

# What proportion of caries into dentine at age 5 is present at age 3?

N. Monaghan<sup>1</sup> and M. Morgan<sup>2</sup>

<sup>1</sup>Public Health Wales, Cardiff, UK; <sup>2</sup>Cardiff University, Dental Public Health Unit, Cardiff, UK

**Objective:** To explore the proportion of decay at age 5 in Wales presenting by and after age 3 years from geographical and deprivation perspectives. **Basic research design:** Retrospective analysis of data from independent cross-sectional studies of 3-year-olds in early 2013 and 5-year-olds in school year 2014/5. This includes novel graphical presentation of caries at age 3 and estimated 3-5 caries increment at age 5. **Setting and participants:** NHS oral health surveillance programme in Wales examining children in nurseries at age 3 and in schools two years later. **Main outcome measures:** % $d_3mft > 0$  at ages 3 and 5 years, plus estimated 3-5 caries increments for these two indices. Data are analysed using index of deprivation and Health Board population density (as a proxy for rurality). **Results:** In most Health Boards and all deprivation quintiles there is a larger proportion of caries into dentine presenting between ages 3-5 than by age 3. In rural Health Boards the proportion of caries present by age 3 is much smaller. In one Health Board more caries presents by age 3 than after. In rural Health Boards the current prevention activity has potential to push reported caries prevalence at age 5 below 10%. In urban Health Boards action by age 5 will be required to push caries prevalence significantly below 20%. **Conclusions:** Findings from this analysis suggest need for earlier prevention activity in some Health Boards in Wales.

**Key words:** dental caries, children, prevention, Wales, UK

## Introduction

Wales is one of the constituent countries of the United Kingdom with a population of just over 3 million and a mix of urban and rural areas. Cardiff (population approximately 350,000) is the largest city in Wales. The majority of the urban populations are located along the southeast and northern coastal parts of Wales. Most of mid and west Wales is rural. All seven Health Boards have some urban and some rural areas and the balance of these impacts on the population density. At age 5, levels of dental caries in Wales are amongst the highest in the UK and are associated with socio-economic deprivation (Davies *et al.*, 2011; Monaghan *et al.*, 2014).

In response to these high levels of decay, Wales has been implementing a school-based dental decay prevention programme, Designed to Smile (D2S), since late 2008 (Chestnutt, 2013). This initiative is similar to the Scottish ChildSmile programme which has been progressively implemented since 2006 (MacPherson *et al.*, 2010). D2S is focussed upon children aged 3-5 living in deprived communities and incorporates supervised school tooth-brushing and the application of fluoride varnishes or fissure sealants (Welsh Government, 2008). In 2011 a Welsh Government Health Select Committee undertook an inquiry into D2S (National Assembly for Wales, 2012). Members of the Committee asked “Why are children getting tooth decay by age 5?” At the time, it was not possible to indicate specific reasons, or even the age at which the decay was occurring.

The two measures of dental caries at the population level most commonly used are the proportion of the population with decay (% $d_3mft > 0$ ) and the population mean

decay experience ( $d_3mft$ ). The former gives a true picture of the proportion of the population affected by some decay.

If the change in caries between ages 3 and 5 is explored by looking at mean  $d_3mft$  alone, we have no way of knowing whether an increase in mean  $d_3mft$  at age 5 is due to more caries occurring in those children who already have decay experience, or due to previously caries-free children developing caries. If children previously caries-free are developing caries by age 5 then all 3-year-olds in those areas need to be targeted for prevention. This can be explored by looking at the proportion of children who have caries at both age 3 and age 5. This is therefore the indicator to which we give more emphasis in this report.

In early 2013 a survey of 3-year-olds was undertaken in Wales to collect data on caries into dentine. Two years later, between November 2014 and July 2015, a subsequent survey collected data on caries into dentine in 5-year-olds. These two cross-sectional surveys generated caries into dentine data at Local Health Board level for the same “school year cohort” two years apart. This paper reports on analyses undertaken to understand the timing and pattern of caries experience across Wales which could be discerned from these two cross sectional surveys. This information has implications for the targeting of future decay prevention activity.

