PIRKKO-LIISA TARVONEN

This doctoral thesis provided novel information on school children’s dental health in the Democratic People’s Republic of Korea. During the six years operations of the Children’s Oral Health Promotion Programme, the high prevalence of untreated dental caries decreased. After the follow-up, awareness of healthy oral habits was at high level and the recommended healthy oral habits were well adopted with the exception of frequent sweet snacking. Children’s health in developing countries may be promoted with limited resources by promoting healthy oral habits. Early start of the prevention is important.
PIRKKO-LIISA TARVONEN

Children’s Oral Health Promotion Programme
in the Democratic People’s Republic of Korea

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To the Dream Giver
ABSTRACT

Dental caries affects billions of people globally. Development collaboration to promote children’s oral health was started in the Democratic People’s Republic of Korea (DPRK) in 2007. This study aimed to evaluate dental health and oral health habits among school children as well as awareness of healthy oral habits among the children and the parents after a six-year follow-up of the Children’s Oral Health Promotion Programme (COHPP) in Pyongyang, DPRK.

The sample of 2,000 children and 200 parents was collected by schools as a convenience sample and was exposed to intensified, school-based intervention or early, preschool-based intervention. Data were gathered by clinical oral examinations (500 children) and questionnaires. The prevalence and amount of untreated dental caries by intervention groups during 2007–2013 was studied. In 2013, the association between dental caries and children’s self-reported oral health habits was studied, children’s and their parents’ reports concerning the children’s oral health habits were compared, and the associations between children’s self-reported oral health habits as well as their own and their parents’ awareness of healthy oral habits were analysed.

The prevalence of untreated dental caries was high at baseline but decreased in both intervention groups during the follow-up, as did the mean number of decayed teeth. With less effort, the early, preschool-based intervention appeared to be more competent than the intensified school-based intervention. The recommended healthy oral habits were well adopted with the exception of frequent sweet snacking. Regular use of fluoride toothpaste was established among the children during the follow-up. The reports by the children and by their parents concerning the children’s oral health habits were congruent regarding dietary habits but differed regarding oral hygiene habits. Awareness of healthy oral habits was at a high level. Associations between children’s awareness of and compliance with healthy oral habits varied according to the healthy oral habits. Parents’ awareness of healthy oral habits did not associate statistically significantly with their children’s oral health behaviour.

The study provided novel information on children’s dental health in the DPRK. Frequent consumption of sugary snacks was common and formed a major risk for dental health. A significant improvement in the children’s dental health was achieved. The importance of early prevention was emphasized. To promote children’s health in developing countries, development cooperation should more often include promotion of healthy oral habits emphasizing lower sugar consumption and less frequent sweet snacking. Affordable fluoride toothpaste should be available in shops.


Luokitus: WS 440, WU 30, WU 113.6, WU 270
Yleinen Suomalainen asiasanasto: lapset; Korea; karies; ennaltaehkäisy; fluoridit; terveyskäyttäytyminen; terveyden edistäminen; tietoisuus; interventio; suuhhygienia; suun terveys; vanhemmat; varhainen puutuminen; välipalat; seurantatutkimus; kyselytutkimus
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Vantaa December 2016

Pirkko Liisa Tarvonen
List of the original publications

This dissertation is based on the following original publications:


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Contents

1 INTRODUCTION ........................................................................................................ 19

2 LITERATURE REVIEW ........................................................................................ 21
  2.1 Dental caries ...................................................................................................... 21
    2.1.1 Dental caries as a disease ......................................................................... 21
    2.1.2 Dental caries as a public health problem .............................................. 21
    2.1.3 The impact of oral health on children’s health and well-being .................. 23
    2.1.4 Costs of traditional treatment of dental caries ...................................... 24
  2.2 Dental caries in underprivileged populations ............................................. 24
    2.2.1 Children’s dental caries prevalence and oral health habits in the Democratic People’s Republic of Korea ........................................... 27
  2.3 Prevention of dental caries ............................................................................. 27
    2.3.1 Healthy diet ............................................................................................ 27
    2.3.2 Tooth brushing and use of fluorides ....................................................... 28
    2.3.3 Social environment ................................................................................ 29
    2.3.4 Family and the immediate surroundings .............................................. 30
  2.4 Oral health promotion .................................................................................... 31
    2.4.1 Targeting the whole population in the promotion of oral health ............. 31
    2.4.2 Promoting school children’s oral health ................................................ 32
    2.4.3 The WHO Global School Health Initiative ............................................ 33
  2.5 Development collaboration by Fida International in the DPRK .................. 34

3 AIMS OF THE STUDY ............................................................................................ 35

4 SUBJECTS AND METHODS .................................................................................. 37
  4.1 Study design and population ........................................................................ 37
  4.2 Intervention ..................................................................................................... 38
    4.2.1 Oral health education ............................................................................. 39
    4.2.2 Distribution of toothbrushes and fluoride toothpaste ............................... 40
    4.2.3 Education materials and methods .......................................................... 41
    4.2.4 Education for dentists ......................................................................... 42
  4.3 Clinical examinations ...................................................................................... 43
    4.3.1 Baseline oral survey in 2007 ................................................................. 43
    4.3.2 First follow-up in 2010 .......................................................................... 43
    4.3.3 Second follow-up in 2013 ..................................................................... 44
  4.4 Questionnaires ................................................................................................ 45
    4.4.1 Children’s questionnaires ..................................................................... 45
    4.4.2 Parents’ questionnaire ......................................................................... 45
4.5 Statistical methods ................................................................. 46
  4.5.1 The change in dental health during the follow-up
         (Group I and Group II) .......................................................... 46
  4.5.2 Association between dental health and children’s oral health
         habits (Group I and II) .......................................................... 46
  4.5.3 Children’s awareness of and compliance with healthy oral
         habits (Group I, II, III) ....................................................... 46
  4.5.4 Association between parents’ awareness of and children’s
         compliance with healthy oral habits in Subgroup II .......... 47
  4.5.5 Comparison between children’s and the parents’ reports
         of the children’s oral health habits in Subgroup II .......... 47
  4.6 Ethical considerations .......................................................... 47

5 RESULTS ......................................................................................... 49
  5.1 Dental health (I,II) ................................................................. 49
  5.2 Children’s oral health habits .................................................. 51
     5.2.1 Children’s self-reported oral health habits (groups I-III)(III) 51
     5.2.2 Associations between untreated dental caries and self-reported
         oral health habits (groups I and II) (II) ............................... 54
     5.2.3 Congruence between children’s and their parent’s reports
         of the children’s compliance with healthy oral habits
         (Subgroup II)(III) .............................................................. 55
  5.3 Children’s awareness of healthy oral habits (groups I-III) (III) 56
     5.3.1 Associations between children’s awareness of and
         self-reported compliance with healthy oral habits .......... 57
  5.4 Parents’ awareness of healthy oral habits (Subgroup II) (III) .. 59
     5.4.1 Associations between parents’ awareness of healthy oral habits
         and children’s self-reported compliance with them (Subgroup II)
         (Additional information) .................................................. 59

6 DISCUSSION .................................................................................... 61
  6.1 Methodology ........................................................................... 62
  6.2 Comparison between the two interventions ......................... 64
  6.3 Children’s oral health habits and their association with dental
         caries status ........................................................................ 67
  6.4 Children’s awareness of and compliance with healthy oral habits 68
  6.5 Parents’ awareness of healthy oral habits ............................... 69

6 CONCLUSIONS AND RECOMMENDATIONS ................................. 71

REFERENCES ..................................................................................... 73

APPENDICES
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMFS</td>
<td>The sum of tooth surfaces affected by caries or missing due to caries or filled</td>
</tr>
<tr>
<td>DMFT</td>
<td>The sum of teeth affected by caries or missing due to caries or filled</td>
</tr>
<tr>
<td>DPRK</td>
<td>Democratic People’s Republic of Korea</td>
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<td>FI</td>
<td>Fida International</td>
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<td>HPS</td>
<td>Health-Promoting Schools</td>
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<td>KECCA</td>
<td>Korea-Europe Cooperation and Coordinating Agency</td>
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<td>KEF</td>
<td>Korea Education Fund</td>
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<td>MS</td>
<td>Mutans streptococci bacteria</td>
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<tr>
<td>NGO</td>
<td>Non-governmental organization</td>
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<tr>
<td>PDCSP</td>
<td>Primary Dental Care Support Programme</td>
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<tr>
<td>PMC</td>
<td>Pyongyang Medical College, Kim Il Sung University</td>
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<tr>
<td>SES</td>
<td>Socio-economic status</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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</table>
1 Introduction

Untreated dental caries affects billions of people globally. The Global Burden of Disease 2010 Study produced comparable estimates of the burden of 291 diseases and injuries worldwide between 1990 and 2010 (Kassebaum et al. 2015, Marcenes et al. 2013). Untreated dental caries in permanent teeth was found to be the most prevalent chronic condition and untreated dental caries in primary teeth the 10th most prevalent condition. Both distribution and severity of the disease were worst in underprivileged populations. According to Marcenes et al. (2013), responding to the urgent per capita oral health needs is especially challenging in East and South Asia. To fight against this vast health problem, the World Dental Federation (FDI), the World Health Organization (WHO), and the International Association of Dental Research (IADR) have outlined the oral health goal for 2020 as minimizing the impact of oral and craniofacial diseases on health and psychosocial development and emphasizing the promotion of oral health and reduction of oral diseases amongst populations with the greatest disease burden (Hobdell et al. 2003). As outlined in the WHO World Oral Health Report 2003 (Petersen 2003), a wide range of approaches that target populations at the highest risk and involve improving access to care are required when aiming to reduce the disparities. In several developing countries, the most important challenge is to offer essential oral health care within the context of primary health programmes (Petersen 2003, 2014). The priority action areas for global oral health include promotion of affordable fluoridated toothpaste in developing countries, provision of dietary counselling to promote a healthy diet and to decrease the consumption of sugary soft drinks, and promotion of healthy lifestyle and reduction of tobacco use. However, translation of knowledge and experiences of disease prevention into action programmes is challenging. To reduce risk factors and the burden of oral diseases and to improve oral health care systems and the effectiveness of community oral health programmes the WHO Oral Health Programme focuses on stimulating oral health research both in the developed and the developing world (Petersen 2003).

The Democratic People’s Republic of Korea (DPRK) belongs to the developing countries (Sullivan and Sheffrin 2003, World Bank 2014). Development collaboration to promote children’s oral health in the DPRK was started in 2007 between local authorities and Fida International (FI), a Finnish non-governmental organization (NGO). The initiative for the co-operation came from local authorities. They contacted the project officers of other projects by FI already present in the DPRK. The rapid increase in dental caries incidence among young generations had alarmed the local authorities to seek foreign cooperation to suppress this disease which was locally new and unfamiliar. This resulted in the initiation of the development cooperation project Primary Dental Care Support Programme (PDCSP). The project collaborated with the Korea-Europe Cooperation and Coordinating Agency affiliated to the Ministry of Foreign Affairs and the Korea Education Fund (KEF) until the end of 2015.

The main goal of the project was to improve oral health among children and youth. A national programme to promote oral health among kindergarten and primary school children, called the Children’s Oral Health Promotion Programme (COHPP), was launched together with local partners. Locally new, harmful habits fostering dental caries have been most prevalent in urban areas and therefore the COHPP has operated mainly...
in the capital area, but it has also been implemented in some rural areas in Jongju city, North Phyongan Province. After the implementation period, the programme was also introduced in Sepo County in Kangwon Province. In addition to oral health education, the PDCSP has supported primary dental care services provided by the cooperation institutes and dental education provided by Dental Faculty of Pyongyang Medical College (PMC), Kim Il Sung University and other universities around the country.

The project plan for PDCSP included measures and indicators to assess the outcomes and impact of the project after the implementation period in the capital area. The possible change in the prevalence of untreated dental caries among children during the COHPP implementation period was studied. Further, the awareness of healthy oral behaviour among school children and their parents and the children’s compliance with healthy oral habits around Pyongyang city were evaluated. The results were evaluated in this study as part of the research co-operation between the University of Eastern Finland (UEF) and PMC.
2 Literature review

2.1 DENTAL CARIES

2.1.1 Dental caries as a disease
Dental caries is a tooth disease initiated as a result of the metabolism of carbohydrates in the diet by specific bacteria present in the oral cavity (Loesche 1986). The amount of cariogenic bacteria as well as dietary and oral hygiene habits play a major role in the progression of dental caries; however, there are several environmental and social factors which contribute to the differences in the vulnerability (Baelum et al. 2007, Bradshaw and Lynch 2013, Fejerskov 2004, Milgrom et al. 2000, Özdemir 2013, Petersen 2003, WHO 2003).

The oral microbiome is one of the most complex and diverse ecosystems of the human body, with more than 700 species or phylotypes, most of which play an important role in preserving oral and systemic health (Aas et al. 2005). Some specific bacteria resident in the oral cavity are able to adhere to the tooth surface and interact with each other, forming ecosystems where communities of microbes live in organized structures at an interface, communicate with each other and promote the colonization of even more microbes, and to produce acids as a result of sugar metabolism (Aruni et al. 2015, Fejerskov 2004, Loesche 1986, Özdemir 2013). The biofilm (commonly known as plaque) on tooth surface is significantly associated with the main oral diseases, i.e., dental caries as well as gingival and periodontal diseases when left undisturbed for prolonged periods of time (Aruni et al. 2015, Fejerskov 2004, Kidd and Fejerskov 2013, Loesche 1986). The risk is highest during a long-lasting eruption of tooth into functional occlusion (Fejerskov 2004).

Saliva has an important role in the protection of oral tissues against harmful factors by physical and biological defensive mechanisms: cleansing and lubricating the tissues, buffering acids and delivering minerals and antimicrobial proteins to tooth surfaces, gradually raising the pH level to neutral level. At neutral pH level, saliva saturated with minerals promotes the mineralization of enamel while a drop of pH below the critical pH value 5.5 dissolves minerals from enamel and initiates formation of dental carious lesion. The balance between demineralization and remineralization determines whether the lesion grows or diminishes. (Humphrey and Williamson 2001, Kidd and Fejerskov 2013, Lenander-Lumikari and Loimaranta 2000, Loesche 1986, Özdemir 2013, Touger-Decker and van Loveren 2003, WHO 2003)

2.1.2 Dental caries as a public health problem
The main indicators used in epidemiological studies to describe the amount of the disease in a population are the prevalence and incidence of a given disease. Prevalence describes the proportion of affected cases in a population while incidence is the proportion of new cases during a given period. The most commonly used dental caries index to describe the total caries experience is DMFT. The index consists of the sum of all permanent teeth which are affected by caries: teeth with decay (DT), teeth missing due to caries (MT) or filled teeth (FT). To get a more precise comprehension, the indices may be recorded per tooth surfaces as DMF(S), each tooth having five surfaces. Respectively, the
corresponding figures in primary dentition are expressed as dmft or dmfts values. When focusing on the up-to-date prevalence of the disease, the values of the d/D components of dmft/DMFT are performed separately; for example, the sum of all decayed primary and permanent teeth is presented as dt+DT (WHO 2013).

Health was defined as a fundamental human right and the attainment of the highest possible level of health as the most important worldwide social goal in the Alma Ata international conference on primary health care in 1978 (WHO 1978). According to the first international conference on health promotion held in Ottawa, Canada in 1986, good health can be seen as a major resource for social, economic and personal development and an important dimension of quality of life (Petersen 2010, WHO 1986).

During the past few decades, the prevalence of untreated dental caries has decreased, both on the whole and among children, in many industrialized countries with high social and economic development as a result of several public health measures, better living conditions, increased knowledge of healthy oral habits and improved self-care practices (Do 2012, Petersen 2003, 2010, Splieth et al. 2016). However, dental caries is still one of the most common public health problems globally (Bagramian et al. 2009, Kassebaum et al. 2015, Marcenes et al. 2013) and the major public health problem among school-aged children in both industrialized and developing countries (Edelstein 2006, Kassebaum et al. 2015, Marcenes et al. 2013, Ozdemir 2013, Petersen 2003, Petersen et al. 2005) affecting 60–90% of the school-aged children globally according to the WHO (Edelstein 2006). According to the Oral Health Database, Country/Area Profile Program (CAPP), which was established for oral health surveillance in support of the WHO Global Oral Health Programme, the global DMFT for 12-year-olds increased from 1.61 to 1.86 during the ten years from 2004 to 2014 (WHO 2015a).

The Global Burden of Disease 2010 study produced comparable estimates of the burden of 291 diseases and injuries from 1990 to 2010 by analysing 309 studies from several countries (Kassebaum et al. 2015, Marcenes et al. 2013). According to this systematic review, dental caries in permanent dentition was the most common condition affecting 35% of the world population. Further, untreated dental caries in primary dentition was the 10th most prevalent condition affecting 621 million children globally, the prevalence (9%) being at the same level as that of low back pain. The prevalence of untreated caries in primary dentition was shown to be highest at the age of six years, the period of the eruption of the first permanent teeth. The age-standardized incidence in primary teeth had remained at the same level for twenty years (Kassebaum et al. 2015).

The distribution of dental caries is extremely uneven and the difference between populations tends to increase further (Bagramian et al. 2009, Petersen and Kwan 2011, Petersen et al. 2005). Inequality in oral health exists within and between countries with different levels of development, with people in disadvantaged and socially marginalized populations having the worst prognosis (Do 2012, Petersen 2003, 2007). According to the Global Burden of Disease 2010 study, the age-standardized prevalence of untreated dental caries in permanent dentition varied significantly between countries, being lowest in Singapore (12%) and highest in Lithuania (68%); in primary dentition, the prevalence ranged from 4.8% in Australia to 10.8% in the Philippines (Kassebaum et al. 2015). The highest age-standardized incidence of dental caries in primary dentition was found in Southeast and East Asia, while in permanent dentition the highest rate was found in North America (Kassebaum et al. 2015). The total sum of years lived with disability or lost due to premature mortality may be presented by DALYs (disability-adjusted life-years) (Marcenes et al. 2013). Untreated caries was the major cause of DALYs in young adults under the age of 35 years. Further, DALYs due to oral conditions increased 21%
between 1990 and 2010. The least favourable changes in per capita oral health needs were found in East and South Asia.

2.1.3 The impact of oral health on children’s health and well-being

Oral health has a significant association with general health and well-being (Jin et al. 2016, Joseph et al. 2016, Petersen 2003, Petersen and Kwan 2011) affecting people both physically and psychologically (Sheiham 2005). Dental caries is first established in childhood and if not managed, has a detrimental effect on the quality of life for the entire lifespan (Edelstein 2006, Petersen 2003).

Oral health problems and untreated dental caries undermine a child’s quality of life in several ways, affecting vital oral functions as well as overall health and well-being (Bagramian et al. 2009, Jin et al. 2016, Moses et al. 2011); oral infections can even be fatal (Petersen 2003). Untreated dental caries causes significant pain and discomfort and impairment of eating ability, nutrition and growth (Bagramian et al. 2009, Gherunpong et al. 2004, Petersen and Kwan 2011, Sheiham 2005, 2006, WHO 2003). Dental diseases or diseases of the oral mucosa are shown to be the most common causes of facial pain (Quail 2015). Further, decreased weight and height among primary school-aged children has been shown to be associated with a high level of untreated dental caries in several countries (Alkarimi et al. 2014, Mishu et al. 2013, Ngoenwiwatkul and Leela-adisorn 2009). Besides eating problems, oral pain may cause sleep disruptions (Petersen 2003). Adequate duration and quality of sleep have been shown to associate with attention, learning, memory and motor performance (McCoy and Strecker 2011, Walker 2008), features and skills required for success at school. Schoolwork is also disturbed and learning abilities diminished by frequent visits to the dentist (Bagramian et al. 2009, Moses et al. 2011, Sheiham 2005). Chronic sleep disturbances in childhood may even lead to permanent disturbances in cognitive functions (Jan et al. 2010). High caries experience may also contribute negatively to a child’s speech, especially when central incisors are affected (Bagramian et al. 2009, Liang et al. 2015). Good oral health and healthy oral habits have been shown to promote self-esteem during the sensitive years of early adolescence (Jang et al. 2013), while high caries experience has a negative impact on smiling and the child’s quality of life (Gherunpong et al. 2004).

