LUND UNIVERSITY
Faculty of Medicine

Master's Programme in Public Health

Immigrant background and hospital care because of dental caries among preschool children in Sweden: A longitudinal, register-based study in a national cohort.

May 2020

Martina Nanteza

Supervisors
Anders Hjern
CHESS Karolinska Institutet/Stockholm University

Therese Kvist
Institutionen för odontologi & Universitetstandvården, Karolinska Institutet

Abstract

Introduction: Dental caries among preschool children is a global problem, a burden on children's well-being, and an economic burden on healthcare systems. In Sweden, preschool children with an immigrant background have a higher prevalence of caries. Extensive treatment need and long-standing poor oral health may require dental treatment within hospital care. This study aimed to investigate whether an immigrant background among preschool children in Sweden increased the risk for hospital care because of dental caries.

Methods: This was a longitudinal, register-based study using a cohort of 1 621 038 children. The children were 1-6 years old Swedish-born residents between 2001-2013. Data was retrieved from national registers like the Medical Birth Register, LISA, the Multi-Generation Register and the Patient Discharge Register. The registers were accessed via the National Board of Health and Welfare, and Statistics Sweden.

The two exposure variables of interest were parents' region of birth and duration of residence in Sweden, while the outcome was treatment within hospital care. Incidence of hospital care per 10,000 person-years was calculated using person time data. The risk of hospital care was expressed as hazard ratios obtained by Cox regression, with 95% confidence intervals.

Results: Incidence of dental treatment within hospital care was higher among children that were male, had single parents, had parents with low education, belonged to the lowest income quintile, and of Eastern European origin. Two separate regression analyses were done for region of birth, and duration of residence. In the adjusted model, Eastern European origin presented the highest risk for hospital care (HR=5.2, 95% CI=4.2-6.5), Western Europeans and Non-Europeans had almost equal risks (HR= 2.0, 95% CI=1.4-2.7 and HR=1.9, 95% CI= 1.5-2.3 respectively), and a mixed origin entailed the least risk (HR=1.4, 95% CI=1.1-1.8).). A 0-5 years' residence in Sweden increased the risk of hospital care (HR=1.5,95% CI=1.1-2.0) compared to more than 11 years' residence.

Conclusion: An immigrant background, and specifically Eastern European origin increased the risk of hospital care due to dental caries among preschool children in Sweden.

Table of contents

1. Introduction

Dental caries in a global perspective

According to the Global Burden of Disease Study 2017, 2.3 billion people worldwide have carious permanent teeth, whereas 530 million children have carious deciduous teeth (Global Burden of Disease 2017 Disease and Injury Incidence and Prevalence Collaborators 2018). Dental caries therefore greatly contributes to the oral disease burden worldwide (World Health Organization (WHO) 2018), although the prevalence varies across countries (WHO 2011). The WHO country-based annual Decayed, Missing, and Filled Teeth (DMFT) indices visualize these variations and show that middle and low- income countries have increasing rates (WHO 2011). This increase is potentially because of the populations adopting unhealthy dietary habits yet the health systems are inadequately equipped to address oral diseases (Wanchek and Rephann 2014). The prevalence and extent of dental caries in both high and low-income countries is attributed to multiple risk factors in interaction, making prevention difficult (Fisher-Owens et al. 2007). If left untreated, caries progress and eventually lead to loss of tooth substance, pulpal inflammation, and surrounding-tissue infection that may require hospitalization when it spreads beyond the tooth. In children, dental caries affects their appetite and growth, ability to sleep, and participation in school and everyday life (WHO 2015; Sheiham 2006). There are costs to society in the form of reduced productivity due to repeated absence from work and school due to caries (United States Department of Health and Human Services 2000; Casamassimo et al. 2009), as well as a high burden on country resources spent on treating caries (WHO 2015; WHO 2003).

Dental caries in Sweden

In the middle of the 20th century, Sweden had a high prevalence of dental caries among children. The high burden of disease among the population led to the institution of the Public Dental Service in 1938 (National Board of Health and Welfare 2013) as well as implementation of preventive measures (National Board of Health and Welfare 2013). One such measure was “Saturday candy” which later became a social norm, urging parents to limit children’s sugar intake to once a week. The introduction of fluoride mouth rinses and fluoride toothpastes in the 1960s further reinforced caries prevention and the effect was a 13% increase in the number of caries-free children (National Board of Health and Welfare 2013). Later on, dental care became free of charge for children 0-19 years of age, an age span recently expanded to include young adults of up to 24 years old (National Board of Health and Welfare 2013; Försäkringskassan

2018). As a result, oral health in children and young adults in Sweden has generally been good with low caries prevalence in an international comparison. In 2017 however, the National Board of Health and Welfare reported that children 6 years of age have had a 2% increase in caries prevalence in contrast to 3,12 and 19-year-olds where the prevalence remains quite steady (National Board of Health and Welfare 2019). Varying by county,59-82% of 6-year-old children are estimated to be caries-free in Sweden (National Board of Health and Welfare 2019). The goal set by the WHO that in 2020, 80% of all 6-year old children should be caries-free is currently hard to achieve (National Board of Health and Welfare 2019).

Caries risk factors

Caries risk assessment means evaluation of an individual's risk to develop caries, and the level of risk is based on how balanced the protective and risk factors are (Featherstone et al. 2007). In children, parental attitudes and knowledge, their educational achievements and socioeconomic status affect the caries-risk (Ramos-Gomez et al. 2002). Children with an elevated risk to develop caries are those with chronic medical conditions(Stecksén-Blicks et al. 2004), children with traumatic family experiences (Kvist et al. 2013; Valencia-Rojas 2008), children whose siblings have caries (Dobloug and Grytten 2016; Hultquist and Bågesund 2016), immigrant, and refugee children (Stecksén-Blicks et al. 2008; Nicol et al. 2015; Sheiham 2001). At the individual level, irregular tooth brushing, non-supervised tooth brushing (Ju et al. 2019; Pieper et al. 2015; Hilgert et al. 2017) and consumption of free sugars like sucrose in high quantities and frequency (Sheiham 2001) are the main etiological factors. When the acid-tolerant and acidogenic bacteria in the mouth ferment these sugars, the organic acids produced are responsible for the continued demineralization of the teeth, in the long run resulting in carious lesions (Sheiham 2001). Regulation of the daily sugar intake to recommended amounts and regular tooth-brushing with fluoridated toothpaste is essential to maintain a balance and prevents the demineralization (Sheiham 2001).

Immigrant background as risk factor for dental caries

Studies have reported an association between immigrant background and poor oral health among children (Wigen and Wang 2009; Cvikl et al. 2014; Sundby and Petersen 2003; Bissar et al. 2007). A similar trend has been shown in Sweden where pre-school children with an immigrant background have a higher caries prevalence in comparison to their Swedish-born peers (Hjern and Grindefjord 2000; Stecksén-Blicks et al. 2008; Bankel et al. 2006; Stecksén-Blicks et al. 2014; Jacobsson 2011). The risk for poor oral health varies amongst immigrants

too, depending on their country or region of origin (Hjern and Grindefjord 2000; Källestål and Fjelddahl 2007; Christensen et al. 2010; van der Tas et al. 2016; Matsuo et al. 2015). The immigrant background, in association with low socioeconomic status which is more common amongst immigrants(Stronks and Kunst 2009;Farmer and Ferraro 2005), is a strong risk factor for poor oral health (Hjern et al. 2001;Kramer et al. 2017; Heilman et al. 2015; Källestål and Wall 2002). Within low-economic settings, children may adopt the parental low trust and negative attitudes to oral health (Skeie et al. 2006; Skeie et al. 2008), poor diets, and poor oral hygiene habits (Stecksén-Blicks et al. 2008; Mattila et al. 2010). The risk of poor oral health is higher among new immigrants compared to those whose stay is longer than ten years. Of significance too is the age at immigration, where younger immigrants acquire healthier behavior than the older immigrants (Cruz et al. 2009; Ge et al. 2018). The health-seeking behavior of most immigrants differs from in-born Swedish peers, with more missed appointments at hospitals, and often attendance only when in acute need (Norredam et al. 2004; Hjern et al. 2001).

Hospital care due to dental caries

Untreated caries can progress to involve tissues within and around the tooth causing pulpal inflammation, mucosal ulcerations, fistula, and abscess formation (Monse 2010). Beyond the oral cavity, infections could spread to the alveolar bone, via fascial spaces to the ear and neck regions, the blood stream, or further on to the thoracic cavity and brain tissues (Erazo and Whetstone 2019). Severe caries and infections might necessitate referral of the child to a hospital for intravenous antibiotics, extraction, or restorative treatment. For surgical or restorative treatment, general anesthesia (GA) could be indicated when treatment needs and/or uncooperativeness from the child renders traditional modes of treatment impossible (Silva et al. 2015). Besides those with severe caries, young children, children with limited mental/physical abilities, and those with extreme dental fear and anxiety often require dental treatment under GA (Silva et al. 2015). Moreover, certain circumstances like child abuse and neglect (Kvist et al. 2018), dental neglect per se (Kvist et al. 2014), family history of dental treatment under GA, and large family size (Rajavaara 2019) increase the risk of dental treatment with GA. Most commonly, it is children in the pre-school age that are referred for dental treatment under GA (Haubek et al 2006).

In Sweden, all dental treatment under general anesthesia requires an anesthesiologist, often with in-hospital care. The standard procedure to receive GA is initiated by a referral from general dentistry to specialist pediatric dentistry. At this point, if GA is indicated, the child is referred

to a medical hospital or a dental clinic with an associated anesthesiologist where their general medical condition determines their eligibility for GA. The dental treatment under GA is conducted by the pediatric dentist in collaboration with the anesthesiologist. A survey by Klingberg et al (2010) showed that in 2008, 3,210 children had dental treatment under general anesthesia in various hospitals in Sweden. The number of referrals to pediatric dentists concerning severe dental caries and pulpal infections also increased between 2003 and 2008 (Klingberg et al. 2006; 2010). General anesthesia allows for a wide range of quality dental treatments under optimal settings (Silva et al. 2015), is generally safe, less stressful, and saves time (Anderson et al. 2004). However, GA is associated with physical side effects like pain, nasal bleeding, throat discomfort, nausea, and vomiting (Rodd et al. 2014; Farsi et al. 2009), as well as psychological effects on the children and their parents (Backeljauw et al. 2015). Compounding the burden it places on the health system, children treated under GA can experience relapses in dental caries and require further treatment, hence, prevention needs to be initiated immediately after GA (Amin et al. 2015; Batawi 2014).