The main aim of this analysis was to answer, for each Health Board in Wales and for Wales as a whole, the question “How much of the decay into dentine found at age 5 is present by age 3?” In the absence of a large cohort study, comparison of the findings from these two cross-sectional surveys provides the best estimate of caries prevalence at age 3, and caries incidence between ages 3 and 5.

## Method

As a part of the NHS Dental Epidemiology Programme, a survey of 3-year-olds in Wales contemporaneous with the 2013 Child Dental Health Survey (CDHS) was undertaken and collected caries into dentine data. The survey of 3-year-olds used the same clinical criteria as the CDHS employed to survey 5-year-olds to measure caries into dentine (HSCIC, 2015). Staff were trained and calibrated on these criteria. Data were collected between January and July 2013 from 3-year-olds attending day care settings in Wales. Random sampling within each Local Health Board used both care settings registered with the Care and Social Services Inspectorate for Wales and nurseries attached to state schools. This generated caries data at Local Health Board and all Wales levels.

As part of the NHS dental epidemiology programme in 2014/15 caries into dentine data for school year 1 (age 5-6) was collected in Wales. For the survey of 5-year-olds staff were trained and calibrated to collect the data in line with British Association for the Study of Community Dentistry (BASCD) criteria (Pine *et al.*, 1997a; Pitts *et al.*, 1997). Random sampling was undertaken following BASCD sampling guidance (Pine *et al.*, 1997b) at Unitary Authority (local government) level, smaller units than Welsh Local Health Boards, to generate caries estimates at Unitary Authority, Local Health Board and all Wales levels.

These two surveys used very similar caries criteria. In both cases examiners reported visual signs of caries into dentine ( $d_3mft$ ) in the deciduous dentition. The data collected from clinical examinations were used along with data on nursery/school populations in each age group to calculate weighted population caries data (Pine *et al.*, 1997b). Similarity of the BASCD caries criteria (Pitts *et al.*, 1997) and the CDHS criteria (HSCIC, 2015) mean that the resulting caries data were comparable. For analyses in this paper we compared population estimates of caries into dentine among children aged 3 with results from our survey of school Year 1 children (aged 5-6) undertaken 2 years later. Comparisons were made at Local Health Board level and at the all Wales level taking account of the socio-demographic variables population density (as a proxy for rurality) and quintile of deprivation using the Welsh Index of Multiple Deprivation, WIMD (Welsh Government 2011).

## Results

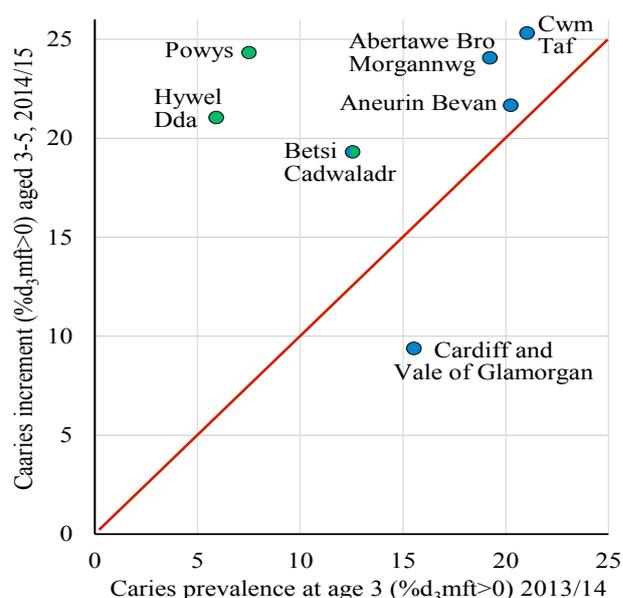
For the survey of 3-year-olds in 2013, 1,483 children were examined across Wales. Within Local Health Boards the sample examined ranged from 177 in Cwm Taf (South Wales valleys including Merthyr Tydfil) to 258 in Betsi Cadwaladr (mainly rural, North Wales). For the 2014/15 survey of Welsh school year 1 children (age 5-6), 7,716 children were examined. The Unitary Authority samples ranged from 108 in Merthyr Tydfil to 1,110 in Cardiff. Weighted Local Health Board estimates of caries were calculated from the samples of these smaller units. Reported caries scores for these surveys are presented in Table 1 alongside data from contemporaneous surveys in England.