The indirect influence of poor oral health on general health is mediated through the response of the body to chronic dental infection. Additionally, specific oral bacteria have been shown to be connected with several systemic diseases later in life, such as bacterial endocarditis, aspiration pneumonia, diabetes, osteomyelitis in children, premature mortality and cardiovascular disease (Li et al. 2000, Petersen 2003). Furthermore, oral diseases share common risk factors with several common non-communicable diseases (Petersen 2003, 2008, Petersen et al. 2005, Sheiham and Watt 2000), for example those related to excess sugar and alcohol consumption and tobacco use (Jin et al. 2016, Petersen and Kwan 2011, Sheiham 2005).

When dental caries is left untreated, poor oral health has a negative effect on the individual’s entire lifespan since there is a strong and significant association between previous caries experience and new caries (Oo et al. 2011); caries status in the primary dentition can be used as a risk indicator for predicting caries in the permanent dentition (Klein et al. 1981, Li and Wang 2002, Seppä et al. 1989, da Silva Tagliaferro et al. 2006, 2008).
2.1.4 Costs of traditional treatment of dental caries

In many countries, dental caries is the fourth most expensive disease to treat (Petersen 2003, 2008, Petersen et al. 2005, Sheiham 2005), being responsible for 5–10% of total health care costs in industrialized countries according to a WHO estimation (Kandelman et al. 2012, Petersen et al. 2005, WHO 2003). In developing, low-income countries, investment in oral health care is typically low and the costs for treatment of all existing cavities beyond the available capacity of society (Baelum et al. 2007, Petersen 2003, Petersen et al. 2005, Sheiham and James 2014, WHO 2003). In many countries, the costs of dental caries in children would exceed the total health care budget for children (Baelum et al. 2007, Yee and Sheiham 2002), and in the absence of public substitution or third party payment, the treatment is too costly for most of the people (Baelum et al. 2007, Petersen 2003, 2014). Additionally, restorations may produce new treatment need through secondary caries or fracture of the filling (Baelum et al. 2007, Jokstad et al. 2001), leading to a circle of re-restorations, widening fillings and other oral treatments (Mjör and Toffenetti 2000). As regards the cost-effectiveness, the prevention of caries with fluoride and the promotion of oral health is always more affordable and sustainable compared to restorative treatment, especially in middle or low-income countries (Kizito et al. 2014, Splieth and Flessa 2008, WHO 2003).

2.2 DENTAL CARIES IN UNDERPRIVILEGED POPULATIONS

The increase in caries affects especially underprivileged people in low-income countries or underprivileged population groups in wealthier countries (Bagramian et al. 2009, Locker 2000, Petersen 2003, Petersen et al. 2005, Petersen and Kwan 2011, Schwendicke et al. 2015b). This is mainly due to the differences in oral health habits related to socioeconomic surroundings (SES) and living conditions (Do 2012, Locker 2000, Petersen and Kwan 2011, Splieth et al. 2016). Children in low-income countries and population groups are more likely to suffer from untreated caries than their counterparts in wealthier populations when more than 90% of caries remains untreated (Baelum et al. 2007, Petersen 2003, Petersen 2005, Yee and Sheiham 2002). As indication of the high amount of untreated dental caries in primary dentition, the dmft value describing the entire caries load in primary dentition is low when the prevalence of untreated caries is high (WHO 2003). Like Do (2012) pointed out, at the global level, dental caries has changed from a disease of affluence to a disease of deprivation during the past century.

The vast burden of dental caries in developing countries is often related to poor oral health habits and inadequate exposure to fluorides (Moses et al. 2011, Petersen 2003, 2008, Petersen et al. 2005). Toothbrushes and toothpaste may not be available or they may be too expensive (Burt and Eklund 2007, Varenne et al. 2006), or knowledge of healthy oral habits may be insufficient (Folayan et al. 2014, Kwan et al. 2005, Moses et al. 2011, Spliet et al. 2016, Varenne et al. 2006). For example in Nepal, as much as 82% of 8- to 16-year-old children were not aware of fluoride and its benefits on teeth (Dixit et al. 2013) and in Burkina Faso, 89% of 12-year-old children were not aware of the benefits of fluoride and only 9% reported using it (Varenne et al. 2006). In contrast, Liu et al. (2007) reported that most school children in Beijing, China, used fluoride toothpaste, and that the availability of fluoride toothpaste on the market is an important reason for its common use.

Furthermore, many developing countries are experiencing transition along with economical, social and political changes. The change of social surroundings has a significant effect on diet and nutrition by transition from the traditional diet, low in

The underlying reasons for the heavy caries load among underprivileged populations may also include factors related to oral health care systems, such as availability, accessibility or costs or contents of the care; i.e., little or no emphasis given to the prevention of diseases (Baelum et al. 2007, Ogunbodede et al. 2015, Petersen 2014), especially when population-directed strategies or programmes are scarce (Bagramian et al. 2009, Do 2012, Petersen 2005, Splieth et al. 2016). The access to oral health care services is often poor due to limited financial resources for health care (Baelum et al. 2007, Gunsam and Banka 2011, Kandelman et al. 2012, Petersen 2003, 2005, 2010, Petersen et al. 2005, Yee and Sheiham 2002). Furthermore, the oral health care services tend to be clustered in big cities, leaving most of the population without proper oral health care due to a limited number of trained personnel (Baelum et al. 2007, Gorbatova et al. 1999, Ogunbodede et al. 2015, Petersen 2014, Tandon 2004). The ratio in the mean number of dentists per inhabitants between low- and high-income countries has been reported to be less than 1/20 (Petersen 2014). Even further, the services tend to focus on pain relief while little or no emphasis is given to the promotion of oral health (Baelum et al. 2007, Do 2012, Gunsam and Banka 2011, Kandelman et al. 2012, Petersen et al. 2005). According to Baelum et al. (2007), a higher number of the assisting personnel is linked to greater emphasis given to the prevention of oral diseases.

Examples of the prevalence of caries, mean number of teeth with untreated dental caries (dt/DT), mean dmft/DMFT values and proportions of children’s oral health habits (toothbrushing more often than once a day, use of fluoride toothpaste and consumption of sweet snacks or drinks daily) among school children in selected Asian and Middle East countries are presented in Table 1. Studies performed in countries with a close proximity to DPRK or in a developing society were chosen.
Table 1. Prevalences of caries, mean number of teeth with caries (dt/DT), mean dmft/DMFT values and proportions of children’s oral health habits (toothbrushing more often than once a day, use of fluoride toothpaste and consumption of sweet snacks or drinks daily) among school children in selected Asian and Middle East countries. When only one value is given for the percentage or the mean score, the figure indicates the overall situation in primary and permanent teeth.

<table>
<thead>
<tr>
<th>Age yrs</th>
<th>dt/DT&gt;0 %</th>
<th>Mean dt/DT</th>
<th>Mean dmft/DMFT&gt;0 %</th>
<th>Brushing &gt; 1/day %</th>
<th>Use of fluoride toothpaste %</th>
<th>Daily snacking %</th>
<th>Country</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-10</td>
<td>70</td>
<td>2.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>DPRK</td>
<td>Goe et al. 2005</td>
</tr>
<tr>
<td>8,12</td>
<td>-</td>
<td>-/-0.5</td>
<td>30,57</td>
<td>-/0.7,-/1.8</td>
<td>-</td>
<td>-</td>
<td>Rep. Korea</td>
<td>Kim et al. 2016</td>
</tr>
<tr>
<td>10-13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-/1.0</td>
<td>-</td>
<td>-</td>
<td>Japan</td>
<td>Osawa et al. 2015</td>
</tr>
<tr>
<td>6-15</td>
<td>48</td>
<td>-/-1.6</td>
<td>-</td>
<td>-</td>
<td>71</td>
<td>78</td>
<td>Japan</td>
<td>Tanaka et al. 2010</td>
</tr>
<tr>
<td>5,6</td>
<td>-</td>
<td>-</td>
<td>84</td>
<td>6.5/-</td>
<td>-</td>
<td>-</td>
<td>China</td>
<td>Wong et al. 2001</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-</td>
<td>42</td>
<td>-/0.9</td>
<td>31-77</td>
<td>-</td>
<td>China</td>
<td>Wong et al. 2001</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-/-0.6</td>
<td>35</td>
<td>-/0.6</td>
<td>25</td>
<td>-</td>
<td>China</td>
<td>Zhang et al. 2014</td>
</tr>
<tr>
<td>6</td>
<td>82</td>
<td>5.5/-</td>
<td>93</td>
<td>6.7/-</td>
<td>-</td>
<td>-</td>
<td>N. Russia</td>
<td>Gorbatova et al. 2012</td>
</tr>
<tr>
<td>6-7</td>
<td>73</td>
<td>-</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Thailand</td>
<td>Ngoenwiwatkul &amp; Leela-adisorn 2009</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-/-0.9</td>
<td>59</td>
<td>-/1.6</td>
<td>80</td>
<td>90</td>
<td>Thailand</td>
<td>Krisdapong et al. 2013</td>
</tr>
<tr>
<td>7-9</td>
<td>-</td>
<td>-</td>
<td>93/51</td>
<td>6.2/1.0</td>
<td>-</td>
<td>-</td>
<td>Malaysia</td>
<td>Oo et al. 2011</td>
</tr>
<tr>
<td>6-12</td>
<td>55</td>
<td>-</td>
<td>61</td>
<td>1.4/0.4</td>
<td>32</td>
<td>-</td>
<td>Bangladesh</td>
<td>Mishu et al. 2013</td>
</tr>
<tr>
<td>6,12</td>
<td>-</td>
<td>8.0,2.7</td>
<td>97,82</td>
<td>8.4/0.7,-/2.9</td>
<td>-</td>
<td>-</td>
<td>Philippines</td>
<td>Monse et al. 2015</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-/-3.0</td>
<td>-</td>
<td>-/3.3</td>
<td>91</td>
<td>-</td>
<td>Indonesia</td>
<td>Amalia et al. 2012</td>
</tr>
<tr>
<td>5,6</td>
<td>-</td>
<td>-</td>
<td>52,41</td>
<td>1.6/0.3</td>
<td>24</td>
<td>-</td>
<td>Nepal</td>
<td>Dixit et al. 2013</td>
</tr>
<tr>
<td>12/13</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.5/0.8</td>
<td>-</td>
<td>Nepal</td>
<td>Dixit et al. 2013</td>
</tr>
<tr>
<td>6-12</td>
<td>-</td>
<td>-</td>
<td>70/25</td>
<td>3.0/0.5</td>
<td>-</td>
<td>-</td>
<td>India</td>
<td>Joshi et al. 2013</td>
</tr>
<tr>
<td>5-8</td>
<td>-</td>
<td>-</td>
<td>66</td>
<td>2.6</td>
<td>-</td>
<td>-</td>
<td>India</td>
<td>Moses et al. 2011</td>
</tr>
<tr>
<td>5,12</td>
<td>-</td>
<td>-</td>
<td>48,43</td>
<td>2.5,1.5</td>
<td>-</td>
<td>-</td>
<td>India</td>
<td>Kundu et al. 2015</td>
</tr>
<tr>
<td>6/7,12</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.9/-,-/2.6</td>
<td>-</td>
<td>-</td>
<td>Afghanistan</td>
<td>Schwendicke et al. 2015a</td>
</tr>
<tr>
<td>12</td>
<td>55</td>
<td>-/-1.3</td>
<td>62</td>
<td>-/1.7</td>
<td>-</td>
<td>-</td>
<td>Iraq</td>
<td>Ahmed et al. 2007</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-/-1.6</td>
<td>64</td>
<td>-/1.6</td>
<td>20</td>
<td>89</td>
<td>Iraq</td>
<td>Matloob 2015</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>-/-3.5</td>
<td>66</td>
<td>-/4.6</td>
<td>-</td>
<td>-</td>
<td>Qatar</td>
<td>Al-Darwish et al. 2014</td>
</tr>
<tr>
<td>6-9</td>
<td>3.3/-</td>
<td>-</td>
<td>78</td>
<td>3.7/-</td>
<td>61</td>
<td>-</td>
<td>Saudi Arabia</td>
<td>Farooqi et al. 2015</td>
</tr>
<tr>
<td>10-12</td>
<td>-</td>
<td>-/-1.8</td>
<td>68</td>
<td>-/1.9</td>
<td>-</td>
<td>-</td>
<td>Arabia</td>
<td>Farooqi et al. 2015</td>
</tr>
</tbody>
</table>
2.2.1. Children’s dental caries prevalence and oral health habits in the Democratic People’s Republic of Korea

The DPRK belongs to the group of developing countries (Sullivan and Sheffrin 2003, World Bank 2014). Oral health has traditionally been highly appreciated in the DPRK and the importance of daily toothbrushing is taught already in kindergarten. Primary health care including oral health care provided at district and provincial level hospitals is supported by the government and is free of charge for all (Goe and Linton 2005). However, because of the economical and environmental difficulties in the 1990s the health care infrastructure has experienced great challenges, as a result of which also the availability of ordinary commodities including toothbrushes and fluoride toothpaste has been insufficient.

Reports of the dental caries epidemiology in the DPRK are extremely rare. In isolated populations, which have a traditional way of life and consistently low intake of sugars, the dental caries level tends to be low (WHO 2003). There is some evidence that the situation in the DPRK has previously been similar. According to WHO statistics, the dental caries level among 35- to 44-year-olds was very low in 2003 but moderate among 12-year-olds (Petersen 2003) and still at the same level eleven years later in 2014 (WHO 2015a). Further, Moreira (2012) reported on the total dental caries experience among 12-year-olds in the world and found the DPRK together with India and Thailand in the WHO region Southeast Asia to have a risk for higher DMFT compared to the regional average (relative risk 1.00-1.89).

A literature search was performed in September 2013 to find previous studies regarding school children’s oral health status in the DPRK. The search was conducted in PubMed, CINAHL(EBSCO), Medic and Psyc (INFO) using the keywords “caries” and “North Korea or Democratic People’s Republic of Korea” or “DPRK”. Only one previous study was found concerning the dental caries prevalence among children in the DPRK. This cross-sectional study by Goe et al. (2005) was performed in Wonsan among 854 children aged 7 to 10 years in 2002. Wonsan is situated in Kangwon province, 200 kilometres east of Pyongyang, the capital of the DPRK. In their sample, 70% of the children were found to have untreated dental caries: 37% with minor caries and 33% with severe caries, and no statistically significant difference was found between genders or age groups. Furthermore, they reported that 98.5% of the children brushed their teeth daily and 83% ate candy regularly.

2.3 PREVENTION OF DENTAL CARIES

Dental caries is a behaviour-related disease: the exposure to risk factors plays a major role in the morbidity (Fejerskov 2004, Petersen 2003, 2005, Petersen et al. 2005). While closely linked with lifestyle, treatment procedures are not sufficient for controlling the disease if the risk factors remain the same – the individual’s behaviour needs to change.

2.3.1 Healthy diet

Sugars which can be used by specific bacteria present in the oral cavity in the production of acids include monosaccharides other than galactose (mostly sucrose but to a lesser extent also glucose, dextrose and fructose), disaccharides (e.g. sucrose, lactose and maltose) and starch, are a compulsory prerequisite for dental caries (Gupta et al. 2013, Sheiham and James 2014, Touger-Decker and van Loveren 2003). The frequency of consumption, the length of time teeth are exposed to the sugars and the amount of sugar in the diet are significant detrimental factors (Gupta et al. 2013, Touger-Decker and van Loveren 2003, WHO 2003): sweet snacking more than twice a day has shown to be associated with high risk of developing dental caries (Matloob 2015). For this reason, frequent consumption of sugared soft drinks and sweets predicts failure in caries control (Guido et al. 2011, Hietasalo et al. 2008, Joshi et al. 2013).
Frequent consumption of sugar has rapidly become common around the world, both in developed and developing countries, and forms a significant risk both for overall and oral health (Ahmed et al. 2007, Petersen 2003, Watt 2005, WHO 2003). According to the results of a large study performed in 24 European countries, soft drink consumption was correlated with lower availability of plant foods and milk and higher availability of meat and sugar products (Naska et al. 2010). According to several studies, males tend to consume sweet snacks and sugary beverages more often than females (Ahmed et al. 2007, Anttonen et al. 2011, Currie et al. 2012, Hasselqvist et al. 2014, Kuusela et al. 1999, Nguyen et al. 2008), but also opposite results have been reported, for example from China (Zhang et al. 2014) and Japan (Kawamura et al. 2008).

The amount and frequency of sugar consumption are the major risk factors for dental caries increment (Moynihan and Kelly 2014, Peres et al. 2016, Sheiham and James 2014); not even fluoride has the potential to protect teeth against sugars (Moynihan and Kelly 2014, Sheiham and James 2014). Other carbohydrates also used as sweeteners, like mannitol, xylitol and erythritol, and non-caloric, high-intensity sweeteners like saccharin, aspartame, sulfame, acesulfame-K and sucralose do not promote caries, but the effect of sorbitol is conflicting according to different studies (Durso et al. 2014, Gupta et al. 2013, Honkala et al. 2014, Touger-Decker and van Loveren 2003). Regular use of xylitol supports dental health (Söderling 2009). The anti-cariogenic properties of the five-carbon polyol used as sweetener were discovered in the 1970s in Turku, Finland (Söderling 2009). While not metabolized by MS, the use of xylitol does not cause any drop in oral pH. On the contrary, xylitol inhibits the growth and metabolism of MS, causing reduction of the counts of MS when used habitually. Also erythritol has been shown to promote dental health (Honkala et al. 2014).

In addition to the restriction of frequent consumption of sweet snacks and drinks, a healthy diet and proper nutrition as well as the use of water as the main drink have an important contribution to oral pH level and good oral health (Nguyen et al. 2008, Petersen 2003, 2005, Petersen et al. 2005, Touger-Decker and van Loveren 2003). Milk products, especially hard cheese, have a beneficial effect on the oral pH level and thus promote dental health. Some foods include favourable elements, e.g. fluoride in black tea. Foods that require mastication also stimulate saliva secretion (Bradshaw and Lynch 2013, Scardina and Messina 2012, WHO 2003).

The colonization of cariogenic bacteria starts after transmission from another person after the eruption of the first tooth (Law et al. 2007, Loesche 1986, Wan et al. 2003). Therefore, the prevention of transmission of cariogenic bacteria in early childhood would markedly decrease the amount of cariogenic bacteria in child’s mouth, contributing effectively to good oral health (Köhler et al. 1988, Law et al. 2007).

2.3.2 Tooth brushing and use of fluorides
Brushing twice daily with fluoridated toothpaste is regarded as fundamental in caries prevention and the most commonly used method to administer fluorides globally (Chankanka et al. 2011, Davies et al. 2003, Kidd and Fejerskov 2013, Petersen 2003, Petersen and Kwan 2011, Petersen et al. 2012). The supportive effect of fluoride on dental health was noticed already in the 1930s and is well documented (Fejerskov 2004, Marinho et al. 2003, Petersen 2003, Twetman 2009, Twetman et al. 2003, Walsh et al. 2010). The preventive effect of toothbrushing with fluoride-containing toothpaste effectively disturbs the growth and development of biofilm and the development of caries (Hietasalo et al. 2008, Kay and Locker 1998), even more when performed properly with interdental cleaning (Nyyd 2003). Cleaning teeth in the evening before going to the bed is important (Ozdemir 2013). Brushing twice daily prevents dental caries better than brushing once (Hietasalo et al. 2008, Nguyen et al. 2008), and in little children, supervised toothbrushing has a superior preventive effect compared to unsupervised brushing (Marinho et al. 2003, Twetman 2009, Twetman et al. 2003).

