



Caries prevalence in 6- to 10-year-old German schoolchildren with and without disability

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Background: Both nationally and internationally, there is a lack of data on the caries experience of schoolchildren with disability, especially for children aged 6 to 10 years. **Aim:** To compare the caries experience of 6- to 10-year-old schoolchildren with disability attending special needs schools (SpS) with children without disability attending primary schools (PS) in two study periods five years apart. **Materials and Methods:** The caries prevalence and severity in schoolchildren aged 6 to 10 years attending PS or SpS was determined according to WHO standards for the school years 2010/2011 and 2015/2016, and the results were compared. **Results:** Data for 6805 schoolchildren were available. In both examination periods the caries prevalence in the deciduous teeth of 6- to 10-year-old children attending SpS was significantly higher than in children attending PS. The mean dmft values for children attending SpS were also significantly higher (2.11 in both years) than for those attending PS (1.48 and 1.77, respectively). **Conclusions:** The dental health of schoolchildren with disability was worse than that of schoolchildren without disability. To improve this situation, caries prevention efforts in day care centers and schools should be intensified for children with disability.

Keywords: Caries prevalence, oral health, schoolchildren, disability, epidemiology

Introduction

Children and adolescents with intellectual, behavioural, learning, or sensory disabilities are a subgroup of the general population for whom more specific knowledge regarding their oral health is needed. According to the few forthcoming German, or international investigations, this particular population group exhibits a higher prevalence and severity of caries than the general population (Schulte *et al.*, 2011; Schulte *et al.*, 2013; Shyama *et al.*, 2001). To date, the main disadvantage of almost all the available studies on this topic is the lack of comparator data for children without disability, especially those from the same region or during the same period. Due to the limitations of existing studies, oral health data for children with disability have had to be compared with data from national or regional studies of the general population, sometimes from many years earlier (Al-Maweri and Al-Sufyani, 2014; Nqocobo *et al.*, 2012; Purohit and Singh, 2012; Scott *et al.*, 1998; Shyama *et al.*, 2001). Moreover, it is striking that most previous studies have focused on 6- to 18-year-olds or 12- to 17-year-olds (Bissar *et al.*, 2010; Hempel *et al.*, 2015; Schüler *et al.*, 2017). Considering that caries prevention should start as early as possible, better knowledge of the caries experience in children with disability in the age group between six and ten years is necessary. Similarly, due to the lack of longitudinal studies, data on the development and prevalence of caries in children and adolescents with disability are lacking.

Although national epidemiological caries studies on representative samples of 6-year-old and 12-year-old children have been conducted in Germany since 1993 (Jordan *et al.*, 2014; Pieper *et al.*, 2013; Pieper and Schulte, 2004; Schulte *et al.*, 2006), these studies have not assessed the oral health data for children with disability. The national data reveal a distinct decrease in caries prevalence in 12-year-olds, and a less distinct decrease in 6-year-olds (Pieper *et al.*, 2013; Pieper and Schulte, 2004; Schulte *et al.*, 2006; Basner, 2017). The reasons for this decrease are various: Since 1989, the statutory health insurances have paid for preventive dental care for schoolchildren and adolescents, regardless of whether it is provided in private dental offices, or in kindergartens and schools in oral health education programs conducted by community dental teams. Furthermore, after 1991, use of fluoridated salt rose to between 60% to 70% of domestic sales (Schulte, 2005). Although, children with disability are entitled to receive the same preventive dental measures as children without, it is unclear whether both groups benefit similarly from these measures.

Therefore, the primary objective of this study was to compare the caries experience of children, aged six to ten years, with and without disability, living the same region, during two examination periods. A secondary objective was to examine whether there was a decline in caries experience in children with disability within the 5-year-observation interval.

