the mean impact score for 'emotional stability' was 0.4 (SD = 1.3) in the CG and this was significantly higher than mean score 0.2 (SD = 1.0) in the IG (p<0.05).

Table 4.29 shows the proportions of schoolchildren experiencing increments in mean total OIDP score after 6 months. Over 6 months, a higher proportion in the CG (30.8%) compared to the IG (25.9%) had experienced increments in mean total OIDP score. However, the difference was not significant.

Tables 4.30 and 4.31 show the prevalence of impact intensity levels (very little – very severe) for the eight daily performances of the Child-OIDP by group at baseline and after 6 months. Overall, 189 (35.3%) schoolchildren at baseline and 188 (37.8%) schoolchildren after 6 months, reported having impacts on at least one daily performance. The categorisation of scores into the various impact intensity levels is summarised in Table 4.32.

Overall, more schoolchildren reported "little" level of impact intensity at baseline (52.9%) (IG =48%, CG = 52.0%) and after 6 months (49.5%) (IG = 53.8%, CG = 46.2%). Between the IG and CG, at baseline a higher proportion in the CG reported "severe" level of overall impact (70.0%) compared to the IG (30.0%) (p<0.05). After 6 months, a higher proportion in the CG reported "very little" level of overall impact (60.9%) compared to the IG (39.1%). A higher proportion in the CG also reported "severe" level of impact intensity on overall impact (64.7%) compared to the IG (35.3%). No differences in levels of impact intensity were observed on all performances between the IG and CG at baseline and after 6 months.

Table 4.33 shows the frequency distribution of oral conditions perceived to have caused the overall impacts in the IG and CG at baseline and after 6 months. More schoolchildren in the IG (25.1%) reported toothache as the main cause of impacts at baseline and 18.3% reported crowding (position of teeth) and colour of the teeth as the main cause of impacts after 6 months. For the CG, more schoolchildren also reported toothache as main cause of impacts at baseline (20.2%). Meanwhile, after 6 months, the schoolchildren also reported toothache (18.2%) as the main cause of impacts as well as bad breath.

There were significant differences between baseline and after 6 months on the cause of impacts for the IG. After 6 months, the three (3) following causes that significantly decreased in percentages namely:

i. toothache from 25.1% to 17.5% (p<0.05).

ii. broken/fractured permanent tooth from 9.6% to 3.2% (p<0.001).

iii. new tooth erupting from 10.4% to 3.6 (p<0.05)

Meanwhile, in the CG, only 1 variable was significantly difference when comparing baseline and after 6 months, namely 'exfoliating primary toot/loose milk tooth' and 'new tooth erupting' (p<0.05).

At baseline, the proportion of 'broken/fractured permanent tooth' and 'shape or size teeth' were significantly higher in the IG (9.6% and 14.3%) compared to the CG (4.0% and 7.7%) as the cause of the impacts (p<0.05), respectively.

Meanwhile, after 6 months, only the proportion of 'colour of teeth/discoloured teeth' shows the significance different, where 18.3% in the IG compared to 11.7% in the CG as the cause of the impacts (p<0.05).

Table 4.34 shows comparison of mean impact scores between the IG and CG at baseline and after 6 months as well as mean increments for each performance and overall impacts. At baseline, in terms of each performance of mean score, there was no significant difference observed between IG and CG. However, after 6 months, emotional stability showed a significant difference between the IG (mean = 0.2, SD = 0.9) and the CG (mean = 0.4, SD = 1.3) ($p<0.05$).

Table 4.35 shows comparison of the number of performance with impact (PWI) between baseline and after 6 months for both groups. More than half of schoolchildren reported having no impact on their daily performances at baseline and after 6 months for both groups. If schoolchildren had an impact on their daily performances, more schoolchildren reported having one PWI at baseline and after 6 months for both groups and no significant difference was observed between groups.

Table 4.27 Prevalence and scores of Oral Impacts on Daily Performances (OIDP) index for the eight (8) performances by group at baseline (N=535)

	Daily performance								
Oral impacts	Overall (n=189)	Eating (n=100)	Speaking (n=42)	Cleaning teeth (n=76)	Relaxing (n=51)	Emotion (n=59)	Smiling (n=48)	Studying (n=25)	Socialising (n=31)
Overall prevalence (%)	35.3	18.7	7.9	14.2	9.5	11.0	9.0	4.7	5.8
Impact score (all)									
Range[1]	0-100	0-9	0-9	0-9	0-9	0-9	0-9	0-9	0-9
Mean (±SD)	2.9 (6.0)	0.5 (1.3)	0.1 (0.6)	0.4 (1.2)	0.2 (0.9)	0.3 (1.1)	0.3 (1.1)	0.1 (0.7)	0.1 (0.7)
Percentiles[2]	(0, 0, 2.8)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)
	Overall (n=94)	Eating (n=54)	Speaking (n=24)	Cleaning teeth (n=33)	Relaxing (n=29)	Emotion (n=28)	Smiling (n=23)	Studying (n=10)	Socialising (n=17)
Intervention (n=270)									
Prevalence (%)	34.8	20.0	8.9	12.2	10.7	10.4	8.5	3.7	6.3
Impact score									
Range[1]	0-100	0-9	0-9	0-9	0-9	0-9	0-9	0-9	0-9
Mean ± SD	2.7 (5.7)	0.6 (1.5)	0.2 (0.6)	0.3 (1.0)	0.3 (1.0)	0.3 (0.9)	0.2 (0.7)	0.1 (0.5)	0.1 (0.5)
Percentiles[2]	(0, 0, 4.2)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)

Table 4.27 Prevalence and scores of Oral Impacts on Daily Performances (OIDP) index for the eight (8) performances by group at baseline (N=535) (continued)

	Daily performance								
	Overall (n=95)	Eating (n=46)	Speaking (n=18)	Cleaning teeth (n=43)	Relaxing (n=22)	Emotion (n=31)	Smiling (n=25)	Studying (n=15)	Socialising (n=14)
Control (n=265)									
Prevalence (%)	35.8	17.4	6.8	16.2	8.3	11.7	9.4	5.7	5.3
Impact score									
Range[1]	0-100	0-9	0-9	0-9	0-9	0-9	0-9	0-9	0-9
Mean ± SD	3.1 (6.2)	0.5 (1.2)	0.1 (0.5)	0.5 (1.3)	0.2 (0.8)	0.3 (1.1)	0.3 (1.3)	0.2 (0.9)	0.2 (0.8)
Percentiles[2]	(0, 0, 2.8)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)
p value [a]	0.699	0.405	0.406	0.139	0.314	0.650	0.669	0.268	0.642

[a] Mann-Whitney Test

[1]Maximum score of specific performance = 9; possible maximum score of Child-OIDP = 100

[2]Percentiles (25, 50, 75)

Level of significance is set at $p<0.05$

Table 4.28 Prevalence and scores of Oral Impacts on Daily Performances (OIDP) index for the eight (8) performances by group after 6 months (N=498)

	Daily performance								
Oral impacts	Overall (n=188)	Eating (n=114)	Speaking (n=61)	Cleaning teeth (n=60)	Relaxing (n=31)	Emotion (n=53)	Smiling (n=61)	Studying (n=19)	Socialising (n=29)
Overall prevalence (%)	37.8	22.9	12.2	12.0	6.2	10.6	0.2	3.8	5.8
Impact score (all)									
Range[1]	0-100	0-9	0-9	0-9	0-9	0-9	0-9	0-9	0-9
Mean (±SD)	3.6 (7.4)	0.7 (1.6)	0.3 (1.0)	0.4 (1.3)	0.2 (0.7)	0.3 (1.1)	0.4 (1.4)	0.1 (0.7)	0.2 (0.8)
Percentiles[2]	(0, 0, 4.2)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)
	Overall (n=88)	Eating (n=60)	Speaking (n=28)	Cleaning teeth (n=26)	Relaxing (n=16)	Emotion (n=20)	Smiling (n=30)	Studying (n=7)	Socialising (n=15)
Intervention (n=251)									
Prevalence (%)	35.1	23.9	11.2	10.4	6.4	8.0	0.4	2.8	6.0
Impact score									
Range[1]	0-100	0-9	0-9	0-9	0-9	0-9	0-9	0-9	0-9
Mean ± SD	3.3 (7.2)	0.7 (1.4)	0.3 (1.1)	0.3 (1.1)	0.1 (0.6)	0.2 (1.0)	0.4 (1.5)	0.1 (0.4)	0.2 (0.8)
Percentiles[2]	(0, 0, 2.8)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)

Table 4.28 Prevalence and scores of Oral Impacts on Daily Performances (OIDP) index for the eight (8) performances by group after 6 months (N=498) (continued)

	Daily performance								
	Overall (n=100)	Eating (n=54)	Speaking (n=33)	Cleaning teeth (n=34)	Relaxing (n=15)	Emotion (n=33)	Smiling (n=31)	Studying (n=12)	Socialising (n=14)
Control (n=247)									
Prevalence (%)	40.5	21.9	13.4	13.8	6.1	13.4	0.0	4.9	5.7
Impact score									
Range[1]	0-100	0-9	0-9	0-9	0-9	0-9	0-9	0-9	0-9
Mean ± SD	3.8 (7.6)	0.7 (1.7)	0.3 (1.0)	0.4 (1.4)	0.2 (0.7)	0.4 (1.3)	0.4 (1.3)	0.2 (0.9)	0.2 (0.7)
Percentiles[2]	(0, 0, 4.2)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)
p value [a]	0.176	0.620	0.510	0.247	0.898	**0.045**	0.883	0.216	0.902

[a] Mann-Whitney Test
[1]Maximum score of specific performance = 9; possible maximum score of Child-OIDP = 100
[2]Percentiles (25, 50, 75)
Level of significance is set at $p<0.05$

Table 4.29 Proportions of schoolchildren experiencing increments in mean total OIDP score after 6 months by groups (N=498)

	Overall (N=498) n (%)	Intervention (n=251) n (%)	Control (n=247) n (%)	*p* value [a]
Increment in mean total OIDP score	141 (28.3)	65 (25.9)	76 (30.8)	0.228
Decrement/no change in mean total OIDP score	357 (71.7)	186 (74.1)	171 (69.2)	

[a] Chi-Square Test

Level of significance is set at $p<0.05$

Table 4.30 Prevalence of impact intensity of the eight (8) performances of the Malay Child OIDP at baseline by group (N=535)

		Daily performance							
Oral impacts on daily performances	Overall impacts* (n=189)	Eating (n=100)	Speaking (n=42)	Cleaning teeth (n=76)	Relaxing (n=51)	Emotion (n=59)	Smiling (n=48)	Studying (n=25)	Socialising (n=31)
Impact intensity (% with impact)									
Very Little	71 (37.6)	24 (24.0)	17 (40.5)	20 (26.3)	15 (29.4)	16 (27.6)	12 (25.0)	10 (40.0)	14 (45.2)
Intervention	38 (53.5)	13 (54.2)	13 (76.5)	11 (55.0)	7 (46.7)	5 (83.3)	6 (50.0)	6 (60.0)	8 (57.1)
Control	33 (46.5)	11 (45.8)	4 (23.5)	9 (45.0)	8 (53.3)	11 (16.7)	6 (50.0)	4 (40.0)	6 (42.9)
Little	100 (52.9)	39 (39.0)	20 (47.6)	29 (38.2)	18 (35.3)	17 (29.3)	17 (35.4)	5 (20.0)	8 (25.8)
Intervention	48 (48.0)	19 (48.7)	8 (40.0)	15 (51.7)	11 (61.1)	11 (64.7)	9 (52.9)	1 (20.0)	6 (75.0)
Control	52 (52.0)	20 (51.3)	12 (60.0)	14 (48.3)	7 (38.9)	6 (35.3)	8 (47.1)	4 (80.0)	2 (25.0)
Moderate	70 (37.0)	23 (23.0)	4 (9.5)	18 (23.7)	14 (27.5)	20 (33.8)	12 (25.0)	5 (20.0)	7 (22.6)
Intervention	36 (51.4)	14 (60.9)	2 (50.0)	4 (22.2)	9 (64.3)	11 (55.0)	8 (66.7)	2 (40.0)	3 (42.9)
Control	34 (48.6)	9 (39.1)	2 (50.0)	14 (77.8)	5 (35.7)	9 (45.0)	4 (33.3)	3 (60.0)	4 (57.1)
Severe	30 (15.9)	12 (12.0)	1 (2.4)	7 (9.2)	4 (7.8)	5 (8.6)	4 (8.3)	5 (20.0)	1 (3.2)
Intervention	**9 (30.0)**[a]	6 (50.0)	1 (100.0)	2 (28.6)	2 (50.0)	1 (20.0)	0 (0.0)	1 (20.0)	0 (0.0)
Control	**21 (70.0)**[a]	6 (50.0)	0 (0.0)	5 (71.4)	2 (50.0)	4 (80.0)	4 (100.0)	4 (80.0)	1 (100.0)

Table 4.30 Prevalence of impact intensity of the eight (8) performances of the Malay Child OIDP at baseline by group (N=535) (continued)

	Daily performance								
Oral impacts on daily performances	Overall impacts* (n=189)	Eating (n=100)	Speaking (n=42)	Cleaning teeth (n=76)	Relaxing (n=51)	Emotion (n=59)	Smiling (n=48)	Studying (n=25)	Socialising (n=31)
Very severe	9 (4.8)	2 (2.0)	0	2 (2.6)	0	1 (1.7)	3 (6.3)	0	1 (3.2)
Intervention	3 (33.3)	2 (100.0)	0	1 (50.0)	0	0	0	0	0
Control	6 (66.7)	0	0	1 (50.0)	0	1 (100.0)	3 (100.0)	0	1 (100.0)

*the difference between reports by schoolchildren in the intervention and control group is statistically significant.

[a] Chi-Square Test

Level of significance is set at $p<0.05$

Table 4.31 Prevalence of impact intensity of the eight (8) performances of the Malay Child OIDP after 6 months by group (N=498)

		Daily performance							
Oral impacts on daily performances	Overall impacts* (n=188)	Eating (n=114)	Speaking (n=61)	Cleaning teeth (n=60)	Relaxing (n=31)	Emotion (n=53)	Smiling (n=61)	Studying (n=19)	Socialising (n=29)
Impact intensity (% with impact)									
Very Little	69 (36.7)	28 (24.6)	16 (26.2)	16 (26.2)	9 (29.0)	12 (22.6)	17 (27.9)	2 (10.5)	11 (38.0)
Intervention	**27 (39.1)**[a]	12 (42.9)	5 (31.3)	5 (31.3)	5 (55.6)	6 (50.0)	8 (47.1)	1 (50.0)	7 (63.6)
Control	**42 (60.9)**[a]	16 (57.1)	11 (68.7)	11 (68.7)	4 (44.4)	6 (50.0)	9 (52.9)	1 (50.0)	4 (36.4)
Little	93 (49.5)	38 (33.3)	19 (31.1)	18 (29.5)	12 (38.7)	15 (28.3)	15 (24.6)	7 (36.8)	7 (24.1)
Intervention	50 (53.8)	24 (63.2)	10 (52.6)	11 (61.1)	6 (50.0)	6 (40.0)	5 (33.3)	4 (57.1)	3 (42.9)
Control	43 (46.2)	14 (36.8)	9 (47.4)	7 (38.9)	6 (50.0)	9 (60.0)	10 (66.7)	3 (42.9)	4 (57.1)
Moderate	74 (39.4)	29 (25.4)	21 (34.4)	15 (24.6)	8 (25.8)	16 (30.2)	14 (23.0)	6 (31.6)	8 (27.6)
Intervention	35 (47.3)	18 (62.1)	10 (47.6)	7 (46.7)	5 (62.5)	6 (37.5)	9 (64.3)	2 (33.3)	4 (50.0)
Control	39 (52.7)	11 (37.9)	11 (52.4)	8 (53.3)	3 (37.5)	10 (62.5)	5 (35.7)	4 (66.7)	4 (50.0)
Severe	34 (18.1)	14 (12.3)	4 (6.6)	6 (9.8)	2 (6.5)	9 (17.0)	9 (14.8)	4 (21.1)	2 (6.9)
Intervention	**12 (35.3)** [a]	5 (35.7)	2 (50.0)	2 (33.3)	0 (0.0)	1 (11.1)	4 (44.4)	0 (0.0)	0 (0.0)
Control	**22 (64.7)** [a]	9 (64.3)	2 (50.0)	4 (66.7)	2 (100.0)	8 (88.9)	5 (55.6)	4 (100.0)	2 (100.0)

Table 4.31 Prevalence of impact intensity of the eight (8) performances of the Malay Child OIDP after 6 months by group (N=498) (continued)

		Daily performance							
Oral impacts on daily performances	Overall impacts* (n=188)	Eating (n=114)	Speaking (n=61)	Cleaning teeth (n=60)	Relaxing (n=31)	Emotion (n=53)	Smiling (n=61)	Studying (n=19)	Socialising (n=29)
Very severe	16 (8.5)	5 (4.4)	1 (1.6)	5 (8.2)	0 (0.0)	1 (1.9)	6 (9.5)	0 (0.0)	1 (3.4)
Intervention	9 (56.3)	1 (20.0)	1 (100.0)	2 (40.0)	0 (0.0)	1 (100.0)	4 (66.7)	0 (0.0)	1 (100.0)
Control	7 (43.7)	4 (80.0)	0 (0.0)	3 (60.0)	0 (0.0)	0 (0.0)	2 (33.3)	0 (0.0)	0 (0.0)

*the difference between reports by schoolchildren in the intervention and control group is statistically significant.
[a] Chi-Square Test
Level of significance is set at $p<0.05$

Table 4.32 Classification of the intensity of oral impacts according to performance scores

The intensity of impact	Severity score		Frequency score	Performances score
Very severe	Severe (3)	X	Severe (3)	9
Severe	Severe (3)	X	Moderate (2)	6
	Moderate (2)	X	Severe (3)	6
Moderate	Moderate (2)	X	Moderate (2)	4
	Severe (3)	X	Little (1)	3
	Little (1)	X	Severe (3)	3
Little	Moderate (2)	X	Little (1)	2
	Little (1)	X	Moderate (2)	2
Very little	Little (1)	X	Little (1)	1
No impact	None (0)	X	None (0)	0

Table 4.33 Frequency distribution of oral conditions perceived to have caused overall impacts at baseline and after 6 months (N=498)

Items	Overall (N=498)			Intervention (n=251)			Control (n=247)				
	Baseline n (%)	After 6 months n (%)	*p* value [a]	Baselin[1] n (%)	After 6 months[2] n (%)	*p* value [a]	Baseline[1] n (%)	After 6 months[2] n (%)	*p* value [a]	*p* value [1]	*p* value [2]
Tooth ache	113 (22.7)	89 (17.9)	**0.033**	63 (25.1)	44 (17.5)	**0.012**	50 (20.2)	45 (18.2)	0.620	0.196	0.841
Sensitive tooth	70 (14.1)	78 (15.7)	0.492	32 (12.7)	39 (15.5)	0.410	38 (15.4)	39 (15.8)	1.000	0.398	0.938
Tooth decay (hole in tooth)	91 (18.3)	79 (15.9)	0.251	48 (19.1)	41 (16.3)	0.360	43 (17.4)	38 (15.4)	0.568	0.621	0.772
Exfoliating primary tooth/loose milk tooth	33 (6.6)	18 (3.6)	**0.050**	15 (6.0)	11 (4.4)	0.556	18 (7.3)	7 (2.8)	**0.043**[c]	0.556	0.355
Spacing in between teeth	36 (7.2)	24 (4.8)	0.067	19 (7.6)	11 (4.4)	0.134[c]	17 (6.9)	13 (5.3)	0.424[c]	0.767	0.646
Broken/fractured permanent tooth	34 (6.8)	16 (3.2)	**0.005**	24 (9.6)	8 (3.2)	***p*<0.001**[c]	10 (4.0)	8 (3.2)	0.804[c]	**0.015**	0.974
Colour of teeth/ discoloured teeth	68 (13.7)	75 (15.1)	0.534	36 (14.3)	46 (18.3)	0.212	32 (13.0)	29 (11.7)	0.755	0.652	**0.040**
Shape or size of teeth	55 (11.0)	33 (6.6)	**0.015**	36 (14.3)	22 (8.8)	0.066	19 (7.7)	11 (4.5)	0.152[c]	**0.018**	0.053

Table 4.33 Frequency distribution of oral conditions perceived to have caused overall impacts at baseline and after 6 months (N=498) (continued)

Items	Overall (N=498)			Intervention (n=251)			Control (n=247)				
	Baseline n (%)	After 6 months n (%)	*p* value [a]	Baselin[1] n (%)	After 6 months[2] n (%)	*p* value [a]	Baseline[1] n (%)	After 6 months[2] n (%)	*p* value [a]	*p* value [1]	*p* value [2]
Crowding (position of teeth)	92 (18.5)	89 (17.9)	0.832	49 (19.5)	46 (18.3)	0.787	43 (17.4)	43 (17.4)	1.000	0.544	0.789
Bleeding gum	77 (15.5)	75 (15.1)	0.920	38 (15.1)	37 (14.7)	1.000	39 (15.8)	38 (15.4)	1.000	0.841	0.841
Swollen/inflamed gum	51 (10.2)	40 (8.0)	0.208	26 (10.4)	22 (8.8)	0.584	25 (10.1)	18 (7.3)	0.296	0.930	0.544
Plaque or/and calculus	21 (4.2)	27 (5.4)	0.377	13 (5.2)	13 (5.2)	1.000[c]	8 (3.2)	14 (5.7)	0.210[c]	0.281	0.810
Oral ulcer	49 (9.8)	58 (11.6)	0.349	23 (9.2)	28 (11.2)	0.522	26 (10.5)	30 (12.1)	0.607	0.610	0.730
Bad breath	87 (17.5)	83 (16.7)	0.762	45 (17.9)	38 (15.1)	0.410	42 (17.0)	45 (18.2)	0.766	0.786	0.357
New tooth erupting	52 (10.4)	25 (5.0)	***p*<0.001**	26 (10.4)	9 (3.6)	**0.002**	26 (10.5)	16 (6.5)	0.064[c]	0.951	0.139
Missing tooth	10 (2.0)	1 (0.2)	**0.012[c]**	7 (2.8)	1 (0.4)	0.070[c]	3 (1.2)	0 (0.0)	0.250[c]	0.211	0.321
Others	0	2 (0.4)	0.500[c]	0	1 (0.4)	1.000[c]	0	1 (0.4)	1.000[c]	-	0.991

[a] Non Parametric test – Mc Nemar Test
[1] and [2] – Chi-Square test
p value [1] = comparison was done between intervention and control groups at baseline
p value [2] = comparison was done between intervention and control groups after 6 months.
[c] = binomial distribution used

Table 4.34 Comparison of mean impact scores between IG and CG at baseline and after 6 months and mean increment for each performance and overall impact by group (N=498)

Item	Overall (N=498)		Mean Increment (±SD)	Intervention (n=251)		Mean Increment (±SD) [3]	Control (n=247)		Mean Increment (±SD) [3]	*p* value[1, b]	*p* value[2, b]	*p* value[3, b]
	Baseline Mean (±SD)	After 6 months Mean (±SD)		Baseline Mean (±SD) [1]	After 6 months Mean (±SD) [2]		Baseline Mean (±SD) [1]	After 6 months (±SD) [2]				
Eating	0.5 (1.3)	0.7 (1.6)	0.2 (1.9)	0.6 (1.5)	0.7 (1.4)	0.1 (1.9)	0.5 (1.2)	0.7 (1.7)	0.2 (2.0)	0.388	0.620	0.623
Speaking	**0.1 (0.5)**	**0.3*** (1.0)**	0.2 (1.1)	**0.1 (0.5)**	**0.3* (1.1)**	0.2 (1.2)	**0.1 (0.5)**	**0.3* (1.0)**	0.2 (1.0)	0.574	0.510	0.396
Cleaning	0.4 (1.1)	0.4 (1.3)	0.0 (1.6)	0.3 (1.0)	0.3 (1.1)	0.0 (1.3)	0.5 (1.3)	0.4 (1.4)	0.0 (1.8)	0.134	0.247	0.521
Relaxing	0.2 (0.8)	0.2 (0.7)	-0.1 (1.0)	0.3 (0.9)	0.1 (0.6)	-0.1 (1.0)	0.2 (0.8)	0.2 (0.7)	-0.1 (1.0)	0.563	0.898	0.474
Emotion	0.3 (1.0)	0.3 (1.1)	0.0 (1.4)	0.3 (0.9)	0.2 (0.9)	0.0 (1.1)	0.3 (1.1)	0.4 (1.3)	0.1 (1.5)	0.460	**0.045**	0.264

Table 4.34 Comparison of mean impact scores between IG and CG at baseline and after 6 months and mean increment for each performance and overall impact by group (N=498) (continued)