The effect of fluoride toothpaste increases with a higher fluoride concentration of 1,000 parts per million or above, while concentrations 550 ppm or below showed no statistically significant
effect when compared with placebo (Davies et al. 2003, Marinho et al. 2003, Walsh et al. 2010). In young permanent dentition, toothpaste with a fluoride concentration of 1,500 ppm appeared to have a superior preventive effect compared to toothpaste with 1,000 ppm fluoride (Marinho et al. 2003, Twetman et al. 2003, Twetman 2009, Walsh et al. 2010). Additionally, the effect of fluoride toothpaste increases with higher baseline levels of decayed or filled tooth surfaces, higher frequency of use (twice or more often compared with once daily) and minimal rinsing afterwards. Due to the risks related to fluoride overdose, the total amount of fluoride should be considered and swallowing of large amounts of fluoride toothpaste avoided in children (Marinho et al. 2003, Walsh et al. 2010).

Other options used in many countries for the administration of fluorides are fluoridation of water (Cho et al. 2014, Jones and Lennon 2007) and fluoridation of milk or salt (Burt and Eklund 2007, Petersen et al. 2012, Jürgensen and Petersen 2013). Oo et al. (2011) reported a high caries experience among 7- to 9-year-old Malaysian children in one area where water fluoridation had been discontinued six years earlier. Cho et al. (2014) concluded that water fluoridation may help to reduce the effect of inequalities related to socio-economic status (SES) on oral health. The use of fluoride mouth rinses has been used as part of school-based programmes or by individuals at home while fluoride varnishes belong to the methods used by professionals (Burt and Eklund 2007).

2.3.3 Social environment

SES is a reflection of social position and comprises factors related to nutrition and diet, income and material resources, living surroundings such as housing, sanitation, even climate, and migration, culture, education, occupation, oral health care system and health literacy, social support, emotional well-being, social justice and human rights (Adler and Snibbe 2003, Casamassimo et al. 2014, Gomaa et al. 2016, Locker 2000, Petersen 2007). SES is commonly measured by income, education and occupation, each of which reflects different resources: knowledge, social networks, housing, nutrition and health care (Adler and Snibbe 2003, Petersen 2007). The association between SES and health is parallel: health increases as SES increases (Adler and Snibbe 2003). Oral health outcomes are affected by the social environment (Baelum et al. 2007, Casamassimo et al. 2014, Locker 2000, Petersen 2005, Petersen and Kwan 2011, Schwendicke et al. 2015b). Higher level of education often relates to higher social status and is shown to be associated with lower caries experience (Petersen 2007, Tanner et al. 2015).

The contribution of SES on individual’s health is also mediated through lifestyle, behavioural patterns as well as values and beliefs which influence individual’s health-related behaviour, thus contributing to the development of disease (Petersen 2005, Thomson 2012). Risky health behaviour that strongly contributes to morbidity and mortality increases along with decreasing SES (Adler and Snibbe 2003, Petersen and Kwan 2011). Due to group pressure, group members tend to conform to group preferences even when their own preferences are not the same (Petersen 2007). Indirectly, low SES contributes to the individual’s behaviour through the amount of experienced psychosocial stress which increases along with decreasing SES of the environment (Adler and Snibbe 2003, Gomaa et al. 2016). Furthermore, increased stress has been found to contribute to the cariogenic bacterial load and thus to the susceptibility to dental caries (Adler and Snibbe 2003, Gomaa et al. 2016). Due to the disparities in social empowerment, the utilization of oral health care services varies even when care is available (Petersen and Kwan 2011, Schwendicke et al. 2015b), and the ability to adopt healthy behaviour is often poorer with lower SES than with higher SES (Baelum et al. 2007, Casamassimo et al. 2014). Health knowledge, beliefs and attitudes vary between different cultures and ethnic groups (Hilton et al. 2007).

Unhealthy oral habits such as poor oral hygiene and harmful dietary habits tend to be associated with other risky health habits like smoking and excessive use of alcohol, all of which tend to increase with decreasing SES (Adler and Snibbe 2003, Currie et al. 2012, Hasselqvist et al. 2014, Hellqvist et al. 2009, Naska et al. 2010, Petersen 2003, Rajala et al. 1980, Tanner et al.
Access to fresh water is crucial for oral health (Petersen 2003, 2005). Previous reports have shown that compared to higher SES, lower SES is associated with more frequent and higher availability of soft drinks in the household (Naska et al. 2010).

Due to the major contribution of social factors to people’s health, addressing the social determinants of health and reducing related health inequities are at centre stage in the new health policy framework for 2020 by WHO (Currie et al. 2012, WHO 2015b).

2.3.4 Family and the immediate surroundings

School children’s oral health behaviour has been recognized as an outcome of several contributing factors from the environment: family, friends and peers, school, day-care institutions, media, the consumer society and health care services (Christensen 2004, Duijster et al. 2015).

A child’s poor oral health has been shown to associate with a poorly functioning household and having a parent or guardian with psychological distress in age groups 1- to 12-year-olds (Renzaho and de Silca-Sanigorski 2013). Furthermore, de Jong-Lenters et al. (2014) found a significant relationship between childhood dental caries and parent-child interaction and parenting practices. Positive interaction between parent and child which includes positive involvement, encouragement, problem-solving, coercion and interpersonal atmosphere, contributed to better dental health among 5- to 8-year-old Dutch children. The interaction between children’s behaviour and the parental experience is not straightforward but includes complexity, especially during the years of late childhood and adolescence (Vanobbergen et al. 2004). When reaching adolescents, the young person’s own oral health knowledge and the role of peers becomes more important than that of his/her parents for his/her oral health behaviour (Prinstein et al. 2001). Adolescents’ oral health behaviour is influenced by knowledge and attitudes towards oral health care, living conditions, parents’ and peer’s approval and school performance (Petersen et al. 2008, Poutanen et al. 2006, Prinstein et al. 2001).

The socioeconomic environment of the family is important for children’s oral health. The family’s economical and social situation has a linear association with children’s oral health, children from high-income families having better oral health than children from low-income families (Petersen et al. 2008, Renzaho and de Silca-Sanigorski 2013). Furthermore, the psychological situation in the family, e.g. the quality of family functioning and the amount of parental psychological distress, contribute to children’s oral health (Renzaho and de Silca-Sanigorski 2013). Socioeconomic conditions during childhood and the length of time spent living in low-SES conditions are important predictors of adult health outcomes (Adler and Snibbe 2003). Kallestål et al. (2000) showed that children’s self-esteem also has parallel associations with the socioeconomic level of the family. Children from lower SES background were found to have poorer self-esteem; furthermore, poor self-esteem was associated with poor social support and poor diet consciousness, among other things. At the age of 4 years and older, children’s own emotional or conduct problems are also associated with their oral health status (Renzaho and de Silca-Sanigorski 2013). Oral health and school performance have a linear relationship (Kallestål et al. 2000, Petersen et al. 2008).

According to the researchers, oral health behaviours are probably mediating factors between parenting practices, family interactions and children’s caries experience (de Jong-Lenters et al. 2014). Children’s and adolescents’ oral health and habits have a positive association with parents’ oral health behaviour and oral-health related knowledge (Angelopoulou et al. 2015, de Castilho et al. 2013, Cooper et al. 2013, Folayan et al. 2014, Poutanen et al. 2006). Health-related habits are likely to develop at a young age (Kay and Locker 1998) while the primary health-related skills and attitudes are learned from the family members, especially from the mother (de Castilho et al. 2013, Cooper et al. 2013). Parents’, especially mothers’, healthy oral behaviour and oral-related knowledge have proved to have a significant effect on children’s oral health habits (Angelopoulou et al. 2015, de Castilho et al. 2013, Folayan et al. 2014, Honkala et al. 1983, Poutanen et al. 2006). Additionally, being a role model in oral health behaviour, parental
monitoring, supervision and parenting strategies to overcome children’s resistance to oral hygiene practices contribute to healthy oral behaviour (Duijster et al. 2015, Poutanen et al. 2006). Parents’ health literacy and self-efficacy have been shown to be significantly correlated with understanding the importance of their child’s oral hygiene and acting on their child’s oral health needs (Angelopoulou et al. 2015, de Silva-Sanigorski et al. 2013). Parents with higher education level have better health literacy, which supports children’s good oral health (Angelopoulou et al. 2015, Fernández et al. 2015, Schwendicke et al. 2015a, da Silva Taliaferro et al. 2006, 2008). However, also contrary findings have been reported: among 12-year-olds in post-war Baghdad, mother’s higher educational status was positively associated with the child’s high caries experience, both with the number of caries lesions and with the number of filled teeth (Ahmed et al. 2007).

For positive outcomes, the health behaviour needs to be implemented both at personal level and at social, community and national levels (Jang et al. 2013, Petersen 2003). A successful change in a young person’s behaviour requires involvement of the family and the surrounding community (de Castilho et al. 2013, Cooper el al 2013, Kwan et al. 2005, Poutanen et al. 2006). Educating parents about healthy oral habits is important (Angelopoulou et al. 2015, de Castilho et al. 2013, de Silva-Sanigorski et al. 2013). The school social environment influences children’s dental health (Fernández et al. 2015).

As pre-school children in many countries spend most of the day time in kindergarten or day care, the primary educators and teachers also contribute to children’s health behaviour and knowledge (Christensen 2004).

2.4 ORAL HEALTH PROMOTION

2.4.1 Targeting the whole population in the promotion of oral health

Healthy oral behaviour is not always learned at home, and this may be due to cultural or socioeconomic factors (Cooper et al. 2013). Traditionally, preventive and educational actions have focused on behaviours which are seen as causal for dental diseases of the individual patient, favouring a chair-side approach, and believing that relevant knowledge and skills lead to healthy behaviour (Baelum et al. 2007, Watt 2005). However, human behaviour is complex, and a sustainable change in lifestyle and behaviour requires more than only knowledge of healthy choices; resources, skills and opportunities to change are also needed (Kay and Locker 1998, Watt 2005). A literature review concerning the provision of dietary advice given by dental practitioners by Franki et al. (2014) showed that dental practitioners only rarely provide dietary advice, or the advice provided is brief and unspecific, although giving dietary advice is regarded as a valuable service. Furthermore, the provision of dietary advice appeared to be influenced by factors such as financial considerations, time limitations, the number of working hours a week, the limited extent of nutritional training received and being a member of a professional association. Recently graduated dentists were more confident in providing dietary advice and dental hygienists had better knowledge relating to nutritional counselling than dentists. (Franki et al. 2014)

To complement these weaknesses in oral health promotion, population-level interventions focusing on the determinants of oral diseases are needed (Watt 2005). The Ottawa Charter published by WHO after the first global conference on health promotion in 1986 defined the key areas of health promotion action as promoting health through public policy, creating supportive environments, developing personal skills, strengthening community action, reorienting health services away from the provision of curative services towards prevention - the goal of achieving health gain and having caring, holism and ecology as essential issues in developing strategies for health promotion (Petersen 2010, WHO 1986).

The whole-population approach targets the entire population instead of only high-risk individuals, and aims to control the causes behind the diseases by influencing the environmental and social factors, opinions and attitudes related to dietary and hygiene patterns
in the community, simultaneously reducing the inequities within the population (Baelum et al. 2007, Fejerskov 1995, Rose 2001, Watt 2005). As young generations are commonly in the focus of the oral health care services, countless efforts have been realized especially in well-off countries, although the health care systems differ greatly between nations (Baelum et al. et al. 2007). In the Nordic countries, i.e., Finland, Sweden, Norway, Denmark and Island, oral health care is free of charge for children of primary school age and younger, and the prevention of oral diseases is an essential part of the services (Nihtilä 2010, Virtanen et al. 2007). Correspondingly, for example, all children in Scotland are provided with toothbrush and high-concentration fluoride toothpaste through a national programme called Childsmile (Duane 2015).


Furthermore, risky behaviour for oral diseases is significant for general health but simultaneously affects several other noncommunicable diseases like obesity, heart disease, stroke, cancers, diabetes and mental illness (Sheiham and Watt 2000, Watt 2005). Adolescents’ healthy oral habits have been found to be positively associated with good general hygiene (Dorri et al. 2009). According to the Common Risk Factor Approach, promotion of oral health and prevention of oral diseases should be provided through integrated approaches of primary health care and general health promotion, especially in countries with limited numbers of oral health personnel (Petersen 2003, 2014, Sheiham and Watt 2000, Watt 2005).

2.4.2 Promoting school children’s oral health

When healthy oral habits are established at a young age, a lifelong positive effect will be achieved (Jürgensen and Petersen 2013, Kwan et al. 2005). Schools form an appropriate environment for promoting children’s oral health as part of the school activities (Cooper et al. 2013, Jürgensen and Petersen 2013, Kwan et al. 2005, Petersen 2003, 2014). The school years are an important period of life when children progress mentally in many areas and are especially receptive. This is an influential period during which lifelong health-related beliefs, attitudes and behaviours are being developed (Cooper et al. 2013, Jürgensen and Petersen 2013, Petersen 2003). The age between 11 and 15 is a period of increased autonomy with independent decision-making in young persons’ development and therefore it is a suitable period for interventions to influence their health and eating habits (Currie et al. 2012). A systematic review of oral health promotion interventions by Kay and Locker (1998) showed that toothbrushing programmes implemented in schools were the most common intervention model aimed at altering the caries levels.

A randomized clinical trial of four years for 11- to 12-year-olds was conducted in Pori, Finland (Hietasalo et al. 2008). The intervention included sessions on both oral hygiene and dietary counselling with emphasis on avoiding frequent sweet snacking and the use of xylitol after meals. Additionally, toothbrushes, fluoride toothpaste and fluoride and xylitol lozenges were distributed and professional preventive procedures were included. This community-level oral health promotion intervention was targeted at schoolchildren, their parents, teachers and other people in the surrounding community who were involved in the children’s daily lives. This intervention aimed to gather information on oral health problems and their prevention and included clinical oral examinations and a questionnaire on oral health behaviour. The results
indicated that frequent toothbrushing predicted success in caries control while eating candy daily increased the probability to develop new caries lesions during the follow-up.

2.4.3 The WHO Global School Health Initiative

The WHO’s international goals for improving oral health define the worldwide dominant oral health promotion strategy to focus efforts mainly on school-aged children through effective use of fluoride, healthy diet and nutrition and tobacco control. Health Promoting Schools (HPS) have a major role in this task, but evidence for oral health policy and formulation of goals also play an important role. The WHO Global School Health Initiative, based on the principles of the Ottawa Charter, aims to mobilize and strengthen health education and promotion through HPS to improve the health of students, school staff, families and the community. (Petersen 2003, 2008, 2010)

Primary school-based interventions to improve children’s oral health typically include education in oral hygiene and managing the consumption of sugary foods and drinks (Cooper et al. 2013). Oral health education as part of school work is cost-effective as large groups of children can be affected at the same time and both theoretical education and practical training of needed skills can be easily accomplished (Cooper et al. 2013, Jürgensen and Petersen 2013, Kwan et al. 2005, Petersen 2003). Teachers’ training is critical (Kwan et al. 2005, Petersen 2003, Nyandindi et al. 1996). Education can be arranged as a separate subject or integrated into other subjects (Kwan et al. 2005). When integrated into the school curriculum, oral health education needs to be continuous, age-specific, child-centred, skills-based and community-oriented (Jürgensen and Petersen 2013). However, changing behaviours is a long-term process and therefore oral health promotion should be a continuous process (Tolvanen et al. 2010). The needed repetitions of the education are easily arranged along with the school work (Jürgensen and Petersen 2013, Kwan et al. 2005).

An essential part of the framework is oral health promotion (Honkala 2014, Jürgensen and Petersen 2013, Kwan et al. 2005, Petersen 2003). Involvement of the family and the community in the actions is critical in health promotion (Jürgensen and Petersen 2013). Oral health promotion through schools as a cost-effective intervention is suitable for low and middle-income countries. Programmes within the framework of HPS have been launched and supported in many low-income countries by the WHO (Honkala 2014, Macnab et al. 2014). The characteristics of HPS include factors related to the school health policy, healthy school environment and oral health education. HPS provides the framework for all oral health activities and should be developed in collaboration with all stakeholders, e.g. parents, teachers, students, dental staff, school nurses and community health workers. Healthy school environment comprises the presence of healthy food, drink and snack alternatives, access to safe water and sanitation, ban on vending machines providing sugary drinks and tobacco use, no access to sweets, safe playground and sports facilities and exposure to adequate fluoride levels using relevant fluoride vehicles (Jürgensen and Petersen 2013).

Furthermore, research for oral health has high priority in the WHO’s Global Oral Health Programme, with special attention given to the research needs of low-income countries. The directions in public oral health research imply a strong emphasis on the social determinants of health, quality of life, oral health systems research, evidence of public health intervention and bridging the gap in oral health research between developed and developing countries. (Petersen 2008, 2010)
2.5 DEVELOPMENT COLLABORATION BY FIDA INTERNATIONAL IN THE DPRK

Fida International (FI) is a Finnish non-governmental organization (NGO) and a partner of Finland’s Ministry of Foreign Affairs. In the DPRK, Fida operates under the name Finnish Agriculture and Health Rehabilitation Programme (FAHRP).

The work of FI started in the DPRK as humanitarian assistance in the late 1990s after a series of environmental disasters. Donations of food, drugs, hospital materials and dental equipment were soon followed by development collaboration projects focusing on the cultivation of virus-free seed potato and support for primary health care including oral health care.

The Primary Dental Care Support Programme (PDCSP) operated in collaboration with the local partners Korea-Europe Cooperation and Coordination Agency (KECCA) and Korea Education Fund (KEF). The cooperation hospitals of PDCSP were Ryonhwa (Central) District Hospital, Potonggang District Hospital and the dental clinic of PMC, all of them situated in downtown Pyongyang, the capital of the DPRK. Additionally, some support was provided to Jongju City Hospital. The main goal of the PDCSP was to improve oral health among children and adolescents in the DPRK. The principal objectives were

- planning and implementation of the Children’s Oral Health Promotion Programme (COHPP),
- development of dental health services in the cooperation hospitals as part of comprehensive development and service provision
- upgraded operational capacity and practical functions of the Dental Faculty of Pyongyang Medical University and
- upgraded dental education for dentists in the cooperation institutes and dental educators at DPRK universities around the country.

A national programme, the COHPP, to promote oral health among kindergarten and primary school children was initiated and implemented as part of the PDCSP. The COHPP comprises the intervention of this study. The programme concentrated on the capital area where the sugar consumption is expected to be most common, but was also expanded to rural areas in Jongju city in North Phyongan Province and in Sepo County in Kangwon Province. During the eight years of the PDCSP, about 273 educators were trained and an organization of the educators was established. The highest-level educators are the four Master Teachers.

Mechanical expertise has enabled the reinstallation and maintenance of donated equipment and professional construction workers have realised the required renovations of the hospital premises and the PMC university dental clinic. These institutes were also provided with necessary equipment, mainly modern dental units and instrument care machinery, as well as materials for treatment procedures of primary oral care. The project activities also included support for the primary oral health care services in the form of further education for dentists and dental educators from universities around the country.
3 Aims of the Study

The general aim of this study was to evaluate children’s dental health and oral health habits in the Democratic People’s Republic of Korea (DPRK) and to assess awareness of self-care principles reported by the children and their parents during the six-year follow-up of the Children’s Oral Health Promotion Programme (COHPP).