Material and methods

This retrospective cross-sectional investigation was conducted in collaboration with the Public Dental Health Service of the Health Authority of the Rhein-Erft-District (RED) in the south-western part of the German Federal State of Nordrhein-Westfalen (North Rhine-Westphalia). The RED has a population of around 465,000 inhabitants and is characterized by rural and urban areas with small towns. The RED is divided into 10 self-administrated municipalities with different structural, economic, and social backgrounds. In 2016, the average disposable income for private households (€ 21,815) was almost identical to the German national average (€ 21,952) (Wirtschafts- und Sozialwissenschaftliches Institut - WSI, 2018).

German primary and special needs schools are normally state funded. Nationwide, the entry age for primary school is six years. Regional differences may exist in other details of education because individual German federal states have constitutional sovereignty over their own educational systems. In the Federal State of Nordrhein-Westfalen, and the RED within it most children attend primary school for four years, before changing to a secondary school. The school catchment areas are determined by the school authorities, and children are obliged to attend their assigned primary or special needs school. Before enrolment, each child must undergo a school entry medical examination, or screening, conducted by pediatricians from the regional health authority. This examination determines whether a child is fit to attend primary school, or whether, in the case of an intellectual, behavioural, learning, or sensory disability, enrolment in a special needs school would be more appropriate. This decision must adhere to the pedagogic concepts introduced in Nordrhein-Westfalen and many other federal states several decades ago, regardless of the socio-economic status of the child's family. Only in a few exceptional cases that require the consent of the school authority, the parents and pediatrician, may a child with a disability be placed in a regular primary school.

In Nordrhein-Westfalen federal state law mandates dental screening of all children and adolescents in day care centers, primary schools, and secondary schools, regardless of their age, by community dentists at least once a year. Furthermore, community dentists are obliged to register the dmft/DMFT values according to WHO criteria for each child they examine. Analysis of these epidemiological data is permitted if the data are anonymised. Parental consent was, thus, not required for this study.

This study evaluated data from two different periods (2010/11 and 2015/16) for a five-year comparison. The data had been collected by 3 community dentists assisted by dental nurses in both study periods. Both the dentists and the dental nurses were employees of the RED Health Authority. The three dentists were also members of the national German examiner team and had been calibrated for the national caries epidemiological studies carried out by the Deutsche Arbeitsgemeinschaft für Jugendzahnpflege (DAJ; in English: German Association for Community Dental Care in Children and Adolescents). The methods and results of those studies have been published previously (Pieper *et al.*, 2013; Pieper and Schulte, 2004; Schulte *et*

al., 2006). The interexaminer mean kappa value for the national examiner team was 0.85 (Pieper *et al.*, 2013).

There were 16 special needs schools in the RED when these data were collected, with 1621 children in 2010/11 and 1536 in 2015/16. Due to organizational reasons, dental examinations had only taken place in 9 of these 16 schools during 2010/11, and in 10 in 2015/16. In comparison, the number of children attending regular primary schools was approximately 17,000 and 16,500 respectively. In both periods, dental examinations had been possible in 75 of the 78 regular primary schools in the RED.

The dental examinations were performed according to the Basic Methods for Oral Health Surveys of the World Health Organization (WHO, 2013) using plain dental mirrors and an artificial light source. Dental explorers were used to remove plaque accumulation from dental surfaces if necessary (Meneghim *et al.*, 2003). The children either stood in front, or sat with their backs to the dentist, with their heads tipped back, to allow examination from a 12 o'clock position. Variations in the examination method had sometimes been necessary, especially for children with physical disabilities, or for those in wheelchairs. Cotton swabs with a thick cotton tip were used to dry the teeth. The dmft/DMFT values determined in each case were entered using bespoke software that allows each participant's data to be saved (MikroPro Health, Mikroprojekt, Kaiserslautern, Germany).

Due to their relatively low numbers, dmft/DMFT values of schoolchildren attending special needs schools were included. However, 20% of children with available dental records attending regular schools were sampled for each evaluation period. A dice was rolled to determine the starting point among the first six names of the list. From this starting point, every fifth data set was included in the sample for this analysis. The data were then anonymised. The study was supported by the ethics committee of the University of Witten/Herdecke (#119/2016).