Item	Overall (N=498)		Mean Increment (±SD)	Intervention (n=251)		Mean Increment (±SD) [3]	Control (n=247)		Mean Increment (±SD) [3]	*p* value[1, b]	*p* value[2, b]	*p* value[3, b]
	Baseline Mean (±SD)	After 6 months Mean (±SD)		Baseline Mean (±SD) [1]	After 6 months Mean (±SD) [2]		Baseline Mean (±SD) [1]	After 6 months (±SD) [2]				
Smiling	**0.3 (1.0)**	**0.4* (1.4)**	0.2 (1.4)	**0.2 (0.7)**	**0.4* (1.5)**	0.3 (1.3)	0.3 (1.2)	0.4 (1.3)	0.1 (1.4)	0.368	0.883	0.368
Studying	0.1 (0.7)	0.1 (0.7)	0.0 (1.0)	0.1 (0.5)	0.1 (0.4)	0.0 (0.6)	0.2 (0.9)	0.2 (0.9)	0.0 (1.3)	0.249	0.216	0.900
Socialising	0.1 (0.7)	0.2 (0.8)	0.0 (1.0)	0.1 (0.4)	0.2 (0.8)	0.1 (0.9)	0.2 (0.9)	0.2 (0.7)	0.0 (1.1)	0.919	0.902	0.810
Total OIDP score												
Mean ± SD	2.9 (5.7)	3.6 (7.4)	0.7 (8.0)	2.6 (5.2)	3.3 (7.2)	0.7 (7.3)	3.1 (6.1)	3.8 (7.6)	0.7 (8.6)	0.495	0.176	0.489

Wilcoxon Signed Rank Test – to find p value within group at baseline and after 6 months
*** $p < 0.001$
** $p < 0.01$
*$p < 0.05$
[b] Mann-Whitney Test
p value[1] = comparison of mean score at baseline between intervention and control group
p value[2] = comparison of mean score after 6 months between intervention and control group
p value[3] = comparison of mean increment score between intervention and control group

Table 4.35 Comparison of the number of performance with impact (PWI) at baseline and after 6 months by group (N=498)

	Overall (N=498)		*p* value [a]	Intervention (n=251)		*p* value [a]	Control (n=247)		*p* value [a]
	Baseline n (%)	after 6 months n (%)		Baseline n (%)	After 6 months n (%)		Baseline n (%)	After 6 months n (%)	
Number of PWI			0.436			0.784			0.416
0	322 (64.7)	310 (62.2)		165 (65.7)	163 (64.9)		157 (63.6)	147 (59.5)	
1	76 (15.3)	85 (17.1)		37 (14.7)	46 (18.3)		39 (15.8)	39 (15.8)	
2	43 (8.6)	42 (8.4)		20 (8.0)	11 (4.4)		23 (9.3)	31 (12.6)	
3	30 (6.0)	23 (4.6)		17 (6.8)	12 (4.8)		13 (5.3)	11 (4.5)	
4	11 (2.2)	15 (3.0)		4 (1.6)	8 (3.2)		7 (2.8)	7 (2.8)	
5	4 (0.8)	12 (2.4)		2 (0.8)	3 (1.2)		2 (0.8)	9 (3.6)	
6	5 (1.0)	8 (1.6)		2 (0.8)	6 (2.4)		3 (1.2)	2 (0.8)	
7	3 (0.6)	2 (0.4)		3 (1.2)	1 (0.4)		0	1 (0.4)	
8	4 (0.8)	1 (0.2)		1 (0.4)	1 (0.4)		3 (1.2)	0 (0.0)	

[a] Non Parametric test - Marginal Homogeneity Test

4.7 Associated factors in relation to schoolchildren's oral health knowledge, attitudes, behaviour, oral health status, and OHRQoL (Objective 2)

4.7.1 Oral health knowledge (OHK)

Table 4.36 shows the relationship between mean increment scores of OHK after 6 months and demographic characteristics of the schoolchildren. Of the 10 independent variables, two variables, i.e. gender, and school location had significant within-group differences. The schoolchildren's mean increment score of OHK was significantly higher in urban areas and in male compared to rural areas and female schoolchildren ($p<0.001$, $p<0.05$), respectively.

Table 4.37 shows the factor associated with OHK increment scores. The regression coefficient of schoolchildren in urban areas was 5.29, which meant they would have 5.29 points higher in mean OHK increment than schoolchildren in rural areas when other factors are similar. Male schoolchildren have a regression coefficient of 1.96 compared to female. Thus, male schoolchildren would have 1.96 points higher in mean OHK increment compared to female, when other factors are similar. The factors explained 7.6% of the total variance of schoolchildren's OHK.

Table 4.36 Univariate relationship between mean increment scores of OHK and categories of the demographic characteristics of the schoolchildren after 6 months (N=498)

Demographic variable	N (%)	Mean increment	SD	*p* value
Type of school				
DMP (intervention group)	251 (50.4)	3.0	10.6	0.626[a]
Non-DMP (control group)	247 (49.6)	3.7	9.6	
Gender				
Male	259 (52.0)	4.4	10.7	**0.009[a]**
Female	239 (48.0)	2.2	9.4	
Ethnicity				
Malay	495 (99.4)	3.3	10.1	0.521[c]
Chinese and Other race	3 (0.6)	8.7	14.2	
School location				
Kota Bharu / Urban	253 (50.8)	5.7	10.4	***p*<0.001[a]**
Pasir Mas / Rural	245 (49.2)	0.9	9.3	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	2.0	10.7	0.571[b]
Secondary school	303 (71.6)	3.2	9.8	
STPM/College	33 (7.8)	2.7	8.3	
University	45 (10.6)	5.4	9.8	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	2.9	11.9	0.969[b]
Secondary school	340 (76.1)	3.3	10.3	
STPM/College	36 (8.1)	3.9	10.9	
University	47 (10.5)	3.0	8.0	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	4.3	15.1	0.805[b]
Secondary school	17 (5.7)	2.2	10.0	
STPM/College	3 (10.0)	-0.7	11.5	
University	4 (13.3)	8.8	6.4	
Household income (n = 480)[1]				
Poor	231 (48.1)	2.0	11.0	0.063[b]
Low	153 (31.9)	4.9	10.0	
Medium-low	38 (7.9)	3.2	7.4	
Medium-high	25 (5.2)	2.4	7.3	
High	33 (6.9)	6.2	10.6	
Appointed as DM				
Yes	4 (0.8)	4.0	14.1	0.837[c]
No and unsure	494 (98.2)	3.3	10.1	

Table 4.36 Univariate relationship between mean increment scores of OHK and categories of the demographic characteristics of the schoolchildren after 6 months (N=498) (continued)

Demographic variable	N (%)	Mean increment	SD	*p* value
Availability of DMP in primary school				
Yes	258 (51.8)	3.1	9.8	0.266[a]
No and unsure	240 (48.2)	3.7	10.7	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.
[a] Parametric statistics = Independent T Test
[b] Parametric statistics = One way ANOVA
[c] Non Parametric statistics = Mann-Whitney U
Level of significance is set at $p<0.05$

Table 4.37 Factor associated with 6-month OHK increment score of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	-0.32				
Gender					
Female					
Male	1.96	(0.16, 3.75)	0.09	2.15	**0.032**
Location					
Rural					
Urban	5.29	(3.50, 7.10)	0.26	5.80	***p*<0.001**

R^2 = 0.076, adjusted R^2 = 0.072. MLR with enter method was used.

Assessment of the statistical assumptions with regard the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (Female, tolerance = 1.0, VIF = 1.0; Urban, tolerance = 1.0, VIF = 1.0)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix G) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix H)

4.7.2 Oral health attitudes (OHA)

Table 4.38 shows univariate relationship between mean OHA increment score after 6 months and demographic characteristics of the sample. Out of 10 independent variables, three (3) variables, i.e. type of school, gender, and school location had significant relationships with OHA increment score (p<0.001).

Schoolchildren's mean increment score of OHA was significantly higher in schools without DMP (p<0.001), male (p<0.001), and those who lived in urban areas (p<0.001).

Table 4.39 shows the results of MLR analysis to develop a model for factors associated with OHA increment score over 6 months among the schoolchildren. Model assessment in terms of statistical assumptions, model fitness, and diagnostic check were checked (Appendix I and J). A continuous variable with a significant association with OHA increment score at univariate analysis (p<0.001) was also entered into the analysis.

From table 4.39, the regression coefficient of school without DMP is 3.53 compared to school with DMP, meaning schoolchildren in non-DMP school would have 3.53 points higher in mean OHA increment score when other factors are similar. The urban area have a regression coefficients of 4.62 compared to rural area, which means schoolchildren in urban areas would have 4.62 points higher in mean OHA increment score than schoolchildren in rural areas when other factors are similar. Male schoolchildren have a regression coefficient of 2.45 compared to female schoolchildren which means male schoolchildren would have 2.45 points higher in mean OHA increment score compared to female schoolchildren.. Increment in OHK is a factor for increment in OHA where schoolchildren with OHK increment score would have 0.39 points higher in mean OHA increment score when other factors are similar. The four factors explained 27.7% of the total variance of schoolchildren's OHA.

Table 4.38 Univariate relationship between mean increment score of OHA and categories of the demographic characteristics of the schoolchildren after 6 months (N=498)

Demographic variable	N (%)	Mean	SD	*p* value
Type of school				
DMP (intervention group)	251 (50.4)	3.0	11.5	***p*<0.001**[a]
Non-DMP (control group)	247 (49.6)	6.5	10.2	
Gender				
Male	259 (52.0)	6.5	11.8	***p*<0.001**[a]
Female	239 (48.0)	2.7	9.8	
Ethnicity				
Malay	495 (99.4)	4.7	11.0	0.684[c]
Chinese and Other race	3 (0.6)	3.6	18.2	
School location				
Kota Bharu / Urban	253 (50.8)	8.1	10.7	***p*<0.001**[a]
Pasir Mas / Rural	245 (49.2)	1.2	10.2	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	2.9	10.8	0.808[b]
Secondary school	303 (71.6)	4.7	11.4	
STPM/College	33 (7.8)	3.7	8.8	
University	45 (10.6)	5.4	9.5	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	0.3	13.3	0.284[b]
Secondary school	340 (76.1)	5.1	11.4	
STPM/College	36 (8.1)	5.7	7.6	
University	47 (10.5)	3.6	10.3	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	1.3	11.0	0.183[b]
Secondary school	17 (5.7)	3.6	7.9	
STPM/College	3 (10.0)	-1.6	6.8	
University	4 (13.3)	16.4	8.1	
Household income (n = 480)[1]				
Poor	231 (48.1)	4.1	11.2	0.682[b]
Low	153 (31.9)	5.8	11.9	
Medium-low	38 (7.9)	4.3	8.4	

Table 4.38 Univariate relationship between mean increment score of OHA and categories of the demographic characteristics of the schoolchildren after 6 months (N=498) (continued)

Demographic variable	N (%)	Mean	SD	*p* value
Medium-high	25 (5.2)	5.3	9.9	
High	33 (6.9)	4.4	8.6	
Appointed as DM				
Yes	4 (0.8)	5.5	12.6	0.917[c]
No and unsure	494 (98.2)	4.7	11.0	
Availability of DMP in primary school				
Yes	258 (51.8)	3.9	10.6	0.101[a]
No and unsure	240 (48.2)	5.6	11.4	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.

[a] Parametric statistics = Independent T Test

[b] Parametric statistics = One way ANOVA;

[c] Non Parametric statistics = Mann-Whitney U

Level of significance is set at $p < 0.05$

Table 4.39 Factors associated with OHA increment score of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	-5.51				
Type of school					
School with DMP					
School without DMP	3.53	(1.87, 5.19)	0.16	4.18	***p*<0.001**
Location					
Rural					
Urban	4.62	(2.90, 6.35)	0.21	5.27	***p*<0.001**
Gender					
Female					
Male	2.45	(0.78, 4.13)	0.11	2.88	**0.004**
Increment in OHK score	0.39	(0.31, 0.47)	0.37	9.37	***p*<0.001**

No interaction between variables
$R^2 = 0.277$, adjusted $R^2 = 0.271$. MLR with enter method was used.

A continuous variable with a significant association with OHA increment score at univariate analysis ($p<0.001$) was increment in OHK.

Assessment of the statistical assumptions with regard the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (Urban, tolerance = 0.9, VIF = 1.1; Male, tolerance = 1.0, VIF = 1.0; School without DMP, tolerance = 1.0, VIF = 1.0; Increment in OHK score, tolerance = 0.9, VIF = 1.1)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix I) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix J)

4.7.3 Oral health behavioural (OHB)

Table 4.40 shows univariate relationships between mean increment score of OHB and demographic characteristic of the schoolchildren. All variables did not show any significant relationship with mean OHB increment, except for ethnicity. However, no further analysis was conducted as the ethnicity data were skewed. A continuous variable with a significant association with OHB increment score at univariate analysis (p<0.05) was OHA increment score, but when OHA increment score was analysed in MLR, no significant association in the model was identified.

Table 4.40 Univariate relationship between mean increment score of OHB and categories of the demographic characteristics of the schoolchildren after 6 months (N=498)

Demographic variable	N (%)	Mean	SD	*p* value
Type of school				
DMP (intervention group)	251 (50.4)	-2.3	18.5	0.880[a]
Non-DMP (control group)	247 (49.6)	-2.1	18.6	
Gender				
Male	259 (52.0)	-1.0	20.1	0.127[a]
Female	239 (48.0)	-3.5	16.6	
Ethnicity				
Malay	495 (99.4)	-2.0	18.4	**0.006[c]**
Chinese & others	3 (0.6)	-33.3	8.2	
School location				
Kota Bharu / Urban	253 (50.8)	-1.8	17.7	0.575[a]
Pasir Mas / Rural	245 (49.2)	-2.7	19.3	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	-0.7	21.6	0.381[b]
Secondary school	303 (71.6)	-3.3	19.4	
STPM/College	33 (7.8)	-1.3	16.5	
University	45 (10.6)	1.9	15.7	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	0.0	13.3	0.440[b]
Secondary school	340 (76.1)	-3.0	20.0	
STPM/College	36 (8.1)	-4.4	15.6	
University	47 (10.5)	1.2	15.1	

Table 4.40 Univariate relationship between mean increment score of OHB and categories of the demographic characteristics of the schoolchildren after 6 months (N=498) (continued)

Demographic variable	N (%)	Mean	SD	*p* value
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	0.0	15.6	
Secondary school	17 (5.7)	0.0	13.4	0.596[b]
STPM/College	3 (10.0)	14.3	14.3	
University	4 (13.3)	0.0	23.3	
Household income (n = 480)[1]				
Poor	231 (48.1)	-4.0	19.5	
Low	153 (31.9)	-1.3	18.7	0.188[b]
Medium-low	38 (7.9)	3.0	19.4	
Medium-high	25 (5.2)	1.1	13.6	
High	33 (6.9)	-1.7	14.2	
Appointed as DM				
Yes	4 (0.8)	-17.9	27.0	0.244[c]
No and unsure	494 (98.2)	-2.1	18.4	
Availability of DMP in primary school				
Yes	258 (51.8)	-1.2	18.3	0.191[a]
No and unsure	240 (48.2)	-3.3	18.7	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.
[a] Parametric statistic = Independent T-Test
[b] Parametric statistic = One way ANOVA
[c] Non Parametric statistic = Mann-Whitney U
Level of significance is set at $p<0.05$

4.7.4 Oral hygiene (plaque score)

Table 4.41 shows a univariate relationship between mean increment of plaque score over 6 months and demographic characteristic of the schoolchildren. Only school location had a significant relationship with increment in plaque score. Univariate relationship was also conducted for continuous data, i.e. OHK, OHA and OHB increments, but no significant correlation was found.

In table 4.42, the MLR model shows schoolchildren in rural areas would have 10.98 points higher in mean plaque score increment compared to schoolchildren in urban areas.

The one factor explained 4.8% of the total variance of mean plaque score increment of the schoolchildren.

Table 4.41 Univariate relationship between mean increment of plaque score and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment of plaque score		*p* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	-31.7	31.0	0.643[a]
Non-DMP (control group)	247 (49.6)	-30.5	25.3	
Gender				
Male	259 (52.0)	-32.4	29.5	0.289[a]
Female	239 (48.0)	-29.7	27.1	
Ethnicity				
Malay	495 (99.4)	-31.2	28.4	0.380[c]
Chinese & Other	3 (0.6)	-19.3	26.3	
School location				
Kota Bharu / Urban	253 (50.8)	-36.8	27.5	***p*<0.001[a]**
Pasir Mas / Rural	245 (49.2)	-25.3	28.1	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	-29.3	26.9	0.422[b]
Secondary school	303 (71.6)	-29.4	29.2	
STPM/College	33 (7.8)	-34.1	26.6	
University	45 (10.6)	-30.1	28.0	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	-27.9	30.2	0.649[b]
Secondary school	340 (76.1)	-30.6	28.5	
STPM/College	36 (8.1)	-33.0	29.8	
University	47 (10.5)	-31.2	26.6	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	-32.3	22.5	0.996[b]
Secondary school	17 (5.7)	-29.1	26.1	
STPM/College	3 (10.0)	-24.7	9.4	
University	4 (13.3)	-30.6	20.8	
Household income (n = 480)[1]				
Poor	231 (48.1)	-31.0	28.4	0.977[b]
Low	153 (31.9)	-29.7	28.0	
Medium-low	38 (7.9)	-32.4	28.0	

Table 4.41 Univariate relationship between mean increment of plaque score and categories of demographic characteristics of the schoolchildren after 6 months (N = 498) (continued)

Demographic variable	N (%)	Net increment of plaque score		*p* value
		Mean	(SD)	
Medium-high	25 (5.2)	-29.2	24.5	
High	33 (6.9)	-29.6	30.5	
Appointed as DM				
Yes	4 (0.8)	-39.9	39.4	0.799[c]
No and unsure	494 (99.2)	-31.1	28.3	
Availability of DMP in primary school				
Yes	258 (51.8)	-28.3	27.9	**0.023[a]**
No and unsure	240 (48.2)	-34.1	28.6	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.
[a] Parametric statistics = Independent T-Test
[b] Parametric statistics = One way ANOVA
[c] Non Parametric statistics = Mann-Whitney U
Level of significance is set at $p<0.05$

Table 4.42 Factor associated with increment in plaque score of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	-49.90				
Location					
Urban					
Rural	10.98	(6.08, 15.89)	0.19	4.40	***p*<0.001**

$R^2 = 0.048$, adjusted $R^2 = 0.044$. MLR with enter method was used.

Assessment of the statistical assumptions with regard the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (District, tolerance = 1.0, VIF = 1.0)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix K) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix L)

4.7.5 Gingival health

Table 4.43 shows univariate relationship between mean increment in score of GIS and categories of demographic characteristics of the schoolchildren. Type of school and mother's education level had a significant association with increment in score of GIS each. Univariate relationship was also assessed for continuous variables, i.e. OHK, OHA and OHB increments but no significant association was found.

In table 4.44, the MLR model shows that DMP school has a regression coefficient of 0.33, meaning schoolchildren in DMP school would have 0.33 points higher in mean score of GIS compared to non-DMP school when other factors are similar. This factor explained 9.4% of the total variance in mean score of GIS increment of the schoolchildren.

Table 4.43 Univariate relationship between mean increment in score of GIS and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment in score of GIS		*p* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	0.2	0.5	***p*<0.001[a]**
Non-DMP (control group)	247 (49.6)	-0.2	0.5	
Gender				
Male	259 (52.0)	0.0	0.5	0.777[a]
Female	239 (48.0)	0.0	0.5	
Ethnicity				
Malay	495 (99.4)	0.0	0.5	0.646[c]
Chinese & Other	3 (0.6)	-0.1	0.2	
School location				
Kota Bharu / Urban	253 (50.8)	0.0	0.4	0.220[a]
Pasir Mas / Rural	245 (49.2)	0.0	0.6	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	0.1	0.4	
Secondary school	303 (71.6)	0.0	0.6	0.189[b]
STPM/College	33 (7.8)	0.1	0.5	
University	45 (10.6)	0.1	0.4	

Table 4.43 Univariate relationship between mean increment in score of GIS and categories of demographic characteristics of the schoolchildren after 6 months (N = 498) (continued)

Demographic variable	N (%)	Net increment in score of GIS		*p* value
		Mean	(SD)	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	-0.2	0.5	
Secondary school	340 (76.1)	0.0	0.5	**0.043[b]**
STPM/College	36 (8.1)	-0.2	0.6	
University	47 (10.5)	0.0	0.5	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	0.1	0.4	
Secondary school	17 (5.7)	0.1	0.5	0.376[b]
STPM/College	3 (10.0)	-0.1	0.4	
University	4 (13.3)	0.5	0.2	
Household income (n = 480)[1]				
Poor	231 (48.1)	0.0	0.5	
Low	153 (31.9)	0.0	0.6	
Medium-low	38 (7.9)	0.0	0.5	0.853[b]
Medium-high	25 (5.2)	0.0	0.5	
High	33 (6.9)	0.1	0.5	
Appointed as DM				
Yes	4 (0.8)	0.1	0.5	0.438[c]
No and unsure	494 (99.2)	0.0	0.5	
Availability of DMP in primary school				
Yes	258 (51.8)	0.0	0.6	0.079[a]
No and unsure	240 (48.2)	0.1	0.5	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.

[a] Parametric statistics = Independent t-test

[b] Parametric statistics = One way ANOVA

[c] Non Parametric statistics = Mann-Whitney U

In mother's education level, the assumption of homogeneity of variance between groups of variable was met, i.e. Levene's test was not significant, p>0.05.

Level of significant is set at p<0.05

Table 4.44 Factor associated with mean increment in score of GIS of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	-0.48				
Type of school					
School without DMP					
School with DMP	0.33	(0.24, 0.42)	0.31	7.16	$\boldsymbol{p<0.001}$

$R^2 = 0.094$, adjusted $R^2 = 0.092$. MLR with backward method was used.

Assessment of statistical assumptions with regard to the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (Group, tolerance = 1.0, VIF = 1.0)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix M) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix N)

4.7.6 Caries incidence

Table 4.45 shows univariate relationship between schoolchildren's 6-month mean increment in decayed teeth (ICDAS ≥1) and categories of demographic characteristics of the schoolchildren. There was no significant relationship found in the univariate assessment. Increments in OHK, OHA and OHB were also assessed in univariate relationship with caries increment. However, no significant association was found. MLR analysis including independent variables with *p* value less than 0.1 at univariate relationship showed no significant factor in the model.

Table 4.46 shows univariate relationship between schoolchildren's 6-month mean increment in cavitated caries (ICDAS ≥3) and demographic characteristics of the schoolchildren. There was a significant relationship between mean increment in cavitated caries and school location. Univariate analysis was also conducted between increments in OHK, OHA, and OHB with increment in cavitated caries (ICDAS ≥3). The results showed that only OHA increment had a significant association with increment in cavitated caries.

Table 4.47 shows the results of MLR analysis to determine factors associated with schoolchildren's 6-month mean increment in cavitated caries (ICDAS ≥3). The model shows that increment in OHA has a regression coefficient of 0.04, which means schoolchildren with increment in OHA would have 0.04 points higher in mean increment of cavitated caries when other factors are similar. This factor explained 4.3% of the total variance of mean increment of cavitated caries of the schoolchildren.

Table 4.48 shows univariate relationship between schoolchildren's 6-month mean increment of decayed surfaces (ICDAS ≥1) and categories of demographic characteristics of the schoolchildren. However, there was no significant relationship found. Increment scores of OHK, OHA and OHB were also entered into the univariate analysis but no significant association was found. MLR was conducted for variables with *p* value less than 0.1 at univariate relationship but no significant factor was identified.

Table 4.49 shows univariate relationship between schoolchildren's 6-month mean increment of cavitated surfaces (ICDAS ≥3) and categories of demographic characteristics of the schoolchildren. In this table, there was a significant relationship of mean increment in cavitated surfaces with school location and the availability of DMP in primary school. Univariate analysis was also conducted between increments in OHK, OHA and OHB and mean increment in cavitated surfaces. The result shows only increment in OHA has a significant association with increment in cavitated surfaces.

In table 4.50, further MLR was conducted for variables with *p* value less than 0.1 at univariate relationship. Surprisingly, the model shows 2 factors, i.e. mother's education level and increment in OHA which are significant factors for increment in cavitated surfaces. The model shows regression coefficients of -0.73 and -0.96 for mother's education up to secondary school and university level, respectively which indicate that mother's levels of educations are protective factors for increment in cavitated surfaces. Meanwhile, increment in OHA had a regression coefficient of 0.05 which means schoolchildren with increment in OHA would have 0.05 points higher in increment of cavitated surfaces when other factors are similar. The three factors explained 6.5% of the total variance of mean increment in cavitated surfaces of the schoolchildren.