More specifically, the aims of the study were:
- to compare the change in dental health in two different intervention groups of the COHPP among school children,
- to evaluate the prevalence of the self-reported oral health habits and their association with dental health among school children,
- to examine awareness of healthy oral habits among children and their parents and children’s self-reported compliance with them,
- to describe the congruence between children’s and their parents’ reports of the children’s compliance with healthy oral habits, and
- to describe the association between parents’ awareness of healthy oral habits and their children’s compliance with the corresponding healthy oral habits.

The working hypotheses were:
- Dental caries decreases during the course of the COHPP. Dental caries decreases more in the school-based intensified intervention group than in the early pre-school-based intervention group.
- Children reporting compliance with the recommended healthy oral habits have less dental caries than those who report poorer oral health habits.
- Children who are more aware of the recommended healthy oral habits commit to them better than those who are less aware of the habits.
- Children’s and their parents’ reports of the children’s compliance with healthy oral habits are congruent.
- Children whose parents are better aware of the recommended healthy oral habits have healthier oral health habits than those whose parents are less aware of them.
4 Subjects and Methods

4.1 STUDY DESIGN AND POPULATION

The target population for the COHPP was children in kindergartens and primary schools in central Pyongyang city, the capital of the DPRK. The programme was initiated in two central districts of Pyongyang city in 2007 (Central or Ryonhwa district and Potonggang district) and spread towards the suburbs. Six years later, in 2013, the programme covered the entire capital area. In 2012, the programme was introduced outside Pyongyang to educators in Jongju city in North Phyongan province and in 2014 to Sepo County in Kangwon province.

Four months prior to the launching of the programme in 2007, a sample of 250 7-year-old children (45.2% females) was selected from two primary schools situated in Ryonhwa and Potonggang districts in central Pyongyang city, the capital of the DPRK. They were provided with an intensified intervention for the entire programme implementation period (2007-2013), thus forming Group I (the intensified, school-based intervention group, for details see chapter 4.2). Group II was formed in 2010 to represent the intervention provided generally. They had already been exposed to the COHPP since 2007 from the age of 4 years, which is why they were called the preschool-based intervention group. A subgroup of 200 children in Group II and their parents was formed in 2013 to compare the children’s own reports of their oral health habits with the reports by their parents in order to study the parents’ awareness of healthy oral habits and the association of parents’ awareness to their child’s self-reported oral health behaviour. In the same year, a third group of 1,500 children aged 13 years (Group III) was selected to examine the awareness of healthy oral habits generally among the school-aged children in Pyongyang. All samples were selected by schools as convenience samples by the Korean parties of the development collaboration project. The study design is summarized in Figure 1.
4.2 INTERVENTION

The programme aimed to promote children’s oral health by training local trainers in dental caries prevention, by providing the most important self-care utensils and education materials and by promoting children’s oral health by distributing awareness of healthy oral behaviour widely among decision-makers and ordinary people.

GROUP I: Oral health education with education materials by primary school teachers since 2007 at the age of seven years, toothbrush and fluoride toothpaste delivery twice a year during the six years of programme duration.

GROUP II: Oral health education with education materials by kindergarten and primary school teachers since 2007 at the age of four years, toothbrush and fluoride toothpaste delivery twice during the year of affiliation to the programme.

GROUP III: The duration of oral health education with education materials by primary school teachers varied, toothbrush and fluoride toothpaste delivered once or twice during the year of affiliation to the programme. (Table 2)

All programme planning, implementation and follow-up was performed together with the development collaboration partners KECCA and KEF. They selected and invited the
participants and organized all local arrangements, reporting to the Finnish project coordinator who monitored that the different districts were covered as evenly as possible in the implementation process. Local partners also organized the distributions of all materials to the schools and kindergartens.

Table 2. Study population and the interventions.

<table>
<thead>
<tr>
<th>Group</th>
<th>Year</th>
<th>N</th>
<th>Age</th>
<th>Females</th>
<th>School</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>2007</td>
<td>250</td>
<td>7 yrs</td>
<td>45.2%</td>
<td>Ryonhwa Primary School, Potonggang Primary School</td>
<td>Oral health education with education materials by primary school teachers since 2007, toothbrush and fluoride toothpaste delivery twice a year during the six years of programme duration</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>250</td>
<td>10 yrs</td>
<td>45.2%</td>
<td>Ryonhwa Primary School, Potonggang Primary School</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>242-244</td>
<td>13 yrs</td>
<td>45.9%</td>
<td>Ryonhwa Middle School, Potonggang Primary School</td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>2010</td>
<td>250</td>
<td>7 yrs</td>
<td>46.4%</td>
<td>Potonggang Primary School</td>
<td>Oral health education with education materials by kindergarten and primary school teachers since the age of four years in 2007, toothbrush and fluoride toothpaste delivery twice during the year of affiliation to the programme</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>250</td>
<td>10 yrs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgroup II:</td>
<td>2013</td>
<td>200</td>
<td>10 yrs</td>
<td>46.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>children &amp;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>2013</td>
<td>1,500</td>
<td>13 yrs</td>
<td>40.9%</td>
<td>Inhung Middle School, Janggyong Middle School, Kwangbok Middle School, Songhwa Middle School, Chongryu Middle School</td>
<td>The duration of oral health education with education materials by primary school teachers varied, toothbrush and fluoride toothpaste delivered once or twice during the year of affiliation to the programme</td>
</tr>
</tbody>
</table>

4.2.1 Oral health education
The oral health education focusing on dental caries prevention followed the principles of the WHO Global Schools Health Initiative (Petersen 2003, Kwan et al. 2005). This education was provided by the COHPP to the professionals involved in primary education or primary health care as two- to three-day seminars once to twice a year during the years 2007 to 2013. These professionals who served as local trainers included teachers and headmasters of kindergartens and primary schools, dentists and dental educators, physicians and officials of different national institutions (e.g. Teacher Training Centre, Dentist Refresher Training Centre, Pre-Schooling Section of the Educational Science Academy and National Institute of Public Health
Administration). Oral health-related subjects were taught to children continuously as part of the curriculum of the schools and kindergartens and to parents during dental visits and in training sessions. The trained officers from teachers’ and dentists’ training institutions, in turn, mediated the new doctrines to other teachers, dentists and university lecturers for dental students, thus contributing to the implementation process.

Each oral health education session followed the same content. The main topics were: the structure of the tooth, regular toothbrushing twice a day with fluoride toothpaste, healthy and unhealthy diet with water as the recommended main drink and thirst quencher instead of sugary beverages, and the recommendation to eat regularly and avoiding frequent sweet snacking. Traditionally, the main drink in Korea is tea, which is served sugar-sweetened for children, but tap water is also drinkable. In addition, the processes of demineralization and remineralization, the transmission of oral bacteria and the outline of the beneficial effect of xylitol were introduced. Xylitol-containing chewing gum has become common during recent years and is available in some shops in Pyongyang.

The educators were provided with a printed booklet called Teacher’s Guide consisting of the main doctrines of the education. This booklet and the basic contents of the education were designed by Fida Health Promotion and they have also been used by several other development cooperation programmes in different countries.

Korean dentists have been responsible for the further implementation of the COHPP since 2011. Information of the new doctrines has been disseminated through different means, such as oral health education programmes on television and participation in national health competitions. The new doctrines are also effectively disseminated as part of the dental curriculum at universities around the country.

4.2.2 Distribution of toothbrushes and fluoride toothpaste

In 2007, when the programme was initiated, toothbrushes and fluoride toothpaste were not available to all children although regular toothbrushing is highly appreciated in the Korean culture: according to a well-known saying, toothbrushing is one of the five factors required for a happy life. Therefore, distribution of toothbrushes and fluoride toothpaste for the children was included in the activities (Figures 2 and 3). The distribution was organized by the schools and kindergartens along with the education of the personnel when affiliated to the programme. During the first two years, toothbrushes and toothpaste were imported from Finland, but local manufacturing of children’s toothbrushes and fluoride toothpaste was started in 2009 and after that, the utensils were purchased there. The fluoride concentration of the locally manufactured toothpaste was analysed in Finland in 2008 and was found to be 500 ppm, as agreed. Due to local legislation, the concentration may not exceed 500 ppm in toothpaste for children.

For the children in the intensified, school-based intervention group these utensils were provided twice each year during the years 2007–2013 while for the other children they were provided only once or twice during the year of affiliation to the programme. The local project partner organized the distributions of the education materials to the schools and kindergartens and reported the actions to the project coordinator. The costs were paid by the PDCSP.

Supervised toothbrushing was part of the daily schedule at the schools and kindergartens affiliated to the programme. The kindergartens and schools had small pigeonholes for each child to keep the toothbrushes and toothpaste provided by the COHPP.
Figures 2 and 3. The first batches of locally manufactured toothbrushes and fluoride toothpaste ready for distribution to children in primary schools and kindergartens (Photos by Mrs. Yang Gon Suk, published with permission).

4.2.3 Education materials and methods
To enable the children’s daily self-care activities, toothbrushes, fluoride toothpaste and a children’s workbook called “My Book” were provided and distributed to the children participating in the programme (Figure 4). Like the Teachers’ Guide, also My Book was originally designed by Fida Health Promotion. My Book was translated and modified to fit the local culture in collaboration with the partners of the PDCSP.

Figure 4. A batch of locally manufactured My Book workbooks (Photo by Mrs. Yang Gon Suk, published with permission).

Additionally, several other education materials were purchased or designed and prepared as part of the COHPP: brushing models, memory game, posters, a tooth costume and a computer game (Figure 5). The materials followed the content of the lectures: the structure of the tooth, recommendation to brush teeth regularly twice a day with fluoride toothpaste, healthy and unhealthy diet with water as recommended thirst quencher instead of sugary beverages and the
recommendation to avoid frequent sweet snacking. Attention was given to reproducing the pictures similarly throughout all education sessions and materials to support the learning process. The education methods and materials were adjusted for each age group using different education materials. The materials were distributed to kindergartens, primary schools and dental hospitals. The Korean tradition has some special songs about toothbrushing which are familiar both to the educators and the children. The programme aimed to promote child-friendly education methods and involvement of local songs and stories. Additionally, the trainers were motivated to use plays and drama especially when teaching young children.

![Image of teaching materials](Photo by PLT)

**Figure 5.** Examples of teaching materials (Photo by PLT).

### 4.2.4 Education for dentists

The activities of the development collaboration also included further education for dentists working in district-level hospitals and for dental educators at the universities around the country. Similarly to the education on dental caries prevention, also that focusing on primary dental care was organized once to twice a year. The topics included oral examination, preventive treatment procedures, atraumatic restoration treatment (ART), instrument hygiene practices, and basics in periodontal treatment procedures, oral epidemiology and articular functions. In addition to the theoretical part, the trainings included a practical, hands-on session, which provided the participants experience in the use of the new appliances and materials introduced in the educations (Figure 6). The material and technical support and comprehensive renovations of the premises provided by the PDCSP markedly upgraded the level of the dental treatment procedures provided in these hospitals.
4.3 CLINICAL EXAMINATIONS

Each time (in 2007, 2010 and 2013), the dental examinations were performed at schools in broad daylight with the help of a mouth mirror and dental probe. Information on both primary and permanent teeth was used; recorded by codes referring to teeth that were decayed or filled. Caries was detected and recorded at tooth level in the baseline oral survey and first follow-up, and in the second follow-up from all surfaces but recorded at tooth level. A lesion was registered according to the following criteria: cavitation extending into dentine with a soft surface. The sum of decayed primary (dt) and permanent teeth (DT) was calculated for each child and used as an outcome. Similarly, fillings were detected from all surfaces but recorded at tooth level. The sum of filled primary (ft) and permanent teeth (FT) was calculated for each child.

4.3.1 Baseline oral survey in 2007
The principle of this baseline oral health survey was agreed between the Finnish and Korean partners of the PDCSP. All local arrangements were made by the local partners, KEF and KECCA, and the instruments as well as the examination form, WHO Oral Health Assessment Form (WHO 1997) were provided by the Finnish partner (Appendix 1).

A clinical oral health examination was performed for the 7-year-old first-grade pupils by two practicing Korean dentists from Ryonhwa District Hospital. They worked together; both of them in turn as examiner and as assistant and recorder. These examinations were realized solely by the Korean partners before the initiation of the PDCSP and the educations provided by the Finnish educators (PLT and Hanna Koskela).

4.3.2 First follow-up in 2010
The children in Group I were examined clinically for the second time at 10 years of age in 2010 while the children in Group II were examined for the first time at 7 years of age. Both groups
had been exposed to the intervention for the past three years, Group I in primary school and Group II in kindergartens since 4 years of age.

Like in the baseline oral health survey, the clinical oral examinations were conducted by the same two Korean practicing dentists at schools in broad daylight with the help of a mouth mirror and dental probe. The examiners had actively participated in the trainings arranged for the dentists by the PDCSP since the beginning of the programme. Training concentrating on the study methodology, the coding system and the examination form used in the study was arranged a couple of months before the examinations by the Finnish educators (PLT and Hanna Koskela). Since the examiners reported having found the examination form used in the baseline oral survey to be complicated, a simpler examination form was developed in co-operation with them (Appendix 2). The form was designed to include only information which was relevant for the evaluation of the programme, i.e., the number of untreated carious lesions. The different stages of dental caries lesion had been included in the education for the dentists prior to the examination. The intention was to record initial caries as well, but this was not realized.

4.3.3 Second follow-up in 2013
The third clinical oral examination for the children in Group I and the second clinical oral examination for those in Group II were performed in 2013. The 13-year-old children in Group I had now started secondary (middle) school. Most of them continued in the closest secondary school situated in the same district as the primary school. However, the most talented children had been selected to attend special schools situated in other areas of the city. This change of school caused a drop-out of eight students in Group I, resulting the final number of participants to be 242 children in the clinical oral examinations (females 46%). However, two more children in this group participated in the qualitative part of this study by responding to the questionnaire performed at a different time.

Five practicing Korean dentists were responsible for the clinical oral examinations in 2013. The other three came from Pyongyang Medical College Kim Il Sung University and from Potonggang District Hospital. All of them had participated actively in the collaboration and trainings provided by PDCSP during the years 2007–2013. Each dentist worked with another dentist serving as assistant and recorder.

The examination form used in 2013 was modified from the one used in 2010 to provide more precise information such as carious lesions per tooth surface (Appendix 3). The examiners were familiarized with the form during the training on oral examination arranged three months earlier. During this training, the examiners were also calibrated against the referee examiner by examining nine children. However, due to limited time, it was possible to analyse the inter-examiner reliability only between the two Korean dentists who had participated in all three examinations (in 2007, 2010 and 2013) and the referee examiner (the researcher). For $dt+DT$, the inter-examiner reliability for the two Korean dentists against the referee was $Kappa = 0.66$ ($p < 0.001$) and $0.66$ ($p < 0.001$), respectively. The Kappa-values regarding the filled teeth was $0.70$ ($p < 0.001$) and $0.77$ ($p < 0.001$), respectively. The values indicated good reproducibility (Landis and Koch 1977).

4.4 QUESTIONNAIRES
Separate, partly structured, self-completed questionnaires were administered to the children (Appendix 4) and to the parents (either mother or father, Appendix 5) of 200 children from Group II (Subgroup II) to gather information on their awareness and on children’s compliance with healthy oral habits.

The questionnaires for both the children and their parents were designed specifically for this study. The translation of the questionnaires from English to Korean was done by Mrs Yang Gon
Suk. The questionnaire forms were formulated in English and translated to Korean. As professor of English and interpreter for high-level government delegations, her language skills in English are excellent. The questionnaires were validated through double-checking of the translation by another native speaker. They were piloted among 21 dentists and dental educators in Pyongyang three months before the administration of the questionnaires. Only minor changes were made to the questionnaires after piloting. The questionnaires were translated back into English in the training session arranged by the COHPP for lecturers and dentists of the Dental Faculty of PMC and the collaboration hospitals. The teachers distributed the forms to the children during the school day and they were to be filled in at home. The participants were requested to return the forms to the teacher on the following day.

4.4.1 Children’s questionnaire
To gather information on the awareness of healthy oral habits the children were asked to state the main points of the oral health education by the COHPP with an open question: “How can you keep your teeth healthy? Do you remember the four important things?” The recommended healthy oral habits (toothbrushing twice a day, use of fluoride toothpaste, healthy diet including water as the main thirst quencher and infrequent sweet snacking) were sought and, if mentioned in the answers, were recorded as being aware of the habit. Additionally, the children were asked about their toothbrushing frequency, use of fluoride toothpaste and the frequency of their sweet snacking (juice, ice cream, candy, biscuit) with multiple-choice questions and about their main thirst quencher with an open question as follows:

“In everyday life
- How often do you brush your teeth?”
With options: __ times a day / __ times a week / more seldom / never.
- “Do you use fluoride toothpaste?”
With options: yes / no.
- “How often do you eat sweet snacks (juice, ice cream, candy, biscuit)?”
With options: __ times a day / __ times a week / more seldom / never.
- “What do you usually drink when you are thirsty?”
The children’s response rate was 99.7%.

4.4.2 Parents’ questionnaire
To gather information on the parents’ awareness of healthy oral habits the respondents were asked to state the main points of the oral health education by the COHPP with an open question: “How can you promote your child’s good dental health? Do you remember any of the main points taught during the project?” Similarly to the children’s questionnaire, when the recommended healthy oral habits (toothbrushing twice a day, use of fluoride toothpaste, healthy diet including water as the main thirst quencher and infrequent sweet snacking) had been mentioned, were recorded as being aware and if not found, were recorded as not being aware of the habit.

The parents were asked about their child’s oral health habits as follows:
- “In everyday life, how often does your child brush his/her teeth?”
With options: __ times a day / __ times a week / more seldom / never.
- “Does he /she use fluoride toothpaste?”
With options: yes / no.
- “How often does he/she eat sweet snacks (juice, ice cream, candy, biscuit)?”
With options: __ times a day / __ times a week / more seldom / never.
- “What does he/she usually drink when feeling thirsty?”
The parents’ response rate was 100.0%.
4.5 STATISTICAL METHODS

All statistical analyses were performed by SPSS 21.0 (SPSS 21.0, IBM Corp. Armonk, NY) and the level of significance was set to $p < 0.05$.

4.5.1 The change in dental health during the follow-up (Group I and Group II)

The total number of decayed primary teeth (dt), decayed permanent teeth (DT), decayed teeth in total (dt+DT) and the total number of fillings (ft+FT) was calculated for each child. Further, the absolute risk reduction (ARR) in the total number of decayed teeth during the follow-up was compared between groups I and II. In relation to the number of decayed and filled teeth, the statistical significance of differences by gender, group and school was tested using Mann-Whitney U-test.

Association between group status and the change in the mean number of decayed teeth (dt+DT) was analysed using Poisson regression with generalized estimating equations as it can take into account the correlation structure due to the follow-up data for count data. Associations were first adjusted for gender, followed by school. Results were expressed as risk ratios (RR) and their 95% confidence intervals (95%CI).

4.5.2 Association between dental health and children’s self-reported oral health habits (Group I and II)

For the analyses, the total sum of decayed teeth (dt+DT) was dichotomized into no caries (dt+DT=0) and presence of caries (dt+DT≥1). Children’s oral health habits other than the use of fluoride toothpaste were dichotomized as follows:

- toothbrushing frequency: less than twice a day or at least twice a day,
- sweet snacking frequency: less than twice a day or at least twice a day,
- the main drink: water or sugary beverages including juice, non-alcoholic cider or tea

As 100% of the children reported using fluoride toothpaste this habit was excluded from the analyses of the dichotomized habits.

Statistical significances of the associations between dichotomized oral health habits and age were evaluated using Chi-square tests. Further, the associations between dichotomized oral health habits and gender were evaluated separately in different study groups using Chi-square tests. In relation to the number of decayed and filled teeth, the statistical significance of differences by gender, group and school was tested using Mann-Whitney U-test.