Statistical analyses were performed using MS Excel, WinStat, and SPSS 24. Caries prevalence rates were calculated by including all children with dmft > 0 or DMFT > 0. The mean and standard deviations were calculated for dt, mt, ft and dmft for deciduous teeth, and for DT, MT, FT and DMFT for permanent teeth. Caries prevalence rates and the dmft/DMFT values were compared using the respective 95%-confidence intervals (95% CI).

Results

In total, 6805 dental health records could be analysed. In each year, approximately half of the children attending primary school were male (Table 1). More of the children with disability attending SpS were male (64.6% in 2010/11 and 72.2% in 2015/16).

In both examination periods, the caries prevalence for both deciduous and for permanent teeth was higher in children with disability than in children without (Table 2). In 2010/11, 45.0% of the children in the primary schools had caries in comparison to 56.6% in children attending SpS. Nearly the same values were observed for both groups in 2015/16. The corresponding values of the permanent teeth were 7.8% and 18.9% in 2010/11, and

Table 1. Ages and gender of children attending primary and special needs schools in 2010/11 and 2015/16.

	<i>Primary 2010/11</i>	<i>Primary 2015/16</i>	<i>Special need 2010/11</i>	<i>Special need 2015/16</i>
6-year-olds	351	502	10	38
7-year-olds	685	775	25	80
8-year-olds	728	756	41	75
9-year-olds	794	689	60	82
10-year-olds	588	358	76	92
6- to 10-year-olds	3,146	3,080	212	367
mean age (yrs)	8.2	7.9	9.3	8.8
6- to 10-year-old males (n and %)	1,544 49.1%	1,569 50.9%	137 64.6%	265 72.2%
6- to 10-year-old females (n and %)	1,602 50.9%	1,511 49.1%	75 35.4%	102 27.8%

7.3% and 13.1% in 2015/16. The 95%-confidence intervals for children with disability and without disability did not overlap in either examination period (Table 2). The same pattern was observed for caries severity (Table 2).

To allow comparison of our findings with other German regional and national data, caries prevalence and severity were calculated separately for 6- and 7- and for 8- to 10-year-old children. In both age groups, higher caries prevalence rates and mean dmft values were observed in children with disability attending SpS than in children without disability attending primary schools (Table 3). The data for 8- to 10-year-olds are available on request.

Our secondary objective was to investigate whether declines in caries could be observed between 2010/11 and 2015/16. In children attending regular primary school, caries prevalence for deciduous and for permanent teeth, remained similar over time (Table 2). Likewise, in children with disability attending special needs schools, caries prevalence in deciduous teeth did not change between both observation periods. However, caries prevalence for permanent teeth declined in this group (Table 2).

Mean dmft for the deciduous teeth of children at primary schools increased over time, whereas the mean DMFT for permanent teeth remained similar (Table 2). Likewise, dmft for children attending special schools remained at the same level over the two periods, whereas mean DMFT for the permanent teeth decreased by 50.0%. The confidence intervals for this difference just overlap (Table 2).

Discussion

This investigation is one of very few that permits comparison of contemporaneous caries data from the same region in children with and without disability. The data from two different examination periods, permit investigation of changes in caries prevalence and severity in children with disability in Germany for the first time.

Although the results of this study were based on the data from only two-thirds of the special needs schools (SpS) in the RED, the effect of this circumstance on the overall values for caries prevalence and severity is

likely to be negligible. This assumption is based on the following considerations: First, the catchment areas for special needs schools are much larger than for primary schools, and thus enrolment in special needs schools is less dependent on locality than that for regular schools. The influence of local socio-economic factors is therefore reduced for children attending SpS. Secondly, because nearly all special needs schools in the RED are accessible to pupils with a wide variety of impairments, there is less risk of selection bias. Unfortunately, we could not describe the dental health of children with specific types of disability as data protection laws do not entitle school dentists to access this information. Analysis of this kind would require a study combining a dental examination and questionnaire data. Such a study would also require informed consent from the parents.