Public health relevance

Due to the overrepresentation of immigrants among children with poor oral health in Sweden, we hypothesized that most children that required treatment within hospital care would be of immigrant origin. Studies elsewhere have shown that immigrant background among preschool children is a predisposing factor to treatment under GA (Haubek et al. 2006; Alcaino et al. 2000; Savanheimo et al. 2012). With the increasing number of children with an immigrant background in Sweden, and with evidence of unsuccessful preventive measures within this high-risk group (Anderson et al. 2016), chances are high that their level of caries will continue to rise. It would not be sustainable to manage the high caries prevalence via emergency treatment. It was therefore important to understand how an immigrant background influenced the risk for caries treatment in hospital care, what the other contributory factors were, and how they interacted with one another. As of our knowledge, there was no published study in this matter elsewhere in Sweden.

Study aim and hypothesis

The aim with this study was to investigate whether an immigrant background increased the risk of hospital care due to dental caries among preschool children in Sweden. A secondary aim was to determine how the duration of residence in Sweden amongst immigrants affected the risk of hospital care. The null hypothesis was that an immigrant background amongst preschool

children in Sweden did not increase the risk for hospital care due to dental caries. The alternative hypothesis stated that an immigrant background increased the risk of hospital care due to dental caries among preschool children in Sweden.

2.Methods

Study population and data source

This was a register-based study in a national cohort of 1 621 038 preschool children between 2001-2013. The registers were Swedish national registers held by the National Board of Health and Welfare, and Statistics Sweden, and were linked through the unique personal code number present in all national registers. The children were identified in the Medial Birth Register. Data on exposure variables like year of birth, gender, family type in infancy, household income, mother's and father's education, and parents' country of birth in regional categories was retrieved from LISA (The longitudinal integration database for health insurance and labor market studies), and linked to the study subjects through the Multi-Generation Register.

The outcome variable, also considered as the event of interest in this study, was defined as at least one entry into the in- or out-patient versions of the Patient Discharge Register, with a main diagnosis of dental caries (ICD 10: K02), or infection in the mouth or jaw emanating from a tooth (ICD 10 : K04), from age 1 to age 6 during 2001-2013. The outcome was dichotomized according to receipt of dental treatment within hospital care, and person-time was calculated for all study subjects as the number of days of follow-up until dental treatment within hospital care, or exit from the study due to age, emigration or death. The mean person-time of a given category was obtained through dividing the total person-time in that category by its number of subjects. This mean person-time was then changed into person-years by dividing it by 365. The children were followed from age 1 or January 1st 2001, whichever came last, to age 6 or December 31st 2013, whichever came first. Ethical permission for the study was granted by the Regional Ethical Board in Stockholm (2013/811-33).

Analytical process

Statistical analysis was conducted using Statistical Package for Social Sciences (IBM SPSS Statistics version 25.0, [SPSS, Inc., IBM Corp., Armonk, NY, USA]).

Univariate analysis included frequencies and valid percentages for the study population's sociodemographic characteristics. Cross-tabulations with other variables were done for parents' region of birth and duration of residence in Sweden. The cross-tabulations showed the proportions of these other variable-categories within parents' region of birth and duration of residence in Sweden. The incidence of dental treatment within hospital care per 10,000 person-years was calculated within all study variables.

The data was analyzed with person-time-based Cox regression analysis, where risk was summarized as Hazard Ratios (HR), with 95% confidence intervals (CI). Cox proportional hazards regression was appropriate because we could simultaneously assess the impacts of multiple predictors on the occurrence of hospital care for dental caries, with utilization of the person-time data (van Dijk et al. 2008) .The main covariate of interest in the first analysis was parental region of birth in five categories of: (i) two Swedish-born parents, (ii) one Swedish-born and one of immigrant origin (Mixed), (iii) Eastern European, (iv) Western European and (v) Non-European. When both parents were foreign-born with origin in different regions, maternal origin was used as the base for categorization. Disposable household income was summarized into quintiles. Mother's and father's education was divided into three categories of 0-9 years of basic education, 10-12 years equivalent to upper secondary education, and more than 12 years as tertiary education. The educational level categorizations were based on the Swedish education system. The family type during the child's infancy was divided into two categories of single, and married/ cohabiting parents, while the child's gender was either male or female. All these variables were added to the analysis as potential confounders, and gender was in addition assessed for interaction effects by creating interaction terms between it and parental region of birth.

A separate Cox regression analysis was carried out amongst only children with an immigrant background, using duration of residence in Sweden as the main covariate. Year of birth in four categories, gender, family type in infancy, and parents' region of origin were added to the analysis and assessed for confounding and interaction effects. Socioeconomic factors of income, and mother's and father's education were excluded from this analysis.

3. Results

The sociodemographic characteristics of the 1 621 308 children in the study are summarized in **Table 1**. The majority of the children had two parents with a Swedish background (75.5%). The mixed category had one Swedish, and one immigrant parent, and comprised 11.9% of the study population. Children with parents from Eastern Europe, Western Europe and from Non-European countries accounted for 3.0%, 2.6% and 7.0% respectively. Amongst the immigrant parents, more than half (52.3%) had not resided for more than 5 years in Sweden, 22.3% had not exceeded 10 years of residence, while 25.4% had stayed longer than 11 years. During infancy, most of the children lived in two-parent households (89.4%) while 10.6% lived with single parents.

There were 799 children that received hospital care for severe caries. The type of care was either inpatient (n=111) or outpatient care (n=699). There were eleven children that received both inpatient and outpatient hospital care.

The results of the crosstabulation of region of birth with other independent variables are summarized in **Table 2**. Among children with two Swedish parents, almost half of the mothers (47.8%) had an educational level of 10-12 years, while mothers with more than 12 years followed closely by (43.1%). Less than 10% of the Swedish mothers had less than 10 years of education. More immigrant mothers had a shorter education than Swedish-born mothers, while the educational level was more similar for fathers over region of birth categories. Families with Swedish-born parents more often had incomes in the higher income quintiles, while the reverse was true for the immigrant families, with parents from Non-European countries having the lowest incomes.

Crosstabulations between parental duration of residence in immigrant families and other covariates are shown in **Table 3**. Among mothers whose residence did not exceed 5 years, 45.1% had low education. Almost half of the immigrant mothers that had the longest duration of residence in Sweden had attained 10-12 years of education (49.7%). Immigrant fathers slightly differed from immigrant mothers in that amongst those with at most 5 years of residence, a larger number (36.8%) had attained 10- 12 years of education. In all duration of residence categories, the largest number of immigrants were in the lowest income quintile. Immigrants in the 0-5 years' category had lower incomes than those who had resided for longer durations in Sweden.

The incidence of hospital care for severe caries for all covariates is shown in **Table 4**. The incidence of hospital care varied with gender and was higher among male (I=1.2/10,000 person years) than female children (I=0.9/10,000 person years). There was a reduction in the incidence of hospital care for severe caries as the level of education between mothers and fathers increased. Duration of residence in Sweden was inversely related to incidence of hospital care, which was highest among children whose parents had the shortest residence (I=3.8/10,000 person years). Children from single-parent households during infancy had a higher incidence of hospital care (I= 2.4/10,000 person years) than those living with both parents (I=0.9/10,000 person years). In addition, having two Swedish parents seemed protective against hospital care (I=0.7/10,000 person years), whereas being of Eastern European origin presented the highest incidence (I=6.2/10,000 person years). As the level of income increased, the incidence for hospital care for severe caries decreased.

Cox Regression Analysis

Two separate analyses were carried out using region of birth and duration of residence as the main predictors.

Table 5 highlights findings from the crude model with region of birth categories as the main predictor. Eastern European children had the highest risk for severe caries (HR=9.5, 95% CI =7.8-11.6), followed by Non-European children (HR=4.0, 95% CI =3.3-4.9). Western European origin presented the lowest risk amongst immigrants (HR=3.6, 95% CI=2.7-5.0), whereas being of mixed origin resulted into a much lower risk (HR=1.7, 95% CI=1.4-2.1) than having two immigrant parents.

The table also includes findings of region of birth adjusted for gender, year of birth, family type, mother's, and father's education. Although the presence of potential confounders reduced the risk for hospital care among Eastern European children by 45.3 %, the gradient in HR between Eastern European children and the other immigrant categories was still present with HR=5.2, 95% CI =4.2-6.5. Both Western European and Non-European backgrounds among children were almost as equally risky (HR= 2.0, 95% CI=1.4-2.7 and HR=1.9, 95% CI= 1.5-2.3 respectively), unlike in the crude model where a slightly larger difference was observed. Being of mixed origin still had the lowest hazard ratio (HR=1.4, 95% CI=1.1-1.8), albeit much closer to the other immigrant categories than in the crude model.

Table 6 demonstrates a Cox regression analysis of duration of residence categories. In the crude model 1, 0-5 years of residence amongst immigrant parents increased the risk of hospital care for their children (HR=1.5, 95% CI=1.1-2.0) compared with a duration of residence of 11 years or more. Adjusting for covariates in model 2 barely attenuated this risk to HR=1.4, 95% CI =1.0-1.8.

4. Discussion

Main findings

This was a longitudinal, register-based study that revealed that an immigrant background among preschool children in Sweden significantly increased the risk of hospital care due to dental caries. Socioeconomic factors confounded the increase in risk. Eastern European origin entailed a five-fold increase in risk for hospital care due to dental caries after adjustment for confounders, non-European and Western European backgrounds increased the risk by almost equal amounts, and these effects were only slightly higher than that of a mixed background. A duration of residence in Sweden of not more than 5 years by immigrant parents significantly increased the risk of hospital care among their children.

Immigrant background and the risk for hospital care

In this study, an immigrant background increased the risk of hospital care for dental caries. A similar pattern was observed with incidence for hospital care being higher amongst immigrant families, corroborating findings by Dahlander et al (2015). Various studies have reported a high rate of caries among immigrant children in comparison with native children (Cote et al. 2004; Källestål and Fjelddahl 2007; Hjern and Grindefjord 2000). However, some of these studies looked at child-migrants whose level of caries and oral health behavior might differ from the Swedish- born immigrant children in our study. Regardless, our findings are comparable because after being socialized to the parents' country of origin (Mendoza 2009), Swedish-born immigrant children acquire oral health behavior similar to child-immigrants. Since severe caries which require hospital care could be because of long-standing poor oral health, our findings imply that immigrant preschool children probably had worse oral health compared to Swedish children. This is supported by previous research among pre-school children in Sweden (Hjern and Grindefjord 2000; Stecksén-Blicks et al. 2008; Bankel et al. 2006; Stecksén-Blicks et al. 2014; Jacobsson 2011).

Compared to preschool children born to Swedish parents, children with at least one immigrant parent had a 40% increase in the risk for hospital care (HR=1.4, 95% CI=1.1-1.8). Despite this increase, having at least one Swedish parent seemed protective against the risk of hospital care when compared to children with two immigrant parents. Much as immigrant children in Sweden have higher prevalence rates for dental caries, the prevalence varies amongst the immigrant groups as they have different cultures and different levels of acculturation in Sweden. Children

to immigrants from Western Europe and Non-European countries had an almost equal risk for hospital care, but it is impossible to explain this finding within the scope of this study because of the broad categorization of the countries of origin.