The occurrence of caries (dt+DT≥1) was used as the dependent variable in the logistic regression analyses, which were first run separately for each explanatory variable, followed by a multivariate model. Gender, age and district were used as confounding variables, the explanatory variables being the dichotomized oral health habits: i.e., toothbrushing frequency, sweet snacking frequency and main drink (water or sugary beverages juice, non-alcoholic cider or tea). Hosmer and Lemeshow were used as a statistical test for goodness of fit for the logistic regression model. Prior to the logistic regression analysis, the Spearman correlations between all the explanatory variables were tested. No variables were excluded from the analysis due to high correlations (highest $c = -0.296$).

4.5.3 Children’s awareness of and compliance with healthy oral habits (Group I, II, III)

The statistical significances of the associations between children’s awareness of healthy oral habits and their compliance with them by gender, age and group status were evaluated by Chi square tests. Multivariate logistic regression analyses were used to evaluate the association of explanatory variables with each healthy oral habit (toothbrushing at least twice a day, use of fluoride toothpaste, sweet snacking less than twice a day and use of water as the main thirst quencher) reported by the children themselves. Explanatory variables included children’s awareness and compliance with self-reported healthy oral habits other than the dependent
variable (toothbrushing twice a day, use of fluoride toothpaste, sweet snacking less than twice a day and water as the main thirst quencher). Concerning other healthy oral habits except the use of fluoride toothpaste, confounding variables included gender and group, the latter also indicating age. Concerning the use of fluoride toothpaste, confounding variables included only gender as coverage in the use of fluoride toothpaste was found to be 100% in Groups I and II. As awareness of healthy oral habits appeared to be comprehensive, these variables were not included in the multivariate logistic regression analyses. Hosmer and Lemeshow were used as a statistical test for goodness of fit for the logistic regression model. Prior to the analyses, the correlations between the explanatory variables were tested with Spearman rank-order correlation coefficient. No variables were excluded from the analysis due to high correlations (highest c = 0.125).

4.5.4 Association between parents’ awareness of and children’s compliance with healthy oral habits in Subgroup II
The statistical significances of the associations between parents’ awareness of each healthy oral habit and the children’s compliance with the corresponding habit were analysed with Chi square tests.

4.5.5 Comparison between children’s and parents’ reports of the child’s oral health behaviour in Subgroup II
The children’s and their parents’ reports of the child’s oral health habits (toothbrushing frequency, use of fluoride toothpaste, sweet snacking frequency and the main thirst quencher) were compared by McNemar test.

4.6 ETHICAL CONSIDERATIONS

The data were collected during the ordinary clinical examination without any extra visit or treatment measure. This study was first designed to evaluate the effectiveness of the COHPP, not for research purposes. The baseline study was completed before the start of the development collaboration by the Korean authorities, and both the first and the second follow-up studies were planned as part of this collaboration to gather information on the outcomes of the programme before implementing the programme in other areas of the country. The study was planned jointly with Pyongyang Medical College Kim Il Sung University and the University of Eastern Finland, as part of the research cooperation. The approval for the research plan, including ethical issues, was given by the Korea-Europe Cooperation and Coordinating Agency in the form of the research cooperation contract.

The questionnaire for both the children and the parents included information about the use of the data to analyse the outcomes of the COHPP. In addition, details of the local contact person and the institutes responsible for the research were included. The participants were informed that responding was totally voluntary; filling in and returning the questionnaires would be taken as positive consent for the use of the data in this study.

The data for research purposes (clinical examinations and the questionnaires) were coded, saved and analysed as separate files without any possibilities to identify the children or their parents.
5 Results

5.1 DENTAL HEALTH (I,II)

The results showed a significant improvement in dental health in both groups. The absolute risk reduction (ARR) in the total number of decayed teeth between the groups was 16% at the age of 7 years and 14% at the age of 10 years. The simultaneous progress of healthy dentition with no caries in need of treatment in the two intervention groups is shown in Figure 7.

In the baseline oral health examination, 83% of the 7-year-old children (boys 83%, girls 83%, p=0.614) in Group I had untreated dental caries. Three years later at the age of 10 years, the prevalence of dental caries was 34% (boys 37%, girls 31%, p=0.568) and at the age of 13 years, 25% (boys 24%, girls 26%, p=0.544). Respectively, in Group II, the prevalence of untreated dental caries was 67% (boys 64%, girls 71%, p=0.441) at the age of 7 years in 2010 and 20% (boys 24%, girls 16%, p=0.099) at the age of 10 years in 2013. The mean and median number of decayed and filled teeth is presented in Table 3. The number of decayed primary teeth
decreased while the number of decayed permanent teeth remained stable and the number of filled teeth increased in both groups.

Table 3. Mean and median number of decayed primary (dt) and permanent teeth (DT) and decayed teeth in total (dt+DT) as well as filled teeth in total (ft+T) from 2007 to 2013 separately in Group I (intensified, school-based intervention) and Group II (early, pre-school-based intervention).

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 years</td>
<td>10 years</td>
</tr>
<tr>
<td></td>
<td>n=250</td>
<td>n=250</td>
</tr>
<tr>
<td>dt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.81</td>
<td>0.11</td>
</tr>
<tr>
<td>Median</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SD</td>
<td>0.70</td>
<td>0.34</td>
</tr>
<tr>
<td>Range</td>
<td>0-2</td>
<td>0-2</td>
</tr>
<tr>
<td>DT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.25</td>
<td>0.27</td>
</tr>
<tr>
<td>Median</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SD</td>
<td>0.53</td>
<td>0.48</td>
</tr>
<tr>
<td>Range</td>
<td>0-2</td>
<td>0-2</td>
</tr>
<tr>
<td>dt+DT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.05</td>
<td>0.38</td>
</tr>
<tr>
<td>Median</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SD</td>
<td>0.64</td>
<td>0.56</td>
</tr>
<tr>
<td>Range</td>
<td>0-3</td>
<td>0-2</td>
</tr>
<tr>
<td>ft+FT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.11</td>
<td>0.48</td>
</tr>
<tr>
<td>Median</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>SD</td>
<td>0.35</td>
<td>0.58</td>
</tr>
<tr>
<td>Range</td>
<td>0-3</td>
<td>0-2</td>
</tr>
</tbody>
</table>

The mean values of decayed teeth and dental fillings with standard deviation according to gender, age and school in 2013 after the intervention are presented in Table 4. The only significant differences were found according to age and school. The number of DT was higher among 13-year-olds than among 10-year-olds. Respectively, the number of DT and the number of ft+FT were higher in Ryonhwa than in Potonggang.

The association between group status and the change in the number of decayed teeth between ages 7 to 13 years in Group I and in Group II between ages 7 to 10 years was statistically significant ($p=0.042$) when adjusted for gender according to Poisson regression
analysis with generalized estimating equations. The change was slightly superior in Group I compared to Group II (RR 1.14, 95% CI 1.01-1.30, \( p=0.042 \)) but disappeared when the school was included in the model (RR 1.07, 95% CI 0.88-1.31, \( p=0.496 \)). Regardless of whether the school was included in the model or not, no statistically significant difference was found between genders (RR 0.97, 95% CI 0.85-1.10, \( p=0.612 \) for boys and RR 0.97, 95% CI 0.85-1.10, \( p=0.587 \) for girls, respectively).

Table 4. Mean values (SD) of decayed primary teeth (dt), decayed permanent teeth (DT), decayed teeth in total (dt+DT) and dental fillings in total (ft+FT) among 492 school children (Groups I and II) in 2013.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>dt</th>
<th>DT</th>
<th>dt+DT</th>
<th>ft+FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td>mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>265</td>
<td>0.07 (0.25)</td>
<td>0.17 (0.39)</td>
<td>0.24 (0.43)</td>
<td>0.52 (0.59)</td>
</tr>
<tr>
<td>Girls</td>
<td>227</td>
<td>0.04 (0.21)</td>
<td>0.17 (0.39)</td>
<td>0.21 (0.42)</td>
<td>0.54 (0.65)</td>
</tr>
<tr>
<td>( p ) value</td>
<td></td>
<td>0.255</td>
<td>0.772</td>
<td>0.378</td>
<td>0.877</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>242</td>
<td>-</td>
<td>0.26 (0.45)</td>
<td>0.26 (0.45)</td>
<td>0.57 (0.66)</td>
</tr>
<tr>
<td>10</td>
<td>250</td>
<td>0.11 (0.32)</td>
<td>0.09 (0.28)</td>
<td>0.20 (0.40)</td>
<td>0.49 (0.58)</td>
</tr>
<tr>
<td>( p ) value</td>
<td></td>
<td>NA</td>
<td>0.000</td>
<td>0.161</td>
<td>0.318</td>
</tr>
<tr>
<td>District</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ryonhwa</td>
<td>309</td>
<td>-</td>
<td>0.23 (0.44)</td>
<td>0.23 (0.44)</td>
<td>0.62 (0.68)</td>
</tr>
<tr>
<td>Potonggang</td>
<td>183</td>
<td>0.09 (0.29)</td>
<td>0.14 (0.34)</td>
<td>0.23 (0.42)</td>
<td>0.47 (0.57)</td>
</tr>
<tr>
<td>( p ) value</td>
<td></td>
<td>NA</td>
<td>0.011</td>
<td>0.974</td>
<td>0.028</td>
</tr>
</tbody>
</table>

\( p \) values refer to Mann-Whitney U-test, NA=value not available

5.2 CHILDREN’S ORAL HEALTH HABITS

5.2.1 Children’s self-reported oral health habits (groups I-III) (III)
When comparing the dichotomized oral health habits (healthy vs. unhealthy) between age groups, the difference was statistically significant in toothbrushing frequency, in sweet snacking frequency and in compliance with all recommended healthy oral habits; the older children had healthier habits than the younger ones (\( p \)-values 0.003, <0.001 and <0.001, respectively) (Table 5).
Table 5. Dichotomized self-reported oral health habits by age among school children (n=1,994) after the intervention in 2013.

<table>
<thead>
<tr>
<th>Age</th>
<th>10 (n=252)</th>
<th>13 (n=1742)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothbrushing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2/day</td>
<td>92%</td>
<td>96%</td>
<td>0.003</td>
</tr>
<tr>
<td>&lt;2/day</td>
<td>8%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Use of fluoride toothpaste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>100%</td>
<td>99%</td>
<td>0.127</td>
</tr>
<tr>
<td>No</td>
<td>0%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Sweet snacking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2/day</td>
<td>11%</td>
<td>21%</td>
<td>0.000</td>
</tr>
<tr>
<td>≥2/day</td>
<td>89%</td>
<td>79%</td>
<td></td>
</tr>
<tr>
<td>Healthy diet and water as the main thirst quencher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>71%</td>
<td>75%</td>
<td>0.138</td>
</tr>
<tr>
<td>No</td>
<td>29%</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>All recommended healthy oral habits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3%</td>
<td>15%</td>
<td>0.000</td>
</tr>
<tr>
<td>No</td>
<td>97%</td>
<td>85%</td>
<td></td>
</tr>
</tbody>
</table>

p values refer to Chi-square test

The differences in the compliance with healthy oral habits between genders were statistically significant regarding sweet snacking frequency and the compliance with all recommended healthy oral habits (p values 0.006 and 0.002, respectively). Furthermore, in Group III, the differences were statistically significant regarding sweet snacking frequency, the main thirst quencher and the compliance with all the recommended oral health habits (p-values 0.008, 0.006 and 0.006, respectively). The summaries of the children’s compliance with the dichotomized self-reported oral health habits by gender in the study groups and among all children are presented in Table 6.
Table 6. Dichotomized self-reported oral health habits among school children (n=1,994) by gender and group after the intervention in 2013.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>age</td>
<td>13 yrs</td>
<td>10 yrs</td>
<td>13 yrs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n=244</td>
<td>n=250</td>
<td>n=1,500</td>
<td>n=1,994</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habit</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothbrushing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ≥2/day</td>
<td>97%</td>
<td>94%</td>
<td>90%</td>
<td>94%</td>
</tr>
<tr>
<td>- &lt;2/day</td>
<td>3%</td>
<td>6%</td>
<td>10%</td>
<td>6%</td>
</tr>
<tr>
<td>p value</td>
<td>0.306</td>
<td>0.303</td>
<td>0.529</td>
<td>0.582</td>
</tr>
<tr>
<td>Fluoride toothpaste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- in use</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>- not in use</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>p value</td>
<td>-</td>
<td>-</td>
<td>0.431</td>
<td>0.385</td>
</tr>
<tr>
<td>Sweet snacking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- &lt;2/day</td>
<td>12%</td>
<td>11%</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td>- ≥2/day</td>
<td>88%</td>
<td>89%</td>
<td>89%</td>
<td>90%</td>
</tr>
<tr>
<td>p value</td>
<td>0.739</td>
<td>0.864</td>
<td>0.008</td>
<td>0.006</td>
</tr>
<tr>
<td>Healthy diet and water as the main thirst quencher</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>72%</td>
<td>68%</td>
<td>73%</td>
<td>70%</td>
</tr>
<tr>
<td>- No</td>
<td>28%</td>
<td>32%</td>
<td>27%</td>
<td>30%</td>
</tr>
<tr>
<td>p value</td>
<td>0.449</td>
<td>0.510</td>
<td>0.006</td>
<td>0.085</td>
</tr>
<tr>
<td>Compliance with all recommended healthy oral habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>- No</td>
<td>96%</td>
<td>96%</td>
<td>96%</td>
<td>97%</td>
</tr>
<tr>
<td>p value</td>
<td>0.782</td>
<td>0.624</td>
<td>0.006</td>
<td>0.002</td>
</tr>
</tbody>
</table>

p values refer to Chi-square test between gender

When comparing the dichotomized, self-reported oral health habits by groups, toothbrushing twice a day was highest in groups I and III. Sweet snacking less than twice a day and observance of healthy diet with water as the main thirst quencher were highest in Group III (Table 7).
Table 7. Dichotomized self-reported oral health habits among school children (n=1,994) by group after the intervention in 2013.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=244</td>
<td>n=250</td>
<td>n=1,500</td>
<td>n=1,994</td>
</tr>
<tr>
<td>age</td>
<td>13 yrs</td>
<td>10 yrs</td>
<td>13 yrs</td>
<td></td>
</tr>
<tr>
<td>Toothbrushing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ≥2/day</td>
<td>96%</td>
<td>92%</td>
<td>96%</td>
<td>96%</td>
</tr>
<tr>
<td>- &lt;2/day</td>
<td>4%</td>
<td>8%</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td></td>
<td></td>
<td>0.011</td>
</tr>
<tr>
<td>Fluoride toothpaste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- in use</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>99%</td>
</tr>
<tr>
<td>- not in use</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td></td>
<td></td>
<td>0.070</td>
</tr>
<tr>
<td>Sweet snacking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- &lt;2/day</td>
<td>12%</td>
<td>11%</td>
<td>22%</td>
<td>20%</td>
</tr>
<tr>
<td>- ≥2/day</td>
<td>88%</td>
<td>89%</td>
<td>78%</td>
<td>80%</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
</tr>
<tr>
<td>Healthy diet and water as the main thirst quencher</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>70%</td>
<td>72%</td>
<td>76%</td>
<td>75%</td>
</tr>
<tr>
<td>- No</td>
<td>30%</td>
<td>28%</td>
<td>24%</td>
<td>25%</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td></td>
<td></td>
<td>0.059</td>
</tr>
<tr>
<td>Compliance with all recommended healthy oral habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Yes</td>
<td>4%</td>
<td>3%</td>
<td>17%</td>
<td>14%</td>
</tr>
<tr>
<td>- No</td>
<td>96%</td>
<td>97%</td>
<td>83%</td>
<td>86%</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
</tr>
</tbody>
</table>

*p values refer to Chi-square test

5.2.2 Associations between untreated dental caries and self-reported oral health habits (groups I-II) (II)
The total number of decayed teeth was lower among children who reported to eat sweet snacks less often compared with those who ate them frequently. The difference in the number of decayed permanent teeth (DT) and decayed teeth in total (dt+DT) was statistically significant between those who reported to eat sweet snacks at least twice a day compared to those who reported to eat sweet snacks once a day or more seldom (p=0.011) (Table 8).
Table 8. Mean number (SD) of decayed primary teeth (dt), decayed permanent teeth (DT), decayed teeth in total (dt+DT) and filled teeth in total (ft+FT) according to oral health habits among 492 children (groups I and II) after the intervention in 2013.

<table>
<thead>
<tr>
<th>Habit</th>
<th>n</th>
<th>dt</th>
<th>DT</th>
<th>dt+DT</th>
<th>ft+FT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothbrushing</td>
<td></td>
<td>mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥2/day</td>
<td>462</td>
<td>0.06 (0.23)</td>
<td>0.17 (0.38)</td>
<td>0.23 (0.43)</td>
<td>0.52 (0.60)</td>
</tr>
<tr>
<td>&lt;2/day</td>
<td>30</td>
<td>0.07 (0.25)</td>
<td>0.13 (0.35)</td>
<td>0.20 (0.41)</td>
<td>0.73 (0.83)</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td>0.812</td>
<td>0.591</td>
<td>0.725</td>
<td>0.204</td>
</tr>
<tr>
<td>Sweet snacking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2/day</td>
<td>55</td>
<td>0.02 (0.24)</td>
<td>0.07 (0.26)</td>
<td>0.09 (0.29)</td>
<td>0.49 (0.57)</td>
</tr>
<tr>
<td>≥2/day</td>
<td>437</td>
<td>0.06 (0.24)</td>
<td>0.18 (0.39)</td>
<td>0.24 (0.44)</td>
<td>0.53 (0.62)</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td>0.189</td>
<td>0.044</td>
<td>0.011</td>
<td>0.733</td>
</tr>
<tr>
<td>Main drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>348</td>
<td>0.07 (0.25)</td>
<td>0.18 (0.39)</td>
<td>0.24 (0.44)</td>
<td>0.53 (0.63)</td>
</tr>
<tr>
<td>Sugary beverages</td>
<td>144</td>
<td>0.03 (0.18)</td>
<td>0.15 (0.36)</td>
<td>0.19 (0.39)</td>
<td>0.53 (0.58)</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td>0.172</td>
<td>0.537</td>
<td>0.189</td>
<td>0.638</td>
</tr>
</tbody>
</table>

p values refer to Mann-Whitney U-test

Sweet snacking twice a day or more often was the only habit which was significantly associated with the occurrence of caries also according to logistic regression analysis (univariate analysis p=0.016, multivariate analysis p=0.019). Compared with less frequent sweet snacking, the association of more frequent sweet snacking with dental caries was three-fold. Additionally, according to the multivariate logistic regression analysis also age (p=0.015) and district (p=0.048) were independently associated with the occurrence of caries.

5.2.3 Congruence between children’s and their parents’ reports of the children’s compliance with healthy oral habits (Subgroup II) (III)

The majority of the parents of the 10-year-old children from Potonggang Primary School reported that their child had healthy oral habits, except for the frequent sweet snacking. The percentages of those having healthy and unhealthy oral habits according to the parents’ reports are presented in Table 9.

Children’s and their parents’ reports differed regarding the child’s toothbrushing frequency (p<0.001) and use of fluoride toothpaste (p<0.001) but were more unanimous regarding the child’s sweet snacking frequency (p=0.736) and use of water as the main thirst quencher (p=0.349).
Table 9. Children’s oral health habits reported by their parents among 200 children aged 10 years (Subgroup II, n=200).