Table 4.45 Univariate relationship between mean increment in decayed teeth (ICDAS≥1) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment in decayed teeth		*p* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	2.4	3.8	0.236[a]
Non-DMP (control group)	247 (49.6)	2.7	3.1	
Gender				
Male	259 (52.0)	2.8	3.6	0.085[a]
Female	239 (48.0)	2.3	3.3	
Ethnicity				
Malay	495 (99.4)	2.5	3.5	0.582[c]
Chinese & Other	3 (0.6)	1.3	1.5	
School location				
Kota Bharu / Urban	253 (50.8)	2.8	3.1	0.136[a]
Pasir Mas / Rural	245 (49.2)	2.3	3.8	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	3.3	3.4	
Secondary school	303 (71.6)	2.5	3.5	0.418[b]
STPM/College	33 (7.8)	3.1	3.7	
University	45 (10.6)	2.0	2.8	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	2.6	3.2	
Secondary school	340 (76.1)	2.5	3.5	0.840[b]
STPM/College	36 (8.1)	3.1	4.1	
University	47 (10.5)	2.4	2.8	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	2.7	4.7	
Secondary school	17 (5.7)	1.4	3.8	0.533[b]
STPM/College	3 (10.0)	4.7	4.2	
University	4 (13.3)	2.3	0.5	
Household income (n = 480)[1]				
Poor	231 (48.1)	2.4	3.6	
Low	153 (31.9)	2.8	3.5	
Medium-low	38 (7.9)	2.7	3.4	0.719[b]
Medium-high	25 (5.2)	2.5	3.6	
High	33 (6.9)	2.1	2.6	
Appointed as DM				
Yes	4 (0.8)	3.8	2.6	0.321[c]
No and unsure	494 (99.2)	2.5	3.5	

Table 4.45 Univariate relationship between mean increment in decayed teeth (ICDAS≥1) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498) (continued)

Demographic variable	N (%)	Net increment in decayed teeth		*p* value
		Mean	(SD)	
Availability of DMP in primary school				
Yes	258 (51.8)	2.3	3.4	0.071[a]
No and unsure	240 (48.2)	2.8	3.4	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.
[a] Parametric statistics = Independent t-test
[b] Parametric statistics = One way ANOVA
[c] Non Parametric statistics = Mann-Whitney U
Level of significance is set at $p<0.05$

Table 4.46 Univariate relationship between mean increment of cavitated caries (ICDAS≥3) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment cavitated caries		*P* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	1.4	2.0	0.338[a]
Non-DMP (control group)	247 (49.6)	1.6	2.0	
Gender				
Male	259 (52.0)	1.5	1.8	0.577[a]
Female	239 (48.0)	1.6	2.2	
Ethnicity				
Malay	495 (99.4)	1.5	2.0	0.270[c]
Chinese & Other	3 (0.6)	0.3	0.6	
School location				
Kota Bharu / Urban	253 (50.8)	1.8	2.1	**0.003[a]**
Pasir Mas / Rural	245 (49.2)	1.2	1.9	
Father's education level (n=423)[1]				
Primary school	42 (9.9)	1.5	2.3	0.060[b]
Secondary school	303 (71.6)	1.5	2.0	
STPM/College	33 (7.8)	1.4	2.0	
University	45 (10.6)	1.1	1.7	
Mother's education level (n=447)[1]				
Primary school	24 (5.4)	1.7	2.1	0.070[b]

Table 4.46 Univariate relationship between mean increment of cavitated caries (ICDAS≥3) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498) (continued)

Demographic variable	N (%)	Net increment cavitated caries		*P* value
		Mean	(SD)	
Secondary school	340 (76.1)	1.4	2.0	
STPM/College	36 (8.1)	1.4	1.9	
University	47 (10.5)	1.3	1.7	
Carer's education level (n=30)[1]				
Primary school	6 (20.0)	2.7	2.7	
Secondary school	17 (5.7)	1.4	1.9	0.654[b]
STPM/College	3 (10.0)	1.3	2.5	
University	4 (13.3)	1.3	1.3	
Household income (n=480)[1]				
Poor	231 (48.1)	1.5	2.0	
Low	153 (31.9)	1.5	1.9	0.272[b]
Medium-low	38 (7.9)	1.3	1.9	
Medium-high	25 (5.2)	1.9	2.7	
High	33 (6.9)	0.8	1.0	
Appointed as DM				
Yes	4 (0.8)	2.8	1.3	0.066[c]
No and unsure	494 (99.2)	1.5	2.0	
Availability of DMP in primary school				
Yes	258 (51.8)	1.3	1.9	0.055[a]
No and unsure	240 (48.2)	1.7	2.1	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.
[a] Parametric statistics = Independent t-test
[b] Parametric statistics = One way ANOVA
[c] Non Parametric statistics = Mann-Whitney U
Level of significance is set at $p<0.05$
Post hoc was conducted for father's education and increment of sound teeth, however there were no significant differences between each level of education.

Table 4.47 Factor associated with mean increment of cavitated caries (ICDAS ≥3) of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	1.33				
Increment in OHA	0.04	(0.02, 0.05)	0.21	4.74	***p*<0.001**

R^2 = 0.043, adjusted R^2 = 0.041. Enter method was used for MLR.

Assessment of the statistical assumptions with regard the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (Increment in OHA, tolerance = 1.0, VIF = 1.0)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix O) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix P)

Table 4.48 Univariate relationship between mean increment of decayed surfaces (ICDAS ≥1) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment in decayed surfaces		*p* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	3.3	5.1	0.985[a]
Non-DMP (control group)	247 (49.6)	3.3	4.2	
Gender				
Male	259 (52.0)	3.6	5.0	0.081[a]
Female	239 (48.0)	2.9	4.3	
Ethnicity				
Malay	495 (99.4)	3.3	4.7	0.154[c]
Chinese & Other	3 (0.6)	0.0	2.0	
School location				
Kota Bharu / Urban	253 (50.8)	3.6	4.2	0.123[a]
Pasir Mas / Rural	245 (49.2)	2.9	5.1	
Father's education level (n=423)[1]				
Primary school	42 (9.9)	3.7	4.7	0.125[b]
Secondary school	303 (71.6)	3.2	4.7	
STPM/College	33 (7.8)	4.2	5.1	
University	45 (10.6)	1.8	4.1	
Mother's education level (n=447)[1]				
Primary school	24 (5.4)	2.9	3.5	0.528[b]
Secondary school	340 (76.1)	3.2	4.8	
STPM/College	36 (8.1)	4.0	5.5	
University	47 (10.5)	2.5	3.9	
Carer's education level (n=30)[1]				
Primary school	6 (20.0)	4.2	6.9	0.621[b]
Secondary school	17 (5.7)	2.5	4.9	
STPM/College	3 (10.0)	7.0	7.0	
University	4 (13.3)	3.5	1.7	
Household income (n=480)[1]				
Poor	231 (48.1)	3.0	4.9	0.556[b]
Low	153 (31.9)	3.6	4.5	
Medium-low	38 (7.9)	3.5	4.2	
Medium-high	25 (5.2)	3.2	5.4	
High	33 (6.9)	2.3	4.2	

Table 4.48 Univariate relationship between mean increment of decayed surfaces (ICDAS ≥1) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498) (continued)

Demographic variable	N (%)	Net increment in decayed surfaces		*p* value
		Mean	(SD)	
Appointed as DM				
Yes	4 (0.8)	4.5	4.2	0.506[c]
No and unsure	494 (99.2)	3.2	4.7	
Availability of DMP in primary school				
Yes	258 (51.8)	2.9	4.6	0.069[a]
No and unsure	240 (48.2)	3.7	4.7	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.
[a] Parametric statistic = Independent t-test
[b] Parametric statistic = One way ANOVA
[c] Non Parametric statistic = Mann-Whitney U
Level of significant is set at $p<0.05$

Table 4.49 Univariate relationship between increment of cavitated surfaces (ICDAS ≥3) and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment in cavitated surfaces		*p* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	1.7	2.7	0.985[a]
Non-DMP (control group)	247 (49.6)	1.9	2.5	
Gender				
Male	259 (52.0)	1.7	2.3	0.350[a]
Female	239 (48.0)	1.9	2.8	
Ethnicity				
Malay	495 (99.4)	1.8	2.6	0.245[c]
Chinese & Other	3 (0.6)	0.3	0.6	
School location				
Kota Bharu / Urban	253 (50.8)	2.1	2.7	**0.005[a]**
Pasir Mas / Rural	245 (49.2)	1.5	2.4	

Table 4.49 Univariate relationship between increment of cavitated surfaces (ICDAS ≥3) and categories of demographic characteristics of the schoolchildren after 6 months (N=498) (continued)

Demographic variable	N (%)	Net increment in cavitated surfaces		*p* value
		Mean	(SD)	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	1.9	2.7	
Secondary school	303 (71.6)	1.8	2.5	0.063[b]
STPM/College	33 (7.8)	1.7	2.5	
University	45 (10.6)	1.3	2.2	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	2.9	3.5	
Secondary school	340 (76.1)	3.2	4.8	0.063[b]
STPM/College	36 (8.1)	4.0	5.5	
University	47 (10.5)	2.5	3.9	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	3.2	3.2	
Secondary school	17 (5.7)	1.7	2.8	0.350[b]
STPM/College	3 (10.0)	2.0	3.6	
University	4 (13.3)	1.3	1.3	
Household income (n = 480)[1]				
Poor	231 (48.1)	1.8	2.6	
Low	153 (31.9)	1.8	2.4	
Medium-low	38 (7.9)	1.6	2.5	0.349[b]
Medium-high	25 (5.2)	2.1	3.2	
High	33 (6.9)	0.9	1.2	
Appointed as DM				
Yes	4 (0.8)	3.5	2.5	0.080[c]
No and unsure	494 (99.2)	1.8	2.6	
Availability of DMP in primary school				
Yes	258 (51.8)	1.6	2.4	**0.030[a]**
No and unsure	240 (48.2)	2.1	2.7	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.

[a] Parametric statistics = Independent t-test

[b] Parametric statistics = One way ANOVA

[c] Non Parametric statistics = Mann-Whitney U

Level of significance is set at $p<0.05$

Table 4.50 Factor associated with mean increment of cavitated surfaces (ICDAS ≥3) of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	2.48				
Mother's education level					
Primary school					
Secondary school	-0.73	(-1.35, -0.10)	-0.13	-2.28	**0.023**
University	-0.96	(-1.87, -0.05)	-0.11	-2.06	**0.040**
Increment in OHA	0.05	(0.03, 0.07)	0.21	4.83	***p*<0.001**

No interaction between variables
R^2 = 0.065, adjusted R^2 = 0.056. MLR with backward method was used.

Assessment of the statistical assumptions with regard the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (Mother's education level; secondary school, tolerance = 0.6, VIF = 1.8, university, tolerance = 0.7, VIF = 1.5 and increment in OHA, tolerance = 1.0, VIF = 1.0)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix Q) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix R)

4.7.7 Oral health-related quality of life (OHRQoL)

Table 4.51 shows univariate relationship between mean increment of OIDP score and demographic and related characteristic of the schoolchildren. In this table, only schoolchildren appointed as DM had a significant relationship. However, this variable was not analysed further due to its skewed data. Univariate relationship was also conducted for continuous variables, i.e. increments in OHK, OHA, and OHB with significant associations found for OHK and OHA increment scores.

Table 4.52 shows the factor associated with mean increment of OIDP score. Only mean increment in OHK has a significant association with mean increment in OIDP score. Schoolchildren with a point higher in mean increment of OIDP score would have -0.09 points lower in mean increment of OHK when other factors are similar (p<0.05). This factor explained 1.3% of total variance in mean increment of OIDP score of the schoolchildren.

Table 4.53 shows univariate relationship between the presence of at least one OIDP and the demographic and related characteristic of the schoolchildren after 6 months. Analyses involving categorical and continuous variables showed three (4) categorical variables, i.e. gender, ethnicity, gargling with water after meal, and flossing frequency were significantly associated with the presence of at least one OIDP at follow up. Three (3) continuous variables namely increment in OHK, cavitated caries (ICDAS ≥3) and decay teeth (ICDAS ≥1) were significantly associated with the presence of at least one OIDP after 6 months.

A significantly higher proportion of female schoolchildren (43.1%) compared to male (32.9%) reported having at least one OIDP in the past three months. A significantly higher proportion of schoolchildren flossing less than once daily (40.9%) reported having at least one OIDP than those who flossed at least once daily (27.2%) (p<0.05).

Schoolchildren who reported having at least one OIDP were schoolchildren who gargle with water after meal (35.7%) compared to those who did not gargle after meal (53.4%) ($p<0.05$).

Table 4.54 shows the results of multiple logistic regression analysis to determine significant factors associated with at least one OIDP in the past three months. Out of eight (8) significant factors at univariate analysis, four (4) factors are significantly associated with at least one OIDP, i.e. gender, gargle with water after meal, flossing frequency, and increment in cavitated caries (ICDAS ≥3).

In the model, female are 1.93 more likely to experience at least one OIDP compared to male students (OR=1.93, 95% CI= 1.30-2.88, $p<0.01$).

Schoolchildren who do not gargle after meal are 1.95 more likely to experience at least one OIDP compared to schoolchildren who gargle after meal (OR=1.95, 95% CI= 1.08-3.52, $p<0.05$).

Schoolchildren who floss their teeth less than once daily are 1.94 more likely to experience at least one OIDP compared to schoolchildren who floss at least once daily (OR=1.94, 95% CI= 1.19-3.18, $p<0.01$).

Schoolchildren with high mean increment in cavitated caries (ICDAS ≥ 3) are 1.20 more likely to experience at least one OIDP compared to schoolchildren with less increment in cavitated caries (OR=1.20, 95% CI= 1.09-1.33, $p<0.001$).

For each factor, the odds were calculated after controlling for the effects of other factors. The Hosmer & Lemeshow test showed a non-significant value ($R^2 = 0.94$) indicating a good fitting model with moderate to good predictive accuracy (classification table 62.2%).

Table 4.51 Univariate relationship between mean increment of total OIDP score and categories of demographic characteristics of the schoolchildren after 6 months (N = 498)

Demographic variable	N (%)	Net increment of OIDP score		*p* value
		Mean	(SD)	
Type of school				
DMP (intervention group)	251 (50.4)	0.7	7.3	0.963[a]
Non-DMP (control group)	247 (49.6)	0.7	8.6	
Gender				
Male	259 (52.0)	0.5	8.5	0.595[a]
Female	239 (48.0)	0.9	7.3	
Ethnicity				
Malay	495 (99.4)	0.7	8.0	0.879[c]
Chinese & Other	3 (0.6)	-2.8	8.4	
School location				
Kota Bharu / Urban	253 (50.8)	0.4	8.2	0.349[a]
Pasir Mas / Rural	245 (49.2)	1.0	7.7	
Father's education level (n = 423)[1]				
Primary school	42 (9.9)	-0.9	6.5	
Secondary school	303 (71.6)	0.8	7.9	0.372[b]
STPM/College	33 (7.8)	-0.5	6.1	
University	45 (10.6)	2.2	9.7	
Mother's education level (n = 447)[1]				
Primary school	24 (5.4)	-0.5	4.3	
Secondary school	340 (76.1)	0.6	8.2	0.804[b]
STPM/College	36 (8.1)	1.3	8.0	
University	47 (10.5)	1.6	8.7	
Carer's education level (n = 30)[1]				
Primary school	6 (20.0)	6.7	11.9	
Secondary school	17 (5.7)	2.0	6.9	0.302[b]
STPM/College	3 (10.0)	0.9	7.0	
University	4 (13.3)	-3.5	6.9	
Household income (n = 480)[1]				
Poor	231 (48.1)	0.5	8.1	
Low	153 (31.9)	0.8	7.9	
Medium-low	38 (7.9)	1.1	6.7	0.548[b]
Medium-high	25 (5.2)	-0.8	9.5	
High	33 (6.9)	2.7	8.3	
Appointed as DM				
Yes	4 (0.8)	-3.8	3.1	**0.033[c]**
No and unsure	494 (99.2)	0.7	8.0	

Table 4.51 Univariate relationship between mean increment of total OIDP score and categories of demographic characteristics of the schoolchildren after 6 months (N = 498) (continued)

Demographic variable	N (%)	Net increment of OIDP score		*p* value
		Mean	(SD)	
Availability of DMP in primary school				
Yes	258 (51.8)	0.2	7.8	0.127[a]
No and unsure	240 (48.2)	1.3	8.1	

[1] Sample size did not equal to N = 498 due to missing data. The schoolchildren lived with his/her father/mother/carer.

[a] Parametric statistics = Independent t-test

[b] Parametric statistics = One way ANOVA

[c] Non Parametric statistics = Mann-Whitney U

Level of significance is set at p<0.05

Table 4.52 Factor associated with mean increment in total OIDP score of the schoolchildren (result of MLR analysis)

Factor	*b* coefficient	(95% CI)	β Standardised Coefficient	*t* statistics	*p* value
Constant	1.01				
Mean increment in OHK	-0.09	(-0.16, -0.02)	-0.11	-2.56	**0.011**

R^2 = 0.013, adjusted R^2 = 0.011. MLR with backward method.

Assessment of the statistical assumptions with regard the model showed all assumptions had been met:

i. Collinearity indicated that multicollinearity was not a concern (Increment in OHK, tolerance = 1.0, VIF = 1.0)

ii. Other assumption such standard residuals (error terms) that were approximately normally distributed in a histogram and P-P plot (Appendix S) and plotting the standardised residual (ZRESID) against the standardised predicted values (ZPRED) showed that the standardised residuals appeared scattered on both sides of and along the zero line and dispersion was approximately constant along standard predicted value. These satisfied the linearity and homoscedasity assumptions of the model and reflected good overall model fitness (Appendix T)

Table 4.53 Univariate relationship between the presence of at least one OIDP and the demographic and related characteristics of the schoolchildren after 6 months (N = 498)

Variable	Total n (%)	Presence at least one OIDP		*p* value
		Yes (n = 188) row %	No (n = 310) row (%)	
Gender				
Male	259 (52.0)	85 (32.8)	174 (67.2)	**0.012***
Female	239 (48.0)	103 (43.1)	136 (56.9)	
Ethnicity				
Malay	495 (99.4)	185 (37.4)	310 (62.6)	**0.026***
Chinese and Other	3 (0.6)	3 (100.0)	0 (0.0)	
Gargling with water after meal				
Yes	440 (88.4)	157 (35.7)	283 (64.3)	**0.007***
No	58 (11.6)	31 (53.4)	27 (46.6)	
Flossing frequency				
At least once daily	114 (22.9)	31 (27.2)	83 (72.8)	**0.005***
Less than once daily	384 (77.1)	157 (40.9)	227 (59.1)	

*Chi-square test

Level of significant is set at $p<0.05$

Variables presented in the above table are variables that have significant values only.

Continue variables with a significant association with the presence of at least one OIDP in simple logistic regression are increment in oral health knowledge, cavitated caries (ICDAS≥3), and decayed teeth (ICDAS≥1) with $p<0.05$.

Variables with non-significant associations were Group, Ethnicity, Father's education level, Mother's education level, Carer's education level, Household income, School location, Appointed as DM in school, Availability of DMP in primary school, Frequency of brushing teeth, Using of fluoride toothpaste, Sweet intake and Smoking habit.

Table 4.54 Factors associated with the presence of oral impacts on daily performances of the schoolchildren after 6 months (result of multiple logistic regression analysis) with enter method.

Factor	B (SE)	Wald	95% CI for Odd Ratio		
			Lower	Odds Ratio	Upper
Included					
Constant	-1.72 (0.27)	-	-	-	-
Gender					
Male	-	-	-	-	-
Female	**0.66 (0.20)	10.51	1.30	1.93	2.88
Gargling with water after meal					
Yes	-	-	-	-	-
No	*0.67 (0.30)	4.87	1.08	1.95	3.52
Flossing at least once daily					
Yes	-	-	-	-	-
No	**0.67 (0.25)	7.06	1.19	1.94	3.18
Increment in cavitated caries (ICDAS ≥3)	***0.19 (0.05)	13.85	1.09	1.20	1.33

R^2 = 0.94 (Hosmer & Lemeshow), 0.08 (Cox & Snell), 0.10 (Nagelkerke)

Model X^2 (4) = 39.23, $p<0.001$

Overall predictive accuracy = 62.2%

*** $p<0.001$, ** $p<0.01$, *$p<0.05$

The assumption of linearity of the logit has been met for the continuous variable increment of decay teeth (ICDAS ≥3).

All variables with significant value $p<0.05$ in univariate relationship were further analysed in multiple logistic regression except for ethnicity due to skewed data (almost 100% of ethnicity was Malay). However, after further analyses were done, only gender, behavioural on gargling, flossing, and increment in caveated caries (ICDAS ≥3) showed significant values in multiple logistic regression.

4.8 Summary results of quantitative study

In general, the present study did not show results in favour of the IG compared to the CG after 6 months exposure to DMP in secondary school.

The impacts of DMP can be divided into immediate impact (increment in OHK and OHA scores), intermediate impact (increment in OHB and reduction in plaque scores), and health impact (increment in gingival health, reduction in caries incidence, and improvement in OHRQoL).

For immediate impact:

i. there was no significant difference in mean increment of OHK between IG and CG after 6 months. Both groups showed a significant increment in total OHK score after 6 months.

ii. the mean increment score of OHA was significantly higher in CG compared to IG (p<0.001) after 6 months. Comparison within-group of mean OHA total scores between baseline and after 6 months showed that in both groups, the mean OHA total scores were significantly higher after 6 months.

For intermediate impact:

i. the mean OHB decrement score was higher in IG compared to CG but the difference was not statistically significant. There was a significant within-group decrement in mean OHB score in IG after 6 months.

ii. after 6 months, the CG showed a significantly higher plaque score compared to IG. However, both groups showed a significant decrement of plaque score after 6 months.

For health impact:

i. the mean increment score of GIS in the IG was significantly higher than the CG (p<0.001).

ii. both groups showed a significant within-group increment in mean decayed teeth (p<0.001) in each group. However, there was no between-group difference in mean decayed teeth after 6 months.

iii. there was no significant difference in mean increment of OIDP score between both groups.

Meanwhile, for associated factor that related to schoolchildren's OHK, OHA, OHB, OHS and OHRQoL as below:

i. male schoolchildren would have 1.96 points higher in mean OHK increment than female schoolchildren. Schoolchildren in urban areas have 5.29 points higher in mean OHK increment than schoolchildren in rural areas when factor are similar.

ii. schoolchildren in urban areas would have 4.62 points higher in mean OHA increment than schoolchildren in rural areas when other factor are similar. Male schoolchildren would have 2.45 points higher in mean OHA increment than female schoolchildren. The schoolchildren in non-DMP school would have 3.53 points higher in mean OHA increment than schoolchildren in DMP school. The increment in OHK is a factor for increment in OHA level.

iii. the schoolchildren in rural areas would have 10.98 points higher in plaque score increment compared to schoolchildren in urban areas.

iv. the schoolchildren in DMP would have 0.33 points higher in increment score of GIS compared to schoolchildren in non-DMP school.

v. increment in OHA score (0.04) was associated with increment of cavitated caries.

vi. the regression coefficient of mother's education levels up to secondary school (-0.73), university (-0.96), and increment in OHA (0.05) are associated with increment of cavitated surface.

vii. decrement in OHK score (-0.09) was associated with decrement in total OIDP score of the schoolchildren.

viii. 4 factors are significantly associated with the presence of at least 1 OIDP when other factors are similar, i.e. gender, gargle mouth with water after meal, flossing frequency, and increment in cavitated caries (ICDAS $\geq$3).

4.9 Result of FGD (Objective 3)

Overall, sixteen (16) DMs took part in 2 sessions of FGD which aimed to gather qualitative data on the process implementation of DMP from the perspectives of DM schoolchildren. To achieve this, opinions and views from DM perspectives were sought through FGD. Data collection was carried out at two schools in the IG, i.e. SMK Tanjug Mas and SMK Bunut Susu.

In each session, eight (8) DM schoolchildren were involved. Table 4.55 shows the schoolchildren profile.

Table 4.55 Profile of DM schoolchildren

Schoolchildren profile	SMK Tannjung Mas n (%)	SMK Bunut Susu n (%)	Total n (%)
Male	1 (12.5)	6 (75.0)	7 (43.8)
Female	7 (87.5)	2 (25.0)	9 (56.2)
Total	8 (100)	8 (100)	16 (100)

4.9.1 Results of FGD according to domain

(A) Selection of DM

Question: What are your opinions about the selection process and appointment of DM in your school?

In general, it was found that DM's in both schools were recruited through appointments by teachers. None of them came forward and volunteered to be a DM in the first place.

(*All participants from SMK Bunut Susu).*

The selection criteria were schoolchildren with good academic performance (e.g. Science & Arabic class schoolchildren), having good communication skills, and who have been appointed as DMs in the previous year.