The relatively low risk observed within immigrants from Western Europe could be attributed to the reduction in caries in these countries as a result of improved diet, improved oral hygiene practices and use of fluorides by the populace within the past three decades (Patel 2012). Additionally, Western European countries are reported to resemble Sweden in many aspects of oral health (Patel 2012).

Children from some Non-European regions like Africa have repeatedly been shown to have lower dental care needs than other immigrant children (Sundby and Petersen 2003; Cote et al. 2004) and lower caries levels than native children (Christensen 2010). The reasons for this are the traditionally low sugar diets in Africa (Cote et al.2004) and the use of brush-sticks (Adams et al.2013), both of which are protective to the teeth. The low risk observed amongst Non-Europeans, however, cannot be attributed to African immigrants, because in the study period, most Non-European immigrants came from the Middle Eastern countries of Iran, Iraq, and Lebanon. Immigrants from these countries have been reported to have poor oral health (National Board of Health and Welfare 2017).

Amongst immigrant children, Eastern European children had the highest risk for hospital care and were more than five times as likely as Swedish children (HR=5.2 95% CI =4.2-6.5) to receive hospital care for dental caries. This is probably due to a high prevalence of dental caries and a high treatment need in this group as exhibited in other studies (Bissar et al. 2007; Cote et al. 2004; Källestål and Fjelddahl 2007; Julihn 2010). Caries prevalence is not only high in Eastern European immigrant children, but also in their home countries, with only minor improvements in the last three decades (Patel 2012; Widström et al. 2014). Oral health in children in Eastern Europe has stalled after the decentralization and privatization of government services caused a shortage in school-based oral health programmes and raised the prices of caries-preventive products (Marthaler 2004; Petersen 2003). Moreover, the privatization resulted in parents seeking children-dental services for mostly operative rather than preventive care (Petersen 2003). Maes et al (2006), reported high rates of poor oral hygiene practices in some East European countries with many adolescents brushing only once daily. Compared to Western Europe, the practice of brushing twice daily follows a social gradient in Eastern Europe, as the disadvantaged cannot afford buying fluoride toothpaste and toothbrushes (Marthaler and Pollack 2005). With free dental care for children in Sweden, the reasons for

continued poor oral health in Eastern European children could be their subjection to a sugar-rich diet, negative parental attitudes towards oral health, and the socialization of the children to their ethnic cultures (Mendoza 2009).

The effect of socioeconomic factors, gender, and family type on the risk for hospital care

Socioeconomic status of the parents, which in this study was defined by household income quintile and level of education of either parent, confounded the relationship between immigrant background and the risk for hospital care. Of these socioeconomic factors, mother's education and income quintile were the strongest confounders and generally accounted for more than 30% of the increase in the risk for hospital care.

Preschool children to mothers with only basic elementary education had an almost fourfold increase in the risk of hospital care (HR =3.7, 95% CI =2.9-4.7) compared to children whose mothers had more than twelve years of education. The importance of a mother's educational level in caries prevention has been demonstrated in previous studies (Mattila et al.2003; Luciana et al. 2008; Dini et al. 2002 Auad et al. 2008; Ferreira et al. 2007; Feldens et al. 2010). Because of their close relationship with children, mothers through their knowledge about oral health, attitudes, and oral health habits, impact the dental health of their children (Adeniyi et al. 2009), an impact which possibly extends into adulthood. In preschool children, this impact is stronger as they are entirely dependent on their mothers for moderation of their feeding and oral hygiene behavior (Adeniyi et al. 2009). Though this study did not investigate how the knowledge, attitudes and practices of mothers affect the children's risk for hospital care, these aspects have been shown to be significantly influenced by educational level (Mahmoud et al. 2018; Mohebbi et al. 2007; Adair et al. 2004; Suresh et al. 2016; Williams et al. 2002).

Oral health literacy, defined as "the degree to which individuals have the capacity to obtain, process and understand basic oral health information and services needed to make appropriate health decisions" (US Department of Health and Human Services,2010), has been linked with level of education (Veerasamy and Kirk 2013;Atchison et al. 2010). This link is said to be even stronger among ethnic minorities, especially those whose main language is different from the natives' (Atchison et al. 2010). Our findings imply that children of immigrant mothers with low education are at a higher risk of hospital care. This may be because of low oral health literacy, as the mothers may be less likely to seek after, understand or appropriately utilize available dental services.

In their conceptual model, Fisher-Owens et al (2007) emphasize the interrelationship between several factors in the causation of caries. Low educational achievement leads to lower prospects on the job market and thus limited earnings (Schuring et al. 2013; McKnight et al. 2016). Economically strained families cannot afford healthy foods and follow sugar-rich diets which increases the risk of dental caries among the children (Mobley et al. 2009). Immigrant children are at a greater risk because their parents adopt harmful diets during the process of acculturation (Riggs et al. 2015). In this study, a disposable family income within the lowest quintile more than tripled the risk of hospital care for dental caries in preschool children (HR=3.3, 95% CI=2.3-4.8), as shown in other studies (Christensen et al. 2010a; Christensen et al. 2010b; Hallett et al. 2006; Nunn et al. 2009; Chianna et al. 2010).

Saldūnaitė et al (2014) observed that parents with low incomes utilized both preventive and curative dental services less often and were indifferent towards oral health education. The same study reported that the use of anti-caries measures like dental floss, fluoride gel and varnish were dependent on the household income. Crosstabulations of income quintiles with parents' region of birth showed that within immigrant families, the majority belonged to the lowest quintile, with less than 10% in the highest quintile. This is in line with earlier reports of immigrants in Sweden having a lower income status in comparison to the natives (Nordin and Rooth 2009; Statistics Sweden 2019; Grand and Szulkin 2003). This could explain the results in this study, that immigrants due to low income, are less likely to engage in caries-promoting behavior, which would increase the risk of dental caries and subsequently hospital care for their children.

The incidence of hospital care was higher in male children, and their risk for hospital care increased by 20%, a disparity by gender reported in other studies (Jamjoom et al.2001;Vinckier et al.2001) but for which no concrete explanation exists. Gender was assessed for interaction effects with the parents' region of birth, but the results were not significant. Children living with both parents during infancy had a 62.5% lower incidence of hospital care for dental caries than those in single-parent households. The risk of hospital care was reduced by 30% (HR= 1.3, 95% CI =1.1-1.6) if children lived with both parents in infancy. Single parenting has been associated with high levels of parenting stress where parents have limited control over the child's oral health (Quiñonez et al. 2001). Other family characteristics like the size, birth rank of the child and parents' age are known risk factors for caries in preschool children (Wellappuli and Amarasena 2012; Piva et al. 2017; Julihn et al. 2020).

Duration of residence in Sweden and the risk for hospital care

From the adjusted model, immigrant children whose parents had the shortest duration of residence in Sweden had a 40% increase in the risk of hospital care for dental caries (HR= 1.4, 95% CI=1.0-1.8). These children had incidence of hospital care much higher than children whose parents had resided for longer than a decade in Sweden, suggesting that oral health improves with length of stay in the host country (Ge et al. 2018; Cruz et al. 2009). This improvement in oral health is attributed to acculturation, whereby immigrants with time change their behavior, norms, and attitudes to those that suit the host country and promote better health outcomes (Cruz et al. 2004; Luo et al. 2016). Via improved utilization of oral health services (Gao et al. 2010), better knowledge about the healthcare system (Ge et al. 2018), change in oral hygiene practices (Dahlan et al. 2019; Schulter et al. 2017) and improved dietary habits (Rosenmöller et al. 2011), the oral health of immigrants changes for the better. However, there is evidence that use of duration of residence as the only indicator of acculturation is inadequate (Gao and McGrath 2011) and many other indicators could be employed (Tiwari and Albino 2017).

Interestingly, the incidence of hospital care was similar among children to immigrant parents with a maximum of five years, and those with ten years of residence. By these results, it appears that a moderately long period spent in Sweden did not positively impact the immigrants' oral health. During this period, also known as cultural marginality, immigrants have abandoned their culture but have not yet fully adapted the host country's culture and are more prone to disease (Choi 2001; Gao et al. 2010). This period could be characterized by a change towards a more cariogenic diet but coupled with poor utilization of available caries-preventive measures (Geltman 2013). In regression analysis, a decade-long duration of residence of immigrant parents was not significantly predictive of hospital care for their children.

Study findings in a broader context

Our results confirmed that, preschool children with an immigrant background received hospital care for dental caries more than Swedish preschool children. Hospital care in this study could have comprised intravenous antibiotics, or extractions and restorative treatment under general anaesthesia. There might be other reasons for immigrant children having a higher risk for hospital care, but our study leans more towards the cause being a high caries rate. This is evidenced by Eastern European children, who had previously been shown to have a high caries-prevalence, also exhibiting the highest incidence and risk of hospital care in this study. Children with extensive caries require several dental visits which increases their negative experiences of pain and traumatic treatment, leading to dental fear and anxiety (Raadal et al 2006). Haubek et al (2006) stated that it is the combination of a high caries-prevalence and the resulting dental anxiety that leads to immigrant children predominating dental treatment under general anesthesia.

In Sweden, the guidelines for the management of severe caries in children depend on the region, but there is a consensus that the use of general anesthesia is only when conventional treatment by local anesthesia or conscious sedation is impossible. Most importantly, the use of GA among children in Sweden follows the recommendations of the United Nations Convention on the Rights of the Child (United Nations Human Rights,1989), which prioritize the wellbeing of children. GA is administered to outpatients in the dental chair for minor extractions, to day-care patients in need of minor oral surgeries, and to inpatients whose surgical procedures and extractions are complex (Cantlay et al. 2005). There is no recent data in Sweden, but in many developed countries, the use of GA in children is on the rise. In North America, 37% of pediatric dental training programs were reported to use clinic and hospital-based general anesthesia for dental treatment, with 64 % of the training directors anticipating an increase in the demand for dental anesthesiologists (Hicks et al. 2012). In New Zealand, Hunt et al (2018) found a 65% increase between 2004-2014, while in England, 13,120 children aged 0-5 years had extractions under GA in 2018-2019 (NHS Digital, 2019). The increasing incidence of early childhood caries in some parts of the world, changing parental preferences (Adams 2014), as well as improved availability (Gosnell 2011), are some of the reasons for the rise in the use of GA. In addition, amongst general dentists, inadequacy in conscious sedation, lack of necessary equipment, plus the financial and time constraints from conscious sedation contribute to choosing general anesthesia (Freeman and Carson 2003).