Although, preventive dental measures are open to all children in Germany, irrespective of physical and/or intellectual disability, these data suggest that children with disability benefit less from these measures than do children without disability. This observation, which was true for both the deciduous and the permanent dentition in children, is consistent with the few German and international studies on this topic (Anders and Davis, 2010; Bissar *et al.*, 2010; Hempel *et al.*, 2015; Marks *et al.*, 2018; Schöler *et al.*, 2017). It is important to note that this inequality in oral health does not develop during the school years, rather, it is already manifest at the time of enrolment in primary school, as demonstrated by the data for 6- to 7-year-old children with disability (Table 3). Consequently, preventive measures for caries should be intensified not only for children aged 6 to 10 years, but also for those of preschool age.

Our results are in line with the only other two German studies that have, to date, been conducted for 6- and 7-year-old children attending special needs schools in the Federal State of Thüringen (Table 3). Several reasons are responsible for the higher caries severity in children with disability. The care of children with disability places a higher burden on parents, not only to the on-going support in brushing their teeth, but also to many other aspects of health care. As a result, parents may sometimes lack

Table 2. Caries prevalence and severity of 6- to 10-year-old children in 2010/11 and 2015/16.

Type of School	2010/11		2015/16	
	<i>Primary</i>	<i>Special need</i>	<i>Primary</i>	<i>Special need</i>
Mean age	8.2 yrs	9.3 yrs	7.9 yrs	8.8 yrs
Deciduous teeth				
n schoolchildren	3,146	212	3,080	367
caries prevalence % (dmft >0)	45.0%	56.6%	46.6%	56.4%
95% CI	43.8-46.2	51.8-61.4	45.3-47.8	54.5-58.3
mean dmft (± SD)	1.48 (± 0.4)	2.11 (± 2.7)	1.77 (± 0.45)	2.11 (± 2.6)
min/max dmft	0-16	0-14	0-14	0-12
95% CI dmft	1.47-1.50	1.75-2.47	1.75-1.79	1.83-2.37
mean dt (min/max)	0.68 0-12	0.58 0-11	0.65 0-11	0.94 0-11
mean mt (min/max)	0.17 0-14	0.41 0-10	0.24 0-12	0.49 0-12
mean ft (min/max)	0.63 0-8	1.12 0-7	0.87 0-10	0.67 0-8
Permanent teeth				
n schoolchildren	3,103	212	3,000	367
caries prevalence % (DMFT >0)	7.8%	18.9%	7.3%	13.1%
95% CI	6.6-9.0	16.4-21.4	5.5-8.8	11.2-15.0
mean DMFT (± SD)	0.14 (± 0.07)	0.46 (± 1.4)	0.13 (± 0.07)	0.22 (± 0.66)
min/max DMFT	0-5	0-11	0-7	0-4
95% CI DMFT	0.13-0.14	0.28-0.64	0.13-0.14	0.15-0.29
mean DT (min/max)	0.07 0-4	0.23 0-6	0.07 0-7	0.13 0-4
mean MT (min/max)	0.00 0-3	0.10 0-8	0.00 0	0.01 0-1
mean FT (min/max)	0.06 0-5	0.13 0-7	0.06 0-4	0.08 0-4

the energy to regularly help brush their child's teeth. Furthermore, in some types of disability (e.g., early childhood autism or cerebral palsy) it is difficult to provide a balanced diet. In addition, it may be that few German dental schools include the dental care of patients with disability in their regular curriculum. Thus, German dentists may be ill-prepared to provide adequate dental care for patients with disability.