"Selection of DM starts from first class. Form 5 Science, 4 Science, 3 Bahasa Arab and 2 Bahasa Arab. DMs were chosen from the first classes is due to their ability to communicate well and academic reasons"

P9**,** Male, Malay, 17, F5 Sc

"DMs were selected from the previous year's DM. If you had been a DM the year before, you'll automatically be chosen to become a DM in the following year"

P2, Female, Malay, 16, F4D

Although they can refused the appointment, none of them refused because they were interested and willing to become DM.

"If those who are not interested can withdraw"

P9, Male, Malay, 17, F5 Sc

Nevertheless, it was also reported that there was a quota for the number of members in DM club to ensure that other school clubs would have enough members to function properly.

"There is a quota. The teacher has set a quota (limit) on the DM membership due to the high number of interested students (in the DM) that caused other clubs to have very little members"

P6, Female, Malay, 16, F4D

(B) Training of DM

Question: What are your opinions about the training received by the DM?

There were mixed responses in terms of the sufficiency of training and exposure received by DM. In terms of training, the participants can be divided into two groups. One group was those appointed as DM in the previous year and had more than 1-year experience and the other group had just been appointed in this current year. Surprisingly, the vast majority of DM from both schools (even the experienced DM) perceived that their training was insufficient. Whereas, a few DM in SMK Bunut Susu (which have better and sufficient resources) perceived their training was sufficient.

"Maybe it's enough"

P1, Female, Malay, 14, F2G

"I do not think it is enough"

P5, Male, Malay, 16, F4D, P12, Male, Malay, 16, F4 Sc

The participants mentioned that they obtained informal exposure from health personnel who came to school to provide health-related information. The participant was also informed that they had made a visit to primary school to provide tooth-brushing drill to the primary schoolchildren.

"We also got exposure from the health unit and hospitals that came here to teach what we did not know"

P9, Male, Malay, 17, F5 Sc

"There are numerous activities in this school's DMP. I even went to primary school to teach them on tooth brushing"

P10, Male, Malay 17, F5 Sc

A participant shared her experience of undergoing a "training of trainers" (TOT) course following her appointment as DM and later conducted an echo training to other DM. We detected an unstandardised pattern of training among the participants. DM from the 1st school (SMK Tanjung Mas) reported of being self-trained, to choose own topics and learn on the selected topics they have chosen from the DMP module. In contrast, training in SMK Bunut Susu was more systematic, carried out in small group discussions on top of being trained by the teachers who were in-charge of the DM club at their school. Normally two (2) scopes/topics were covered in a monthly basis. The known reason/s for perceiving their training were insufficient were contributed by;

i. the way they were trained,

ii. not all DMs attended the meeting/training,

iii. time constraints due to the need to give way to other compulsory activities i.e. sports and uniformed activities. However, we do not know why DM teachers in SMK Tanjung Mas were perceived as not trainning their DM schoolchildren.

"After I was appointed as DM; at the beginning of the year, I was sent to a course, along with 2 other colleagues for DM training of trainers. So, I knew more as compared to other DMs. Later, I conducted echo- training at school"

P11, Male, Malay, 17, F5 Sc

"Teacher would give the DMP's book, and then we need to choose the topic that we are interested in"

P2, Female, Malay, 16, F4D

The participants perceived that they have insufficient training also due to lack of supervision from DM teachers. They also perceived that DM teachers do not care if DM do not attend meeting and training for the DM club.

"Yes (DM teacher does not mind if DM absent from the DM class)"

P12, Male,16, F4 Sc

(C) Implementation of DMP

Question: What are your opinions about the implementation of DMP at your school?

It was clear that SMK Bunut Susu managed to implement their DMP in a more organised, systematic, and effective way as compared to SMK Tanjung Mas. With regard to the conduct of the DM club and DM activities, some issues have been identified particularly the conduct of DM club's (meeting frequency & attendance), the DM teacher's attitude, other schoolchildren's acceptance of the health messages delivered and effectiveness of the health messages. Although ideally the DM club meeting/training should be conducted on weekly basis (on Wednesday-co-curriculum day), in reality in occurred only once in 3 weeks (SMK Bunut Susu) due to other compulsory activities e.g. sports and uniformed activities.

"Supposedly, the DM club meeting should be held on a weekly basis; every Wednesday, However, sometimes meeting is conducted according to the needs. Due to this Wednesday, sometimes there are activities of co-curriculum units, uniformed bodies, associations and sports clubs and games. Sometimes on the day of the DM meeting, members of the DM club gather and conduct their own activities"

P10, Male, Malay, 17, F5 Sc

Participants from SMK Bunut Susu also shared the fact that not all DM attended the meeting cum training sessions and even their teacher did not mind of the non-attendees also doing so, inadvertently contributing to the perception of having insufficient training among the DMs.

"Some DMS are constantly absent during every meeting"

P13, Male, Malay, 14, F2 Arab

Pertaining to acceptance of the health messages among the schoolchildren, again mixed responses were reported. Some DMs perceived better acceptance from schoolchildren with better academic performances (front classes) as compared to schoolchildren in the back classes whom just ignored, ran away or being stubborn. Nevertheless, other DM perceived no difference of acceptance between the front and back classes student's, as it depends on the student's attitude. DM from SMK Tanjung Mas reported no/little experience of positive changes following delivery of health messages among their friends except for reduction of sugary drinks intake. However, their counterparts in SMK Bunut Susu achieved outcomes that are more positive.

"In my case, my friends was accepted my advices because we are from the same class. However, for students in the lower or end classes, it is rare for them to listen and follow what I have delivered; maybe because they are living in their own world"

P9, Male, Malay 17, F5 Sc

(D) Support and materials for DMP

Question: What are your opinions about the support and materials provided by the school for DMP?

DM in both schools reported of having support from their DM teachers especially in answering queries from the DMs. Some teachers were more helpful as compared to the other DM teachers. Again, dissimilarity in resources were reported between the 2 schools.

"If I did not know the answer, I would refer to the DM's teacher and we'll discuss it"

P11, Male, Malay 17, F5 Sc

While DMs in SMK Bunut Susu perceived sufficient reading materials, support and financial resources (obtained through DMP club fees), their counterparts in SMK Tanjung Mas experienced the opposite. The DMP in both schools are facing constraints in terms of obtaining the required resources. They obtained information from the internet and used their own money to produce materials needed to conduct activities.

"Every members need to pay an annual fee of RM 3 each. The club's money would be used to carry out any project"

P9, Male, Malay, 17, F5 Sc

"Funding is by our own money"

All participants in SMK Tanjung Mas

Participants from SMK Bunut Susu shared positive feedback regarding their infrastructures, having the presence of the health room (despite being small/ narrow) and the science laboratory as their meeting venue.

"I think it's already enough because DM meetings would be held in the science laboratory"

P12, Male, Malay, 16, F4 Sc

The DMPs in SMK Tanjung Mas were fortunate to receive support from the health clinics in conducting their activities (health carnival) and even collaborated with the Hospital Raja Perempuan Zainab II in a programme related with accidents before. Sadly, they also informed that there was no support given/ obtained from the dental side.

"We have collaborated before with the hospital during the health carnival. Information was shared with friends through the pamphlet provided by the hospital"

P3, Female, Malay, 16, F4D

(E) Benefits of the DMP

Question: What are your opinions about the benefits of the DMP?

Participants reported various benefits of being a part of the DMP. They perceived that they have attained health knowledge and practicing healthy lifestyles, i.e. weight management, the need to reduce sugar intake, smoking harms.

"*In terms of us who do not know anything before, we attained new health knowledge"*

P6, Female, Malay, 16, F4D

"I had an obesity problem. Having involved with this club, I have learned how to reduce and get an ideal weight"

P16, Female, Malay, 15, F3 Arab

The health-related information that obtained from DMP is able to share with other schoolchildren, family members, and community.

"Health is not just for ourselves, but also our families"

P12, Male, Malay, 16, F4 Sc

Participants also perceived that DMP able to attract friends from other classes and they can share the information to other schoolchildren. Indirectly, they can motivate the positive changes among the schoolchildren.

"Able to give awareness to friends who smoked cigarette and vape. Although it's not much but some friends did change"

P6, Female, Malay, 16, F4D

Participants also stated that they have developed a good teamwork among the DM members to conduct activities in their school.

"So far, the DMP ran smoothly and gets co-operation from both students and teachers"

P7, Female, Malay, 16, F4D

Participants acknowledged when involved in the DMP, they are more confident in communicating and speaking in front of public to share health-related information.

"I followed a course that taught me public speaking. Since I was involved with DMP and sent to that course, I was more confident talking in the public and does not stutter anymore, know the techniques of doing presentation etc"

P9, Male, Malay, 17, F5 Sc

The lack of collaboration could be driven by the actual motives of one in joining the DM club. As the most active club in schools (having various activities) and more opportunities to join a multitude of competitions, students are interested to be DM for the benefits of getting merits and certificates for their future.

"As for me, I joined this club because DM Club is the most active club and would contribute high marks to further my study later"

P2, Female, Malay, 16, F4D

(F) Weaknesses of the DMP

Question: What are your opinions about the weaknesses of the DMP?

Unfortunately, despite several issues or loopholes in the DMP, all DM in SMK Tanjung Mas and SMK Bunut Susu agreed and claimed that they perceived no strong weaknesses to the DMP. However, we have detected several issues regarding the DMP.

In general, the allocated time for delivering DM activities were insufficient and conflicted with other activities. For example, to demonstrate the hand-washing technique during recess time (a short and busy time for everybody) or the norm of conducting activities in the afternoon session (which is shorter than the morning session).

"Well, actually the teacher informed that we need to deliver the assigned title during recess time, for example the correct hand washing method. It was not done because there is not enough time"

P8, Female, Malay, 16, F4D

It was also found that there was a lack of collaboration among the DM themselves. Not all DM attend the meeting/ training, which lead to only the same people involved in almost each activity. In addition to that, most DMs are selected from the front classes and they perceived that they have other activities to complete.

"Collaboration only between the active students".

P14, Male, Malay, 14, F2 Arab

DM also expressed concerns on the heavier burden borne by DMs from the front classes where it affected their learning time and other activities (as they need to deliver the programme).

"Some of the DM felt burdened with the tasks related to the DM club"

P14, Male, Malay, 14, F2 Arab

"Should this DM club have to be exposed to other classes too. Because the students in the front class have many activities to do"

P15, Female, Malay, 15, F3 Arab

Although some DM managed to deliver health messages in a tactful manner, others reported a more autocratic and arrogant approaches (telling others to keep quiet and walk away when people did not heard their advice) which may lessen the aspired outcomes of

DMP. Their peers prefer to be involved in hands-on health-related activities such as a singing competition rather than just listening to a talk.

"Some would listen while others were tired of hearing a talk"

P2, Female, Malay, 16, F4D

"Students are more interested in the performance-based activities (entertainment-based), *for example the singing performances. There must be elements of entertainment or they would get bored with just the talk approach"*

P2, Female, Malay, 16, F4D

(G) Recommendations

Question: In your opinions, what are your recommendations to improve the DMP at your school?

It was suggested to implement DMP for every school as the contents of DMP are good, structured and is beneficial. Due to the busy nature of the DM teachers and the infrequent visit by the school's health advisor, participant felt that a health adviser should dedicated in their school.

"A health advisor for the school, whom only visits once or twice a week. If someone dedicated here, it's better. Because need to depend on Cikgu Mat, he is busy in teaching other students"

P11, Male, Malay, 17, F5 Sc

Due to the small number of membership in the DM club despite high work burden (numerous topics to be covered and activities to be conducted throughout the year), participants have suggested to increase the number of DM club membership and extends it to other students too (e.g. from the back classes). Participants perceived the back classes students as being marginalised, and subjected to unfair selection of DM, as reflected by the fact that existing DM are selected only among students from the front classes to be the role models due to their better communication skills and better academic performance (that would help to follow the DMP's syllabus) despite that they were also students from the back classes whom are good and interested to be DM.

"It should be made equal (chance) to both end and front classes. Each class should have a DM representative as a role model"

P14, Male, Malay, 14, F2 Arab

They also suggested for the activities to be delivered in the morning session (longer time available).

"To conduct activity in morning session (longer session as compared to the afternoon session)"

P3, Female, Malay, 16, F4D

Figure 4.1 shows a summarised findings of the factors affecting the implementation of DMP in SMK Bunut Susu and SMK Tanjung Mas from the perspectives of the DM. Meanwhile, Table 4.56 shows the domains, theme and verbatim gathered from the FGD sessions.

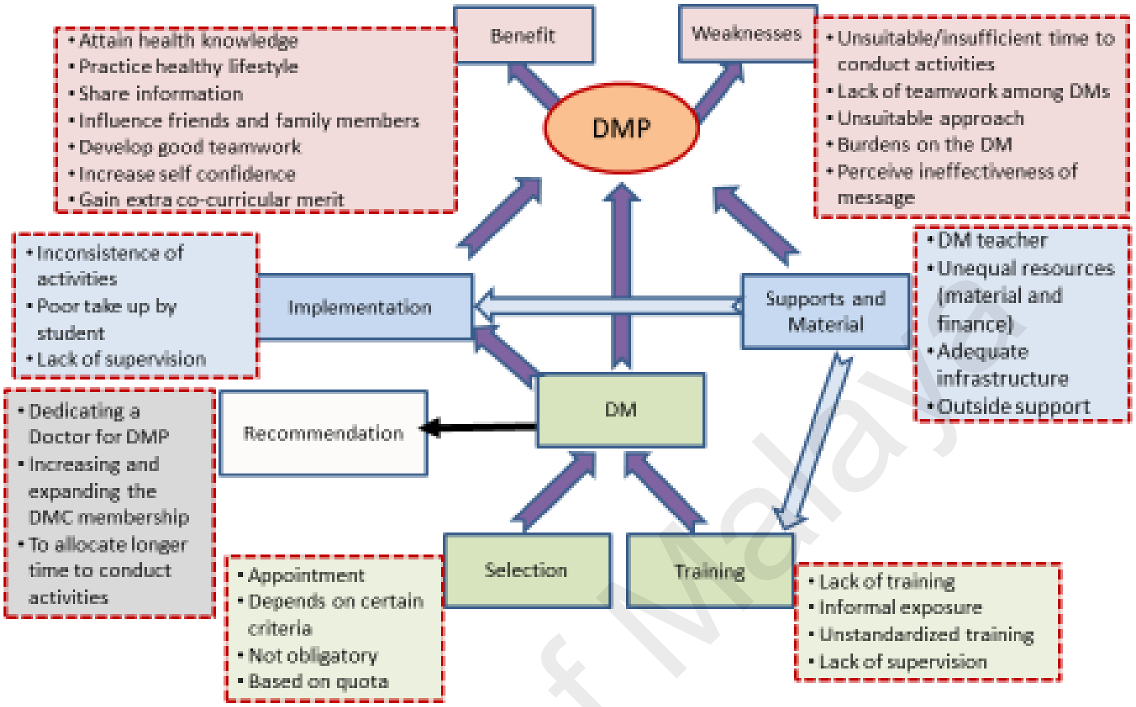

Figure 4.1 Contributing factors affecting the implementation of DMP in secondary schools in District of Pasir Mas and Kota Bharu.

Table 4.56 Results of the FGD according to domain

DOMAINS	THEMES	Verbatim
(A) Selection of DM	**1 By appointment**	• *I am selected by Cikgu Munirah who is the teacher and facilitator for DM in this school* **P1,**Female, Malay, 14, F2G • *I was chosen to be DM.* **P11,** Male,17, F5 Sc, **P13**, Male,Malay, 14, F2 Arab and **P16**, Female, Malay, 15, F3 Arab • *Yes..it's the same for us (Appointed and we're willing)* All participants in SMK Bunut Susu.
	2 Depends on certain criteria.	• *Selection of DM starts from first class. Form 5 Science, 4 Science, 3 Bahasa Arab and 2 Bahasa Arab. DMs were chosen from the first classes is due to their ability to communicate well and academic reasons.* **P9,** Male, Malay, 17, F5 Sc • *Since last year, in form 4 science.* **P11,** Male,17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *DMs were selected from the previous year's DM. If you had been a DM the year before, you'll automatically be chosen to become a DM in the following year.* **P2,** Female, Malay, 16, F4D
	3 Not obligatory	• *If those who are not interested can withdraw.* **P9,** Male, Malay, 17, F5 Sc • *As I've mentioned earlier, all students from the sience clases in Forms 4 and 5 will be selected all as DM. Then Cikgu Mat will ask, if they are interested. The names of those who are uninterested would be removed. But for the lower forms, they are selected among interested students from the Bahasa Arab class* **P9,** Male, Malay, 17, F5 Sc
	4 Based on quota	• *There is a quota. The teacher has set a quota (limit) on the DM membership due to the high number of interested students (in the DM) that caused other clubs to have very little members.* **P6,** Female, Malay, 16, F4D

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
(B) Training of DM	**1 Lack of training**	• *Maybe it's enough* **P1,**Female, Malay, 14, F2G • *I do not think it is enough.* **P5,** Male, Malay, 16, F4D, **P12,** Male, Malay, 16, F4 Sc • *No (training given to the DMs)* All participants in SMK Tanjung Mas
	2 Informal exposure	• *We also got exposure from the health unit and hospitals that came here to teach what we did not know.* **P9,** Male, Malay, 17, F5 Sc • *There are numerous activities in this school's DMP. I even went to primary school to teach them on tooth brushing.* **P10**, Male, Malay 17, F5 Sc
	3 Unstandardized training	• *The teacher will divide students into several DM groups. Each group would be given a title from the DM syllabus. For example, a charming smile title will tell about your teeth, smoking, and vape.* **P6,** Female, Malay, 16, F4D

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *Teacher would give the DMP's book, and then we need to choose the topic that we are interested in.* **P2,** Female, Malay, 16, F4D • *The teacher would present the remaining (unselected) topic/s* **P3,** Female, Malay, 16, F4D • *Otherwise, we also listened to what is being delivered by other DM groups.* **P7,** Female, Malay, 16, F4D • *After I was appointed as DM; at the beginning of the year, I was sent to a course, along with 2 other colleagues for DM training of trainers. So, I knew more as compared to other DMs. Later, I conducted echo- training at school.* **P11,** Male, Malay, 17, F5 Sc • *When all DMs are assembled, Cikgu Mat will deliver information according to topics. After the information is presented, several groups will be formed and assigned different topics to be discussed. The relevant groups need to elaborate information on selected topics. Each group consists of 15 DMs.* **P11,** Male, Malay, 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
	4 **Lack of supervision**	• *many DMs do not attend the classes and training of DM Club* **P12,** Male,16, F4 Sc • *Yes (DM teacher does not mind if DMs absence from the DM class)* **P12,** Male,16, F4 Sc
(C) Implementation of DMP	1. **Inconsistence of activities**	• *Morning activity. The morning activities are for example; giving talk about vape and others. Meanwhile, DM club meeting would be held after the school session in the afternoon* **P2,** Female, Malay, 16, F4D, **P3,** Female, Malay, 16, F4D • *Supposedly, the DM club meeting should be held on a weekly basis; every Wednesday, However, sometimes meeting is conducted according to the needs. Due to this Wednesday, sometimes there are activities of co-curriculum units, uniformed bodies, associations and sports clubs and games. Sometimes on the day of the DM meeting, members of the DM club gather and conduct their own activities.* **P10**, Male, Malay, 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *After the assembly, about once a month, depending on the time (availability) and topic.* **P3,** Female, Malay, 16, F4D • *In average, about once a month.* **P2,** Female, Malay, 16, F4D • *Approximately once in 3 weeks* All participants in SMK Bunut Susu • *The campaign is run on a monthly basis and each month a topic would be covered* **P2,** Female, Malay, 16, F4D
	2. Lack of supervision	• *Some DMs are constantly absent during every meeting* **P13**, Male, Malay, 14, F2 Arab • *Yes (DM teacher does not mind if DMs absence from the DM class)* **P12,** Male,16, F4 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
	3. Poor take up by student	• *Although there are many members of DM are but only a few whom are attending meeting* **P12,** Male, Malay, 16, F4 Sc • *There are some who would asked, some who just kept silent while others just do not bother.* **P1,**Female, Malay, 14, F2G • *In my case, my friends was accepted my advices because we are from the same class. However, for students in the lower or end classes, it is rare for them to listen and follow what I have delivered; maybe because they are living in their own world.* **P9,** Male, Malay 17, F5 Sc • *Students in the front class, they already know what is good and bad for themselves. It is a little bit hard for those from back classes. If we advise and talk to them, they would run away.* **P11,** Male, Malay 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
(D) Support and materials for DMP	**1. DM Teacher**	• *Teacher would briefly inform us on how to perform the assigned task.* **P3,** Female, Malay, 16, F4D • *Teachers only provide the topics whereas we need to produce the materials on our own.* **P2,** Female, Malay, 16, F4D • *If I did not know the answer, I would refer to the DM's teacher and we'll discuss it.* **P11,** Male, Malay 17, F5 Sc
	2. Unequal resources (Material and financial)	• *In terms of material, it is not enough.* **P4** ,Female, Malay, 16, F4D • *Funding is by our own money* All participants in SMK Tanjung Mas • *Yes (we need to use our own money), due to the little allocation. When the money is scarce, we need top up with our own money.* **P6,** Female, Malay, 16, F4D • *None (reference books for certain topics)* **P10**, Male, Malay 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
	3. **Adequate infrastructures**	• *Every members need to pay an annual fee of RM 3 each. The club's money would be used to carry out any project.* **P9,** Male, Malay, 17, F5 Sc • *The DM room is narrow, expanding it would be good for conducting DM activities. Sometimes, if there is a health check-up conducted in the DM room, the room would be congested* **P9,** Male, Malay, 17, F5 Sc • *I think it's already enough because DM meetings would be held in the science laboratory* **P12,** Male, Malay, 16, F4 Sc • *It feels like the DM stuff is already enough.* **P10**, Male, Malay, 17, F5 Sc
	4. **Outside support**	• *Yes (we did get some help). For example, we have collaborated to conduct an exhibition in school. About constructing the food pyramid, we assisted by clinic (health) but not the dental clinic.* **P3,** Female, Malay, 16, F4D

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *We have collaborated before with the hospital during the health carnival. Information was shared with friends through the pamphlet provided by the hospital.* **P3,** Female, Malay, 16, F4D • *We also got exposure from the health unit and hospitals that came here to teach what we did not know.* **P9,** Male, Malay, 17, F5 Sc • *There is a health advisor for the school, whom only visits once or twice a week* **P11,** Male, Malay, 17, F5 Sc
(E) Benefits of DMP	**1. Attain health knowledge**	• *In terms of us who do not know anything before, we attained new health knowledge* **P6,** Female, Malay, 16, F4D • *After I joined in DM club, I was able to experience a lot of knowledge that I rarely encountered and not in the syllabus at school. The DM Club is more inclined towards medicine, so it suits me as I aspire to become a doctor. DMC teaches more on the basis of health besides being a role model for other students in the school.* **P10**, Male, Malay, 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *I have gained knowledge on how to maintain health also the advantages and disadvantages of it.* **P11,** Male, Malay, 17, F5 Sc
	2. Practice healthy lifestyles	• *I had an obesity problem. Having involved with this club, I have learned how to reduce and get an ideal weight.* **P16**, Female, Malay, 15, F3 Arab • *For me, by joining this DMP I can practice a healthy way of life. Healthy eating, better managing daily life. DM focuses more on healthier lifestyle* **P9,** Male, Malay, 17, F5 Sc • *It promotes good, daily health practices to us and relates to our daily lives* **P10**, Male, Malay, 17, F5 Sc
	3. Share information with family members and communities	• *DMP is good, we can take care of our health and provide information to families and friends* **P13**, Male, Malay, 14, F2 Arab

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *I can inform the community about the dangers of chemical substances contained in the cigarette smoke and how it affects the human body. In conclusion, what we have learned in the DMP can be delivered to outsiders.* **P11,** Male, Malay, 17, F5 Sc • *The DMP has allowed me to teach those who do not know and understand what l have learned from it.* **P9,** Male, Malay, 17, F5 Sc • *Health is not just for ourselves, but also our families.* **P12,** Male, Malay, 16, F4 Sc • *We shared it with our family.* All participants in SMK Bunut Susu.
	4. Influence friends and family members towards positive changes	• *Able to give awareness to friends who smoked cigarette and vape. Although it's not much but some friends did change.* **P6,** Female, Malay, 16, F4D • *There is changes, some reduced the intake of sugary drinks* **P4** ,Female, Malay, 16, F4D

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *I think there are positive changes, mostly among the obese. If they ask for advice from me, I will give them advice and information. I'll encourage them to play sports like futsal, practice healthy dietary intake* **P11,** Male, Malay, 17, F5 Sc • *I have friends from other schools that are heavy cigarette smokers and vapes. When I advised them, they've reduced from many to 3 sticks a day. Likewise with vape, they also reduce the frequencies of vape intake.* **P13**, Male,Malay, 14, F2 Arab
	5. Develop good teamwork	• *Co-operation and teamwork* **P6,** Female, Malay, 16, F4D • *DMP ran smoothly because the students are co-operating well* **P14**, Male, Malay, 14, F2 Arab • *So far, the DMP ran smoothly and gets co-operation from both students and teachers.* **P7,** Female, Malay, 16, F4D