Despite its advantages, the use of GA is a burden to the country healthcare systems with reported costs of up to £30 million in the UK (Faculty of Dental Surgery 2015) and $21.2 million in Canada (Canadian Institute for Health Information 2013). In fact, the international set of guidelines followed during GA that make it of high standard, inadvertently make it an expensive choice (Alcaino et al. 2000). Moreover, the many referrals for GA lead to overcrowding in the scheduled treatments and the children and their parents are subjected to long periods of waiting. In Sweden, the waiting time varies depending on the level of priority of the patient, and the region of residence. In 2008, the average waiting time for all patients was reported as 3.2 months, while high priority patients waited for only one month (Klingberg et al. 2010). Some argue that long-waiting times may lead to dentists finding their way around the delays by skipping routine methods like tell-show-do and referring patients much earlier, leading to undesirable changes in their referral behavior and encouraging the parents' continued dependence on GA (Godwin 2014).

Parents whose children utilize GA have been reported to hold false beliefs about dental health (Karki et al.2011), and the ready availability of GA which they perceive as a reliable means to restore oral health, diminishes the parents' interest in their own or the children's oral health (Acs et al. 2001). Amin et al (2006) found that most parents who prefer GA to alleviate short-term effects of caries like dental pain were previously disinterested in the children's oral health. The poor oral health of their children in turn leads to parents favoring GA (Jankauskiene et al. 2014), creating a vicious cycle. It is worth mentioning that because of the well- functioning healthcare system in Sweden, GA is available and accessible to all. However, because parents access it for free, GA probably encourages laxity in caries-preventive behavior, and leads to repeat visits in the emergency room. Pediatric dentists can encourage this behavior when their choice of dental treatment for the patient is determined by the socioeconomic status (Harper et al. 2000), and when cariostatic interventions after GA are omitted (Tickle et al. 2002).

Strengths and limitations

The strengths of this study lay in the use of data from national registers and the large sample size. The Swedish national registers are regularly updated and provided high-quality data on all the variables. The use of register data about education for immigrants however is not completely reliable because the Swedish system sometimes fails to capture educational achievements from abroad. Thus, the effect of education on the risk for hospital care among immigrants could have been underestimated in this study. There was incomplete or missing data on some of the variables, which could have introduced selection bias into the study (Frisell 2016). Regardless, the attrition rate in our study was low and could not have substantially affected our results. The large sample size with data from all regions in Sweden increased the power of this study and made our findings generalizable to target populations countrywide. The number of events was however small compared to the sample size, which we attributed to admission data from some hospitals in some regions not being captured in the national registers.

Conclusion and Recommendations

This is the first study in Sweden to investigate how immigrant background affects the risk for hospital care due to dental caries. Altogether, this study demonstrated that preschool immigrant children in Sweden are more likely to be treated in hospitals for dental caries and associated conditions. We also showed that the risk for hospital care varied amongst immigrant groups and was highest among Eastern Europeans.

Based on our findings, the emphasis therefore, should be placed on caries-preventive measures, initiated early in a child's life, and with continued participation from the parents. Our recommendation is for preventive interventions delivered to at-risk immigrant families in an environment they are comfortable with, like a home-setting. The importance of this is to ensure a proper dialogue where health workers are not merely informing but striving to understand the at-risk families too. The interventions ought to be culturally sensitive and structured to accommodate not only the child, but other family members as well. Families receiving GA should be followed up more intensively, and a strong relationship between the referring dentist and the specialist pediatrician would be essential for this to work. All this calls for more financial investments and prioritization of children's oral health by policy makers.

For future research, we recommend investigating what type of hospital care the children receive and how this varies with immigrant background. The type of care would be indicative of the

severity of the problem, give insight into which immigrant children suffer the most serious dental complications, and help direct preventive measures to the right group. Additionally, conclusions about costs to the health system by immigrant background could be drawn from the type and amount of care received. We also recommend looking at immigrant country differences rather than regions in the risk for hospital care.

Ethical considerations

The data used in this study was accessed via Stockholm University, and used only while on university premises. Being register data, no informed consent was sought from the study subjects, as by Swedish law, such data is a property of the state, whose permission we had already received. After extracting the data from the registers, the personal identifying numbers were removed and replaced with random numbers to create anonymity, and summarizing of the findings at group level reinforced this anonymity. The conclusion that Eastern European background presented the greatest risk of hospital care due to caries could victimize immigrants from this region. We however assert that these findings would be very essential for adequate planning for public oral health interventions in immigrants from Eastern Europe, benefits from which would outweigh the probable harm.

Acknowledgements

I would like to acknowledge Anders Hjern and Therese Kvist, my supervisors, for their input, guidance, and support throughout this project. I am grateful to my family, friends, and especially my sambo Jörgen, for the emotional support rendered to me for the entire two years.

References

Acs, G., Pretzer, S., Foley, M and Ng, W., (2001). Perceived outcomes and parental satisfaction following dental rehabilitation under general anesthesia. *Pediatric Dentistry*. **23**(5), 419-423.

Adams, A.C., (2014). Trends in paediatric general anesthesia in Canada [online]. *Oral Health*. [Viewed 6 May 2020]. Available from: https://www.oralhealthgroup.com/features/trends-inpaediatric-general-anesthesia-in-canada/

Adams, J.H., Young, S., Laird, L.D., Geltman, P.L., Cochran, J.J., Hassan, A., Egal, F., Paasche-Orlow, M.K., Barnes, L.L., (2013). The cultural basis for oral health practices among Somali refugees pre- and post-resettlement in Massachusetts. *Journal of Healthcare for the Poor and Undeserved.* **24**(4), 1474-1485.

Adeniyi, A.A., Ogunbodede, O.E., Jeboda, O.S and Folayan, O.M., (2009). Do maternal factors influence the dental health status of Nigerian pre-school children? *International Journal of Paediatric Dentistry*. **19**, 448-454.

Alcaino, E., Kilpatrick, N.M & Smith, K., (2000). Utilization of day stay general anesthesia for the provision of dental treatment to children in New South Wales, Australia. *International Journal of Paediatric Dentistry*. **10**, 206-212.

Alm, A., Wendt, L.K., Koch, G & Birkhed, D., (2007). Prevalence of approximal caries in posterior teeth in 15-year-old Swedish teenagers in relation to their caries experience at 3 years of age. *Caries Research*. **41**, 392-398.

Amin, M., Nouri, R., Elsalhy, M., Shah, P & Azarpazhooh, A., (2015). Caries recurrence after treatment under general anaesthesia for early childhood caries: a retrospective cohort study. *European Archives of Pediatric Dentistry*. **16**, 325-331.

Amin, M.S., Harrison, R.L and Weinstein, P., (2006). A qualitative look at parents' experience of their child's dental general anaesthesia. *International Journal of Paediatric Dentistry*. **16**, 309-319.

Anderson, H.K., Drummond, B.K& Thomson, W.M., (2004). Changes in aspects of children's oral-health-related quality of life following dental treatment under general anaesthesia. *International Journal of Pediatric Dentistry*. **14**, 317-325.

Anderson, M., Dahllöf, G., Twetman, S., Jansson, L., Bergenlid, A.C., Grindefjord, M., (2016). Effectiveness of early preventive intervention with semiannual fluoride varnish application in

toddlers living in high-risk areas: A stratified cluster-randomized controlled trial. *Caries Research*. **50**, 17-23.

Atchison, K.A., Gironda, M.W., Messadi, D and Der-Martirosian, C., (2010). Screening for oral health literacy in an urban dental clinic. *Journal of Public Health Dentistry*. **70**, 269-275.

Auad, S.M., Waterhouse, P.J., Nunn, H.J and Moynihan, P.J., (2009). Dental caries and its association with sociodemographics, erosion, and diet in schoolchildren from Southeast Brazil. *Pediatric Dentistry*. **31**(3), 229-235.

Backeljauw, B., Holland, K.S., Altaye, M & Loepke, A.W., (2015). Cognition and brain structure following early childhood surgery with anesthesia. *Pediatrics*. **136**(1).

Bankel, M., Eriksson, U., Robertson, A & Köhler, B., (2006). Caries and associated factors in a group of Swedish children 2 -3 years of age. *Swedish Dental Journal*. **30**, 137–146.

Bissar, A.R., Oikonomou, C., Koch, M.J & Schulte, A.G., (2007). Dental health, received care, and treatment needs in 11- to 13-year-old children with immigrant background in Heidelberg, Germany. *International Journal of Paediatric Dentistry*. **17**, 364– 370.

Canadian Institute for Health Information, (2013). *Treatment of preventable dental cavities in preschoolers: A focus on day surgery under general anesthesia* [online]. Canadian Institute for Health Information. [Viewed 7 May 2020].

Available from: https://secure.cihi.ca/free_products/Dental_Caries_Report_en_web.pdf

Cantlay, K., Williamson, S and Hawkings, J., (2005). Anaesthesia for dentistry. *Continuing Education in Anaesthesia, Critical Care & Pain*. **5**(3), 71-75.

Casamassimo, P.S., Thikkurissy, S., Edelstein, B.L., Maiorini, E., (2009) Beyond the dmft: the human and economic cost of early childhood caries. *The Journal of the American Dental Association*. **140**(6), 650–657.

Choi, H., (2001). Cultural marginality: a concept analysis with implications for immigrant adolescents. *Comprehensive Pediatric Nursing*. **24**, 193-206.

Christensen, L.B., Petersen, P.E & Hede, B., (2010a). Oral health in children in Denmark under different public dental health care schemes. *Community Dental Health*. **27**, 94-101.

Christensen, L.B., Twetman, S& Sundby, A., (2010b). Oral health in children and adolescents with different socio-cultural and socioeconomic backgrounds. *Acta Odontologica Scandinavica*. **68**(1), 34-42.

Cote, S., Geltman, P., Nunn, M., Lituri, K., Henshaw, M and Garcia, R.I., (2004). Dental caries of refugee children compared with US children. *Pediatrics.* **114,** 733-740.

Crocombe, L.A., Allen, P., Bettiol, S& Soares, L.F.B., (2018). Parental Education Level and Dental Caries in School Children Living in Dili, Timor-Leste. *Asia Pacific Journal of Public Health*. **30**(2), 128-136.

Cruz, G.D., Chen, Y., Salazar, C.R & Le Geros, R.Z., (2009). The association of immigration and acculturation attributes with oral health among immigrants in New York City. *American Journal of Public Health.* **99**(2), 474–480.

Cruz, G.D., Shore, R., Le Geros, R.Z and Tavares, M., (2004). Effect of acculturation on objective measures of oral health in Haitian immigrants in New York City. *Journal of Dental Research*. **83**(2), 180-184.

Cvikl, B., Drabo, P., Hagmann, M., Gruber, R. et al., (2014). Migration background is associated with caries in Viennese school children, even if parents have received a higher education. *Biomed Central Oral Health.* **14**(51).