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothbrushing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ≥2/day</td>
<td>78%</td>
<td>79%</td>
<td>78%</td>
</tr>
<tr>
<td>- &lt;2/day</td>
<td>22%</td>
<td>21%</td>
<td>22%</td>
</tr>
<tr>
<td>Fluoride toothpaste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- in use</td>
<td>92%</td>
<td>92%</td>
<td>92%</td>
</tr>
<tr>
<td>- not in use</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
</tr>
<tr>
<td>Sweet snacking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- &lt;2/day</td>
<td>9%</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td>- ≥2/day</td>
<td>91%</td>
<td>86%</td>
<td>88%</td>
</tr>
<tr>
<td>Main thirst quencher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Water</td>
<td>79%</td>
<td>75%</td>
<td>77%</td>
</tr>
<tr>
<td>- Juice</td>
<td>18%</td>
<td>19%</td>
<td>17%</td>
</tr>
<tr>
<td>- Non-alcoholic cider</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>- Tea</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>- Milk</td>
<td>1%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>- Not answered</td>
<td>0%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>All recommended healthy oral habits</td>
<td>3%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

5.3 CHILDREN’S AWARENESS OF HEALTHY ORAL HABITS (GROUPS I-III) (III)

Children’s awareness of the recommended healthy oral habits by groups is presented in Table 10. According to their response, all healthy oral habits had been well adopted. Almost all children (99%) mentioned the oral hygiene habits of toothbrushing twice a day and use of fluoride toothpaste; no statistically significant difference was found between the studied groups (p values 0.268 and 0.459, respectively). In contrast, healthy diet and use of water as the main thirst quencher as well as avoidance of frequent sweet snacking were mentioned less often (94% and 94%, respectively); the difference between the study groups was statistically significant regarding both habits (p<0.001, p<0.001, respectively). Awareness of all recommended healthy oral habits was lower in Group III: all recommended healthy oral habits were mentioned by 98.8% of the children in Group I, by 98.4% in Group II and by 83.9% in Group III (p<0.001).
Table 10. Awareness of the recommended healthy oral habits by gender and by group among 1,994 children after the intervention in 2013.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th></th>
<th>Group II</th>
<th></th>
<th>Group III</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>All</td>
<td>Boys</td>
<td>Girls</td>
<td>All</td>
</tr>
<tr>
<td>Toothbrushing twice a day</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>99 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>p-value</td>
<td></td>
<td></td>
<td></td>
<td>0.355</td>
<td></td>
<td>0.339</td>
</tr>
<tr>
<td>Use fluoride toothpaste</td>
<td>99 %</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>99 %</td>
<td>100 %</td>
</tr>
<tr>
<td>p-value</td>
<td>0.372</td>
<td>0.278</td>
<td>0.646</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet snacking at most once a day</td>
<td>100 %</td>
<td>100 %</td>
<td>100 %</td>
<td>99 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>p-value</td>
<td></td>
<td></td>
<td></td>
<td>0.355</td>
<td></td>
<td>0.853</td>
</tr>
<tr>
<td>Healthy diet and water as the main thirst quencher</td>
<td>99 %</td>
<td>100 %</td>
<td>99 %</td>
<td>99 %</td>
<td>100 %</td>
<td>100 %</td>
</tr>
<tr>
<td>p-value</td>
<td>0.206</td>
<td>0.355</td>
<td>0.680</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness of all healthy oral habits</td>
<td>98 %</td>
<td>100 %</td>
<td>99 %</td>
<td>98 %</td>
<td>99 %</td>
<td>98 %</td>
</tr>
<tr>
<td>p-value</td>
<td>0.120</td>
<td>0.396</td>
<td>0.431</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

p values refer to Chi-square test in differences between genders

5.3.1 Associations between children’s awareness of and self-reported compliance with healthy oral habits

The explanatory variables related to compliance with each recommended healthy oral habit were analysed by multivariate logistic analyses. The explanatory variables included awareness of each healthy oral habit and self-reported compliance with other healthy oral habits except the habit in question.

The use of fluoride toothpaste, being aware of healthy diet with water as the recommended thirst quencher and the habit to drink water for thirst statistically significantly increased the probability of brushing teeth at least twice a day. The habit to eat sweet snacks less frequently was almost significantly associated with the habit of brushing teeth at least twice a day. Being aware of the recommendation to use fluoride toothpaste, having the habit to brush teeth at least twice a day or to drink water for thirst increased the probability to use fluoride toothpaste statistically significantly. Toothbrushing at least twice a day slightly increased, whereas the use of water for thirst slightly decreased the probability of less frequent sweet snacking. Having the habit to brush teeth at least twice a day and to use fluoride toothpaste statistically significantly increased the probability of using water for thirst. Additionally, being aware of the recommendation to avoid frequent sweet snacking slightly increased, whereas having the habit to eat sweet snacks less often than twice a day slightly decreased the probability of drinking water for thirst. The results are summarized in Table 11.
Table 11. Associations of explanatory variables with self-reported healthy oral habits among 1,994 children after the interventions in 2013 according to multivariate logistic regression analysis.

<table>
<thead>
<tr>
<th></th>
<th>Tooth brushing ≥2/day&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Fluoride toothpaste in use&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Sweet snacking &lt;2/day&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Water as the main thirst quencher&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
<td>OR (95%CI)</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ref. females)</td>
<td>0.9 (0.6-1.5)</td>
<td>0.8 (0.3-2.3)</td>
<td>1.3 (1.1-1.7)</td>
<td>0.8 (0.7-1.0)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.764</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.615</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.012</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.106</td>
</tr>
<tr>
<td><strong>Group (ref. Group I)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>0.5 (0.2-1.0)</td>
<td>-</td>
<td>0.9 (0.5-1.6)</td>
<td>1.1 (0.8-1.7)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.059</td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.789</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.535</td>
</tr>
<tr>
<td>Group III</td>
<td>1.1 (0.5-2.2)</td>
<td>-</td>
<td>2.2 (1.4-3.3)</td>
<td>1.5 (1.1-2.0)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.805</td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;&lt;0.001</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.010</td>
</tr>
<tr>
<td><strong>Awareness of the recommended healthy oral habits (ref. not aware)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toothbrushing ≥2/day</td>
<td>-</td>
<td>-</td>
<td>0.7 (0.2-2.3)</td>
<td>2.0 (0.7-5.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.548</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.236</td>
</tr>
<tr>
<td>Use of fluoride toothpaste</td>
<td></td>
<td>12.9 (1.4-119.0)</td>
<td>1.9 (0.4-8.7)</td>
<td>0.6 (0.2-2.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.024</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.380</td>
</tr>
<tr>
<td>Infrequent sweet snacking</td>
<td>0.8 (0.3-2.3)</td>
<td>-</td>
<td>1.3 (0.8-2.2)</td>
<td>1.5 (1.0-2.2)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.676</td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.238</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.072</td>
</tr>
<tr>
<td>Healthy diet and water as the main thirst quencher</td>
<td>2.2 (1.0-4.9)</td>
<td>-</td>
<td>0.8 (0.5-1.2)</td>
<td>1.1 (0.7-1.7)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.047</td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.270</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.614</td>
</tr>
<tr>
<td><strong>Compliance with healthy oral habits (ref. not compliant)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toothbrushing ≥2/day</td>
<td>-</td>
<td>10.5 (3.2-33.8)</td>
<td>1.9 (1.0-3.8)</td>
<td>3.1 (2.0-4.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;&lt;0.001</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.063</td>
</tr>
<tr>
<td>Fluoride toothpaste in use</td>
<td>10.2 (3.2-33.2)</td>
<td>-</td>
<td>1.8 (0.4-8.3)</td>
<td>3.5 (1.2-9.8)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;&lt;0.001</td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.426</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.019</td>
</tr>
<tr>
<td>Infrequent sweet snacking</td>
<td>1.9 (1.0-3.8)</td>
<td>1.4 (0.3-6.6)</td>
<td>-</td>
<td>0.8 (0.6-1.0)</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.056</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.648</td>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;=0.063</td>
</tr>
<tr>
<td>Water as the main thirst quencher</td>
<td>3.1 (2.0-4.8)</td>
<td>3.1 (1.1-8.8)</td>
<td>0.8 (0.6-1.0)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>&lt;i&gt;p&lt;/i&gt;&lt;0.001</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.037</td>
<td>&lt;i&gt;p&lt;/i&gt;=0.066</td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Hosmer and Lemeshow \(\chi^2=12.21, p=0.094\), 95.6% of cases classified correctly

<sup>2</sup> Hosmer and Lemeshow \(\chi^2=3.22, p=0.864\), 99.2% of cases classified correctly

<sup>3</sup> Hosmer and Lemeshow \(\chi^2=10.63, p=0.101\), 80.4% of cases classified correctly

<sup>4</sup> Hosmer and Lemeshow \(\chi^2=18.61, p=0.005\), 74.8% of cases classified correctly
5.4 PARENTS’ AWARENESS OF HEALTHY ORAL HABITS (SUBGROUP II) (III)

A great majority of the parents of the 200 children aged 10 years in Subgroup II were aware of all recommended healthy oral habits. In parents’ responses to the questionnaire, the proportions of recommended healthy oral habits were as follows:
- toothbrushing twice a day 97.5%
- use of fluoride toothpaste 98.5%
- sweet snacking infrequently 98.0%
- healthy diet and water as main thirst quencher 98.0%.

5.4.1 Associations between parents’ awareness of healthy oral habits and children’s self-reported compliance with them (Subgroup II) (Additional information)

No statistically significant association was found between parents’ awareness of healthy oral habits and the children’s compliance with the corresponding habits. The percentage of the children reporting to brush their teeth twice a day was 91.5% among those whose parents had mentioned the habit and 100% among those whose parents had not mentioned it (p=0.490). Since the use of fluoride toothpaste was reported by all children, this association was not evaluated. Frequent sweet snacking was common although parents were aware of the relevance of the sweet snacking restriction: the use of sweet snacks once a day or more seldom was reported by 10% of the children whose parents had mentioned the habit and by none of those whose parents had not mentioned the habit (p=0.501). Similarly, parents’ awareness of healthy diet avoiding sugary beverages did not appear to associate with the children’s behaviour: 73% of the children whose parents had mentioned this habit reported to drink water for thirst while the percentage was 75% among those whose parents had not mentioned this habit (p=0.927).
6. Discussion

The present study evaluated the outcomes of the COHPP and provided new and interesting information about children’s oral health in the DPRK, a country where previous reports on this topic are extremely rare. At baseline, the prevalence of dental caries and the mean number of decayed teeth were high, but decreased in both intervention groups during the six-year follow-up period of the COHPP. Against our hypothesis, there was no significant difference in dental health between the groups, indicating that the less intensified intervention was more competent than the intensified intervention. The finding emphasizes the importance of early prevention. Despite the frequent sweet snacking, the recommended healthy oral habits were well adopted and associated with better dental health. The awareness of healthy oral habits was at high level both among the children and their parents. The association between awareness of and compliance with healthy oral habits varied between the groups. Awareness of healthy oral habits was highest among children who had participated longest in the COHPP. Toothbrushing twice daily was more common among older children, but those of them who had joined the programme latest had healthier dietary habits than the other children. Awareness of the beneficial effect of fluoride in toothpaste associated strongly with the use of fluoride toothpaste, but awareness of the recommendation to avoid frequent sweet snacking did not associate with the sweet snacking frequency. Reports by the children and the parents regarding the children’s oral health habits were mostly congruent. However, parents’ awareness of the recommended healthy oral habits did not correlate with their child’s oral health.

This study followed up the dental health of a sample of 250 school children (242 in the second follow-up) from 2007 to 2013 and another group of 250 children from 2010 to 2013, both groups being from two districts in downtown Pyongyang. During this period, the children in the first group grew from first-graders of primary school to adolescence and the other ones from first- to third-graders of primary school. Additionally, children’s and parents’ awareness of healthy oral habits as well as children’s compliance with them were assessed among a larger group of children at the end of the implementation of the COHPP. Meanwhile, a transition from traditional lifestyle towards a more western one continued to change the surrounding society bringing kiosks, cafeterias and new, more diverse leisure time activities for the children and adolescents in Pyongyang; a roller-skating ring, an inside ice rink, amusement parks, a water park and a dolphin park were constructed in the city. These changes have also created new and rapidly increasing temptations to consume sugary snacks and drinks. As children’s nutritional status is more sensitive to the social and dietary transitions than that of adults (Cai 2014), young generations in the DPRK have been exposed to new, serious health risks. Additionally, the limited awareness of healthy oral habits and the poor availability of fluoride make the young dentition more vulnerable to dental caries than in well-off countries where the children are readily exposed to oral health education and their teeth are protected by several ways of fluoride administration.

The development collaboration to support primary dental care in DPRK began in 2007. The epidemic of a locally new oral health problem, dental caries, which had earlier been relatively unknown, was affecting children in particular. Local authorities became alarmed and sought cooperation in this field with Fida International, a Finnish NGO already successfully operating in the country. The main activity of the collaboration, implemented with a relatively small budget, focused on the education for dentists in primary dental care and the promotion of children’s oral health by educating other professionals closely involved with school children and their families, i.e., physicians, primary school and kindergarten teachers, headmasters and officers from different national institutions and government bureaus, in accordance with the
WHO Global School Health Initiative (Jürgensen and Petersen 2013, Kwan et al. 2005, Petersen 2003). Additionally, toothbrushes and fluoride-containing toothpaste were provided for the children and education materials for kindergartens, primary schools and dental hospitals. Furthermore, primary dental care provided by cooperation hospitals was supported by educating dentists and renovating premises and providing the institutes with new appliances and other material support. Local dentists have been responsible for the further implementation of the COHPP since 2011 as the PDCSP has concentrated on the development of the dental education in the DPRK through providing further education for dental educators from different universities around the country and by supporting the operations of the Dental Faculty in PMC.

The COHPP has been implemented in the whole capital area and Jongju city, north-west of Pyongyang and in Sepo County, east of Pyongyang. In addition to primary schools and kindergartens, promotion of healthy oral habits has been implemented by various means including oral health education via television and through national health competitions. Today, the prevention of dental caries is also part of the dental curriculum of dental students in DPRK universities.

### 6.1 METHODOLOGY

This study was planned and implemented together with Korean dentists, researchers and the development collaboration parties of the PDCSP. The effect of the COHPP was evaluated by the change in the number of decayed teeth between 2007–2013 among primary school children in a six-year and three-year follow-up, and assessing the knowledge and compliance of the children with the healthy oral habits recommended by the COHPP. The study protocol may be regarded as a relatively valid setting to provide information about the impact of oral health promotion among school children in a country with changing lifestyles and high caries prevalence. The sampling was performed by the local partners as convenience samples.

The participation rates in both the clinical examinations and questionnaires were high, which increases the value of this study. The minimal number of drop-outs may be regarded as unrealistic but not surprising in the context of this study. The samples were collected by schools, which enabled the teachers to control the returning of the questionnaires. Furthermore, respect for authorities is more prominent in the DPRK than in Western countries and was probably a contributing factor in this. Additionally, having a chance to participate in research performed in cooperation with a foreign university is unique and may also have been a motivating factor.

A major weakness of the study is the lack of a control group, which is why the actual effect of the COHPP could not be fully analysed. Due to that, it was not possible to eliminate all confounding factors, such as changes in the society. This weakens the analysis of the change in the number of decayed teeth during the follow-up. Additionally, no information on the oral health habits or awareness of them was available at the baseline. These deficiencies relate to the original purposes of the follow-up of a group of children. Originally, the study groups were not formed for research purposes; the follow-up was included in the project plan of the PDCSP to analyse the outcomes of the development collaboration project. For this purpose, the intensified intervention group was formed in 2007 from the group of children who were clinically examined before any activities were started. When the programme spread to new areas of the city, it became necessary to form another, simpler intervention protocol (=less intensified intervention), and for comparison of the outcomes of these two different interventions another group of the same size as the first group was formed in 2010 from one of the same primary schools. The interventions for both groups had started at the same time, but the children in the second group had been affiliated to the programme at a younger age while still in kindergarten.

The PDCSP project focused primarily on oral health promotion and education, and only secondarily on material support for the cooperation institutes. The indicators for the evaluation
of the project were chosen to measure whether or not the awareness of healthy oral behaviour increased and whether or not the possible increase in awareness resulted in healthier habits and better dental health. To analyse the coverage of the awareness of the recommended healthy oral habits, a group of 1,500 children of the same age as the children in the first group (the intensified intervention group) was formed from different areas of Pyongyang city. Additionally, we wanted to assess whether the information had also reached the parents. The indicators may be regarded as valid and the use of dt+DT more accurate than the more commonly used DMFT index as measuring the amount of untreated dental caries is essential in a community where carious lesions often remain untreated. Even though the results provide interesting information about the effect of the different interventions, it should be noted that the groups were not directly comparable as they differed in regard to the baseline caries status, the age when included in the programme and the length of the follow-up. The dental caries status at the baseline may have differed between the groups as it was examined only in the intensified, school-based intervention group.

The group sizes can be considered large enough to draw conclusions on the matters under study. The number of drop-outs was low in the intensified intervention group and non-existent in the other group, probably due to the strong commitment of the local partners to this study. The loss of the eight children in the clinical examinations of the second follow-up study in 2013 was due to the move from primary school to secondary school. In Pyongyang, most of the children continue in the secondary school in the same district and only the most talented ones get access to special schools. They may have been more skilled in different ways, such as in sports, arts, music, mathematics, just to mention some characteristics. Due to the diversity in the areas of mastery, these children probably did not differ from the other ones in terms of dental health, and this drop-out of 3% is therefore unlikely to cause any bias in this study.

The six-year follow-up of oral health education for children performed in a developing country may be regarded as long when compared with the previous studies; for example, the three-year follow-up for primary school children in China by Tai et al. (2009), the two-year follow-up for young primary school children in Thailand by Petersen et al. (2015), and the 15-month follow-up for primary school children in Brazil by Zanin et al. (2007). Studies with longer follow-ups have been reported from developed countries, for example a six-year-long intervention from Belgium (Vanobbergen et al. 2004) and a ten-year-long follow-up from Germany (Schmoeckel et al. 2015).

Another weakness was the change of the clinical oral examination forms; however, the information collected in all three clinical oral examinations was the number of carious teeth and dental fillings. When planning the follow-ups the Korean dentists asked for simpler examinations forms than those used in the baseline oral survey as they considered them too complicated. Performing the clinical oral health examinations was difficult for the Korean dentists due to the fact that the coding system of teeth and the other symbols were previously unknown to them, and therefore the forms needed to be simplified. The oral health assessment form was revised to include only parts which were essential for this study, such as name, age, school, district, sex, date, code, examiner and dental status. The revision of the form was done together with the Korean dentists and they were tested during the educations organized for the dentists. With their approval, the form was slightly updated for the third examination to provide more accurate information. The changes made to minimize the risk for errors in the markings were minimal and did not jeopardize the comparison of the results. A strength is that all data recordings were made by only two persons, the researcher (PLT) and Mrs Yang Gon Suk, Senior Officer of KEF and the partner’s representative during the entire length of the PDCSP. She was responsible for all local activities during the entire COHPP and also for matters related to this study.

One weakness in the performance of the clinical oral examinations in the second follow-up study in 2013 was the unexpected increase in the number of the examiners due to some unknown local reasons. All clinical examiners had been calibrated three months prior to the
clinical oral examinations by examining nine patients against the trainee (PLT) who acted as the referee standard. Due to limited time, it had been possible to analyse the inter-examiner reliability only between the two Korean dentists who had performed also the previous examinations and the referee examiner. All these five examiners had participated actively in the collaboration and educations provided, but it is still possible that this may have caused some inaccuracies.

It would have been informative to evaluate also oral health risk indicators, e.g. the amount of plaque, in addition to the number of carious lesions and fillings. The recording of erupting and missing teeth was also insufficient despite the instructions. These are not generally recorded in the DPRK, and the importance of these codes was probably not emphasized sufficiently in the education preceding the examinations.

The study aimed to examine how well the oral health education provided by the COHPP had been adopted. The questionnaires for both the children and their parents were designed especially for this purpose. The questionnaires were formulated in English and translated into Korean. Three months before the administration of the questionnaires, they were validated by double-checking the translation and piloted among dentists and dental educators in Pyongyang. The forms were indicated to be suitable for the purpose.