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
	6. Increase self confidence	• *By joining this club, it can increase confidence level. They would experience the 'feel' of managing and administering an organization in order to conduct the activities. They can use the skills for future* **P11**, Male, Malay, 17, F5 Sc • *I followed a course that taught me public speaking. Since I was involved with DMP and sent to that course, I was more confident talking in the public and does not stutter anymore, know the techniques of doing presentation etc.* **P9,** Male, Malay, 17, F5 Sc
	7. Gain extra co-curricular merit	• *As for me, I joined this club because DM Club is the most active club and would contribute high marks to further my study later.* **P2,** Female, Malay, 16, F4D • *DMP have a lot of activities, so we could obtain many certificates.* **P3,** Female, Malay, 16, F4D • *Certificates are awarded based on participation in any contest and the co-curriculum score.* **P10**, Male, Malay, 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
(F) Weaknesses of DMP	**1. Unsuitable/insufficient time to conduct activities**	• *10 minutes (to give talk, performances, gimmick) after assembly* **P2,** Female, Malay, 16, F4D • *Well, actually the teacher informed that we need to deliver the assigned title during recess time, for example the correct hand washing method. It was not done because there is not enough time.* **P8,** Female, Malay, 16, F4D
	2. Lack of teamwork among DMs	• *They only want the certificates but do not follow the activities that were conducted.* **P12,** Male, Malay, 16, F4 Sc • *Some DM members do not know the roles of DM i.e. during sports day and what to do. Furthermore, not many want to be a volunteer.* **P16**, Female, Malay, 15, F3 Arab • *It will be more successful if all the DMC members co-operate adequately* **P12,** Male, Malay, 16, F4 Sc • *Lack of collaboration between the upper and lower form* **P9,** Male, Malay, 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
	3. Burdens on the DM	• *Lack of volunteerism among members' during school activities.* **P16**, Female, Malay, 15, F3 Arab • *Collaboration only between the active students.* **P14**, Male, Malay, 14, F2 Arab • *Some of the DM felt burdened with the tasks related to the DM club* **P14**, Male,Malay, 14, F2 Arab • *Should this DM club have to be exposed to other classes too. Because the students in the front class have many activities to do.* **P15**, Female, Malay, 15, F3 Arab • *forcing the same person (other DM) to deliver DMP-related activities, thus may disturb the learning session for the other DM.* **P9,** Male, Malay, 17, F5 Sc
	4. Unsuitable approach	• *I am a friendly and friends with student from end class. When I advise them, such as to not to smoke, if they are not following my advised. I would just walk away.* **P9,** Male, Malay, 17, F5 Sc

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
	5. Perceive ineffectiveness of message	• *Some would listen while others were tired of hearing a talk.* **P2,** Female, Malay, 16, F4D • *Students are more interested in the performance-based activities (entertainment-based), for example the singing performances. There must be elements of entertainment or they would get bored with just the talk approach.* **P2,** Female, Malay, 16, F4D
(G) Recommendations	**1. Dedicating a Doctor for DMP** **2. Increasing and expanding the DMC membership**	• *A health advisor for the school, whom only visits once or twice a week. If someone dedicated here, it's better. Because need to depend on Cikgu Mat, he is busy in teaching other students.* **P11,** Male, Malay, 17, F5 Sc • *I think DM is lacking in membership. Only the same person will carry out the tasks if membership is not increased* **P14**, Male,Malay, 14, F2 Arab

Table 4.56 Results of the FGD according to domain (continued)

DOMAINS	THEMES	Verbatim
		• *It should be made equal (chance) to both end and front classes. Each class should have a DM representative as a role model* **P14,** Male,Malay, 14, F2 Arab • *Open the DM club membership to back class students as well.* **P11,** Male, Malay, 17, F5 Sc
	3. To allocate longer time to conduct activities	• *Not enough time* **P8,** Female, Malay, 16, F4D • *To conduct activity in morning session. (longer session as compared to the afternoon session)* **P3,** Female, Malay, 16, F4D

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter will discuss the results of the study, compare the results with past studies, and recognise the research finding differences in the present study with other related studies in Malaysia and elsewhere. In addition, the differences in the findings between this study and the data from the Oral Health Programme, Ministry of Health, Malaysia are also highlighted.

5.2 Response rate

The response rates were high at baseline and after 6 months. At baseline, the overall response rate was 97.6%, where the percentage in the IG and CG was 97.8% and 97.4%, respectively. The high response rate could be due to the good collaborations and support provided by the teachers as well as the school administrators. The teachers helped to distribute the consent form and informed the parents about the study. The consent forms were collected by the teachers and returned to the researcher (SK) before data collection began. During data collection, the teachers assigned one student to call the schoolchildren to come to the health education room to participate in the study. In addition, the discipline teacher in the schools played his part by ensuring the schoolchildren followed the instructions given by the researcher and did not went away until the study had been completed. The schoolchildren in the schools were captive groups, therefore there were easily accessible on school days, thus, explaining the high response rates in this research.

The response rates after 6 months were slightly reduced to an overall 90.9%; 90.9% in the IG, and 90.8% in the CG. The main reason for the slightly reduced rates was because a small number of schoolchildren from the schools moved to other schools. The number of schoolchildren who moved schools were 34 (as stated in Chapter 3). Typically, Year 6 (11-12 year olds) schoolchildren from primary school will enter secondary school at age 12-13 years (Form 1). The admission into the secondary school was based on the closest secondary school to the primary school when the child was in Year 6 of primary school. However, for schoolchildren with excellent academic results in Year 6, they tended to move into boarding schools and religious-based schools, whose offers were only known in February or March after baseline data collection had been carried out. During follow-up data collection after 6 months, some children who had moved to other schools would not be involved in the study any longer.

The number of schoolchildren who completed the study after 6 months was 498, whose number was about 7% less from the baseline. The percentage reduction was approximately similar to a previous study, which was 6% (D'Cruz & Aradhya, 2013). The study was conducted by D'Cruz and Aradhya (2013) with the objective of the study to assess the effectiveness of OHE programme on oral hygiene knowledge, practices, plaque control, and gingival health among schoolchildren aged 13 to 15 years in Bangalore City, India.

However, the total number of schoolchildren who completed the study after 6 months was not less than the estimated sample size of 428. Nevertheless, the number was less than the estimated sample size after 20% inflation, i.e. 513. If the estimated sample size was increased only by 15%, the final estimated sample size would have been 492 and it would be included in the overall sample size after 6 months.

5.3 Demographic characteristics of the sample

Matching the DMP schools with the nearest non-DMP schools in the same area, which acted as control was to ensure that the schoolchildren would have similar demographic background between the IG and CG. However, there were significant differences in mother's education level, household income, and the availability of DMP in primary school between the two groups. The difference was found in the mother's education levels, where mothers with education level up to STPM/College were higher in the CG compared to the IG (p<0.005). For household income differences, it was found that families with poor income level were significantly higher in the IG compared to the CG (p<0.005). In terms of DMP in primary schools, it was found that the proportion of schoolchildren in the IG who were exposed to DMP in primary school was lower compared to schoolchildren in the CG (p<0.001). This factor was not within the control of the researcher. However, the influence of this factor could be investigated through further multivariate analysis in this study. As of now, it could be said that the effectiveness of the DMP in secondary school could be less evident as compared to the CG due to the fact that significantly more schoolchildren in the CG were had been exposed to the DMP in primary school.

After 6 months, the differences observed in the demographic characteristics between the groups were similar, i.e. mother's education level, household income, and the availability of DMP in primary school. The similarity of demographic characteristics at baseline and after 6 months in the IG and CG indicated that both groups did not change after 6 months. Therefore, within-group comparison of outcome variable changes in the sample demographics between baseline and after 6 months can be done without significant changes in the sample demographics.

The vast majority of schoolchildren in the IG (100%) and CG (98.9%) were Malays, respectively. This was expected as the population in Kelantan was mainly comprised of Malays (98.8%), and only a small proportion was from other races (Kelantan State Government, 2018).

There were more male than female schoolchildren in the sample. However, the difference was not significant. A higher number of male schoolchildren in the sample reflected that of the schoolchildren population in the districts of Kota Bharu and Pasir Mas, Kelantan (Kelantan Education Department, 2017).

The DMP schools selected in this study were from urban and rural areas. Therefore, the influence of location on the outcomes would have been omitted as much as possible.

Majority of the schoolchildren in the IG and CG had parents with education up to secondary school level. This finding was similar to a finding of a study conducted in Kelantan to assess the characteristics of education and socio-economics of the population where they found that the majority of respondents in Kelantan had education up to secondary school level (Zurina Ahmad Saidi, Hukil Sino, & Norinsan Kamil Othman, 2018).

There were more schoolchildren in the IG and CG came from poor families, followed by low-income level, and medium-low income level. The distribution of household income levels in our sample were reflective of the variations in the Kelantan population's socio-economic background reported in 2016 (Department of Statistics Malaysia, 2017). Therefore, to some extent, our sample was representative of the state's socio-economic pattern of its population.

Skewed data were observed in schoolchildren who were appointed as DM in the DMP schools. There were four DMs schoolchildren in the IG. The presence of DMs in the IG might introduce bias in the study outcomes as they were more knowledgeable compared to their peers. However, their number was very small and unlikely to have a significant influence in the study outcomes.

5.4 Immediate impact of DMP

5.4.1 The schoolchildren's levels of oral health knowledge (OHK) (Objective 1a)

In the present study, there was no significant difference in mean knowledge score between the IG and CG at baseline. Both groups had a mean total score of 78.0 each. However, after 6 months, the CG had a slightly higher mean total score than the IG but the difference was not statistically significant. This finding indicated that the impact of DMP on schoolchildren's OHK was not significantly different than the school without DMP.

The non-significant difference in OHK between the IG and the CG could be due to several factors. First, the DMP oral health messages may have some similarities with the OHE messages given by the visiting dentist in the IDC programme in particular oral health messages related to sugars, oral hygiene instructions, and fluoride use. In Malaysia, secondary schools are visited by the IDC team annually for oral examinations, treatment provision, and OHE. The IDC programme coverage in secondary schools in Kelantan in 2018 was 97.1%, and in the district of Kota Bharu it was 97.1%, and in Pasir Mas district it was 96.5% (Oral Health Programme, 2018b). However, differences in the mode of OHE delivery by the IDC team exist depending on the dental clinics in charge of the respective secondary schools. If the IDC team uses interesting methods for delivering OHE and can attract the schoolchildren's attention, then the schoolchildren would gain more knowledge on oral health resulting in better OHK. The differences between OHE delivered in the DMP and the IDC was on the frequency and mode of delivery whereby the DMP health messages covered both oral health and general health, frequently delivered all year round by the DMs instead of the IDC team.

Second, the OHE messages in the DMP are general messages on oral health, which are also available in the media, and could be received through parents. In DMP, the oral health module comprised topics on mouth malodour, malocclusion, dental trauma/ injury and how to detect abnormalities in the mouth through extra and intraoral self-examination. This module is in addition to the DMP module in primary school, which included OHE messages on caries, gum disease (Health Promotion Unit, 2015), contains information on sugary food and drinks as causes of caries, plaque as the cause of gum disease, oral hygiene methods, teeth crowding, dental visit, mouth protection during sports activity, and smoking. The IDC team also delivers some of this information routinely once a year.

Thirdly, it should be noted that the mean score of OHK in both groups were high. Therefore, the impact of DMP over and above that provided by the IDC team and other possible sources such as the media and parents would have been minimal. The benefit of DMP is that the messages are repeated and reinforced regularly by DMs, thus complementing the efforts by the IDC team. This could explain the non-significant difference in OHK scores between the IG and CG.

These study findings provide a basis for a health education officer to re-evaluate the content and scope of the DMP oral health module if changes were necessary. If so, any changes should aim to add more value to DMP while keeping the essential topics relevant and up-to-date. In addition to that, a review of current topics in the DMP should be undertaken if necessary to promote effectiveness.

In terms of individual items, the IG had significantly higher mean scores at baseline on item 12: “Smelly breath is caused by infection in the mouth such as tooth decay and gum disease” and item 16: “A person with abnormal jaws such as jaws that are too big or small can be treated with orthodontic treatment” (p<0.05). Meanwhile, after 6 months, the IG had significantly higher mean scores on item 3: “For adequate fluoride supply, a person must brush teeth at least twice a day using fluoride toothpaste”, and item

4: “Brushing teeth with fluoride toothpaste prevents tooth decay”. The significant differences in the findings could be due to the repetitive preventive messages in the DMP oral health module.

When each items of OHK were compared after 6 months between the IG and CG, we observed that following items were scored higher in the CG than IG:

i. “Gum disease can cause teeth become loose” ($p<0.05$)

ii. “Smoking habit is bad for oral health” ($p<0.05$)

iii. “Smelly breath can be caused by the presence of impacted food and plaque accumulation in between the teeth” ($p=0.056$)

iv. “Smelly breath is caused by eating food with peculiar smell such as petai and jering” ($p<0.05$)

v. “Smelly breath is caused by smoking” ($p=0.081$)

vi. “Mouth self-examination can help to detect changes in the mouth such as ulcers that do not heal within 2 weeks, white spots, or growth” ($p=0.072$)

vii. “A person with abnormal jaws such as jaws that are too big or small can be treated with orthodontic treatment” ($p=0.194$)

viii. “Using a mouth guard is important when doing extreme sports such as cycling or rugby as it can protect the teeth from injury” ($p=0.081$)

Only data after 6 months were observed for each OHK items as it took into account that schoolchildren were exposed to the dental topics under DMP after the baseline data were collected at the beginning of 2018. Out of 17 items, only 3 items were scored higher in IG than the CG after 6 months. Meanwhile, 6 items were scored the same for both groups. Surprisingly, the CG was scored higher in the items that added in the syllabus (intervention packages) of DMP in secondary school. This happen could be due to the topics were not well covered in the training of DMs in secondary school. As a result, DMs are unable to deliver related oral health messages effectively.

The categorisation of total scores into levels of OHK showed that more schoolchildren in the IG and CG had “moderate” level of OHK at baseline. After 6 months, the majority of schoolchildren in the IG and CG had “good” level of OHK. However, there was a significant finding where a small proportion of schoolchildren in the IG had “poor” level of OHK. Although the number of schoolchildren with “poor” level of OHK in the IG was only 7, this number gave a significant finding when compared with the CG. The reason for this finding was uncertain. It could be that these 7 schoolchildren were those who refused to listen to the oral health messages delivered by DMs. This was supported in part by the findings in the FGD, where some schoolchildren were reported to ignore the messages given by the DMs. Alternatively, the 7 schoolchildren could be those who were academically weak and performed poorly in any class test including the study questionnaires.

For item 2: “A soft toothbrush is better than a hard toothbrush to clean the teeth”, both groups showed a mean score of 3.8 indicating less than ‘good’. It could be due to the contents for the training of trainers (TOT) which is available on the *Kelab Doktor Muda* website. The TOT contents were based on the course conducted in Penang in 2014. In the TOT, there was no information provided regarding the selection of toothbrushes. It mentioned about how to prevent dental caries by brushing teeth with fluoride toothpaste at least twice daily (morning and night), and to use an appropriate toothbrush. However, the type of toothbrush was not specified (Noor Syahidah Hisamuddin, 2014). This could explain why schoolchildren in the DMP did not score high on this item than the CG. Besides, the same results were seen for both groups indicating the item was not included in the OHE delivered by the IDC team.

For the item 8: “Gum disease can cause teeth to become loose”, and item 12: “Smelly breath is caused by infection in the mouth such as tooth decay and gum disease”, the schoolchildren in the IG and CG scored below 4.0 points, indicating that both groups had moderate knowledge on these items. These findings were not expected, as these items were important items in the DMP oral health module for secondary schools. Overall, these findings confirmed the lack of knowledge in gum disease among the schoolchildren. The impact of DMP in secondary schools on those items could be seen when a significantly higher mean score was observed in the IG compared to the CG.

For the additional item in the module of DMP for secondary school, i.e. “Mouth self-examination can help to detect changes in the mouth such as ulcers that do not heal within 2 weeks, white spots, or growths”, this item was scored low in the IG (mean score 3.5) after 6 months. A reason could be that the item is a new item in the DMP. The content of MSE is available in the module of DMP in secondary school (Health Promotion Unit, 2015). However, this information was not available in the contents of TOT, which is uploaded in the *Kelab Doktor Muda* website (Noor Syahidah Hisamuddin, 2014). Because of this, there was a possibility that not all DMs and teacher advisors were well informed of the item resulting in the lower score for the item in the study.

For comparison of increment scores between IG and CG after 6 months, both groups showed a significant improvement within the group with small effect size. However, no between-group difference was observed in the mean OHK increment score over 6 months. Therefore, it is not conclusive whether DMP was better than the non-DMP school in this respect. The non-significant difference in the mean increment of OHK between groups could also be due to the high proportion of schoolchildren in the CG had been exposed to the DMP in primary schools.

The findings in the current study were comparable with the findings in a previous study on DMP conducted in primary schools. The DMP in primary schools had positive impacts on OHK. However, the findings did not show significant differences between the IG and CG (Zamros Yuzadi Mohd Yusof, 2013).

There were other studies that showed significant differences between the IG and the CG on the effect of OHE on oral health-related knowledge. The findings were in favour of the IG than the CG in all the studies (Chapman et al., 2006; D'Cruz & Aradhya, 2013; Deschesnes et al., 2009; Eden et al., 2019; Hebbal et al., 2011; Lee et al., 2008; Macnab, Rozmus, Benton, & Gagnon, 2008; Rashidi Birgani & Niknami, 2019).

5.4.2 The schoolchildren’s levels of oral health attitudes (OHA) (Objective 1a)

The results of this study showed that the effect of DMP on schoolchildren’s OHA as compared to the CG was inconclusive. This was because the mean total OHA score at baseline was significantly higher in the IG than the CG, with four items had a significantly higher score in the IG. The significant items were item 1(a): “Brushing teeth is important to me because it prevents my teeth from decay”, 1(d): “It is part of the whole body cleanliness”, item 2(c): “Sweet foods and drinks are not necessarily my choice most of the time”, and item 5: “If I have an irregular teeth alignment problem, I will seek for orthodontic treatment (dental braces)”.

However, the results after 6 months showed differently. After 6 months, although both groups had an increase in mean OHA score, the total score of OHA was significantly higher in the CG than the IG. The reason for this was not very clear. It might be that a higher OHK increment score in the CG than the IG over 6 months had led to a higher score in OHA in the CG compared to IG over 6 months.

When the total score was categorised into "good", "moderate", and "poor" levels of OHA, the majority of schoolchildren in the IG and CG had "good" level of attitudes with no significant difference between the groups. After 6 months, majority of schoolchildren in the IG and CG had "good" level of attitudes with significantly higher proportion was observed in the CG than the IG. This could be due to high proportions of schoolchildren in the CG had "good" and "moderate" levels of OHK compared to the IG after 6 months. Although this study did not specifically evaluate the cause and effect relationship between OHK and OHA scores, the Precede-Proceed framework model by Green and Kreuter (2005) indicates that improvements in knowledge and attitudes often co-exist and grouped as an immediate outcome of an intervention programme (Green & Kreuter, 2005).

The findings in the present study showed significant improvements in total OHA scores after 6 months in both groups. However, the mean increment score was significantly higher in the CG. Our finding was contradicted with a finding in a study in China where attitudes towards dental care were significantly higher in the IG than the CG (Tai, Du, Peng, Fan, & Bian, 2001). There were other studies that showed schools implementing the HPS concept had comparatively more positive attitudes towards oral health. A quasi-experimental study was conducted in Indonesia to identify the relationship between school oral health programme (SOHP) and the behaviour of students in first- (6-year-olds) and second- (9-year-olds) grades. The SOHP intervention included education about brushing teeth properly, mass teeth brushing, dental health education, and independent plaque screening by students. The findings showed a significant increase in attitude scores indicating students' understanding of educational materials could lead to personal changes in students' attitudes towards oral health (Muhammad et al., 2018). A study conducted in Malaysia on DMP in primary schools also showed positive impacts of DMP in OHA improvement (Zamros Yuzadi Mohd Yusof, 2013).

There were also studies that showed improvements in knowledge had not necessarily led to improvements in OHA. A study conducted in Mysore city, India involving pre-university students concluded that although the students had good knowledge on basic oral health measures necessary to maintain oral health, their attitudes and practices towards oral health were relatively poor (Reddy, Bennadi, Gaduputi, Kshetrimayum, Siluvai, & Reddy, 2014). Another study conducted in Spain showed that there was an association between oral health knowledge, attitudes, and practices among 12-year-old schoolchildren. However, the results also showed that attitudes were not totally explained by knowledge, where attitudes cannot be understood simply as an intermediate variable in a knowledge-practice causal chain. Specifically, the results indicate that the sociocultural environment could modify the association between knowledge, attitudes, and practice. They concluded that oral health education was clearly important to increase public knowledge on the risk factors for dental disease. However, the efficacy of such education will be limited if health programmes do not directly impinge on attitudes, and take into account factors related to the environment, education, social status, and economic level of the targeted population (Ernesto, Francisco, & Paula, 2007).

The findings in the present study on OHA cannot be concluded that the improvement in OHA could be attributed to DMP in secondary school. Although there was increment in OHA score over 6 months in both groups, the increment was significantly higher in the CG than the IG. Therefore, it can be said that there was a possibility of DMP in secondary schools playing a role in this increment, however it cannot be said that the increment was due to the DMP in secondary school alone or other programmes such as the IDC.

There were other possible factors that contributed towards OHA improvement among the schoolchildren. One factor could be due to differences in the mode of deliveries of oral health education by the IDC team in each school. Each school may receive OHE in different methods of deliveries, e.g. the schoolchildren may receive OHE at class level or by the whole academic year or by individual level at chairside before treatment is given (Nurdini, 2018; Wan Rosliha, 2018). As such, the schoolchildren may receive OHK differently from the dentist and may have varying levels of OHA as the result. The differences in the delivery of OHE were beyond our control because it is delivered by the IDC staff from different dental clinics.

More schoolchildren in the IG and CG had good attitudes in two domains. These domains were related to the importance of brushing teeth and the importance of reducing sweet food and drinks intake. Nurul Ashikin Abdullah conducted a study in 2010 and found that the amount of sugar consumption by schoolchildren in Pasir Mas was very high at 93 grams per person (Nurrul Ashikin Abdullah, 2010). A report from the Oral Health Programme on the dietary habits and caries severities of adults in Kelantan stated that the majority of Kelantan population (81.2%) consumed sugary food and beverages more than four times a day. Meanwhile, the estimated daily intake of sugars from all sources was 81.6 grams per adult in Kelantan (Oral Health Division, 2014). This could be the reason why they could not resist the temptation of sweets food and drinks consumption, even though the schoolchildren had good attitudes toward preventive measures on caries.

The psychosocial theories stated that knowledge may be important in forming beliefs, but helpful attitudes and behaviours do not necessarily develop (McGoldrick, 1997). These theories place great emphasis on the importance of supportive environments to enable individuals to make changes in health behaviours. The schoolchildren's environments included the family and home settings, their peers, local social circumstances, and school settings. Existing barriers in these environments may include in poor parental attitudes, and a lack of healthy dietary choices could be the reason why schoolchildren were finding it difficult to refuse the temptation of sugary food and drinks in their daily diet.

5.5 Intermediate impact

5.5.1 The schoolchildren's levels of oral health behaviour (OHB) (Objective 1b)

The study findings did not show strong evidence which supported the potential benefit of DMP in promoting schoolchildren's OHB. This conclusion was derived from several findings that favoured the CG than the IG after 6 months.

At baseline, the results showed that a significantly higher proportion of schoolchildren in the IG brushed their teeth at least twice daily compared to schoolchildren in the CG. However, a significantly higher proportion of schoolchildren in the IG smoked cigarettes compared to schoolchildren in the CG.

After 6 months, the changes were observed in the proportion of schoolchildren practicing good behaviour in tooth brushing at least twice daily. A significantly higher proportion of schoolchildren in the CG brushed their teeth at least twice daily compared to the IG. However, the proportion of schoolchildren who smoked after 6 months had reduced by half in the IG.

In terms of levels of OHB, i.e. schoolchildren with more or less good OHB, the proportion of schoolchildren reported practicing more good OHB after 6 months in the IG had reduced slightly, but no change was seen in the CG. In addition to this, the IG showed a significant decrement in OHB score after 6 months, while in the CG, the decrement was not significant compared to the baseline score.