Dahlan, R., Badri, P., Saltaji, H and Amin, M., (2019). Impact of acculturation on oral health among immigrants and ethnic minorities: A systematic review. *PLOS ONE*. **14**(2).

Dahlander, A., Jansson, L., Carlstedt, K., Grindefjord, M., (2015). The influence of immigrant background on the choice of sedation method in paediatric dentistry. *Swedish Dental Journal*. **39**(1), 39-45.

Djuister, D., de Jong-Lenters, M., de Ruiter, C., Thijssen, J., van Loveren, C and Verrips, E., (2014). Parental and family-related influences on dental caries in children of Dutch, Moroccan and Turkish origin. *Community Dentistry and Oral Epidemiology*. **43**, 152-162.

Dobloug, A and Grytten, J., (2016). Correlation between siblings in caries in Norway. A quantitative study. *Community Dentistry and Oral Epidemiology*. **44**, 416-425.

El Batawi, H.Y., (2014). Factors affecting clinical outcome following treatment of early childhood caries under general anaesthesia: a two-year follow-up. *European archives of Pediatric Dentistry*. **15**, 183-189.

Erazo, D. and Whetstone, D, R., (2020). *Dental Infections.* Treasure Island, Florida: StatPearls Publishing.

Eshghi, A., Samani, M.J., Najafi, F.N and Hajiahmadi, M., (2012). Evaluation of efficacy of restorative dental treatment provided under general anesthesia at hospitalized pediatric dental patients of Isfahan. *Dental Research Journal*. **9**(4), 478-482.

Farmer, M.M and Ferraro, K.F., (2005). Are racial disparities in health conditional on socioeconomic status? *Social Science and Medicine*. **60**, 191-204.

Farsi, N., Ba'akdah. R., Boker, A and Almushayt, A., (2009). Postoperative complications of pediatric dental general anesthesia procedure provided in Jeddah hospitals, Saudi Arabia. *BioMed Central Oral Health*. **9**(6).

Featherstone, J.D.B., Domejean-Orliaguet, S., Jenson, L., Wolf, M and Young, D.A., (2007). Caries risk assessment in practice for age 6 through adult. *Journal of the California Dental Association*. **35**(10), 703–713.

Feldens, C.A., Giugliani, E.R.J., Vigo, A and Vitolo, M.R., (2010). Early Feeding Practices and Severe Early Childhood caries in four-year-old children from Southern Brazil: A birth cohort study. *Caries Research*. **44**, 445-452.

Ferreira, S.H., Bèria, J.U., Kramer, P.L., Feldens, E.G and Feldens, C.A., (2007). Dental caries in 0- to 5-year-old Brazilian children: prevalence, severity, and associated factors. *International Journal of Paediatric Dentistry*. **17**, 289-296.

Fisher-Owens, S.A., Gansky, S.A., Platt, L.J.et al., (2007). Influences on children's oral health: A conceptual model. *Pediatrics.* **120**, 510-521.

Freeman, R and Carson, P., (2003). Relative analgesia and general dental practitioners: attitudes and intentions to provide conscious sedation for paediatric dental extractions. *International Journal of Paediatric Dentistry*. **13**, 320-326.

Frisell, T., (2016). SP0187 Why missing data is a problem, and what you should not do to solve it. *Annals of the Rheumatic Diseases.* **75**(2), 45.

Försäkringskassan, (2018). Höjd åldersgräns för kostnadsfri tandvård [online]. [Viewed 8 February 2020]

Availablefrom:https://www.forsakringskassan.se/privatpers/tandvard/tandvardsstod/hojdaldersgrans

Gao, X-L and McGrath, C., (2011). A Review on the oral health impacts of acculturation. *Journal of Immigrant and Minority Health*. **13**, 202-213.

Ge, S., Wu, B and Dong, X., (2018). Associations between acculturation and oral health among older Chinese immigrants in the United States. *Gerontology and Geriatric Medicine*. **4**, 1-10.

Geltman, P.L., Adams, J.H., Cochran, J., Doros, G., Rybin, D., Henshaw, M., Barnes, L.L and Paasche- Orlow, M., (2013). The impact of functional health literacy and acculturation on the oral health status of Somali refugees living in Massachusetts. *American Journal of Public Health.* **103**(8), 1516-1523.

Global Burden of Disease 2016 disease and injury incidence and prevalence collaborators, (2017). Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: A systematic analysis for the global burden of disease study 2016. *Lancet*. **390**(10100), 1211-1259.

Goodwin, M., (2014). The use of general anaesthetic for dental extractions in children: researching the complex causal networks and approaches to reducing need. Ph.D. thesis, University of Manchester. [Viewed 6 May 2020].

Availablefrom:https://www.research.manchester.ac.uk/portal/files/54568866/FULL_TEXT.PDF

Gosnell, E.S., (2011). *Criteria for Treatment of Children Under General Anesthesia by Pediatric Dentists and Parents*. Columbus, Ohio: The Ohio State University. [Unpublished].

Hallet, K.B and O'Rourke, P.K., (2006). Pattern and severity of early childhood caries. *Community Dentistry and Oral Epidemiology*. **34**, 25-35.

Harper, R.S., Khan, I., Chen, R and Nevill, A., (2020). Oral health inequalities in 0-17-year-old children referred for dental extractions under general anaesthesia in Wolverhampton, 20132017. *Community Dental Health*. **36**, 1-6.

Haubek, D., Fuglusang, M., Poulsen, S and Rolling, I., (2006). Dental treatment of children referred to general anesthesia--association with country of origin and medical status. *International Journal of Paediatric Dentistry.* **16**, 239–246.

Heilmann, A., Tsakos, G and Watt, R. G., (2015). Oral health over the life course. In: C.B. Jeangros, S. Cullati, A. Sacker and D. Blane, eds. *A life course perspective on health trajectories and transitions*. 4th Vol. Geneva: Springer Open. pp.39-59.

Hicks, C.G., Jones, J.E., Saxen, M.A., Maupome, G., Sanders, B.J., Walker, A.L., Weddell, J.A and Tomlin, A., (2012). Demand in Pediatric Dentistry for Sedation and General Anesthesia by Dentist Anesthesiologists: A Survey of Directors of Dentist Anesthesiologist and Pediatric Dentistry Residencies. *Anesthesia Progress*. **59**, 3-11.

Hilgert, L.A., Leal, S.C., Bronkhorst, E.M and Frencken, J. E., (2017). Long-term effect of supervised toothbrushing on levels of plaque and gingival bleeding among schoolchildren. *Oral Health and Preventive Dentistry*. **15**, 537-542.

Hilton, I.V., Stephen, S., Barker, J.C and Weintraub, J.A., (2007). Cultural factors and children's oral health care: a qualitative study of carers of young children. *Community Dentistry and Oral Epidemiology*. **35**, 429-438.

Hjern, A and Grindefjord, M., (2000). Dental health and access to dental care for ethnic minorities in Sweden. *Ethnicity & health*. **5**(1), 23-32.

Hjern, A., Grindefjord, M., Sundberg, H and Rosén, M., (2001). Social inequality in oral health and use of dental care in Sweden. *Community Dentistry and Oral Epidemiology*. **29**, 167-174.

Hjern, A., Haglund, B., Persson, G and Rosén, M., (2001). Is there equity in access to health services for ethnic minorities in Sweden? *European Journal of Public Health*. **11**(2).

Hooley, M., Skouteris, H., Boganin, C., Satur, J& Kilpatrick, N., (2012). Parental influence and the development of dental caries in children aged 0-6 years: A systematic review of the literature. *Journal of Dentistry*. **40**, 873-885.

Hultquist, A.I and Bågesund, M., (2016). Dentin caries risk indicators in 1-year-olds. A two-year follow-up study. *Acta Odontologica Scandinavica*. **74**(8), 613-619.

Hunt, G.R., Foster, P.L.A and Thomson, W.M., (2018). Dental treatment of children under general anaesthesia in District Health Boards in New Zealand. *New Zealand Dental Journal*. **114**, 156-163.

Jacobsson, B., Koch, G., Magnusson, T and Hugoson, A., (2011). Oral health in young individuals with foreign and Swedish backgrounds-a ten-year perspective. *European Archives of Paediatric Dentistry*. **12**(3).

Jamjoom, M.M., Al-Malik, M.I., Holt, R.D and El-Nassry, A., (2001). Dental treatment under general anesthesia at a hospital in Jeddah, Saudi Arabia. *International Journal of Paediatric Dentistry*. **11**, 110-116.

Jankauskiene, B., Virtanen, J.I., Kubilius, R and Narbutaite, J., (2014). Oral health-related quality of life after dental general anaesthesia treatment among children: a follow-up study. *BioMed Central Oral Health*. **14**(81), 1-14.

Ju, X., Do, L., Ha, D and Jamieson, L., (2019). Association of modifiable risk factors with dental caries among indigenous and non-indigenous children in Australia. *JAMA Network Open*. **2**(5).

Julihn, A., Ekbom, A and Modeer, T., (2010). Migration background: a risk factor for caries development during adolescence. *European Journal of Oral sciences*. **118**, 618-625.

Julihn, A., Soares, F.C., Hammarfjord, U., Hjern, A and Dahllöf, G., (2020). Birth order is associated with caries development in young children: a register-based cohort study. *BioMed Central Public Health*. **20**(1), 218.

Kapur, A and Kapur, V., (2019). Conscious sedation in dentistry. *Annals of Maxillofacial Surgery*. **8**(2), 320-323.

Karki, A.J., Thomas, D.R and Chestnutt, I.G., (2011). Why has oral health promotion and prevention failed children requiring general anaesthesia for dental extractions? *Community Dental Health*. **28**, 255-258.

Karlberg, G.L and Ringsberg, K.C., (2006). Experiences of oral health care among immigrants from Iran and Iraq living in Sweden. *International Journal of Qualitative Studies on Health and Well-being*. **1**, 120–127.

Klingberg, G., Andersson-Wenckert, I., Grindefjord, M., Lundin, S-A. et al., (2010). Specialist pediatric dentistry in Sweden 2008-a 25-year perspective. *International Journal of Paediatric Dentistry*. **20**, 313–321.

Klingberg, G., Dahllöf, A-L., Erlandsson, M., Grindefjord, M. et al., (2006). A survey of specialist pediatric dental services in Sweden: results from 2003, and trends since 1983. *International Journal of Paediatric Dentistry*. **16,** 89–94.

Kramer, A.A.C., Petzold, M., Hakeberg, M and Östberg, A.L., (2017). Multiple socioeconomic factors and dental caries in Swedish children and adolescents. *Caries Research*. **52**, 42-50.

Kvist, T., Annerbäck, E-M., Dahllöf, G., (2018). Oral health in children investigated by Social services on suspicion of child abuse and neglect. *Child Abuse and Neglect*. **76**, 515-523.