Although a nationwide decline in caries has been observed in 12-year-olds in Germany (Jordan and Micheelis, 2016; Pieper *et al.*, 2013), a similar decrease in caries prevalence or severity could not be ascertained for the deciduous teeth of children with or without disability over the five years. Nevertheless, an improvement could be observed for permanent teeth in children with disability (Table 2). A concrete reason for this development cannot be provided. It may be that teachers and caregivers in special needs schools have supervised and supported toothbrushing more regularly in their pupils than previously. In addition, children attending special needs schools may have received more frequent applications of fluoride varnish at their family dentist than in previous times.

The extent to which these results can be applied to the entire country can only be answered, in limited measure, using socio-economic data. Interestingly, the socio-economic profile for the RED, is similar to the Federal Republic. For example, average per capita income for private households in the RED was € 21,815, compared to € 21,952 in Germany (Wirtschafts- und Sozialwissenschaftliches Institut - WSI, 2018). Likewise, the national mean dmft of 1.7 for 6- and 7-year-olds was almost identical that of 1.8 for children without disability here (Table 3). Even cautiously interpreted, these comparisons suggest that the caries experience of children with disability in Germany could be similar to these data.

Children with disability represent a group with increased caries risk. Caries prevention measures should, therefore, be intensified for them. To achieve this, we propose the following measures: 1) Systematic application of fluoride varnish. While topical application of fluoride varnish twice a year reduces the experience of caries by about 25% (Marinho, 2009; Marinho *et al.*, 2016), a working group at the University of Marburg recommends four applications per year for high-risk

Table 3. Caries prevalence and severity in 6- and 7-year-old schoolchildren with and without disability in Nordrhein-Westfalen and Thüringen.

	Germany (DAJ 2017)	<i>This study</i> 2015/16 Primary School	<i>This study</i> 2010/11 Primary School	<i>This study</i> 2015/16 Special needs	<i>This study</i> 2010/11 Special needs	<i>Dziwak et al.</i> 2017	<i>Schüler et al.</i> 2017
Year	2015/16	2015/16	2010/11	2015/16	2010/11	2010/11	2010/11
Region	Germany	Nordrhein-Westfalen	Nordrhein-Westfalen	Nordrhein-Westfalen	Nordrhein-Westfalen	Thüringen	Thüringen
n schoolchildren	151,555	1,277	1,036	118	35	67	44
dmft >0 (%)	43.6%	41.9%	41.8%	55.1%	54.3%	65.7%	72.7%
95% CI	NS	41.3-42.4%	41.3-42.3%	53.9-56.3%	39.7-68.8%	53.7-75.9%	NS
mean dmft	1.7	1.8	1.5	2.3	2.7	2.8	3.3
95% CI	NS	1.77-1.84	1.46-1.53	2.22-2.39	1.59-3.73	NS	NS
SD	NS	0.6	0.5	0.5	3.2	3.2	3.4

NS denotes not specified

groups (Pieper *et al.*, 2015). Dentists caring for children with disability should bear the results of these studies in mind. 2) Application of pit and fissure sealants, as these are another effective measure for caries prevention (Ahovuo-Saloranta *et al.*, 2017). In a previous study, we observed that fewer children with disability received pit and fissure sealants than children without (Bissar *et al.*, 2010). To improve this situation, pit and fissure sealants should be as applied more consistently in children with disability. 3) As caries incidence in children with disability occurs before school enrolment in (Table 3), and many parents only begin brushing their children's teeth around the age of two- or three- years (Bissar *et al.*, 2014), parents should be encouraged to brush their baby's teeth with fluoridated toothpaste as soon as the first tooth emerges.

Despite these preventive measures, and in view of the small number of published studies in this field, more epidemiological investigations and caries-preventive measures are required with children and adolescents with disabilities. All countries that ratified the UN Convention on Rights of Persons with Disabilities (UN, 2017) are encouraged to support this important objective.

Conclusion

Even in Germany, a country with high efforts in caries prevention, schoolchildren with disability are disadvantaged by a greater caries burden than children without disability. A prevention program including oral health education and the application of fluoride varnish should be introduced in all kindergartens and schools caring for children with disabilities.

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