The findings in our study were similar to findings in a cross-sectional survey carried out to compare the school health programme (SHP) networks and non-SHP networks. The aim of SHP networks was to reinforce the partnership between education and health sectors in preventing and reducing risk behaviours among students or the school population. The SHP networks involved teachers and school administration who received training based on the objectives of the SHP model, the scope, and their roles in the implementation and sustainability of the programme. The findings of this study showed that the SHP networks had no substantial impact on students' health behaviours (El Halabi Ezzeddine & Salameh, 2016).

On the other hand, our findings were not comparable with findings from other related studies. Other studies showed improvements in OHB after schoolchildren had been exposed to schools with the HPS concept or other OHE programmes in schools (D'Cruz & Aradhya, 2013; Eden et al., 2019; Lai et al., 2016; Lee et al., 2008; Leite et al., 2015; Macnab et al., 2008; Rashidi Birgani & Niknami, 2019; Takeuchi et al., 2017). A local study assessing the DMP impact on primary schools also showed that the IG had a significantly higher mean OHB score than the CG (p<0.001) (Zamros Yuzadi Mohd Yusof, 2013).

At baseline, the majority of schoolchildren in the IG and CG reported good OHB, i.e., brushed teeth at least twice daily with fluoride toothpaste, rinsed mouth with water after meal, consumed less sugars, conducted MSE, and smoked fewer cigarettes. After 6 months, the majority of schoolchildren reported similar behaviours as the baseline. Besides, higher proportions of schoolchildren in both groups reported practicing more good OHB at baseline. After 6 months, these higher proportions remained in both groups. Therefore, any increment in OHB was difficult to observe as the proportions of schoolchildren in both groups practicing good OHB was already high at baseline.

In addition, schoolchildren's behaviours could be influenced by other external factors and could not solely relied on OHE messages delivered in the DMP or other related programmes. It has been noted that children often receive oral health information from other sources and their behavioural patterns are influenced by their mothers (Roberts-Thompson & Spencer, 1999), the family, home settings, their peers, local social circumstances, and the school environment (McGoldrick, 1997).

A qualitative study in 2015 showed that there were many external influences on children's oral health behaviours, operating at child, family, and community levels. Perceived influences on children's tooth brushing behaviour were primarily located within the direct family environment and social status as well as parental knowledge, perceived importance and parental confidence in tooth brushing, locus of control, role modelling, parental monitoring and supervision, parenting strategies, and tooth brushing routines and habituation (Duijster et al., 2015). Another study in 2012, linked behaviours to the conditions in which people were born, grow, live and work, and to age (Marmot, Allen, Bell, & Goldblatt, 2012). However, many of these factors were not investigated in the current study. Although individuals make choices about how to behave, these choices are made within economic, historical, family, cultural, and political contexts. Therefore, individual behaviours, commonly referred to as proximal factors, are largely influenced by social environments, and some structures make it easier to promote healthier lifestyles than others (Marmot et al., 2012).

The success of the DMP could have relied on the teachers as well. Currently, dedicated teachers for the DMP are limited to only 2 persons per school. Based on the FGD in this current study, only 2 teachers were tasked to monitor and supervise all DMP activities in schools which was considered not enough. In addition to this, the guidance provided to teachers by the DMP central committee in the Health Division may be insufficient. The time spent to conduct DMP activities in schools were also not standardised and only 10 minutes were spent to deliver the health messages (Table 4.55 Result of FGD). The study conducted by Muhammad et al., (2018) showed that it was necessary to provide continuous teacher guidance to promote effective activities that could impact on the oral health behaviours of the schoolchildren. There was also a need for special hours for routine oral health programmes, and this should be supported by local educational authority's policies assisted by local health centres (Muhammad et al., 2018).

5.5.2 Oral hygiene level (plaque score) (Objective 1.b)

In the present study, the O'Leary index was used in assessing schoolchildren's oral hygiene level. The O'Leary Index is primarily chosen because it does not depend on the clinical judgment of the examiner and therefore not influenced by examiner subjective factors (nogueira Pigozzo, nakakuki de Campos, & Yamada, 2008). It determines the presence or absence of plaque, taking into account the faces of the teeth along the gum margins (O'Leary, Drake, & Naylor, 1972). In addition, this index was chosen due to other factors such as its precision, efficiency, and speed of assessment (Tiberio, Silva, Ramos, & Lacerda, 2017).

At baseline, the proportion of schoolchildren with "good" level of plaque score in the IG was significantly higher compared to CG. At the same time, the proportion of schoolchildren with "poor" level of plaque score in the IG was significantly lower compared to the CG. Similar trend was also observed after 6 months. The results showed that schoolchildren in the IG already had "good" level of plaque score than the CG at baseline and after 6 months.

In addition, there were improvements in oral hygiene levels when comparing the mean plaque scores at baseline and after 6 months for both groups. However, the mean decrement was not statistically significant. Therefore, the evidence from the study is considered not conclusive to say that the improvement in oral hygiene levels was due to the DMP.

Both groups showed a decrement in plaque score after 6 months with large effect size each. At baseline, the CG had a significantly higher mean plaque score compared to the IG. The same finding was also observed after 6 months. In terms of mean decrement of plaque score, the IG showed a slightly higher mean plaque score decrement compared to the IG. The reason for this was not very clear in relation to the DMP especially when the IG was not significantly better in OHK, OHA, and OHB compared to the CG. There could be other factors influencing the outcomes of the study. The finding in our study was similar with findings from another study in Tanzania in 2013. The study assessed the impact of oral health promotion programme in a health-promoting school (HPS) initiative on the oral health outcomes of secondary school students. It was found that the mean number of teeth with plaque decreased significantly in both the IG and CG. No significant difference in caries increment and plaque score declined was observed between groups. The intervention activities did not show any impact concerning plaque status among the students in the IG when compared with the CG (Mbawalla et al., 2013).

On the other hand, many studies showed improvements in oral hygiene when children were exposed to OHE in schools, regardless of the type of OHE given. Watt and Marinho (2005) reviewed and summarised the studies' findings of OHP effectiveness concerning oral hygiene and gingival health. From the studies reviewed, they concluded that reduction in plaque and gingival bleeding were achieved in short-term in the majority of studies reviewed (Watt & Marinho, 2005). Many recent studies also reported that plaque score reductions were highly significant in intervention schools compared to the control schools. In these studies, the intervention packages were entirely directed towards oral health only unlike the DMP where the messages cover wider scopes including oral and general health (Alsumait et al., 2015; Eden et al., 2019; Hebbal et al., 2011; Shenoy & Sequeira, 2010; Ueno et al., 2012).

5.6 Health impact

5.6.1 Gingival health (Objective 1c)

In the present study, the GIS index was used to assess the schoolchildren's gingival health. This index was selected in order to compare the gingival health status obtained from the present study with the gingival health status reported by the Oral Health Programme in Kelantan as well as in Malaysia. The GIS index is not used in other countries, therefore comparisons were only done with local data and by comparing the gingival health status in general.

In general, the GIS index was reported in categorical data from GIS score 0 to 3 (score explanations are described in Chapter 3). However, in this study, the scores were also treated as continuous data, where the GIS score for each tooth was summed and divided by the number of index teeth to give the mean score, and named as the mean score of the GIS index. This method was used to see the changes in scores of the GIS index after 6 months. In addition, the continuous data would be relatively sensitive to detect changes in gingival health conditions by looking at the mean score of the GIS index as compared to assessing the highest GIS score for the person only.

At baseline, significantly more schoolchildren in the IG had GIS score 0 (61.0%) compared to those in the CG (42.5%), and significantly more schoolchildren in the CG (34.4%) had GIS score 3 compared to those in the IG (18.7%) (p<0.001).

However, there was no significant difference in the proportion of GIS scores between IG and CG after 6 months. This is because the proportion of schoolchildren in the IG with GIS score 0 after 6 months was significantly reduced to half compared to baseline. While the proportion of schoolchildren with GIS score 1 in the IG and CG had increased at equal proportions. In addition, the proportion of schoolchildren in the IG with

GIS score 3 had significantly increased after 6 months, while in the CG, the proportion had reduced. It seemed the gingival health status of schoolchildren in the IG got worsen compared to the gingival health of schoolchildren in the CG over 6 months.

The results obtained in the present study for the GIS score 0 after 6 months were much lower in both groups compared to similar findings reported by the Kelantan Oral Health Division (56.9%) in 2018. This could be due to the current study including only Form 1 schoolchildren for the GIS assessment. On the other hand, data from the Kelantan Oral Health Division relied entirely on the IDC team which conducted gingival health assessment on all schoolchildren (Form 1 until Form 5) in the school. Thus, the percentage obtained was based on all schoolchildren and not focussing on the Form 1 schoolchildren only as the numerator. So, the GIS score tended to be worse. However, despite this, Kelantan's prevalence of gingivitis free teeth was much lower than the national level of 70.0% for secondary schoolchildren (Oral Health Programme, 2018a).

When comparisons were made between groups on the schoolchildren's experience in mean score of GIS increment, the finding showed that a significantly higher proportion of schoolchildren in the IG experienced increments in mean score of GIS compared to the CG. The same scenario was seen when the mean increment scores of GIS were compared between baseline and after 6 months, where the IG showed an increment in mean score of GIS, but the CG showed a decrement in the mean score of GIS. The reason for this is also not very clear. It could be that the different IDC teams who went to the respective schools carried out a range of gingival health treatment that may differ from one team to another. For example, some dentists may do scaling and polishing due to heavy deposits of calculus. This treatment provided by the IDC team would certainly improve gingival health, and as a result would reduce gingival inflammation over 6 months. If this happened, the influence of DMP in the schoolchildren's gingival health would not be fully observed.

In the present study, the plaque scores had decreased after 6 months, but the GIS scores had increased in the IG. In the GIS, the score was recorded based on the presence of gingival bleeding and calculus. However, the plaque score only looks at the visible plaque on the teeth surfaces regardless of a present of calculus. Furthermore, this plaque can also be eliminated by brushing the teeth frequently. The decrement in plaque score but an increment in the GIS scores observed might be due to the schoolchildren brushing their teeth before going to school on data collection day as they were informed of our arrival at school to conduct the second oral health examination after 6 months. Improvement in plaque scores could happen immediately following teeth brushing. However, improvement in gingival health would take longer.

Another factor is that schoolchildren are susceptible to gingival inflammation due to hormonal changes. The presence of gingival inflammation without increased plaque scores may occur in children at puberty (Pari, Ilango, Subbareddy, Katamreddy, & Parthasarthy, 2014). Therefore, unhealthy gingiva may also be exacerbated by hormonal changes in the presence of minimal plaque and not entirely due to poor brushing method.

Some studies commented that a shorter-term follow up of a few months would make it difficult to see improvements in gingival health. Few authors believed that short-term preventive programmes with or without professional instrumentation induces only a transient improvement in gingival health of schoolchildren and that too only occurred during the instructional period. The maintenance of improved gingival health over longer periods requires prolonged, repeated instruction by oral health instructors (Arrow, 1998; Frencken, Borsum-Andersson, Makoni, Moyana, Mwashaenyi, & Mulder, 2001; Howat, Rock, & Foster, 1982; van Palenstein Helderman, Munck, Mushendwa, Van't Hof, & Mrema, 1997; Vanobbergen, Declerck, Mwalili, & Martens, 2004).

The results from the present study were contradicted with the results from another study that showed schoolchildren in the school with the HPS concept had better gingival health. A study stated that more favourable changes in the IG compared to the CG occurred with respect to bleeding on probing, suggesting a weak but positive effect on students' gingival health status (Mbawalla et al., 2013).

5.6.2 Caries incidence (Objective 1c)

In the present study, the ICDAS score was used to assess the schoolchildren's caries incidence and increment. The understanding of the caries process has continued to advance with the vast majority of evidence supporting caries as a dynamic process, which is affected by numerous modifiers tending to push the mineral equilibrium in one direction or another, i.e. towards remineralisation or demineralisation (Pretty, 2006). Most studies conducted to measure the prevalence of caries had used DMFT(S)/dmft(s) index, thus allowing the recording of cavitated lesions only and not the initial stage of caries. Therefore, the ICDAS is a suitable tool to assess caries activities in schoolchildren, either the caries is progressing or regressing.

The proportion of schoolchildren experiencing increments in ICDAS score after 6 months was significantly higher in the CG (78.9%) compared to the IG (70.9%). The increment in ICDAS score reported here was an increment in mean ICDAS score between baseline and after 6 months. This finding indicated that some benefits on caries prevention might be rendered by the DMP. However, it may not be conclusive.

However, for incidence of new caries after 6 months (ICDAS >0), the IG (16.4%) had a slightly higher proportion of schoolchildren with new caries compared to the CG (15.0%). However, both groups showed no significant difference in new caries lesions. One reason could be due to the shorter-term evaluation. Generally, a longer-term evaluation would be preferable to see a more meaningful changes in schoolchildren's oral health. However, in schoolchildren with high sugar consumption and low water fluoridation, early signs of caries may be noticeable as early as 6 months with the use of ICDAS.

In terms of the incidence of new cavitated caries lesions after 6 months (ICDAS≥3), the CG (7.1%) showed a higher proportion of schoolchildren with new cavitated caries lesions compared to the IG (6.4%). However, the difference in the incidence rate was not statistically significant. The caries incidence referred to the tooth with ICDAS score <3 (non-cavitated), which changed into ICDAS score 3 and above (cavitated caries) after 6 months. The DMP school has a prevented fraction (PF) of 14.3% meaning more than 1 of 10 children would be prevented from developing cavitated caries if enrolled in the DMP school compared to control school. The difference between non-cavitated and cavitated caries was relatively easier to assess as cavitated caries were more visible and did not require tooth drying.

After 6 months, although both groups showed a significant within-group increment in mean decayed teeth (p<0.001), no significant differences were observed in mean caries scores or mean increment scores, between the IG and CG. More importantly, schoolchildren in the IG had lower 6-month mean caries increment (mean = 2.4, SD =3.8) compared to CG (mean = 2.7, SD = 3.1) with lower effect size of 0.5 compared to 0.7 in CG.

Even though the DMP in secondary schools had no significant effect on gingival health, the evidence on caries, i.e. lower proportion of IG who experienced caries increment, lower cavitated caries incidence, and lower caries increment score after 6 months showed that the DMP might have some effects on caries prevention. More conclusive evidence on the effect of DMP on caries could be seen if a longer-term evaluation over 3 years was carried out. If longer-term follow up was carried out, the findings could have been similar with the findings in a study conducted in China on caries incidence where mean caries increments after 2 years in the IG and CG were 2.47 and 3.56 dmfs, respectively (Rong, Bian, Wang, & De Wang, 2003).

5.6.3 Schoolchildren's oral health-related quality of life (OHRQoL) (Objective 1d)

Overall, the present study showed that the DMP in secondary schools had some benefits on 12-13 year olds' OHRQoL after 6 months of exposure to the programme. This conclusion was based on many positive findings in OHRQoL outcome measures that were supportive of the IG. However, the evidence was not statistically significant.

At baseline, the overall prevalence of oral impact in the IG (34.8%) was lower than that of the CG (35.8%). In addition, the prevalence of oral impact in each of the eight performances was lower in the IG than the CG except for eating, speaking, cleaning teeth, relaxing, and socialising where the scores in the IG were higher. After 6 months, the overall prevalence of oral impact in the IG (35.1%) continued to be lower than that in the CG (40.5%). The prevalence of oral impact in each of the eight performances was lower in the IG than the CG except for the eating, relaxing, smiling, and socialising. Schoolchildren in the non-DMP schools had a significantly higher mean score on emotional impact due to their oral health status compared to the IG. Overall, the prevalence of oral impact was higher after 6 months in both groups compared to the prevalence at baseline.

The findings may indicate that the DMP in secondary school has some potential impacts on the OHRQoL of schoolchildren. However, the findings were not significant, except for emotional stability.

In our study, a lower proportion of schoolchildren in the IG experienced an increment in mean total OIDP score compared to that in the CG. Although the difference was not significant, it shows positive findings in favour of the IG, and more meaningful outcomes could be seen in longer-term evaluations. A possible reason for this finding was that lesser proportion of schoolchildren in the IG experienced caries increment than those in the CG. Caries increment will involve new caries development which often accompanied by pain and sensitivities that could affect the OHRQoL (Bekes & Hirsch, 2013; Gherunpong et al., 2004b). As such, less experience in caries increment would lead to lesser impact on the OHRQL as seen in this study. Another study was conducted in Rio de Janeiro to assess the association between OHRQoL, measured through the Child-OIDP, and demographic characteristics, self-reported oral problems, and clinical oral health measures, among 11-12 year old school children. The findings showed that the Child-OIDP was associated with dental caries experience and sensitive teeth and they concluded that the odds of having higher levels of Child-OIDP were positively associated with dental caries experience (Castro, Portela, Leão, & de Vasconcellos, 2011).

In comparison, the prevalence of oral impacts in the present study at baseline and after 6 months were lower than that in other studies in the United Kingdom, India, Italy, Uganda, and Kuwait (Alsumait et al., 2015; Åstrøm & Okullo, 2003; Saheer et al., 2015; Tubert-Jeannin, Pegon-Machat, Gremeau-Richard, Lecuyer, & Tsakos, 2005; Yusuf et al., 2006). This could be explained by differences in disease levels, age groups, culture, and location of the sample. The present study also showed a lower prevalence of oral impacts compared to the study on DMP in primary school (Yusof & Jaafar, 2013)

In terms of an impact score, the mean impact score in the IG (2.7) was lower than that in the CG (3.1) at baseline. An increment was observed after 6 months in terms of an impact score for both groups. However, the score was consistently lower in the IG (3.3) compared to that in the CG (3.8). The impact score in the present study was much lower compared to a study on the DMP in primary school (7.20) (Yusof & Jaafar, 2013). However, the impact score in the present study was higher than the study conducted in

Indonesia (Amalia et al., 2017) but lower than those conducted in New Zealand and Kuwait (Alsumait et al., 2015; Clark, Thomson, & Page, 2018). More importantly, the impact score in each performance was lower in the IG than the CG except for speaking, smiling, and socialising after 6 months. The 3 performances above had similar mean impact scores, but the differences were observed in the SD, which were higher in the IG than CG. This trend in favour of the IG could be attributed to the effect of DMP on the schoolchildren's oral health over 6 months, but the net effect was not statistically significant. A longer-term evaluation is recommended to see the effect of DMP over the schoolchildren's OHRQoL.

In terms of impact intensity, at baseline, the only impact intensity with a significant difference between the IG and CG was on the 'severe' level of impact intensity. A significantly higher proportion of schoolchildren in the CG reported a 'severe' level of impact intensity on overall impact compared to the IG. Meanwhile, after 6 months, the impact intensity with a significant difference between the IG and CG was 'very little' and 'severe' level of impact intensity. A significantly higher proportion of schoolchildren in the CG reported 'very little' level of impact intensity on overall impact compared to the IG. The best potential impact of the DMP in secondary schools could be seen at the 'severe' level of impact intensity after 6 months. A significantly higher proportion of schoolchildren in the CG reported 'severe' level of impact intensity after 6 months. At this level, the prevalence of schoolchildren with 'severe' level of impact intensity in all performances was consistently lower in the IG than the CG. These findings suggested that the DMP in secondary schools could have some positive effects against the'severe' level of impact intensity in all daily performances.

Majority of the schoolchildren reported having 'little' to 'moderate' levels of impact intensity after 6 months. These findings were similar to findings in a study on the DMP in primary schools in 2013 (Yusof & Jaafar, 2013). A study conducted in Thailand reported a higher proportion of children perceived to suffer from ‘severe’ level of impact intensity (Gherunpong et al., 2004a).

In terms of perceived causes of oral impacts, at baseline, in the IG showed only 4 out of 17 of oral conditions perceived to have caused overall impacts were lower in proportion than the CG. Meanwhile, after 6 months, the proportions of schoolchildren in the IG were reported lower in 6 out of 17 oral conditions perceived to have caused oral impacts than that of the CG. However, no significant differences were observed.

For comparison of oral conditions perceived to have caused overall impacts between the IG and CG after 6 months, only the impact of teeth colour or discoloured teeth had a significant difference where a higher proportion of schoolchildren in the IG perceived that the colour of their teeth had impacted on their daily performance. The significant difference could be due to the schoolchildren in the IG had more awareness and become more concerned with their appearance than schoolchildren in the CG, after they were exposed to the information from the DMP in secondary schools. The schoolchildren’s concern about their teeth aesthetic appearance usually becomes significant when they approach adolescence (Smolak, 2004).

Overall, a toothache was the most prevalent cause of oral impacts reported by the schoolchildren, followed by crowding and tooth decay. It seemed that caries and its sequelae remained the main cause of the oral impacts in Kelantan schoolchildren despite improvement in the prevalence of caries-free teeth (Oral Health Programme, 2018a). The highest mean impact score was observed in eating for both groups at baseline and after 6 months. In the present study, the most frequently indicated cause of impairment was a toothache, and the most prevalent impact was on eating. This result is consistent with studies from Tanzania and Sudan in comparable populations using the CS-Child-OIDP (Mashoto, Åstrøm, David, & Masalu, 2009; Nurelhuda, Ahmed, Trovik, & Åstrøm, 2010)

In terms of increment in total OIDP score between baseline and after 6 months. There was no significant difference in mean total OIDP score after 6 months within and between the groups. One reason could be due to the total OIDP scores which were very low in the first place (baseline). Therefore, any increment over 6 months was difficult to observe.

In terms of the number of performances with impact, more than half of schoolchildren reported having no oral impact on their daily performances at baseline and after 6 months in both groups. The findings in the present study were similar with the findings on the national oral health report in the Annual Report 2016, where 53.0% of schoolchildren in secondary schools in Kelantan did not require any dental treatment (Oral Health Programme, 2018a).

As the present study aimed to assess the oral health impacts of health promoting school, i.e. the DMP in secondary schools, comparisons could be made with a similar study conducted on DMP in primary schools in 2013 (Zamros Yuzadi Mohd Yusof, 2013).

The 2013 study was a large retrospective cohort study to evaluate the DMP effect on children's levels of oral health knowledge, attitudes, behaviour, caries progression, and OHRQoL after 6 years of DMP implementation (2006–2011 enrolment). The sample comprised 3455, Year 6 (11–12 year old) children; 1282 from DMP (intervention) and 2173 from non-DMP (control) schools. The Malay Child-OIDP index was used to evaluate children's levels of oral impacts on 8 daily performances after 6 years of DMP implementation (2006–2011). They concluded that the health promoting school model, i.e. the *Doktor Muda* Programme for primary schools in Malaysia had some positive impacts on 11–12 year old children's oral health related quality of life (Yusof & Jaafar, 2013). The same finding was observed in the present study.

Another study which may be considered as closely related to the present study was the quasi-experimental study involving 335, 10 to 13 year old New Zealand children with high caries experience from 5 Northland schools. All children completed an oral health-related quality of life questionnaire at baseline. Half of the children participated in a supervised tooth brushing session on each school day, and the remainder served as the control group (N = 176). Questionnaires were completed again 9 months later. Effect sizes were calculated based on the change in OHRQoL from baseline to follow-up. The results showed that children in the tooth brushing group had higher Child Perceptions Questionnaire (CPQ) scores representing the poorer OHRQoL at baseline than those in the control group. At follow-up, children in the tooth brushing group had lower scores than those in the control group. Although the OHRQoL improved for both groups, the largest improvement was observed among those in the tooth brushing group, with a moderate effect size. They concluded that a supervised tooth brushing programme successfully implemented in 5 Northland schools had to improve the OHRQoL among the children (Clark et al., 2018). The difference between the study conducted in New Zealand and the present study was that our study did not include a supervised tooth brushing session on each school day. In addition, in the present study, the oral health education component was an integral part of a broad general health education package. In terms of similarity, both studies were evaluated after the programme was implemented in less than a year.

In the present study, another possible reason for the DMP apparent lack of effectiveness in improving schoolchildren's OHRQoL could be due to the high consumption in sugary food and drinks and lack of water fluoridation among the schoolchildren. The limitation of water fluoridation in districts of Kota Bharu and Pasir Mas could allow the significant differences in OHRQoL were observed, which will show the effectiveness of DMP on improving the OHRQoL of schoolchildren in DMP schools.

However, due to the shorter-term evaluation, the results of the DMP on schoolchildren cannot be observed as expected. Despite having a lack of water fluoridation, toothache as the main cause of oral impact was reduced significantly in the IG compared to the CG after 6 months. The tooth decay was also reduced in the IG after 6 months. However, the reduction was not significant.

5.7 Associated factors in relation to schoolchildren's oral health knowledge, attitudes, behaviour, oral health status, and OHRQoL (Objective 2)

5.7.1 Oral health knowledge (OHK)

From the multivariate analysis involving demographic characteristics and increment in OHK score after 6 months, two independent factors were significantly associated with the increment of schoolchildren's OHK, i.e. gender, and school location with small effect size (R^2 = 0.076). Between these two factors, the school location had the greatest effect (β standard coefficient = 0.26) followed by gender (β standard coefficient = 0.09). The model fulfils all statistical assumptions and could be generalised to the 12-13 year old schoolchildren in the 2 districts.