Kvist, T., Annerbäck, E-M., Sahlqvist, L., Flodmark, O and Dahllöf, G., (2013). Association between adolescents' self-perceived oral health and self-reported experiences of abuse. *European Journal of Oral Sciences*. **121**, 594-599.

Kvist, T., Zedrén-Sunemo, Graca, E and Dahllöf, G., (2014). Is treatment under general anesthesia associated with dental neglect and dental disability among caries active preschool children? *European Archives of Paediatric Dentistry*. **15**(5), 327-332.

Källestål, C and Fjelddahl, A., (2007). A four-year cohort study of caries and its risk factors in adolescents with high and low risk at baseline. *Swedish Dental Journal*. **31**(1), 11-25.

Källestål, C and Wall, S., (2002). Socio-economic effects on caries. Incidence data among Swedish 12-14-year-olds. *Community Dentistry and Oral Epidemiology*. **30**, 108-114.

le Grand, C and Szulkin, R., (2002). Permanent disadvantage or gradual integration: explaining the immigrant-native earnings gap in Sweden. *Labour*. **16**(1), 37-64.

Lee, H.H., Milgrom, P., Starks, H and Burke, W., (2013). Trends in death associated with pediatric dental sedation and general anesthesia. *Paediatric Anesthesia*. **23**, 741-746.

Luo, H and Wu, B., (2016). Acculturation and dental service use among Asian immigrants in the U.S. *American Journal of Preventive Medicine*. **51**(6), 939-946.

Maes, L., Vereecken, C and Vanobbergen, J., (2006). Tooth brushing and social characteristics of families in 32 countries. *International Dental Journal*. **56**, (159-167).

Mahmoud, N., Kowash, M., Hussein, I., Hassan, A and Halabi, M.A., (2017). Oral health knowledge, attitude, and practices of Sharjah mothers of preschool children, United Arab Emirates. *Journal of International Society of Preventive and Community Dentistry*. **7**(6), 308314.

Marthaler, T.M., (2004). Changes in Dental Caries 1953–2003. *Caries Research*. **38**, 173-181.

Marthaler, T.M and Pollack, G.W., (2005). Salt fluoridation in Central and Eastern Europe.

Schweiz Monatsschr Zahnmed. **115**, 670-674.

Matsuo, G., Rozier, G.R and Kranz, A.M., (2015). Dental Caries: racial and ethnic disparities among North Carolina kindergarten students. *American Journal of Public Health*. **105**(12), 2503-2509.

Mattila, M.L., Rautava, P., Aromaa, M., Ojanlatva, A. et al., (2003). Behavioural and demographic factors during early childhood and poor dental health at 10 years of age. *Caries Research*. **39**, 85-91.

Mattila, M.L., Rautava, P., Sillanpää, M and Paunio, P., (2000). Caries in five-year-old children and associations with family-related factors. *Journal of Dental research*. **79**(3), 875-881.

McGrath, C., Yeung, C.Y.Y.J and Bedi, R., (2002). Are single mothers in Britain failing to monitor their oral health? *Postgraduate Medical Journal*.**78**, 229-232.

McKnight, A., Stewart, K., Himmelweit, S.M and Palillo, M., (2016). *Low pay and in-work poverty: preventative measures and preventative approaches* [online]. Luxembourg: Publications Office of the European Union. [Viewed 13 May 2020]. Available from: http://www.lse.ac.uk/business-and-consultancy/consulting/assets/documents/Low-Pay-and-InWork-Poverty.pdf

Mejia, G.C., Elani, H.W., Harper, S., Thomson, W.M. et al., (2018). Socioeconomic status, oral health and dental disease in Australia, Canada, New Zealand and the United States. *BioMed Central Oral Health*. **18**, 176.

Mendoza, F.S., (2009). Health disparities and children in immigrant families: A research agenda. *Pediatrics*. **124**(3),187-195.

Mobley, C., Marshall, T.A., Milgrom, P and Coldwell, S.E., (2009). The contribution of dietary factors to dental caries and disparities in caries. *Academic Pediatrics*. **9**, 410-414.

Mohebbi, S.Z., Virtanen, J.I., Murtomaa, H., Vahid-Golpayegani and Vehkalahti, M.M., (2008). Mothers as facilitators of oral hygiene in early childhood. *International Journal of Pediatric Dentistry*. **18**, 48-55.

Monse, B., Heinrich-Weltzien., Benzian, H., Holmgren, C and Helderman, W.V.P., (2010). PUFA – An index of clinical consequences of untreated dental caries. *Community Dentistry and Oral Epidemiology*. **38**, 77-82.

Mortazavi, H., Baharvand, M and Safi, Y., (2017). Death rate of dental anaesthesia. *Journal of Clinical and Diagnostic Research.* **11**(6).

National Board of Health and Welfare., (2019). *Karies bland barn och ungdomar - epidemiologiska uppgifter för år 2017* [online]. Stockholm: National Board of Health and Welfare. [Viewed 16 March 2020].

National Board of Health and Welfare., (2013). *Sociala skillnader i tandhälsa bland barn och unga Underlagsrapport till Barns och ungas hälsa, vård och omsorg* [online]. Stockholm: National Board of Health and Welfare. [Viewed 30 March 2020]. Available from : https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/20135-34.pdf

National Board of Health and Welfare., (2017). *Tillståndet och utvecklingen inom hälso- och sjukvård. Lägesrapport 2017* [online]. Stockholm: National Board of Health and Welfare. [Viewed 25 March 2020]. Availablefrom:https://www.socialstyrelsen.se/globalassets/sharepointdokument/artikelkatalog/ovrigt/2017-3-1.pdf

National Health Service Digital, (2019). *Hospital Episode Statistics: Hospital tooth extractions, 0-19-year-olds, 2011-12 to 2018-19* [online]. London: National Health Service Digital. [Viewed 6 May 2020]. Available from: https://www.gov.uk/government/collections/oralhealth

Ng, M.W., (2003). Multicultural influences on child-rearing practices: implications for today's pediatric dentist. *Pediatric Dentistry*. **25**(1).

Nicol, P., Anthonappa, R., King, N., Slack-Smith, L., Cirillo, G and Cherian, S., (2015). Caries burden and efficacy of a referral pathway in a cohort of preschool refugee children. *Australian Dental Journal.* **60**, 73-79.

Nielsen, S.S., Hempler, N.F and Krasnik, A., (2013). Issues to consider when measuring and applying socioeconomic position quantitatively in immigrant health research. *International Journal of Environmental Research and Public Health.* **10**, 6354-6365.

Nordin, M and Rooth, D-O., (2009). The ethnic employment and income gap in Sweden: Is skill or labor market discrimination the explanation? *The Scandinavian Journal of Economics*. **111**(3), 487-510.

Nunn, M.E., Dietrich, T., Singh, H, K., Henshaw, M.W and Kressin, N., (2009). Prevalence of early childhood caries among very young urban Boston children compared with US children. *Journal of Public Health Dentistry*. **69**(3), 156-162.

Oliveira, L.B., Sheiham, A., Bönecker, M., (2008). Exploring the association of dental caries with social factors and nutritional status in Brazilian preschool children. *European Journal of Oral Sciences*. **116**, 37-43.

Patel, R., (2012). *The State of Oral Health in Europe* [online]. [Viewed 12 May 2020]. Available from: www.oralhealthplatform.eu

Peres, M.A., Peres, K.G., Traebert, J., Zabot, N.E and de Lacerda, J.T., (2005). Prevalence and severity of dental caries are associated with the worst socioeconomic conditions: A Brazilian cross-sectional study among 18-year-old males. *Journal of Adolescent Health*. **37**, 103-109.

Petersen, P.E., (2003). Changing oral health profiles of children in Central and Eastern Europe - challenges for the 21st century. *WHO-Oral Health* [Viewed 24 April 2020]. Available from: https://www.who.int/oral_health/publications/icd01/en/

Pieper, K., Winter, J., Krutisch, M., Völkner-Stetefeld and Jablonski-Momeni, A., (2016). Prevention in kindergartens with 500 ppm fluoride toothpaste- a randomized clinical trial. *Clinical Oral Investigations*. **20**, 1159-1164.

Piovesan, C., Mendes, F.M., Ferreira, F.V., Guedes, R.S and Ardenghi, T.M., (2010).

Socioeconomic inequalities in the distribution of dental caries in Brazilian preschool children.

Journal of Public Health Dentistry. **70**, 319-326.

Quiñonez, R.B., Keels, M.A., Vann Jr., W.F., Mclver, F.T., Heller, K and Whitt, J.K., (2001). Early childhood caries: analysis of psychosocial and Biological factors in a high-Risk Population. *Caries Research*. **35**, 376- 383.

Raadal, M., Strand, G.V., Amarante, E.C., Kvale, G., (2002). Relationship between caries prevalence at 5 years of age and dental anxiety at 10. *European Journal of Paediatric Dentistry*. **1**, 22-26.

Rajavaara, P., (2019). *Children's dental general anesthesia- reasons and associated factors*.

Oulu: University of Oulu. [Unpublished item].

Ramos-Gomez, F.J., Weintraub, J.A., Gansky, S.A., Hoover, C.I and Featherstone, J.D.B., (2002). Bacterial, behavioural and environmental factors associated with early childhood caries. *The Journal of Clinical Pediatric Dentistry*. **26**(2), 165-173.

Riggs, E., Gibbs, L., Kilpatrick, N., Gussy, M., van Germet, C., Ali, S and Waters, E., (2015). Breaking down the barriers: a qualitative study to understand child oral health in refugee and migrant communities in Australia. *Ethnicity and Health*. **20**(3), 241-257.

Rodd, H., Hall, M., Deery, C., Gilchrist, F., Gibson B. J and Marshman, Z., (2014). 'I felt weird and wobbly.' Child- reported impacts associated with a dental general anesthetic. *British Dental Journal*. **216**(17).

Rosenmöller, D.L., Gasevic, D., Seidell, J and Lear, S.A., (2011). Determinants of changes in dietary patterns among Chinese immigrants: a cross-sectional analysis. *International Journal of Behavioral Nutrition and Physical Activity*. **8**, 42

Saldūnaitė, K., Bendoraitienė, E.A., Slabšinskienė, E., Vasiliauskiene, I., Andruškevičienė, V and Zūbienė, J., (2014). The role of parental education and socioeconomic status in dental caries prevention among Lithuanian children. *Medicina*. **50**, 156-161.

Savanheimo, N., Sundberg, S.A., Virtanen, J.I &Vehkalahti, M.M., (2012). Dental care and treatments provided under general anesthesia in the Helsinki Public Dental Service. *BioMed Central Oral Health.* **12**, 45.