When analysing the results, it should be noted that there may be some risk of overestimation regarding the self-reported oral health habits. Furthermore, as the forms were filled at home, the accuracy of the response regarding awareness of the recommended healthy habits may be too optimistic since the respondents may have used the education materials to refresh their memory. Particularly, regarding parents’ response; the family members may have provided a helping hand. The risk of overestimation is always a concern when using questionnaires but possibly even more in the context of this study (Brener et al. 2003). Additionally, it should be noted that the results may not be generalized to the whole country, but only to the capital area of the DPRK. Furthermore, the parents’ questionnaire did not discriminate the response between fathers and mothers, which is why we were not able to analyse the differences between them.

The publication process of the articles was challenging, albeit rewarding, after several attempts to get them accepted by qualified scientific journals. We found it surprising as these articles contained truly novel information not published earlier. Gathering clinical data is always challenging, especially in circumstances of this kind where internationally approved scientific practice and knowledge were unfamiliar. This is why education in basic research methodology was required. In addition, according to the information gathered during the educations, the knowledge on dental prevention was weak in the beginning of the project; for example, fluoride was unknown, but the coverage was shown to be nearly universal among the children and their parents at the end of the project. Furthermore, the local dentists and dental researchers who participated in the study gained knowledge on the formulation of study questionnaires, performance and calibration of the clinical examinations, recording of the data and proof-reading of the articles. All this increased their capacity to perform scientific studies independently in the future.

6.2 COMPARISON BETWEEN THE TWO INTERVENTIONS

Prior to the interventions, the prevalence of untreated dental caries was high and the number of fillings low in Pyongyang. The findings support an earlier report from Wonsan, the DPRK, by Goe et al. (2005). They showed that 70% of the primary school children aged seven to ten years suffered from untreated dental caries. Similar high levels of dental caries among school-aged children have also been reported both from developed and developing countries (Table 1).

Caries prevalence and the mean number of decayed teeth decreased despite the high prevalence in the primary teeth at the baseline and regardless of the intensity of the
intervention. The greatest change occurred between ages 7 to 10 years in both groups: the percentage of the children affected by caries decreased 49% in the school-based intensified group and 47% in the less intensified preschool-based group. The decrease in the mean number of decayed teeth (dt+DT) was -0.67 in the first group and -0.59 in the second group. For the children in Group I, a further decrease of -9% / -0.12 was observed until the age of 13 years. As the number of decayed permanent teeth remained somewhat stable, the change was probably mainly due to the exfoliation of the decayed primary teeth. However, the improvement in children’s oral health was significant as carious primary teeth form a risk for caries in the newly erupted permanent teeth (Schmoekel et al. 2015, Oo et al. 2011).

At the end of the programme, a significant difference in the prevalence of dental caries was found between the age groups and the schools; older children had a higher number of caries lesions in the permanent dentition and more dental fillings than the younger ones. Furthermore, more dental fillings were found among the children in Ryonhwa School than Potonggang School. As the pupils normally come from the district surrounding the school, the higher socioeconomic position of Ryonhwa district compared to Potonggang district probably explains this difference. This is in line with previous studies from different countries (Ahmed et al. 2007, Bagramian et al. 2009, Schwendicke et al. 2015).

No statistically significant difference was found between genders in dental caries prevalence in this study. The result is parallel with the previous study performed in the DPRK (Goe et al. 2005). Equal caries experience among boys and girls has also been reported from other countries, for example Afghanistan (Schwendicke et al. 2015a), Malaysia (Oo et al. 2011), India (Moses et al. 2011) and Saudi-Arabia (Farooqi et al. 2015). A study from Thailand reported similar early childhood caries experience between genders, but boys presented more severe dental caries lesions compared with girls (Pattanaporn et al. 2013). Other reports from North Russia (Gorbatova et al. 2012), India (Joshi et al. 2013) and rural areas of Southern China (Wong et al. 2001) showed boys to have a greater risk for caries than girls while also contrary reports have been published, for example from the Republic of Korea (Cho et al. 2014), Qatar (Al-Darwish et al. 2014) and among 12- to 15-year-old Thai children (Krisdapong et al. 2013).

Based on the DPRK legislation, the fluoride concentration in toothpaste for children could not exceed 500 ppm. The preventive effect of this concentration has been shown to be questionable and markedly below the recommended level for primary school children in numerous studies conducted in developed countries (Marinho et al. 2003, Twetman et al. 2003, Twetman 2009, Walsh et al. 2010). In an environment where the use of fluoride was still new, it may be that the interventions alone have had some preventive effect. However, the actual effect of fluoride toothpaste on caries reduction in this study remained unknown.

The finding that the more expensive intensified school-based intervention did not result in a greater increase in dental health than the markedly less expensive early, pre-school-based intervention is interesting and stresses the importance of the evaluation of cost-effectiveness when planning future oral health interventions. Also, Albino and Tiwari (2016) concluded their recent review by noting that systematic assessment of the cost-effectiveness of prevention interventions is essential for the adoption of effective approaches. Similar findings as in the present study have also been reported by Hausen et al. (2000), Vanobbergen et al. (2004) and Hietasalo et al. (2008), although performed in very different environments. Hausen et al. (2000) reported of a study performed among 12-year-olds in Finland aiming to determine whether prevention targeted to high-risk individuals also benefits a child population with low caries frequency. The intensified intervention in this study included oral hygiene counselling, supervised toothbrushing and professional preventive treatment procedures, the frequency of which varied between the intervention group and the control group. After a follow-up of three years, the researchers reported no additional benefit from the intensified prevention but concluded that the same effect could have been obtained with substantially less effort and lower costs by the basic prevention. Vanobbergen et al. (2004) reported of a six-year-long oral health education programme targeting primary school children in Belgium. They studied the clinical
and the behavioural effects of a school-based oral health education programme in a low-caries prevalence region. Their target population during the intervention was similar to the sample of this present study according to age. The intervention appeared to have a positive effect on the children’s oral health habits, but no statistically significant difference was found in dental health between the intervention group and the control group. In conclusion, the researchers pointed out that caries reduction is difficult to achieve in a population with low caries activity. In another Finnish study by Hietasalo et al. (2008), a minor difference was found between the intervention group and the control group among 11- to 12-year-old school children. More children in the experimental group had none or very little DMFS increment compared to their counterparts in the control group. The contents of the oral health educations in the present study emphasized the same oral health habits and the health education materials were designed according to the recipients’ age, similarly to the studies by Vanobbergen et al. 2004 and Hausen et al. 2000. Opposite to the study by Hausen et al. (2000), the COHPF did not include any prevention procedures performed in clinical settings. Furthermore, the circumstances in this present study were markedly different, especially with regard to baseline caries level, the health care system and society as a whole.

Other interventions with similar activities as in the present study but implemented in circumstances more similar to the present study than those mentioned above have been reported for example in Thailand (Petersen et al. 2015), China (Tai et al. 2009) and Brazil (Zanin et al. 2007. However, they used dmft/s/DMFT/S as the primary outcome of the study while this study had dt/DT as the primary outcome. Furthermore, the results are not comparable with the present study since no control group was included.

Petersen et al. (2015) reported of a significant reduction in caries and improvement in dental plaque scores in the intervention group compared with a control group after a two-year-long oral health promotion programme for children aged 4–6 years in Thailand. The outcomes were even more positive in schools that participated actively in the programme activities. Their intervention was markedly shorter, but they combined the oral health promotion programme with higher concentration (1,450 ppm) fluoride toothpaste than in the present study. As in this study, supervised toothbrushing was performed at school after lunch; the intervention group using high concentration toothpaste and the control group using regular toothpaste (1,000ppm). The children were provided with toothbrushes and toothpaste and oral health education by the teachers at school; their parents and caretakers were also engaged in the oral health education. In addition, the education materials used were very similar.

In the Chinese study by Tai et al. (2009), no statistically significant difference in the 3-year net mean DMFT increment score was found between the intervention group and the control group, but the net mean DMFS increment score differed statistically significantly between the study group and the control group. Most of the children in the intervention group (74%) reported to brush their teeth at least twice a day, but no statistically significant difference in the consumption of sugary drinks and food was found after the intervention, similarly to the present study. Both studies reported a significant decrease in dental plaque scores.

A similar but shorter educational programme performed among 6-year-olds in Brazil was shown to be efficient in reducing gingival and plaque indexes, the percentage of children affected and caries incidence (Zanin et al. 2007). The authors reported of a 15-month intervention in Brazil to teach pre-school children (aged 4 to 7 years) age-modified toothbrushing technique by instruction and demonstration. Supervised, individual brushing sessions together with guidance on dental hygiene and the consumption of cariogenic food and drink were organized at three-month intervals for the children in the experimental group. Additionally, multimedia interface, puppet play and various activities including sports, arts and plays were used to reinforce the health promotion. Toothbrushing training in groups once a year and professional fluoride applications were organized for those in the control group.
6.3 CHILDREN’S ORAL HEALTH HABITS AND THEIR ASSOCIATION WITH DENTAL CARIES STATUS

Children’s self-reported oral health habits appeared to be relatively favourable and followed the recommendations of the oral health education provided by the COHPP. Fluoride toothpaste, which was relatively unknown even to professionals and not readily available in 2007, is now produced locally and has rapidly become common: over 99% of the children in the studied sample reported using fluoride toothpaste in 2013.

Most of the children had healthy oral habits; however, unhealthy oral habits such as toothbrushing less frequently than twice a day, not using fluoride toothpaste and drinking sugary beverages for thirst appeared to accumulate to the same children. The frequency of sweet snacking twice a day or more often compared with once a day or more seldom appeared to associate with dental caries. This finding is in line with earlier findings showing a positive association between higher sugar consumption and increased incidence of dental caries (Moynihan and Kelly 2014, Perez and Sheiham et al. 2016, Sheiham and James 2014). Similar findings have also been reported from India by Joshi et al. (2013). The finding that frequent toothbrushing did not associate statistically significantly with the prevalence of decayed teeth whereas the frequency of sweet snacking did is partly parallel and partly opposite with the study by Zhang et al. (2014) showing that neither toothbrushing nor sweet snacking frequency had a statistically significant association with the prevalence of dental caries among Bulang children in China. Infrequent toothbrushing (less than twice a day) and frequent consumption of sweet snacks (twice a day or more often) appeared to decrease along with age in the present study. This is opposite to the previous findings showing that the consumption of sugary foods and drinks tends to increase along with age in this phase of life (Currie et al. 2012, Petersen et al. 2008).

All children reported to brush their teeth daily with fluoride toothpaste and as many as 94% of them, twice a day or more often. These figures are very high in international comparison (Honkala et al. 2015). This is understandably due to the traditionally common appreciation of healthy teeth and good oral hygiene in the DPRK together with the relatively long intervention by the COHPP. Daily toothbrushing among school children was also reported by Goe et al. (2005). Also related to this strong tradition, oral hygiene instructions have probably been highlighted in the oral health education provided by local dentists and teachers since this part of the contents of the materials was most familiar to them. The tendency of oral hygiene to get more attention than dietary counselling has been noticed also after previous oral health behavioural interventions (Cooper et al. 2013).

Keeping in mind that fluoride toothpaste was not readily available to all children before the onset of the COHPP and that the distribution of it for most of the children lasted only the year of affiliation to the programme, the comprehensive use of it after the follow-up period proved that its use had been generally adopted in the capital area. The common use of water for quenching thirst instead of sugary beverages (75%) was also a delightful result. Cho et al. (2014) studied the oral health habits among 11-year-old children from the Republic of Korea, the sibling population of the DPRK. They found 21% of the children drinking sugary beverages twice a day or more often and the caries experience of those eating sugary snacks twice a day or more often to be little less than 50%, which is much less than in the present study.

The use of sugary snacks was very common as also reported by Goe et al. (2005). In the present study, only minimal gender differences were detected in the use of sweet snacks and sugary beverages. Boys drank sugary beverages more often than girls, but girls had a habit of eating sweet snacks more often than boys. These findings are partly linear and partly contradictory with the results of previous research which have shown more frequent use of sugary snacks and drinks among boys than among girls (Currie et al. 2012, Hasselqvist et al. 2014, Ahmed et al. 2007, Petersen et al. 2008). Opposite gender differences have been reported...
from China (Zhang et al. 2014) and Japan (Kawamura et al. 2008), the neighbouring countries of
the DPRK. Common use of sweet snacks is detrimental as a habit, but it may also cause further
harm by contributing to an increase in the use of sugary beverages in the future (Hasselqvist et
al. 2014). In 2012, the consumption of centrifugal sugars in the DPRK was reported to be 3.8
kilogrammes per capita, which is very low when compared to the neighbouring countries,
China (11.4 kg), Japan (17.2 kg), the Russian Federation (39.5 kg) or the Republic of Korea (24.2
kg) (WHO 2015a).

6.4 CHILDREN’S AWARENESS OF AND COMPLIANCE WITH HEALTHY ORAL
HABITS

Children’s awareness of healthy oral habits was comprehensive throughout the city of
Pyongyang: most of the children appeared to be aware of each healthy oral habit recommended
by the COHPP. Oral hygiene practices such as toothbrushing twice a day and use of fluoride
toothpaste were a little more well-known than the dietary recommendations for a healthy diet
and the use of water as thirst quencher as well as avoiding sweet snacks between meals. No
significant difference was observed between the genders. In China, only minor gender
differences were reported in oral health-related awareness among 12-year-olds by Zhang et al.
(2014).

The oral health habits were good among all children, but frequent sweet snacking was an
exception; although the awareness was at good level, sweet snacks were commonly used twice
a day or more often. Awareness of the healthy oral hygiene habits was at the same level in all
three study groups, but the dietary recommendations were statistically less often known by the
children who had been affiliated to the programme later than the children in the other
intervention groups. However, the compliance with healthy oral habits was highest among
them. They reported following all recommended habits more often than their counterparts in
the other two intervention groups; the difference in favour of this group was statistically
significant regarding toothbrushing twice daily and eating sweet snacks more seldom than
twice daily. Regarding the use of water as the main thirst quencher, the difference was almost
significant. It might be that the oral health behaviour among young generations in Pyongyang
has changed in general due to the wide dissemination of information, but those affiliated to the
programme only recently may have only modest theoretical knowledge of healthy oral
behaviour.

Awareness of the importance of toothbrushing twice daily, the use of fluoride and avoidance
of frequent sweet snacks were much better among 10- to 13-year-olds in Pyongyang than
among 8- to 16-year-old children in Nepal (Dixit et al. 2013) where only 18% of the respondents
were aware of the beneficial effect of fluoride on dental health and, respectively, 50% were
aware of the association between the use of sugar and dental caries. Comprehensive knowledge
of the harmful effect of sugar consumption and the protective effect of toothbrushing and the
use of fluoride toothpaste has also been reported among 12-year-old Chinese children, with
large differences between children living in urban areas compared to those living in rural areas
(Wong et al. 2001).

Two oral health promotion programmes for primary school children with similar activities
have previously been organized in China, the northern neighbour of the DPRK, one in Yichang
Like the DPRK, China has experienced great changes during the past decades, which have a
significant impact on and have been reflected in the oral health (Hu et al. 2011). Dental caries is
a vast public health problem in China, as in the DPRK. According to Hu et al. (2011), there is a
need to emphasize prevention and to strengthen oral health care services as 89% of the carious
teeth in children aged 12 years are left untreated and over 85% of the oral health care expenses
are paid by the patients themselves.
The finding that awareness of healthy dietary habits was not statistically significantly associated with healthy eating health habits is linear with results of previous oral health interventions from other countries. Similarly with the present study, no statistically significant difference in the consumption of sugary drinks and food was found after a three-year intervention in Yichang City, Hubei, China by Tai et al. (2009). The intervention included similar activities as the present study. After the intervention, the children in the intervention group were found to have healthier oral habits compared with the control group, with the exception of the use of sugary drinks and food. In an earlier study from China performed in Wuhan by Petersen et al. (2004), healthier oral hygiene habits were adopted more often in the intervention group than in the control group after a three-year-long intervention but regarding the consumption of sugary foods or drinks, statistically significant differences were not that evident. Toothbrushing at least twice a day after the intervention was reported more commonly in Pyongyang (94%) than in Yichang City (74%; Tai et al.2009) or Wuhan (61%; Petersen et al. 2004). On the other hand, a decrease in sweet snack consumption was reported in Wuhan while the impact appeared to be modest in Pyongyang.

Anttonen et al. (2011) reported of a year-long dietary and oral hygiene intervention performed among 13- to 14-year-old school children in 2007–2008 Finland, Europe. The context of this study, Scandinavia, where the prevention of oral diseases has a long tradition, is very different to the previous studies. They aimed to study the effect of a dietary intervention on school children’s eating habits and on their dental health. The activities included common information of the intervention for a school class, individual counselling by a dental hygienist and a follow-up visit 2 months after the individual counselling. The methods included a questionnaire and laser fluorescence measurement of the teeth before and after the intervention. Some improvement in the children’s eating habits was found after the intervention; the habit to use water for quenching thirst also increased. The frequency of toothbrushing at least twice a day was lower (59–70%) than in Pyongyang but the proportion of children drinking water instead of sugary beverages for thirst quenching at school was at a similar level as in the present study and increased during the follow-up. On the other hand, the consumption of sweet snacks was markedly more common in Pyongyang than in Finland. The results are not directly comparable due to the different time intervals, culture and surroundings and due to the differences in the study design and the questionnaires. Oral health education for the whole population has a long a tradition in Finland and the main self-care principles of caries control are largely familiar to the general population.

6.5 PARENTS’ AWARENESS OF HEALTHY ORAL HABITS

Like the children, also the parents appeared to have good knowledge of healthy oral behaviour. All healthy oral habits promoted by the COHPP were mentioned by almost all of the parents. However, it should be noted that the sample of parents was from the most central part of Pyongyang where the COHPP had operated longest. The children of these parents had been affiliated to the COHPP while in kindergarten, which may be a contributing factor to the parents’ good knowledge of the recommendations of this programme. The sample is relatively small and does not allow generalization of the results to the entire capital area.

Parents’ comprehension of the child’s oral health behaviour was consistent with the child’s own report regarding sweet snacking frequency (p=0.736) and the main thirst quencher (p=0.349) but differed regarding the child’s oral hygiene habits. This may be explained by the incomplete awareness of the supervised daily toothbrushing practice at school. This inconsistency between the child’s and his/her parents’ report of the child’s oral health behaviour supports the truthfulness of the reports as it could be more parallel as the questionnaires were filled at home.
The finding that no statistically significant association was found between the child’s oral health habits and the parents’ awareness of the corresponding oral health habit may be explained by the age group of the children. Among school children, the effect of the family and the parents becomes less important and is replaced by the attitudes and behaviour of friends and peers (Petersen et al. 2008, Poutanen et al. 2006, Prinstein et al. 2001). However, Folayan et al. (2014) showed a significant association between knowledge of caries preventive measures among school children and their parents in Nigeria. Contrary to them, Vanobbergen et al. (2004) observed that measuring parental responses is not always self-evident when children are the target, as the interaction between children’s behaviour and parental experience and feeling is complex and difficult to explore. In this study, parents’ own oral health habits were not assessed.
7 Conclusions and recommendations

This study provided novel information on the dental health status, awareness of and compliance with oral health habits among school children in the DPRK, information which has so far been almost nonexistent. Furthermore, an insight is provided into the potential of a development collaboration project with a small budget focusing on children’s oral health habits in a low-income country in the middle of transition. The vast need to enhance oral health promotion among children and adolescents in developing countries urgently requires international support and co-operation. Raising awareness of healthy oral habits by training also other than oral health professionals to educate children and their families along with their daily activities at kindergartens and primary schools does not require unreasonable resources. On the contrary, a great decrease in suffering and an improvement of children’s quality of life can be achieved with a relatively small budget. When investing in young generations, the impact will last for the entire life of the individual.