According to the model, male schoolchildren living in urban areas would have higher levels of OHK than female schoolchildren living in rural areas.

Schoolchildren who live in urban areas would have more exposure to health messages through various channels in particular through internet and other medias. This is likely to cause schoolchildren in urban areas to have higher levels of OHK compared to schoolchildren in rural areas. In addition, schoolchildren in urban areas would tend to come from families with more educated parents and better household income levels than those in rural areas. A study conducted in Kelantan to assess the educational levels and socio-economic status of adults in rural areas found that majority of the respondents in rural areas had secondary school education and family incomes below MYR 1000 (Zurina

Ahmad Saidi et al., 2018). A study on DMP in primary school found that one of the independent factors associated with schoolchildren's OHK was parent's educational level. Schoolchildren of parents with higher educational levels would have higher levels of OHK (Zamros Yuzadi Mohd Yusof, 2013). Another study conducted in Iran showed that urban students had significantly higher scores in oral health knowledge than students in rural areas (p = 0.0001) (Rad, Shahravan, & Haghdoost, 2015).

In the model, male children have better OHK than female children. The reason for this is not very clear. This finding contradicted with a finding in a study conducted in India where females had better OHK than males (Burman et al., 2019). However, there were other studies that reported similar findings with the current study where male schoolchildren had a significantly higher OHK compared to female schoolchildren (Lian, Phing, Chat, Shin, Baharuddin, & Jalil, 2010).

In summary, this study showed that the effect of DMP in secondary schools on schoolchildren's OHK was not more effective compared to the CG. The significant factors associated with schoolchildren's OHK are gender and school locations with an overall small effect size. Based on the results, the benefits of DMP in secondary schools cannot be proven in terms of OHK improvement but it may be justified because of the involvement of schoolchildren in delivering oral health messages that may compliment the OHE delivered by IDC team. In addition, majority of the schoolchildren in both groups have high levels of OHK in the first place. Therefore, the improvement in OHK with or without DMP is more difficult to see.

5.7.2 Oral health attitudes (OHA)

In the present study, the MLR shows that increments in OHA scores over 6 months are significantly associated with three independent factors, i.e. type of school, gender, and school location when other factors are equal. In addition to this, increment in OHK is also a significant factor associated with increments in OHA scores. Among the 4 factors, increment in OHK has the greatest influence on schoolchildren's attitudes (β standardised coefficient = 0.37), while gender has the lowest effect (β standardised coefficient = 0.11). The model fulfils all statistical assumptions and therefore could be generalised to 12-13 year old schoolchildren in the districts of Kota Bharu and Pasir Mas.

According to the model, schools without DMP, situated in urban areas, male, and those with OHK increment would have higher levels of OHA than a school with DMP, situated in rural areas, female, and poor OHK increment. Schoolchildren in non-DMP schools having a higher increment in OHA score could be potentially attributed to the success of the IDC team in delivering the oral health messages and improving the schoolchildren's OHA. The IDC team in non-DMP in Kota Bharu delivered OHE messages to all Form 1 and Form 2 students together in a school hall. In addition, some schoolchildren were given OHE at the chairside by showing and explaining to them about their oral health condition in front of a mirror. On the other hand, the IDC team in DMP schools delivered the OHE messages to schoolchildren in the class and provided treatment in the same visit (Nurdini, 2018). Delivering in-class OHE would involve lesser time as there were many classes to cover. At the same time, doing treatment on the same day as giving OHE would be less tolerated by the children as they would be very apprehensive with regards to treatment and less likely to concentrate on the OHE. This could be the reason why OHA was significantly higher in the CG than the IG.

Schoolchildren in urban areas have better OHA increment scores simply because they would be in better situations in terms of household income, parent's educational levels, living infrastructure, and access to online information compared to rural areas. Therefore, they would be more aware and more conscious regarding health information and appearance. This model is supported by a study conducted in Iran that showed urban students had significantly higher scores in oral health knowledge, attitudes and practices than students in rural areas (p=0.0001) (Rad et al., 2015).

Better oral health attitudes were observed in male schoolchildren than the female schoolchildren. It could be due to the fact that male schoolchildren scored higher in OHK than the female schoolchildren. The finding in the present study contradicted the findings from several studies that showed female schoolchildren had better attitudes, especially on brushing and flossing compared to male schoolchildren (Farsi, Farghaly, & Farsi, 2004; Harikiran, Pallavi, Hariprakash, & Nagesh, 2008; Östberg, Halling, & Lindblad, 1999).

Increment in OHA score is significantly associated with an increment in OHK score. This finding was not unexpected because the evidence shows that there is a relationship between oral health-related knowledge, attitudes, and behaviour among adolescents. The results showed that knowledge had a smaller effect on behaviour than on attitudes. The results provide support for theories about the causal chain of cognitive, attitudinal, and behavioural aspects of dental health and hygiene (Tolvanen, Lahti, Miettunen, & Hausen, 2012).

In summary, the results showed that the effect of DMP on OHA improvement was not significant. Improvement in OHA is significantly associated with non-DMP school, gender (male), school location (urban), and increment in OHK score. Based on the model, the evidence for educational intervention through DMP to increase schoolchildren's level of OHA is inconclusive.

5.7.3 Oral health behaviour (OHB)

In the univariate analysis, ethnicity was the only factor associated with OHB increment score after 6 months. However, data on ethnicity were skewed because majority of the schoolchildren in the sample was Malay which reflected the composition of ethnic Malay in Kota Bharu and Pasir Mas in Kelantan (Department of Statistics Malaysia, 2019).

A continuous variable with a significant association with OHB increment score at univariate analysis (p<0.05) was OHA increment score, but when OHA increment was analysed in MLR, it was not significant. One possible explanation is that improvements in OHA do not necessarily lead to improvements in OHB. Again, the psychosocial theories on why behaviour change occurs highlight the complexities of the relationship between knowledge, attitudes, and beliefs, and how these are strongly influenced by those around us. The knowledge may be important in forming these beliefs, but helpful attitudes and behaviours do not necessarily develop (McGoldrick, 1997). People tend to assume that individuals behave according to their attitudes. However, social psychologists have found that attitudes and actual behaviours are not always perfectly aligned (Kendra, 2019). This psychological theory supported our findings where decrement in OHB score did not align with improvement in the OHA score.

5.7.4 Oral hygiene (plaque score)

In the univariate analysis, after 6 months the decrement in plaque score was significantly associated with school location. Schoolchildren in urban areas had a significantly higher mean plaque decrement score compared to schoolchildren in rural areas.

There is a difference in household income where those who live in urban areas have higher household income compared to those who live in rural areas. Furthermore, those who live in urban areas are more likely to have jobs and better education than those who live in rural areas (Department of Statistics Malaysia, 2017). A study conducted in 2015 showed that children from low-income families failed to maintain regular oral hygiene or were often unable to afford oral hygiene aids, as their main priorities were the search for food, shelter, and clothing (Saheer et al., 2015). A study conducted in Nigeria in 2003 on oral hygiene and periodontal treatment needs of urban schoolchildren compared with that of rural schoolchildren showed that children in the urban areas had significantly better oral hygiene than those in the rural areas (Sofola, Shaba, & Jeboda, 2003). Findings from a study conducted by Mathur *et al.* (2016) in India showed that children in poorer areas were more susceptible for poorer oral hygiene compared to children in urban areas (Mathur, Tsakos, & Parmar, 2016).

Parents play important roles in influencing of their children's behaviour. More parents in urban areas have higher education was educated compared to parents in rural areas. A study conducted in Bachok district, which is a rural area in Kelantan, showed that more than 50% parents never received a formal education. The low level of education among parents in Bachok, Kelantan led them to work in low-skill employment sectors such as labours, farmers, gardeners, and fishermen (Siti Masayu Rosliah Abdul Rashid & Narimah Samat, 2018). They also tended to have low oral awareness. This factor would influence their children oral health status leading to poor oral hygiene and low plaque score decrements in rural areas compared to urban areas.

On the other hand, children in urban areas have more accessed to digital media. Exposure to online information and communication technology (ICT) enables schoolchildren in urban areas to obtain information related to oral health easily. This is supported by a local study conducted in 2012, which showed that those who lived in rural areas had low percentage of computer ownership, low ICT usage, and less likely to acquire basic ICT skills. These findings indicate that digital gap is a persistent issue in rural areas (Hazura Mohamed, Hairulliza M Judi, Siti Fadzilah M Nor, & Zawiyah M Yusof, 2012).

The result in the present study showed the schoolchildren in urban areas had more decrement in plaque scores compared to the schoolchildren in rural areas. It could be due to schoolchildren in urban areas are more concern with their appearance and being more aware of the importance of oral hygiene than the schoolchildren in rural areas as they are more exposed to the oral health information. Schoolchildren in urban areas had more exposure to oral health information than the schoolchildren in rural areas could be associated with parents high in educational level, high household income, and the ability to access the information from digital media.

More children in urban areas would seek preventive dental treatment compared to schoolchildren in rural areas (Santos, da Fontoura Motta, Dalpian, & Garcia, 2014). Preventive measures such as the scaling of teeth can improve oral hygiene status and may lead to an improvement in plaque score for schoolchildren in urban areas compared to schoolchildren in rural areas. They also tend to receive OHE from the dental staff. There was a study reported in 2004 on factor influencing used of dental services in rural and urban communities. They found that more patients in rural areas reported seeking emergency dental treatment compared to patients in urban areas (Heaton, Smith, & Raybould, 2004). It shows that people in rural areas are less likely to go to the dentist for preventive treatment and only go for emergency treatment. The finding from these two studies supported finding in our study on higher decrement of plaque scores was associated with schoolchildren in urban areas than the rural areas. It could be due to schoolchildren in urban areas more utilised dental health care and high seeking behaviour on preventive dental treatment than the rural areas. Therefore, oral hygiene in schoolchildren in urban areas is better than the rural areas.

5.7.5 Gingival health

From the univariate analysis, two variables, i.e. type of school and mother's education level had significant associations with the mean increment score of GIS. The univariate test was also conducted for continuous variables, i.e. OHK, OHA, and OHB increment scores but no significant association was observed for each variable.

In the MLR analysis, DMP schools are significantly associated with an increment in the score of GIS when other factors are equal. This situation occurred might be due to the same reasons as described earlier in 5.6.1. First, it could be due to the lack of ability of DMs in secondary school compared to the IDC team in delivering effective oral health messages to schoolchildren including tooth brushing instructions. Second, the possibility of schoolchildren in the CG were under the care of the IDC team who have a better way of delivering effective oral health messages than the IG. Third, the IDC team also would provide treatment to the schoolchildren such as scaling and polishing. Therefore, the treatment provided by the IDC team in each school would improve gingival health and reduce the GIS score. Thus, the influence of DMP in secondary schools cannot be fully observed. Therefore, the influence of the DMP in secondary school cannot be concluded to cause improvement in gingival health.

A study was conducted in the United Arab Emirates to assess the impact of knowledge acquired in preventive aspects of dental education on dental student's health attitudes, oral hygiene, and gingival status. The results showed that despite having a high level of oral health attitudes, this was not reflected in their oral hygiene behaviours and gingival status (Rahman & Al Kawas, 2013). The finding from their study was in line with the finding in the present study, where good attitudes did not translate into good gingival health status.

To control the plaque accumulation in the mouth, which can cause unhealthy gingival is through tooth brushing, flossing at least once daily, and gargle after a meal (WebMD, 2019). Behaviours towards tooth brushing in schoolchildren in both groups were good, over 80% of the schoolchildren brushed their teeth at least twice daily was recorded. Meanwhile, more than 85% of the schoolchildren in both groups rinsed their mouth after a meal.

Based on the results and above discussion, the impacts of DMP on improving gingival health status are not conclusive as both groups had good behaviours in tooth brushing frequency, flossing, and rinsing mouth after a meal. The conclusion to state that DMP has an impact on the schoolchildren's gingival health status cannot be confirmed because of the good behaviours reported by the schoolchildren in both groups.

5.7.6 Caries incidence

The univariate analysis between schoolchildren's six-month mean increment of decayed teeth (ICDAS ≥ 1) and categories of demographic characteristics of the schoolchildren showed no significant relationship. Increments in OHK, OHA, and OHB scores over 6 months were also analysed with mean increment of decayed teeth. However, no significant association was recorded.

Meanwhile, the univariate analysis between schoolchildren's six-month mean increment of cavitated caries (ICDAS ≥ 3) and demographic characteristics of the schoolchildren showed one variable, i.e. school location had a significant association. Univariate analysis was also conducted on OHK, OHA, and OHB increment scores. The result showed that only OHA increment score had a significant association with the mean increment of cavitated caries.

In the MLR analysis, only increment in OHA score is significantly associated with increment in cavitated caries (ICDAS ≥3) when other factors are equal.

To enhance the sensitivity of caries detection using ICDAS, univariate analysis between schoolchildren's six-month mean increment of decayed surfaces (ICDAS ≥1) and categories of demographic characteristics of the schoolchildren was carried out. However, no significant relationship was noted. Increments in OHK, OHA, and OHB scores were also not associated with mean increment in decayed surfaces over 6 months.

Meanwhile, the univariate analysis between schoolchildren's six-month mean increment of cavitated surfaces (ICDAS ≥3) and categorise of demographic characteristics of the schoolchildren showed 2 significant associations, i.e. school location and the availability of DMP in primary schools. As for continuous variables, only increment in OHA is associated with mean increment of cavitated surfaces. In MLR analysis, mother's education levels and increment in OHA are significant variables when other factors are equal.

The same finding was observed in the study conducted in Pakistan in 2016. They reported that more children living in urban areas were detected with dental caries than children residing in rural areas (Umer, Farooq, Shabbir, Zofeen, Mujtaba, & Tahir, 2016). Other studies reported that children in urban areas had significantly more dental caries than children in the rural areas (Gupta, Gaur, Sharma, Zafer, & Kewalramani, 2013; Maserejian, Tavares, Hayes, Soncini, & Trachtenberg, 2008). The higher caries increment in urban areas might be due to the dietary pattern. Therefore the probability of higher consumption of sugary snacks among children in urban areas is high compared to rural areas (Okoye & Ekwueme, 2011). The study conducted in Ghana reported that the intake of sugary snacks was more among urban than rural residents (Blay, Åstrøm, & Haugejorden, 2000).

Schoolchildren who were not exposed to DMP in primary schools had a relationship with a mean increment of cavitated surfaces. This could be due to the possibility that they did not become aware of the causes of caries and the behaviours that can prevent caries. A study conducted in primary schools in 2013 highlighted the positive impacts of DMP in primary schools in reducing caries incidence. The study reported that the IG had a significantly lower mean DMFT and DMFS incremental scores than the CG over 6 years (Zamros Yuzadi Mohd Yusof, 2013).

The findings in the MLR analysis were somewhat unexpected. Past studies had shown that increments in OHA were associated with decrements in dental caries, such that oral health attitudes and behaviours of young adults were significantly associated with their oral status (Kawamura, Sasahara, Kawabata, Iwamoto, Konishi, & Wright, 1993; Sharda & Shetty, 2009). However, in the present study, a negative association was observed in the model. The reasons for this were not clear. However, the *b* coefficients for increment in OHA scores are very low, i.e. 0.04 (cavitated caries) and 0.05 (cavitated surfaces), respectively.

In the model, mother's education level is a significant factor for increment in cavitated surface caries. Mothers with education level up to secondary school and the university would have children with less increment in cavitated surface caries compared to mothers with primary school education. Mothers with low education levels may be less knowledgeable on the importance of oral health and preventive care. In addition, low education levels will affect household income, and low family income will affect optimum oral health care. Generally, people would place more emphasis on basic needs such as foods and shelter, and low priority for oral health. A study in Pennsylvania showed that lower socioeconomic status was associated with lower rates of brushing, less use of sealants, and less recent visit for dental services (Polk, Weyant, & Manz, 2010). Moreover, mother's low education level and frequent sugar consumptions by their children had been associated with poor oral health of the children (Kwan et al., 2005; Sufia et al., 2009; Wijtzes, Jansen, Jansen, Jaddoe, Hofman, & Raat, 2013). A study conducted in Korea reported that mother's education level affected children's caries significantly ($p<0.05$) and children whose mother attended less than high school education had a higher possibility of having caries than children whose mother graduated from college or more ($p<0.05$) (Jung, Kim, Kim, Kang, & Doh, 2009). A study was conducted in Brazil in 2014 to investigate family social determinants associated with the caries history of the child showed that tooth decay was most frequent in children of mothers with low educational attainment, and in children in lower income households who rarely or never visited the dentist. Caries history among children was strongly associated with maternal education, household income, and frequency of visits to a dental professional (Moimaz, Fadel, Lolli, Garbin, Garbin, & Saliba, 2014).

5.7.7 Oral health related quality of life

The MLR result shows that the factor associated with mean increment in OIDP score is a negative increment in the OHK score when other factors are equal. A point increment in mean OIDP score would lead to -0.09 point decrement in mean OHK score when other factors are similar ($p<0.05$). This factor explained 1.3% of the total variance in the mean increment of the OIDP score of the schoolchildren. This model could be explained by the Precede-Proceed Model, where improvements in OHK would lead to improvements in OHRQoL. Schoolchildren with higher OHK would be more aware of good oral health behaviours to improve oral health and prevent oral disease and would be more likely to have better OHS and OHRQoL. The DMP in secondary schools could be seen as a potential medium to import adequate oral health knowledge to schoolchildren and with appropriate supports in terms of oral health facilities, teachers, and school administrators in school would enable schoolchildren to adopt healthy behaviours and improve their OHRQoL.

Meanwhile, the multiple logistic regression (MLogR) analysis to determine significant factors associated with at least one OIDP in the past three months showed 8 significant factors at univariate analysis and 4 significant factors at MLogR when other factors are controlled, i.e. gender, gargling with water after meal, floss and increment in cavitated caries (ICDAS $\geq$3). The model explained 94% of variations in the outcome measures, has good predictive accuracy, and fulfilled the statistical assumptions.

In the model, female is 1.93 more likely to experience at least one OIDP compared to male students (OR=1.93, 95% CI= 1.30-2.88, p<0.01). Our model is similar to findings from other studies which showed that females were more likely to experience a lower quality of life than males (Amalia et al., 2017; Castro et al., 2011; maria da rocha Kozmhinsky, Heimer, & Goes, 2016). It could be due to female tend to have a greater awareness of the teeth, facial appearance, and possible oral problems. A study conducted in *Hospital Universiti Sains Malaysia,* Malaysia in 2011 to assess factors influencings patient's satisfaction with their dental appearance showed that general dental appearance was significantly associated with female (OR = 2.18; 95% CI: 1.18-4.03), unhappiness with tooth colour (OR = 3.05; 95% CI: 1.74-5.34) and the opinion that their teeth protruded (OR = 2.91, 95% CI: 1.44-5.91) (Tin-Oo, Saddki, & Hassan, 2011). Finding in our study could be supported by the findings in the mentioned study that being a female is more concern and more aware of dental appearance and any slight dissatisfaction would lead to lower OHRQoL in than male.

Schoolchildren who do not gargle their mouth after a meal are 1.95 more likely to experience at least one OIDP compared to schoolchildren who gargle their mouth after a meal (OR=1.95, 95% CI= 1.08-3.52, p<0.05). Gargling or rinsing mouth is a way to eliminate food accumulation or debris between and around the teeth, which otherwise could cause caries. The accumulation of plaque on the tooth surfaces and between teeth could lead to the possibility of the occurrence of caries and bleeding gum over a period of time. The possibility of schoolchildren to brush their teeth in school after a meal is most likely not happen. Therefore, rinsing of mouth after meals is crucial, as they may not able to brush teeth at school. Rinsing also ensures plaque is kept to a minimum between a meal and after between meal snacking (Indian Dental Association, 2016). Rinsing is taught in DMP and considered as a good OHB in school (Health Promotion Unit, 2015).

Schoolchildren who floss their teeth less than once daily are 1.94 more likely to experience at least one OIDP compared to schoolchildren who floss at least once daily (OR=1.94, 95% CI= 1.19-3.18, p<0.01). The use of floss has a similar effect as gargling, which is to remove plaque. However, flossing is more effective to remove plaque and food impaction in between the teeth and thus prevent interproximal caries from occurring. Flossing at least once daily is recommended in the module DMP in secondary school (Health Promotion Unit, 2015). A systematic review was conducted to assess the effects of flossing in addition to tooth brushing, as compared to tooth brushing alone, in the management of periodontal disease and dental caries. They stated that tooth brushing removes some plaque but cannot reach in-between the teeth, where gum disease and tooth decay are common. The review showed that people who brush and floss regularly have less gum bleeding compared to tooth brushing alone (Sambunjak, Nickerson, Poklepovic, Johnson, Imai, Tugwell et al., 2011). Flossing helps in minimising the risk of getting cavities, especially in interproximal areas (George, 2016). Dental examination at school is only through a visual examination, and no x-ray is available at school. Therefore, the interproximal caries is difficult to detect. Furthermore, caries that is present unnoticed would enlarge and cause sensitive and pain before being detected. Thus, as a result, OIDP would tend to increase.

Schoolchildren with increment in cavitated caries (ICDAS ≥3) are 1.20 more likely to experience at least one OIDP compared to schoolchildren with less increment in tooth decay (OR=1.20, 95% CI= 1.09-1.33, p<0.001). Cavitated caries often accompanied by pain, discomfort, functional and aesthetic limitations that will alert daily life, provide an explanation for the model. A similar finding was reported in Sudan in 2010 where active caries was associated with reported oral impacts (Child-OIDP score >0) in unadjusted and adjusted logistic regression analysis in the total sample of a group of children (Nurelhuda et al., 2010).

In summary, the evidence showed that the DMP in secondary schools had some benefits on schoolchildren's OHRQoL, but there were not statistically different. Based on the MLR, the significant factor for increment in OIDP score is a decrement in OHK. Based on the MlogR, the significant factors are gender, mouth rinsing after a meal, flossing frequency, and increment in cavitated caries (ICDAS ≥3). Based on the findings in the MLR and MlogR in the present study, future efforts to improve secondary schoolchildren's OHRQoL is through improving schoolchildren's OHK and OHB especially rinsing mouth after eating and flossing at least once daily.

5.8 Summary for the quantitative findings.

The DMP in secondary schools showed some benefits to schoolchildren in terms of improving oral hygiene, less increment in ICDAS score, and improving the OHRQoL.

However, the present study did not show evidence on DMP impact in secondary schools in terms of OHK, OHA, and OHB. These study findings indicated that the impact of DMP in improving schoolchildren's OHK, OHA, and OHB was not better than the control group.

5.9 Result of FGD (Objective 3)

The FGD was conducted to gain insight into the implementation process of the DMP and to support the quantitative findings in the present study. The qualitative part can generate insight understanding of the DMP, which cannot be obtained using quantifiable measurements (Krishna et al., 2010).

A similar study was conducted in 2013 to explore the implementation process of DMP in primary schools using the nominal group technique (NGT) as the method of data collection (Zamros Yuzadi Mohd Yusof, 2013). However, in the present study, FGD was chosen as the method of data collection to evaluate the implementation process of DMP in secondary schools.

The FGD was aimed to allow for a rich discussion by the DMs on focus topics. During the FGD sessions, the participants' expressions were observed, in terms of their voice tone, confidence level, and their answers. An uninterrupted discussion was allowed to take place until the discussion on a certain topic has reached saturation.

In terms of data analysis, the framework method analysis was used to analyse qualitative data (Gale et al., 2013). In this method, the emerging codes were developed based on the set of open-ended questions prepared prior to the FGD. The open-ended questions were prepared to guide the FGD session and to ensure the same questions were asked in the two different sessions of FGD. Therefore, the cumulative opinions gathered from the two different sessions of FGD can be concluded.

The whole FGD comprised 16 DMs, with 8 DMs per session. Only DMs from the secondary schools involved in the present study was included in the FGD. The reasons are described below:

i. The information obtained from the FGDs can be used to support and explain the findings for the quantitative data outcomes in the present study.
ii. The DMs come from the most active DMP schools in Kota Bharu and Pasir Mas districts based on their annual reports and state-level involvement. The results

obtained from the FGDs would be the findings represented DMP schools if the programme was run actively according to the DMP module.

iii. The selection of participants for the FGD involved the most active DMs who have been appointed as DMs over a period of 1 year. This homogeneity selection allowed the DMs to participate actively in the discussion and was able to provide the necessary and valuable feedback on the DMP implementation process.

The selection of DMs to take part in the FGD was not based on randomly sampling but they were selected by the health teachers to fit the criteria mentioned above. The criteria were set up to ensure the DMs selected could give as much information as possible regarding the implementation of the DMP in secondary schools.

Overall, the FGD topic guide consisted of 7 domains, i.e. the selection of DM, training of the DM, implementation of the DMP, support and material provided for the DMP, benefits of the DMP, weaknesses of the DMP, and recommendation for improvement.