Schulter, P.J., Kanagaratnam, S., Taylor, S and Tautolo, E-S., (2017). Acculturation and its impact on the oral health status of Pacific children in New Zealand: findings from the Pacific Islands Families study. *Journal of Public Health Dentistry*. **77**, 225-233.

Schuring, M., Robroek, S.J.W., Otten, F.W.J., Arts, C. H and Burdof, A., (2013). The effect of ill health and socioeconomic status on labor force exit and re-employment: a prospective study with ten years follow-up in the Netherlands. *Scandinavian Journal of Work, Environment and Health.* 39(2), 134-143.

Sheiham, A., (2006). Dental caries affects body weight, growth and quality of life in pre-school children. *British Dental Journal*. **201**, 625-626.

Sheiham, A., (2001). Dietary effects on dental diseases. *Public Health Nutrition*. **4**(2B), 569591.

Silva, C.C., Lavado, C., Arelas, C., Mourão, J and de Andrade, D., (2015). Conscious sedation vs general anesthesia in pediatric dentistry – a review. *Medical Express.* **2**(1).

Skeie, M.S., Raadal, M., Strand, G.V and Espelid, I., (2006). The relationship between caries in the primary dentition at 5 years of age and permanent dentition at 10 years of age -a longitudinal study. *International Journal of Pediatric Dentistry*. **16**, 152-160.

Skeie, M.S., Riordan, P.J., Klock, K.S and Espelid, I., (2008). Caries increment in children aged 3–5 years in relation to parents' dental attitudes: Oslo, Norway 2002 to 2004. *Community Dentistry and Oral Epidemiology*. **36**, 441-450.

Skeie, M.S., Riordan, P.J., Klock, K.S and Espelid, I., (2006). Parental Risk Attitudes and Caries-Related Behaviors Among Immigrant and Western Native Children in Oslo. *Community Dentistry and Oral Epidemiology*. **34**, 103-113.

Skeie, M.S., Riordan, P.J., Klock, K.S., Espelid, I and Haugejorden, O., (2010). Tracking of parents' attitudes to their children's oral health-related behavior-Oslo, Norway 2002-2004. *Acta Odontologica Scandinavica*. **68**(1).

Statistics Sweden (SCB)., (2019). Final income and taxes 2017 [online]. Stockholm: Statistics Sweden (SCB). [Viewed 28 April 2020]. Available from: https://www.scb.se/en/findingstatistics/statistics-by-subject-area/household-finances/income-and-income-distribution/income-and-tax-statistics/pong/statistical-news/final-income-and-taxes-2017/

Stecksén-Blicks, C., Hasslöf, P., Kieri, C and Widman, K., (2014). Caries and background factors in Swedish 4-year-old children with special reference to immigrant status. *Acta Odontologica Scandinavica*. **72**, 852–858.

Stecksén-Blicks, C., Kieri, C., Nyman, J.E., Pilebro, C and Borssen, E., (2008). Caries prevalence and background factors in Swedish 4-year-old children - A 40-year perspective. *International Journal of Paediatric Dentistry*. **18**, 317-324.

Stecksén-Blicks, C., Rydberg, A., Nyman, L., Asplund, S and Svanberg, C., (2004). Dental caries experience in children with congenital heart disease: a case-control study. International *Journal of Paediatric Dentistry*. **14**, 94-100.

Stronks, K and Kunst, A.E., (2009). The complex interrelationship between ethnic and socioeconomic inequalities in health. *Journal of Public Health*. **31**(3), 324-325.

Sundby, A and Petersen, P. E., (2003). Oral health status in relation to ethnicity of children in the municipality of Copenhagen, Denmark. *International Journal of Paediatric Dentistry.* **13**, 150-157.

Suresh, B.S., Ravishankar, T.L., Chaitra, T.L., Mohapatra, A. K and Gupta, V., (2010).

Mother's knowledge about pre-school child's oral health. *Journal of Indian Society of Pedodontics and Preventive Dentistry*. **28**(4), 282-287.

The Royal College of Surgeons of England, (2015). The state of children's oral health in England [online]. London: The Royal College of Surgeons of England. [Viewed 3 May 2020]. Available from: https://www.rcseng.ac.uk/libraryandpublications/rcspublications/docs/report-childrens-oral-health/

Tickle, M., Milsom, K.M and Blinkhom, A.S., (2002). Inequalities in the dental treatment provided to children: an example from the UK. *Community Dental Oral Epidemiology*. **30**, 335341.

Tiwari, T and Albino, J., (2017). Acculturation and pediatric minority oral health interventions. *Dental Clinics of North America*. **61**(3), 549-563.

United Nations Human Rights., (1989). *Convention on the rights of the child* [online]. [Viewed 8 February 2020]. Available from: https://www.ohchr.org/EN/ProfessionalInterest/Pages/CRC.aspx

United States Department of Health and Human Services., (2000). *Healthy People 2010* [online]. 2nd. Office of Disease Prevention and Health Promotion, Washington, DC: U.S. Government Printing Office.

US Department of Health and Human Services., (2000). *Oral Health in America*: *A Report of the Surgeon General* [online]. Rockville, MD: US DHHS, National Institute of Dental and Craniofacial Research, NIH.

Valencia-Rojas, N., Lawrence, H.P and Goodman, D., (2008). Prevalence of early childhood caries in a population of children with history of maltreatment. *American Association of Public Health Dentistry*. **64**(2), 94-101.

van der Tas, J.T., Kragt, L., Elfrink, M.E.C and Bertens, L.C.M., (2017). Social inequalities and dental caries in six-year-old children from the Netherlands. *Journal of Dentistry*. **62**, 18–24.

van der Tas, J.T., Kragt, L., Veerkamp, J.J.S., Jaddoe, V.W.V et al., (2016). Ethnic disparities in dental caries among six-year-old children in the Netherlands. *Caries research*. **50**, 489–497.

van Dijk, P.C., Jager, K.J., Zwinderman, A.H., Zoccali, C and Dekker, F.W., (2008). The analysis of survival data in nephrology: basic concepts and methods of Cox regression. Kidney International. 74, 705-709.

Veerasamy, A and Kirk, R.C., (2013). Oral health literacy of parents of preschoolers in New Zealand. *Journal of Theory and Practice of Dental Public Health*. **1**(4), 20-29.

Vinckier, F., Gizani, S and Declerck, D., (2001). Comprehensive dental care for children with rampant caries under general anesthesia. *International Journal of Paediatric Dentistry*. **11**, 25-32.

Wanchek, T.N and Rephann, T.J., (2014). Dentistry, Economics of. *Encyclopedia of Health Economics*. **1**.

Warren, J.J., van Buren, J.M., Levy, S.M., Marshall, T.A., Cavanaugh, J.E. et al., (2017). Dental clusters among adolescents. *Community Dentistry and Oral Epidemiology*. **45**, 538-544.

Wellappuli, N and Amarasena, N., (2012). Influence of family structure on dental caries experience of preschool children in Sri Lanka. *Caries research*. **46**, 208-212.

Widström, E., Eaton, K.A., Borutta, A., Dybizbánska, E and Broukal, Z., (2001). Oral healthcare in transition in Eastern Europe. *British Dental Journal*. **190**, 580-584.

Wigen, T.I and Wang, N.J., (2009). Caries and background factors in Norwegian and immigrant 5-year-old children. *Community Dentistry and Oral Epidemiology*. **38**(1), 19-28.

Williams, N.J., Whittle, J.G and Gatrell, A.C., (2002). The relationship between sociodemographic characteristics and dental health knowledge and attitudes of parents with young children. *British Dental Journal*. **193**, 651-654.

World Health Organization, (2011). WHO Oral Health Country/Area Profile Programme [online]. [Viewed 6 March 2020].

Available from: http://www.mah.se/CAPP/ https://capp.mau.se/country-areas/

World Health Organization, (2018). Oral health [online]. [Viewed 20 March 2020].

Available from: https://www.who.int/news-room/fact-sheets/detail/oral-health

World Health Organization., (2015). Guideline: Sugars intake for adults and children [online].

[Viewed 6 March 2020].

Available from: https://www.who.int/publications-detail/9789241549028

World Health Organization., (2003). World Oral Health Report [online]. [Cited 9 March 2020].

Available from: http://www.who.int/oral_health/media/en/orh_report03_en.pdf

Table 1: Sociodemographic characteristics of 1-6-year old Swedish children between 2001-2013. (N=1 621 038)

Variable	Frequency (n)	Percentage (%)
Gender*	1,621,037	
Male	833,362	51.4
Female	787,675	48.6
Region of birth*	1,617,051	
Both Swedish	1,220,714	75.5
Mixed	193,116	11.9
EE	49,238	3.0
NE	112,532	7.0
WE	41,451	2.6
Duration of residence**	200,897	
0–5 yrs.	104,983	52.3
6–10 yrs.	44,793	22.3
>11 yrs.	51,121	25.4
Family type		
Single	171,088	10.6
Married/Cohabiting	1,449,950	89.4
Mother's edcn*	1,618,401	
0–9 yrs.	224,066	13.8
10–12 yrs.	732,669	45.3
>12 yrs.	661,666	40.9
Father's edcn*	1,599,263	
0–9 yrs.	234,491	14.7
10–12 yrs.	809,398	50.6
>12 yrs.	555,374	34.7

*N, Total study population. n, number of subjects within a category. *Missing data. ** Including only parents with an immigrant background. Eastern Europe (EE); Non-European (NE); Western Europe (WE). edcn, education.*

Table 2: Cross tabulation of region of birth with other covariates, among 1-6-year-old preschool children living in Sweden between 2001-2013.