Based on this longitudinal study, the effect of the less intensified intervention started earlier seemed to be comparable to the intensified intervention in preventing dental caries, in spite of the fact that in our analysis we were not able to take into account all other factors that may have contributed to the observed improvement. The age of joining the programme appeared to be more significant than the intensity of the intervention, which confirms that the early years before school age are important for the development of oral health behaviour.

Against our hypothesis, there was no difference in the increase of dental health between the two intervention groups during the follow-up. With less effort, the early, preschool-based intervention was more competent than the intensified school-based intervention. However, it should be noted that the groups were not directly comparable as they differed in regard of the baseline caries status, the age when included in the programme and the length of the follow-up. Early onset of prevention is emphasized. The recommended healthy oral habits were well adopted, with the exception of the recommendation to avoid frequent sweet snacking. Most children reported to eat sweet snacks often, and this habit associated significantly with poorer dental health. Regular use of fluoride toothpaste was established among the school children during the follow-up. The reports by the children and by their parents concerning the children’s oral health habits were congruent regarding dietary habits but differed regarding oral hygiene habits. Both children and their parents were well aware of healthy oral habits. However, the associations between children’s awareness of and compliance with healthy oral habits varied according to the healthy oral habits and the groups: healthy oral hygiene habits were more common among older children, the use of fluoride toothpaste was nearly universal, but those who had joined the COHPP latest had healthier dietary habits than those who had joined the programme earlier. Parents’ awareness of healthy oral habits did not associate statistically significantly with their children’s oral health behaviour.

Internationally published research on oral health in the DPRK is almost nonexistent. The situation on children’s dental health is alarming and new research with a control group is needed to study dental caries prevalence in the whole DPRK. The findings of this study apply only to the sphere of action of the COHPP and cannot be generalized to the entire DPRK population. Further studies are needed to determine the oral health status of children elsewhere in the country, including those living in rural areas. A sequential evaluation of children’s dental health comprehensively in the DPRK, e.g. among five-year-olds and 10-12-year-olds, at a couple of years’ intervals would provide essential information on whether or not dental health and children’s oral health habits are changing in a positive or negative direction.
The dietary changes in low-income countries in the middle of nutritional transition cause serious challenges to children’s oral and general health when a healthier traditional diet is replaced by a Westernized diet rich in sugar and fat. In this study, frequent consumption of sugary snacks was shown to be common among school children in Pyongyang, the DPRK, and to be clearly associated with poor dental health. At the same time, a major improvement in the children’s oral health was achieved by development cooperation with a limited budget. Oral health education of the professionals who are involved in children’s and adolescents’ daily lives as well as the promotion of healthy oral habits including diet and regular toothbrushing with fluoride toothpaste should be included more often in development cooperation projects and other internationally run programmes to promote children’s health in low-income countries and population groups. In addition, affordable fluoride toothpaste should be made available. Reducing sugar in the diet, especially less frequent sweet snacking, should be emphasized.
References


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Walker MP. Cognitive consequences of sleep and sleep loss. Sleep Medicine 2008;9(Suppl.1):S29-S34.


# ORAL HEALTH ASSESSMENT FORM

<table>
<thead>
<tr>
<th>번호 Ref No.</th>
<th>년 Year</th>
<th>월 Month</th>
<th>일 Date</th>
<th>검사자 Examiner</th>
</tr>
</thead>
</table>

### 부록 자료 GENERAL INFORMATION:

1. 이름 Name:
2. 나이 Age in years:
3. 성별(남, 여)Sex(M, F):  
4. 현지적 위치 Geographic Location: ①도시 Urban  ② 농촌 Rural
5. 기타 Other data:

### 치주조직 상태 PERIODONTAL STATUS(CPITN)

17:16 11 26/27 0 = 좋은 healthy 1= 피나기 bleeding 2= 치석 calculus  
3 = 4-5mm 레일 pocket 4-5mm  
(부분적으로 보이는 검은 디) (black band of probe partially visible)  
4 = 8mm 또는 그 이상 레일 pocket 8mm or more  
(보이지 않는 검은 디) (black band of probe not visible)

### 치면상태와 필요한 치료 DENTITION STATUS AND TREATMENT NEED

| 상태 status | 55 54 53 52 51 61 62 63 64 65 | 18 17 16 15 14 13 12 11 21 22 23 24 25 26 27 28 |

| 치료 treatment | 85 84 83 82 81 71 72 73 74 75 |

| 상태 status | 48 47 46 45 44 43 42 41 31 32 33 34 35 36 37 38 |

| 치료 treatment |  |

### 상태 Status  

<table>
<thead>
<tr>
<th>영구이 Permanent teeth</th>
<th>유아이 Primary teeth</th>
<th>치료정형 Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 = 정상 sound</td>
<td>A</td>
<td>0 = 없음 none</td>
</tr>
<tr>
<td>1 = 부식 decayed</td>
<td>B</td>
<td>1 = 이식기경치 &amp; 충전</td>
</tr>
<tr>
<td>2 = 충전 &amp; 부식</td>
<td>C</td>
<td>2 = 1 면 충전 one surface</td>
</tr>
<tr>
<td>filled &amp; decayed</td>
<td></td>
<td>3 = 2 또는 그 이상 충전</td>
</tr>
<tr>
<td>3 = 충전 &amp; 부식되지 않음</td>
<td>D</td>
<td>two or more surface fillings</td>
</tr>
<tr>
<td>filled &amp; no decay</td>
<td></td>
<td>4 = 판 또는 다리못접합</td>
</tr>
<tr>
<td>4 = 이식기로 빼짐 missing due caries</td>
<td>E</td>
<td>crown or bridge abutment</td>
</tr>
<tr>
<td>5 = 다른 리유로 빼짐 missing, any other reason</td>
<td>F</td>
<td>5 = 다리못요소 bridge element</td>
</tr>
<tr>
<td>6 = 충전 sealant, varnish</td>
<td>G</td>
<td>6 = 치수치료 pulp care</td>
</tr>
<tr>
<td>7 = 다리못접합 또는 특수판 bridge abutment or special crown</td>
<td></td>
<td>7 = 발치 extraction</td>
</tr>
<tr>
<td>8 = 치명충이발 interrupted tooth</td>
<td>-</td>
<td>8 = 기타치료대책 need for other care</td>
</tr>
<tr>
<td>9 = 피행충이발 excluded tooth</td>
<td>-</td>
<td>9 = 기타 (specify...)</td>
</tr>
</tbody>
</table>
## DENTAL STATUS

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>District</th>
<th>School</th>
</tr>
</thead>
</table>

- **m**: milk tooth
- **[]**: erupting tooth
- **C**: caries (needs treatment)
- **I**: initial caries
- **P**: plaque
- **[]**: permanent tooth
- **[]**: missing tooth
- **X**: extracted (owing caries)
- **B**: bleeding gingiva
- **T**: tartar

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
구강검진표 (DENTAL STATUS)

<table>
<thead>
<tr>
<th>이름 (Name)</th>
<th>생년월일 (Date of birth)</th>
<th>(Code)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ (Boy)</td>
<td>□ (Girl)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>구역 (District)</th>
<th>교명 (School)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>날자 (Date)</th>
<th>검사자 (Examiner)</th>
</tr>
</thead>
</table>

아래의 망에 해당한 이질상태를 표시하시오 (Mark for each relevant tooth with):

- M = (deciduous tooth)
- C = 이식기 (caries, needs treatment)
- Cf = 초기이식기 (initial caries)
- F, f = 충전 (filling)

- ○ = 뻗출이 (erupting tooth)
- = 없는 이 (unerupted tooth)
- X = 이식기로 뺄 수 있는 이 (extracted owing caries)
- P = 치매 (plaque)
- B = 이류 (bleeding gingiva)
- T = 치석 (tartar)

오른쪽 (Right) | 원쪽 (Left)

상 (Upper) |

하 (Lower) |

기타 (Other findings):
Appendix 4

어린이질문서 (Children’s Questionnaire)

2013 년 어린이이미지예방계획, 평양 (Children’s Oral Health Promoting Program, COHPP, 2013 Pyongyang)

저번 6 개월사이에 어린이의 생활에서 이발건강을 위하여 노력한 청명을 우리가 알 수 있도록 다양한 질문에 답을 적어주시기 바랍니다. 레일 담임선생님에게 이 질문서를 주십시오.

이 질문서는 조선유럽동명이조사업소와 조선교육위원급, 페인트농업 및 보건복지단계가 평양의학대학, 동부평안대와 공통으로 진행하는 <어린이이미지예방협회조별> 연구사업의 일환으로 됩니다. 평양시내 2000 명의 어린이참여자들은 어린이가미지예방협회의 효과성과 평가하는 과학연구자료를 제공할 것입니다. 질문서의 자료들은 전자문서로 기입하여 출력하게 됩니다. 부모님 어린이의 이름은 공개되지 않을 것입니다. 본 조사와 관련된 귀대인은 조선교육위원급 책임부서 양진숙(주소: 평양시 중구역 외삼동)입니다.참가자는 자원성의 원칙이며 적극적인 참여를 기대합니다. 이 질문서에 수술을 해주신 본 자료를 연구사업에 이용하는 것을 허락하는 것으로 됩니다.

(Please answer the next questions to help us learn more about your experience of your oral health and its influence on your daily life during the past 6 months. Kindly return the questionnaire to your teacher tomorrow.)

This questionnaire is part of the research programme “COHPP evaluation study”, which is organized by Korean European Cooperation and Coordination Agency (KECCA), Korea Education Fund (KEF) and Finnish Agriculture and Health Rehabilitation Programme (FAHRP), in cooperation with Pyongyang Medical University and University of Eastern Finland. The data collected from 2000 children in Pyongyang will solely be used for a scientific research to evaluate the impact of the Children’s Oral Health Promoting Programme (COHPP). The data obtained from the questionnaires will be saved and analyzed in an electronic format, where your identity cannot be recognized. Contact person of the study is Senior Officer Yang Gon Suk, KEF, address: Desongdong, Central District, Pyongyang City, The participation is voluntary but highly appreciated and valuable. By signing this paper you will give the permission for us to use your data for this research.

이름 (Name) __________________________ 나이 (Your age) _______ □ 남/Boy □ 여/Girl 코드번호 (Code) ________

1. 지난 6 개월사이에 이발아픔이 있었습니까? (During the past 6 months, did you have toothache?)
    □ 에 (Yes) □ 아니오 (No) □ 모르겠음/기억나지 않음 (Don’t know / don’t remember)

2. 이발아픔이 있었습니다안아픔이 심하셨습니까? (If you answered yes to the previous question, how serious was the pain?)
    □ 이발아픔을 느낄 수 없었음 (Could not sleep)
    □ 이발아픔이 자절로 없어졌음 (Disappeared by itself)
    □ 병원에서 이발치료를 받아야 했음 (Had to visit the hospital)

3. 지난 6 개월사이에 이발이나 입안에 아픔이 있었습니까? 아픔이 있었습니다면 어떤 아픔이었습니다가?
    (Have you had any other dental problems during the past 6 months? If yes, please specify.)
    □ 에 (Yes) __________________________ □ 아니오 (No)

4. 1 주일에 1 회 또는 여러번 얼굴이나 턱에 아픔이 있었습니까? (Do you have pain in your face or jaws once a week or more often?)
    □ 에 (Yes) □ 아니오 (No)

5. 1 주일에 1 회 또는 여러번 입을 크게 벌리거나 음식을 벗을 때 아픔이 있었습니다가? (Do you have pain when you open your mouth wide or chew, once a week or more often?)
    □ 에 (Yes) □ 아니오 (No)
3. Do you have any other problems concerning your teeth? If yes, please specify.

4. How can you keep your teeth healthy? Do you remember the four important things?

1. __________________________
2. __________________________
3. __________________________
4. __________________________

8. In everyday life

- How often do you brush your teeth?: 1. once a day, 2. once a week, 3. more seldom, 4. never

- Do you use fluoride toothpaste?: Yes/No

- How often do you eat sweet snacks: 1. once a day, 2. once a week, 3. more seldom, 4. never

- What do you usually drink when you are thirsty?: __________________________

9. When was the last time you had your teeth checked?

- during the past year
- 1-2 years ago
- 2-3 years ago
- 3 or more years ago

10. What was the main reason for your last visit to a dental hospital?

- Went in for check-up
- Pain
- Treatment of a condition discovered at an earlier check-up
- Other

Thank you!
부모질문서 (Parent Questionnaire)

2013 년 아린이이는치의예방계획, 평양 (Children’s Oral Health Promoting Programme, COHPP, Pyongyang, 2013)

지난 6 개월 사이에 아린이가 아일링건강을 위하여 노력한 정책과 그의 업무에 있은 경험이 따른 정책에 대하여 우려가울 수 있도록 다음의 질문에 대답해주시기 바랍니다. 아린 아린이의 모임간생과 해 부모를 보내주십시오. 이 질문서는 조사결과를 정책조사에 사용하기 위해 조사에 사용하기 위해 작성된 수 있습니다. 평양시내 200 명의 부모들로부터 받은 자료는 아린이 아닌의 질문과 조사를 평가하기 위한 연구연구가 이루어진 것으로 됩니다. 질문서에 저명은 전자문서로 기입하여 준수하게 됩니다. 부모님 아린이의 이름은 공개되지 않습니다. 본 조사와 관련한 모든은 조사결과를 조사분석을 통해 본 연구에 사용되도록 합니다. 참가자는 자생산의 원칙이 적극적인 참가를 하고 있습니다. 이 질문서에 수표를 해주면 본 자료는 연구연구에 사용하는 것을 허용하는 것으로 됩니다.

(Please answer the next questions to help us learn more about your child’s experience of his / her oral health and its influence on your daily life during the past 6 months. Kindly return the questionnaire to your child’s teacher tomorrow?)

This questionnaire is part of the research programme “COHPP evaluation study”, which is organized by Korean European Cooperation and Coordination Agency (KECCA), Korea Education Fund (KEF) and Finnish Agriculture and Health Rehabilitation Programme (FAMHP), in co-operation with Pyongyang Medical University and University of Eastern Finland. The data collected from parents of 200 children in Pyongyang will solely be used for a scientific research to evaluate the impact of the Children’s Oral Health Promoting Programme (COHPP). The data obtained from the questionnaires will be saved and analyzed in an electronic format, where your or your child’s identity cannot be recognized. Contact person of the study is Senior Officer Yang Gon Suk, KEF address: Desongdong, Central District, Pyongyang). The participation is voluntary but highly appreciated and valuable. By signing this paper you will give the permission for us to use your data for this research.

아린이 이름(Child’s name) ______________________ 나이(Child’s age) _______ □ 남/Boy □ 녀/Girl
부모수표(Parent’s signature) ______________________ 가록날자(Recording date) ________ 코드번호 (Code) ________

1. 지난 6 개월사이에 아린이에게 이별아픔이 있었습니까? (During the past 6 months, did your child have toothache?)
   □ 예 [Yes] □ 아니오 [No] □ 모름/기억나지 않음 (Don’t know / don’t remember)

2. 왔을까면 아픔이 어느 정도였습니까? (If you answered yes to the previous question, how serious was the pain?)
   □ 지절로 없어졌음 (Disappeared by itself) □ 밤에 잠을 지지 못하였음 (Child stayed awake during the night)
   □ 병원에 가서 치료를 받았음 (Had to visit the hospital)

3. 지난 6 개월사이에 아린이의 입안에 다른 아픔이 있었습니까? 있었다면 설명해보십시오. (Has your child had some other dental problems during the past 6 months? If yes, please specify)
   □ 예 [Yes] □ 아니오 [No]

4. 마지막으로 아린이가 구강병원에 간 리유는 무엇입니까? (What was the main reason for your child’s last visit to dental hospital? Check one).
   □ 구강점검하려 왔음 (Went in for check-up) □ 아파서 왔음 (Pain)
   □ 이별점검 때 의사가 발견한 것을 치료받으려 왔음 (Went in for treatment of a condition discovered at earlier check-up or examination)
   □ 기타 (Other) 무엇입니까? (What) □ 모름/기억나지 않음 (Don’t know / don’t remember)

5. 1 주일에 1 회 또는 그 이상 아린이의 암글이나 턱에 아픔이 있었습니까? (Does your child have pain in face or jaws once a week or more often?) □ 예 [Yes] □ 아니오 [No]
6. 1주일에 1회 또는 그 이상 어린이가 없을 크게 벌리거나 씹음때 악과이 있었습니까? 악과이 있었다면 어떤 악과이었습니다? (Does your child have pain when he/she opens his/her mouth wide or chews once a week or more often?) □ 예(Yes) □ 아니요(No)

7. 어린이가 하루에 이발을 몇 번 했습니까? (In everyday life how often does your child brush his/her teeth): 
   1일 ____ 회(times a day), 1 주 ____ 회(times a week), ____ 드문히(more seldom), ____ 전혀 무척지 않음(never)

8. 어린이가 불소치약을 사용합니까? (Does he/she use fluoride toothpaste): □ 예(Yes) □ 아니요(No)

9. 어린이가 얼마나 자주 단섬유를 먹습니까? 단섬유, 열음과자, 사탕, 과자 (How often does he/she eat sweet snacks (juice, ice cream, candy, biscuit): 1일 ____ 회(times a day), 1 주 ____ 회(times a week), ____ 드문히(more seldom), ____ 전혀 먹지 않음(never)

10. 어린이가 목이 마르면 무슨 음료를 먹습니까? (What does he/she usually drink when feeling thirsty): __________

11. 어린이의 이발을 건강하게 하기 위하여 당신은 어떻게 해야 합니까? 여기에 대하여 배운 것들 중에서 중요한 것들을 알고있습니다? (How can you promote your child's good dental health? Do you remember any of the main points taught during the project?)
   1. __________________________________________________
   2. __________________________________________________
   3. __________________________________________________
   4. __________________________________________________

12. 그러한 내용들이 당신의 이발건강에도 도움을 줍니까? (Do the same factors apply also to your own dental health? Check one.)
   □ 예, 예(Yes, why) __________________________________________________
   □ 아니요, 아니요(No, why) __________________________________________________

13. 어린이의 이발건강에 영향을 줄 수 있는 충분한 상식을 알고있습니다? (Have you got enough information about the means how to influence your child's dental health? Check one.)
   □ 예(Yes) □ 구강의사로부터 (by Dentist) □ 교원 (Teacher) □ 텔레비전 (Television) □ 아니요(No)

14. 누가 당신에게 더 알리주기 바랄까요? (Whom would you like to inform you more?)
   □ 구강의사 (Dentist) □ 교원 (Teacher) □ 텔레비전 (Television) □ 기타(others) __________

15. 무엇에 대하여 더 알고 싶습니까? (What would you like to know more regarding dental health?)
   __________

16. 어린이의 건강모험조에 대해 당신의 의견을 알려주십시오. 이 협조가 도움이 됐습니까 아니면 시간부담이었습니까? 정확히 대답해 주기 바랍니다. (Your opinion about the Oral Health Promotion Programme; have you noticed any benefit of it or has it been waste of time? We appreciate a truthful answer.)

17. 우리에게 더 알려줄 것이 있습니까? (What else would you like to tell us?)

도움을 주어 감사합니다. THANK YOU FOR PARTICIPATING!
PIRKKO-LIISA TARVONEN

This doctoral thesis provided novel information on school children’s dental health in the Democratic People’s Republic of Korea. During the six years operations of the Children’s Oral Health Promotion Programme, the high prevalence of untreated dental caries decreased. After the follow-up, awareness of healthy oral habits was at high level and the recommended healthy oral habits were well adopted with the exception of frequent sweet snacking. Children’s health in developing countries may be promoted with limited resources by promoting healthy oral habits. Early start of the prevention is important.