For the question on the selection of DM, in general, the DMs pointed out that DM's selection in both schools were made through appointments by teachers. None of the schoolchildren came forward and volunteered to be a DM in the first place. Schoolchildren who were selected as DMs tend to be smart and with excellent academic results. Therefore, their selection is in line with the DM selection criteria, where they need to understand the contents of the module of DMP to deliver to other schoolchildren. However, the selection as a DM by the health teachers may result in the possibility of selected DMs do not perform well because they are less interested. DMs do not reject the appointments as DM, although they were less enthusiastic. The situation may be caused by the schoolchildren did not want to object to what their teacher has said. In the Malay community, respecting and honouring older people is a very important value. The value of respecting older people has been nurtured since childhood (Noriati A Rashid, 2005).

Other selection criteria put forward by the DMs were schoolchildren with good academic standing, good communication skills, and who have already been appointed as DM in the previous year. This type of selection process often leads to inequality in the selection process, favouring mainly those with good academic standing and ignoring schoolchildren with poor academics. Although DM with academic excellence is an asset to the DMP, schoolchildren from good academic classes would find it difficult to influence their peers from the lower classes. This could be due to differences in personality and characters between the classes. It has been shown that children who formed friendships tended to have similar personality characteristics than those who did not (Duck & Craig, 1978). Selecting DM from lower classes is recommended to promote equal participation and transmission of health information to all.

In terms of DM training, majority of DMs from both schools (even the experienced DMs) perceived their training was insufficient. The DMs perceived that they did not have enough training in delivering health messages to their peers. This could be one of the reasons why DMP in secondary schools did not produce any significant impact in promoting OHK, OHA, and OHB among the schoolchildren. Training is important to increase human capital among DMs. It is important for an individual to be more knowledgeable to convey their knowledge to influence others (Hamat Mohd Fauzi & Che Nordin Mohd Khairul Naim, 2012).

There were some differences in terms of exposure related to DM training. The participants from SMK Tanjung Mas mentioned that they received informal exposure and training from health personnel who came to the school to provide health-related information. However, the DMs in the SMK Bunut Susu did not have the same opportunity. This showed that not all DMP schools have a close connection with health personnel for the training purposes of DM. The present study also detected an unstandardised pattern of training among the participants. DMs from the first school (SMK Tanjung Mas) reported being self-trained, to select particular topics and learn on the topics chosen they have chosen from the DMP module. In contrast, training in SMK Bunut Susu was more systematic, carried out in small group discussions on top of being trained by the teachers who were in charge of the DM club at their school. Although the two schools have different ways of conducting training, the participants also mentioned that they received a lack of supervision from DM teachers. They also perceived that DM teachers do not care if DMs did not attend meetings and training for the DMP. Again, this could be the one of the reasons why the DMs were not able to influence their peers to adopt healthy lifestyles in this study because of lack of structured training in preparing materials and conducting the activities.

In terms of the implementation of the DMP, findings from the present study showed that there were inconsistencies in conducting the DMP activities, lack of monitoring, and poor take-up by the schoolchildren. Therefore, the implementation of the DMP activities needs to be standardised and improved in the particulars of the supervision and monitoring by teachers. A study was conducted in Austria stated that the implementation of the health promoting school activity was mainly based on the knowledge, personal interests, experiences and concerns of committed individuals, showing the importance of teacher education and training (Adamowitsch, Gugglberger, & Dür, 2017). Therefore, teachers play an essential role in ensuring the DMP activities are conducted consistently and provide close supervision of the DMs. This would allow DMs to be more prepared to be agents of change to influence their peers to adopt positive lifestyles.

The lack of supervision by the teacher-in-charge would be due to the teacher's high administrative workload and the teaching responsibility, which is their main role at the school (Berita Semasa, 2019). In addition, usually DM's teacher is a science subject teacher, where it is one of the core subjects in Malaysia's school syllabus. Therefore, they are more focused on teaching science subjects than as a co-curriculum teacher. So, their task as a DM teacher would be less effective and often disrupted, especially in supervising and monitoring DMs.

In terms of the support and materials for the DMP, the DM perceived they received some support from the DM teachers with adequate infrastructure and some support from outside the school. Health teachers made discussions with DMs concerning what the DMs do not know, for example, the topic in the DM syllabus. DM will ask the health teacher for questions, and discussion will take place between DM and the health teacher. Meanwhile, outside support was also provided, especially when conducting exhibitions in schools. The health clinic assisted in the exhibition, for example, preparing a food pyramid, and provides pamphlets to be distributed to schoolchildren. They also come to school to teach DMs on certain health topics in the DMP syllabus. The support was sufficient to implement the DMP in secondary school successfully. However, the support in the form of materials and financial assistance was only reportedly enough for SMK Bunut Susu. DM in SMK Tanjung Mas reported that they had to use their own money to conduct projects or activities under DMP in secondary school. This situation may cause DMs to be less motivated to carry out the activities, especially for those from the low-income family background. This may further affect the implementation of the DMP. Lack of financial support and teacher's time constraint were also reported in the DMP evaluation in primary schools in relation to the weaknesses of the programme (Zamros Yuzadi Mohd Yusof, 2013).

In terms of the benefits of DMP, DMs perceived that they attained more health knowledge by participating in the DMP, practiced more healthy lifestyles, and be able to share health information from the DMP with their family members and the community, influence friends and family members towards positive behaviours, developed good teamwork among the DMs, increase self-confidence, and gain extra co-curricular merit to further their study. The findings were in line with the DMP objectives which are to inculcate healthy lifestyles, and improves levels of knowledge among the schoolchildren (Health Promotion Unit, 2015). Similar findings were also observed in the evaluation of the DMP in primary schools (Zamros Yuzadi Mohd Yusof, 2013). The important benefits perceived by the DMs in terms of sharing health information with family members, the community, and friends towards healthy lifestyles and positive health changes adhered to the HPS concept introduced by the WHO not too long ago (World Health Organization, 2019b).

Despite the DM's feedback on the perceived benefits of the DMP, they also perceived that there were weaknesses in the DMP in secondary schools. They perceived that they had insufficient time to conduct the activities, lack of teamwork among DMs, burdens on the DM to conduct activities, unsuitable approach, and perceive ineffectiveness of the message delivery.

To conduct any activities, a longer time is needed to deliver health messages effectively. However, in the DMP, they are often allocated 10 minutes to deliver health messages after the assembly through talks, performances, and gimmicks. The limitation of the delivery time could be one of the reasons for the health messages not reaching the schoolchildren effectively. The same finding was also reported on the time constraint in importing health information the DMP in primary schools (Zamros Yuzadi Mohd Yusof, 2013).

The DMs also perceived that there was a lack of teamwork among DMs, and they felt the burdens as a DM. Most of DMs are selected from the front classes who also have other activities to carry out, such as being school prefect, chair of other activities in school where it affects their learning time, as they also need to deliver the DMP activities. Even though good teamwork among the DM was mentioned as the benefit of DMP, this only involved the active DMs. Therefore, the workload was only shared among active DMs, which increased the burden placed over them. Consequently, this would eventually interfere with the implementation of DMP in schools. The same finding was also reported as a threat in the DMP in primary schools (Zamros Yuzadi Mohd Yusof, 2013).

The DMs also raised some recommendations to improve on the implementation of DMP in secondary school. They recommended appointing a health advisor in the school to reduce the burden of their teachers, increasing and expanding the DM club membership, and to allocate longer time to conduct activities.

Health teachers are often busy, as they also need to teach other subjects in school. Therefore, DMs felt the need for a dedicated health advisor at the school to help and guide them to carry out health-related activities at school.

Currently, the number of DM membership in the DMP club is considered small, i.e. about 50 DMs per school. This number was perceived as insufficient with the high work burden of the DMs (numerous topics to be covered and activities to be conducted throughout the year). Therefore, it is suggested to increase the number of DM club membership and extend it to other students in lower academic classes. If the membership of DM club is extended to these classes, schoolchildren in lower academic classes would not feel left behind or marginalised. They would be more welcoming to receive advice from someone from their own classes rather than from DMs from other classes who are smarter than them.

5.9.1 Summary of FGD

The DMs perceived that DMP had contributed towards school health and schoolchildren's behavioural and personal qualities. However, the presence of implementation gaps would threaten the programme's effectiveness. If the weaknesses and suggestions from DMs are taken into account to improve the DMP, the possibility of the DMP to be implemented more successfully could be realised with more promising outcomes.

Based on the FGD, mixed responses were observed pertaining to the training of DMs. DMs in SMK Bunut Susu perceived that they received sufficient training with more systematic methods than DMs in SMK Tanjung Mas. Consequently, schoolchildren in SMK Tanjung Mas could be contributing towards the less favourable findings than schoolchildren in the SMK Bunut Susu. To observe any differences between these two schools, data would need to be analysed separately between the two schools for future reference.

5.10 Implication of the findings

The DMP in primary schools showed positives effects in improving OHK, OHA, OHB, OHS, and OHRQoL after 6 years of implementation (Zamros Yuzadi Mohd Yusof, 2013). Based on the current study, the DMP in secondary schools showed some benefits for secondary schoolchildren in terms of improving oral hygiene, reducing increment in ICDAS score, and improving the OHRQoL.

The outcome of this present study can be used to inform policymakers, and stakeholders namely the planners, managers, sponsors, teachers, the school community, parents, and schoolchildren on the potential impacts or benefits of DMP in secondary schools. The outcomes could provide useful information on the effectiveness and worthiness of the programme to improve schoolchildren's oral health and to justify future funding.

The prevalence of gum disease and caries were high in the Kelantan state (Ministry of Health, 2016; Oral Health Programme, 2018a). As such, although the outcomes of the present study showed minimal improvements in oral health parameters, these improvements in a population with high prevalent of oral diseases showed that DMP could contribute towards positive effects on oral hygiene, caries, and OHRQoL at the population level at large. Based on this argument, the DMP should be continued especially in Kelantan where water fluoridation is non-comprehensive and high consumption of sugars is observed in the population.

Meanwhile, based on FGD findings, the DMs informed that they had to use their own money to conduct the activities. This could be the reason why the implementation of DMP was not successful. Therefore, an annual financial aid should be provided to encourage and motivate DMs to conduct the DMP-related activities effectively.

5.11 Limitation of the study

First, it relates to the questionnaires used in the present study. Ideally, schoolchildren should answer the questionnaire in a fair manner. However, there could be instances where the children answered according to what they thought the researcher wanted to know. This phenomenon is called response bias. It may be caused by many factors, all of which relate to the idea that humans were not acted passively to stimuli, but actively integrate various sources of information to generate responses in certain situations and could influence the participants to respond away from an accurate or truthful responses (Furnham, 1986). In addition, a few schoolchildren in lower academic classes required guidance in answering the questionnaire. As a result, their responses might be influenced by the researcher's presence. Therefore, some tended to answer according to what they should answer as the correct answers rather than based on their circumstances. This situation is known as the Hawthorne effect or also referred to as observer effect. The Hawthorne effect is defined as the type of reactivity in which individuals modify their behaviours or reactions in response to being observed (McCarney, Warner, Iliffe, Van Haselen, Griffin, & Fisher, 2007).

In the present study, schoolchildren answered the questionnaire based on a Likert scale for OHK and OHA items (strongly disagree to strongly agree). The main reason for using the Likert scale was due to compare the outcomes in the present study with the outcomes of the previous study on DMP in primary schools in 2013 whose questionnaire used such rating scale. However, the large spectrum of options for answering the questionnaire could lead to the schoolchildren not being able to give accurate responses. There was no clear-cut point between schoolchildren who had good and poor OHK and OHA for each of the items. This response option could lead to a non-significant difference between the two groups. Generally, people avoid choosing “extreme” options on a Likert scale due to the negative implications of engaging with “extremes” scores, even though extreme choices might be the most accurate answers (LaMarca, 2011). Therefore, in future, it is recommended to use answer options ‘yes’, ‘no’, and ‘don’t know’ for assessing knowledge items.

In terms of the questionnaire on OHRQoL, schoolchildren needed to recall events over the last 3 months on oral-health related experiences and causes of oral problems on them. Krishna et al., (2010) stated that recall bias could be a problem if the measured outcomes require participants to recall events in the past. In addition, a person often recalls positive more than adverse events (Krishna et al., 2010). In children, this may pose greater problems and may affect the true findings on the children’s outcome measures.

In the present study, the GIS was used in the assessment of gingival health. The GIS is only used in Malaysia. Therefore, it was not possible to compare findings of the present study with other studies using different indices elsewhere.

The present study involved a shorter-term follow up of 6 months to observe potential differences in the outcome measures between schoolchildren in DMP and non-DMP schools. Therefore, differences in oral health outcome variables that require longer term evaluation would not be noticeable. Only the immediate outcome measures can be observed. However, the qualitative findings from the present study were valuable to improve the process implementation of the DMP.

The study involved secondary schools with active DMP for over 2 years and the FGD only involved DMs in these schools. Therefore, the findings were only related to secondary school with active DMP, and reasons from schools with less active DMP could not be explored.

The "charming smile" scope in the syllabus of DMP in secondary schools only covered topics on mouth malodour, MSE, malocclusion, and tooth injury (trauma). Information on oral disease and prevention in terms of caries and gingivitis may not be covered well in the syllabus and depended mostly on individual personal access to oral health information and from the dentist who visit the school.

The implementation of oral health-related activities was agreed between the researcher and the school administration, where these activities supposed to be conducted between February 2018 to August 2018. However, the actual date and months of the activities depended on the schools administration. The time differences in conducting oral health-related activities between the schools might give different effects to the outcomes of the study. For example, if the oral health-related activities were conducted early in the year compared to after several months, the outcomes of the findings would be different in the former schools as more time was given for the children to improve their behaviours if the intervention was conducted early in the year.

Finally, apart from DMP in providing oral health promotion in secondary school, the schoolchildren also received oral health messages from the IDC team. The provision of oral health messages depends on the dental clinics responsible for the particular secondary schools. Different schools receive IDC team from different dental clinics. Some dental clinics have good methods of oral health messages deliveries to suit the needs of the schoolchildren. This may result in uneven bias in the levels of knowledge, attitudes, and behaviour among the schoolchildren and may mask the true impact of DMP in the secondary schoolchildren with the excellence IDC team. However, this was beyond the control of the researchers.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The conclusions that can be drawn from the present study are presented according to the study objectives below:

6.1.1 To compare the potential impacts of DMP between schoolchildren who attended DMP schools (intervention group) and schoolchildren who attended non-DMP schools (control group) after 6 months of implementation in terms of levels of oral health knowledge and attitudes (immediate impact) (Objective 1.a)

i. Oral health knowledge

Overall, schoolchildren who attended the DMP and non-DMP secondary schools showed improvements in OHK scores after 6 months, but the difference between the 2 types of schools was not statistically significant. Schoolchildren in DMP schools showed an improvement in knowledge about caries prevention after 6 months. In addition, schoolchildren in DMP schools had a significantly higher score than schoolchildren in non-DMP schools on “a person must brush teeth at least twice a day using fluoride toothpaste” and “brushing teeth with fluoride toothpaste prevents tooth decay”. Therefore, DMP in secondary schools has a role in improving oral health knowledge of schoolchildren after 6 months.

ii. Oral health attitudes

Schoolchildren who attended the DMP and non-DMP secondary schools showed significant improvements in oral health attitudes scores after 6 months. However, the mean oral health attitudes increment was significantly higher in non-DMP schools compared to DMP schools after 6 months. Therefore, DMP in secondary schools was not more effective than non-DMP secondary schools in improving schoolchildren's oral health attitudes after 6 months.

6.1.2 To compare the potential impacts of DMP between schoolchildren who attended DMP schools (intervention group) and schoolchildren who attended non-DMP schools (control group) after 6 months of implementation in terms of levels of oral health behaviour and oral hygiene (intermediate impact) (objective 1.b)

i. Oral health behaviour

Schoolchildren who attended the DMP and non-DMP secondary schools showed a decrement in total score of oral health behaviour after 6 months with no significant difference between the 2 types of school. Despite the decrement in total score, the proportion of schoolchildren who practiced more good oral health behaviours was higher than those who practiced less good oral health behaviours for both schools at baseline (>90%) and after 6 months (>90%). Therefore, DMP in secondary schools was not more effective than the non-DMP secondary schools in improving schoolchildren's oral health behaviours after 6 months.

ii. Oral hygiene

Schoolchildren who attended the DMP and non-DMP secondary schools showed a significant decrement in plaque score for both schools after 6 months but the difference was not statistically significant. The proportion of schoolchildren who experienced either an increment or decrement in plaque score after 6 months between both schools was not statistically significant. Therefore, DMP in secondary schools was not more effective than the non-DMP secondary schools in improving schoolchildren's oral hygiene status after 6 months.

6.1.3 To compare the potential impacts of DMP between schoolchildren who attended DMP schools (intervention group) and schoolchildren who attended non-DMP schools (control group) after 6 months of implementation in terms of oral health status, i.e. gingival health and caries incidence (health impact) (objective 1.c)

i. Gingival health

Significantly more schoolchildren who attended the DMP secondary schools experienced an increment in mean score of GIS compared to schoolchildren who attended non-DMP secondary schools. Schoolchildren who attended the DMP secondary schools showed a higher mean increment in score of GIS after 6 months than schoolchildren in non-DMP secondary schools with statistically significant difference. Therefore, the DMP in secondary schools was not effective than non-DMP secondary schools in improving schoolchildren's gingival health after 6 months.

ii. Caries incidence

A significantly lower proportion of schoolchildren who attended the DMP secondary schools experienced caries increment compared to schoolchildren who attended the non-DMP secondary schools after 6 months. Schoolchildren who attended DMP secondary schools showed a lower proportion with new cavitated caries (ICDAS≥3), and lower 6-month mean caries increment than schoolchildren in non-DMP secondary schools. Therefore, the DMP in secondary schools had some roles against caries over 6 months.

6.1.4 To compare the potential impacts of DMP between schoolchildren who attended DMP schools (intervention group) and schoolchildren who attended non-DMP schools (control group) after 6 months of implementation in terms of oral health-related quality of life (health impact) (objective 1.d)

A lower proportion of schoolchildren who attended the DMP secondary schools experienced an increment in mean OIDP total score than schoolchildren in non-DMP secondary schools after 6 months. Schoolchildren who attended DMP secondary schools showed a lower mean OIDP total score than schoolchildren in non-DMP secondary schools after 6 months but the difference in mean increment scores was not significant. Therefore, the DMP in secondary schools had some roles in schoolchildren's OHRQoL over 6 months but the effects were not significant.

6.1.5 To determine the associated factors in relation to schoolchildren's oral health knowledge, attitudes, behaviours, oral health status, and OHRQoL (objective 2)

i. Oral health knowledge

The MLR model shows that **gender** (*b* coefficient for male = 1.96, 95% CI = 0.16-3.75) and **school location** (*b* coefficient for urban = 5.29, 95% CI = 3.50-7.10) are significant factors associated with OHK increment over 6 months.

ii. Oral health attitudes

The MLR model shows that **type of school** (*b* coefficient for non-DMP school = 3.53, 95% CI = 1.87-5.19), **school location** (*b* coefficient for urban = 4.62, 95% CI = 2.90-6.35), **gender** (*b* coefficient for male = 2.45, 95% CI = 0.78-4.13), and **OHK increment** (*b* coefficient = 0.39, 95% CI = 0.31-0.47) are significant factors associated with OHA increment over 6 months.

iii. Oral health behaviours

No significant association was found between the demographic characteristics, oral health knowledge increment, and oral health attitudes increment with oral health behaviour of the schoolchildren.

iv. Oral health status

a) Oral hygiene

The MLR model shows that **school location** (*b* coefficient for rural = 10.98, 95% CI = 6.08-15.89) is a significant factor associated with plaque score increment over 6 months.

b) Gingival health

The MLR model shows that **type of school** (*b* coefficient for non-DMP school = 0.33, 95% CI = 0.24-0.42) is a significant factor associated with score of GIS increment over 6 months.

c) Caries incidence

- The MLR model shows that **OHA increment** (*b* coefficient = 0.04, 95% CI = 0.02-0.05) is a significant factor associated with cavitated caries (ICDAS≥3) increment over 6 months.
- The MLR model shows that **mother's education level** (*b* coefficient for secondary school = -0.73, 95% CI = -1.35 to -0.10, and *b* coefficient for university level = -0.96, 95% CI = -1.87 to -0.05), and **OHA increment** (*b* coefficient = 0.05, 95% CI = 0.03-0.07) are significant factors associated with cavitated surfaces (ICDAS ≥3) increment over 6 months.

v. OHRQoL

- The MLR model shows that **OHK increment** (*b* coefficient = -0.09, 95% CI = -0.16 to -0.02) is a significant factor associated with total OIDP score increment over 6 months.
- The MLogR model shows that **gender** (OR for female= 1.93, 95% CI = 1.30-2.88), **gargling with water after meal** (OR for not gargling after meal = 1.95, 95% CI = 1.08-3.52), **flossing frequency** (OR for not flossing at least once daily = 1.94, 95% CI = 1.19-3.18), and **increment in cavitated caries (ICDAS ≥3)** (OR = 1.20, 95% CI = 1.09-1.33) are significant factors associated with schoolchildren's OHRQoL

6.1.6 To explore the process implementation of the DMP in terms of DM selection, training, strengths and weaknesses of DMP, and suggestion for improvement from the perspectives of the DM (objective 3)

Based on the FGD involving the DMs, it was concluded that the DMP in secondary schools were perceived to contribute towards improvement in schoolchildren's health knowledge, healthy life-styles, sharing of information on health-related knowledge with family members and communities, influence on friend and family members toward positive behaviours, good teamwork, self-confident level, and extra co-curricular merits. However, despite the benefits, some 'implementation gap' and weaknesses existed which indicated that the DMP still had rooms for improvement. Suggestions for programme improvement and sustainability included improvement in managing the DMP, provision of training and leadership, provision of support and materials, and better collaborations with relevant stakeholders.

6.2 Recommendation

Based on the study findings, the following recommendations are made:

i. Due to the DMP positive effects on some items of oral health knowledge, caries increment, plaque score, and OHRQoL, the implementation of DMP in secondary schools in Kelantan should be continued, especially in rural areas and areas with no water fluoridation.

ii. With regards to improve the implementation aspects of the DMP in secondary schools, these recommendations are made:

a) Annual financial aid to school should include allocation for the DMP. This fund would be used to run the programme effectively throughout the year including purchasing materials and equipment, and funding for outside activities including attending the DMP convention that is held annually.

b) School management should provide better support for DMP in terms of providing more time to conduct the DMP activities, and appointing more than 2 DMP teacher advisors per school including teachers from lower form, i.e. Form 1 and 2 to support the DMP.

c) Extend DM selection criteria to include students from lower academic classes so that children from these classes could relate better in DMP activities when their friends are involved in the DMP activities.

d) In terms of training, the DMs should be exposed to adequate training to become capable role models who are confident in speech, knowledgeable, disciplined, and committed in their tasks. Currently, DMs are using a health-related book kept by the DMP teacher advisor. The provision of more health-related books for DMs is recommended, and the books can be kept in the school library.

e) Constant two-way communications between the stakeholders, i.e. state health and education departments and the school is recommended to ensure the availability of appropriate support, guidance, and expert advice for the

DMP to overcome any difficulties and limitations. A health advisor should be allocated per school. If not possible, regular visits by staff from health clinics to provide training for DMs is recommended.

f) Parental involvement and support for DMP activities are recommended to promote the overall success of DMP. The involvement of parents can be done through actions by parents' sub-committee of the parent-teacher association. DMs can take part in health-related activities during annual parent-teacher general meeting, i.e. do performances, and deliver health-related messages to parents.

iii. Based on some positive impacts of the DMP, it is recommended to introduce the DMP to vernacular and religion-based schools. The Kelantan State Government reported that in 2016 there were 84 religion-based secondary schools in Kelantan (Kelantan State Government, 2018). However, the methods of implementation and module contents may need to be revised to meet the needs, priorities, and learning cultures of the new target groups.

6.3 Recommendation for future studies

Based on the conclusions and limitations faced in this study, the following recommendations are made for future studies on DMP:

i. The undertake longer-term evaluations of the DMP. The current study only involved intervention up to 6 months. This shorter-term evaluation would only be beneficial to see DMP immediate impacts. The longer-term evaluation would be useful to assess DMP impacts in promoting healthy habits, improving oral health status, and OHRQoL. Therefore, it is recommended to follow up the study for the next 5 years.

ii. To conduct similar FGD with schoolchildren from other DMP secondary schools which are not active to identify the barriers and limitations on why the DMP is not active in those schools.

iii. To extend the FGD to involve DMP teacher advisors from all DMP secondary schools in Kelantan in order to explore their perspectives on the facilitators, barriers, and suggestions for improvement of the DMP.

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