	Both Swedish N (%)	Mixed N (%)	EE N (%)	NE N (%)	WE N (%)
Gender					
Male	628,102(51.5)	98,999(51.3)	25,501(51.8)	57,536(51.1)	21,199(51.1)
Female	592,611(48.5)	94,117(48.7)	23,737(48.2)	54,996(48.9)	20,252(48.9)
Mother's edcn					
0–9 yrs.	111,224(9.1)	32,431(16.8)	15,043(31.1)	50,907(45.5)	13,644(33.1)
10–12 yrs.	582,878(47.8)	79,457(41.2)	20,039(41.4)	36,140(32.3)	13,126(31.8)
>12 yrs.	526,315(43.1)	81,072(42.0)	13,365(27.6)	24,891(22.2)	14,474(35.1)
Father's edcn					
0–9 yrs.	136,488(11.3)	34,228(18.0)	11,059(23.5)	40,561(37.7)	11,320(29.0)
10–12 yrs.	647,819(53.4)	84,241(44.4)	24,033(51.1)	38,583(35.8)	13,517(34.6)
>12 yrs.	428,065(35.3)	71,301(37.6)	11,955(25.4)	28,560(26.5)	14,230(36.4)
Income quintiles					
1	165,609(13.6)	48,652(25.3)	23,079(47.8)	64,366(58.0)	19,182(46.9)
2	238,478(19.6)	39,584(20.6)	10,154(21.0)	24,894(22.4)	8,519(20.8)
3	257,172(21.2)	37,329(19.4)	7,526(15.6)	13,065(11.8)	6,264(15.3)
4	274,141(22.6)	32,911(17.1)	5,290(11.0)	5,894(5.3)	3,763(9.2)
5	279,876(23.0)	33,672(17.5)	2,190(4.5)	2,832(2.6)	3,192(7.8)
Family type					
Single	107,146(8.8)	27,828(14.4)	7,084(14.4)	20,905(18.6)	7,212(17.4)
Married/Cohabiting	1,113,568(91.2)	165,288(85.6)	42,154(85.6)	91,627(81.4)	34,239(82.6)
Birth year					
1995–1998	277,796(22.8)	37,238(19.3)	9,837(20.0)	20,803(18.5)	7,560(18.2)
1999–2002	267,988(22.0)	38,466(19.9)	8,285(16.8)	21,627(19.2)	7,127(17.2)
2003–2006	294,240(24.1)	46,905(24.3)	11,111(22.6)	25,494(22.7)	9,150(22.1)
2007–2011	380,690(31.2)	70,507(36.5)	20,005(40.6)	44,608(39.6)	17,614(42.5)

N= number of study subjects within a certain category. Both Swedish, two Swedish parents; MI, one Swedish and one immigrant parent; EE, Eastern Europe; WE, Western Europe; NE, Non-European. Income quintiles, 1 is the lowest and 5 is the highest. edcn, education.

Table 3: Cross tabulation of duration of residence with other covariates, among 1-6-year-old preschool children living in Sweden between 2001-2013.

Duration of Residence	0–5 yrs. N (%)	6–10 yrs. N (%)	>11 yrs. N (%)
Gender			
Male	53,925(51.4)	22,483(51.0)	26,304(51.5)
Female	51,058(48.6)	21,950(49.0)	24,817(48.5)
Mother's edcn			
0–9 yrs.	47,301(45.1)	17,805(39.7)	14,230(27.8)
10–12 yrs.	27,157(25.9)	16,443(36.7)	25,402(49.7)
>12 yrs.	30,525(29.1)	10,545(23.5)	11,489(22.5)
Father's edcn			
0–9 yrs.	33,892(33.7)	13,480(31.3)	15,043(30.9)
10–12 yrs.	37,050(36.8)	17,664(41.0)	20,952(43.0)
>12 yrs.	29,679(29.5)	11,988(27.8)	12,749(26.2)
Income quintiles			
1	63,085(60.7)	22,222(50.1)	20,742(40.9)
2	21,214(20.4)	10,093(22.8)	11,978(23.6)
3	11,459(11.0)	6,499(14.6)	8,724(17.2)
4	5,290(5.1)	3,610(8.1)	5,954(11.8)
5	2,961(2.8)	1,940(4.4)	3,255(6.4)
Family type			
Single	14,062(13.4)	8,615(19.2)	10,965(21.4)
Married/Cohabiting	90,921(86.6)	36,178(80.8)	40,156(78.6)
Region of birth			
EE	22,271(25.0)	10,539(23.5)	11,478(22.5)
NE	57,153(54.4)	25,746(57.5)	28,606(56.0)
WE	21,559(20.5)	8,508(19.0)	11,037(21.6)

N, number of subjects within a category. Income quintiles, 1 is the lowest and 5 is the highest EE, Eastern Europe; WE, Western-European; NE, Non-European. edcn, education.

Table 4: Incidence of hospital care within different covariates, among 1-6-year-old preschool children living in Sweden between 2001-2013.

Variable	Total person time (Days)	Hospital care N (%)	Total N	Incidence per 10,000	Incidence per 10,000 person years
Gender					
Male	1,351,922,338	450(56.3)	833,362	5.4	1.2
Female	1,277,614,364	349(43.7)	787,675	4.4	0.9
Mother's edcn					
0–9 yrs.	354,576,827	328(41.4)	224,066	14.6	3.4
10–12 yrs.	1,192,839,350	360(45.4)	732,669	4.9	1.1
>12yrs.	1,078,594,979	105(13.2)	661,666	1.6	0.4
Father's edcn					
0–9 yrs.	369,433,770	245(31.7)	234,491	10.5	2.4
10–12 yrs.	1,322,158,918	416(53.7)	809,398	5.1	1.2
>12 yrs.	906,809,669	113(14.6)	555,374	2.0	0.5
Duration of residence	158,861,588	165(55.0)	104,983	15.7	3.8
0–5 yrs.					
6–10 yrs.	70,083,980	70(23.3)	44,793	15.6	3.7
>11 yrs.	83,472,153	65(21.7)	51,121	12.7	2.8
Family type					
Single	266,407,968	172(21.5)	171,088	10.1	2.4
Married/Cohabiting	2,363,128,510	627(78.5)	1,449,950	4.3	0.9
Region of birth					
Both Swedish	1,991,543,521	386(48.7)	1,220,714	3.2	0.7
Mixed	312,526,112	102(12.9)	193,116	5.3	1.2
EE	76,632,408	131(16.5)	49,238	26.6	6.2
NE	178,113,039	132(16.6)	112,532	11.7	2.7
WE	64,347,376	42(5.3)	41,451	10.1	2.4
Income quintiles					
1	525,060,437	360(45.7)	322,331	11.2	2.5
2	525,235,392	181(23.0)	322,327	5.6	1.3
3	524,134,319	130(16.5)	321,970	4.0	0.9
4	525,395,897	82(10.4)	322,511	2.5	0.6
5	524,982,412	35(4.4)	322,274	1.1	0.2

N, number of subjects within a category. Both Swedish, two Swedish parents; Mixed, one Swedish and one Swedish parent; EE, Eastern Europe; WE, Western Europe; NE, Non-European. Income quintiles, 1 is the lowest and 5 is the highest. edcn, education.

Table 5: Crude and adjusted hazard ratios of region of birth and hospital care for severe caries among 1-6- year old preschool children living in Sweden between 2001-2013.

Variable	Model 1 Frequency N (%)	HR	95% CI	Model 2 Frequency N (%)	HR	95% CI
Region of birth						
Both Swedish	1,216,968(75.5)	1.0		1,206,950(76.0)	1.0	
Mixed	192,588(11.9)	1.7	1.4–2.1	188,703(11.9)	1.4	1.1–1.8
EE	49,068(3.0)	9.5	7.8–11.6	46,640(2.9)	5.2	4.2–6.5
NE	112,013(6.9)	4.0	3.3–4.9	106,446(6.7)	1.9	1.5–2.3
WE	41,222(2.6)	3.6	2.7–5.0	38,677(2.4)	2.0	1.4–2.7
Gender						
Female				771,403(48.6)	1.0	
Male				816,013(51.4)	1.2	1.1–1.4
Family type						
Married/Cohabiting				1,444,722(91.0)	1.0	
Single				142,694(9.0)	1.3	1.1–1.6
Mother's edcn						
>12 yrs.				652,181(41.1)	1.0	
10–12 yrs.				720,879(45.4)	2.1	1.6–2.6
0–9 yrs.				214,356(13.5)	3.7	2.9–4.7
Father's edcn						
>12 yrs.				551,758(34.8)	1.0	
10–12 yrs.				804,065(50.7)	1.5	1.2–1.9
0–9 yrs.				231,593(14.6)	1.9	1.5–2.4
Income quintiles						
5				320,314(20.2)	1.0	
4				320,327(20.2)	1.7	1.2–2.6
3				318,156(20.0)	2.3	1.6–3.3
2				316,669(20.0)	2.6	1.8–3.7
1				311,950(19.7)	3.3	2.3–4.8

N=number of subjects within a category. Model 1 is the crude model. Model 2 is adjusted for gender, family type, mother's and father's education, and income. HR, hazards ratio. 95%CI, 95 % confidence interval. edcn, education.

Table 6: Crude and adjusted hazard ratios of duration of residence and hospital care among 1-6-year-old preschool immigrant children living in Sweden between 2001-2013.

Variable	Model 1 Frequency N (%)	HR	95% CI	Model 2 Frequency N (%)	HR	95% CI
Duration of residence						
>11 yrs.	50,892(25.4)	1.0		50,892(25.5)	1.0	
6–10 yrs.	44,569(22.3)	1.2	0.9–1.7	44,569(22.3)	1.1	0.7–1.5
0–5 yrs.	104,534(52.3)	1.5	1.1–2.0	104,534(52.3)	1.4	1.0–1.8
Gender						
Female				97,416(48.7)	1.0	
Male				102,579(51.3)	1.1	0.9–1.4
Family type						
Married/Cohabiting				167,127(83.6)	1.0	
Single				32,868(16.4)	1.3	0.9–1.7
Region of birth						
NE				110,995(55.5)	1.0	
EE				48,119(24.1)	2.3	1.8–3.0
WE				40,881(20.4)	0.9	0.6–1.3
Birth year						
2007–2011				81,188(40.6)	1.0	
2003–2006				45,323(22.7)	0.0	0.0–0.1
1999–2002				36,686(18.3)	0.1	0.0–0.1
1995–1998				36,798(18.4)	4.2	2.7–6.7

N=number of subjects within a category. Model 1 is the crude model. Model 2 is adjusted for gender, family type, region of birth and birth year. HR, hazards ratio. 95%CI, 95 % confidence interval. EE, Eastern Europe; WE, Western Europe; NE, Non-European.

Appendix

Popular Science Summary

This study set out to investigate if an immigrant background in preschool children made them more vulnerable to being admitted in hospital with tooth decay, in need of dental treatment.

Ideally, all tooth decay in Sweden should be treated in the out-patient dental clinics (private or public). When many teeth are affected at once, or when the tooth decay has progressed into a serious infection, the out-patient dental clinics have no capacity to manage such children. They send them to hospitals where they can receive strong medication, or have their teeth removed or repaired in the operating room. This hospital treatment is free of charge but is expensive for the government and uses up finances that would otherwise be invested in other sectors.

Our study found that children with an immigrant background were more likely to be admitted to hospitals compared to Swedish children, requiring treatment for tooth decay. Of all immigrant children, Eastern European children were the most likely to end up in hospital. We were not surprised by these results, as previous research has shown that this group of children have a high burden of tooth decay.

We also showed that children to immigrants who have lived in Sweden for not more than five years were more likely to end up in hospital requiring dental treatment. We found it interesting however that children of immigrants who had lived in Sweden for a maximum of ten years were not that better either. This means that ten years is not enough for immigrants to take up the important aspects of the culture in Sweden, like eating less sugars and brushing twice a day. It is after more than eleven years that their behavior changes for the better.

This study was the first of its kind in Sweden and will inform policy makers of the need to invest more in immigrant children’s oral health, especially those with Eastern European origin