**Table 1.** Prevalence and severity of caries among three-year-olds in England (2012) & Wales (2013)

	$\%d_3mft>0$	95%CI	mean $d_3mft$	95%CI
Wales	14.5	12.8,16.4	0.4	0.4,0.5
Northwest England	14.3	13.7,14.9	0.5	0.4,0.5
England	11.7	11.4,12.0	0.4	0.4,0.4

Caries prevalence at age 3 in 2013, at age 5 in 2014/15 and calculated 3-5 caries prevalence increments for Health Boards, Wales plus quintiles of deprivation are presented in Table 2. In Figure 1 some of the data from Table 2 are presented graphically at Local Health Board level presenting the distribution of age 3-5 caries prevalence increment by age 3 caries prevalence. A red line marks where these prevalences are equal. Points below that line have more children with caries presenting before age 3, and those above, more children with caries presenting after age 3. The reason for presenting the data this way relates to the potential impact of caries prevention before age 3 and after age 3. Any initiative commenced at or after age 3 can only move the data points downwards as the decay present by age 3 will not be prevented by later action.

As Table 2 and Figure 1 show, in most Health Boards more caries at age 5 presents into dentine after age 3 than by age 3. There is however a significant proportion of decay already present by age 3. Table 2 demonstrates a similar pattern of caries presentation across all five quintiles of deprivation. Two cross-sectional surveys cannot describe the caries experience of individual children at ages 3 and 5. The pattern of 14.5% of 3-year-olds and a mean  $d_3mft$  of 0.4 averages out at 2.8  $d_3mft$  per child with at least one tooth affected (usually designated as  $d_3mft(d_3mft>0)$ ). By age 5 the equivalent numbers are 35.4%  $d_3mft>0$ , 1.3 mean  $d_3mft$  and 3.6  $d_3mft(d_3mft>0)$ . Clearly there are 21% (35.4%-14.5%) more children with caries by age 5 and the mean  $d_3mft$  at age 5 of a child with decay into dentine experience is greater than at age 3.



**Figure 1.** Distribution of increment in caries prevalence ( $d_3mft>0$ ) from age 3 to 5 by caries prevalence at age 3, labelled by Health Board with predominantly rural areas coloured green, more urban areas coloured blue

**Table 2.** Prevalence of caries ( $%d_{3,mft}>0$ ) at ages three (2013) and five (2015) in Wales, by health board and by quintile of deprivation

Health Board	Population Density <sup>1</sup>	Mostly urban or rural	Prevalence of caries, $%d_{3,mft}>0$			
			age 3, 2013	age 5, 2014-15	3-5 increment, 95%CI <sup>2</sup>	
Cardiff and Vale of Glamorgan	10.0	urban	15.5	24.9	9.4	3.5, 14.2
Cwm Taf	5.5	urban	21.0	46.3	25.3	17.6, 32.1
Abertawe Bro Morgannwg	4.8	urban	19.2	43.3	24.1	17.9, 29.3
Aneurin Bevan	3.7	urban	20.2	41.9	21.7	15.0, 27.3
Betsi Cadwaladr	1.1	mainly rural	12.5	31.9	19.3	14.1, 23.6
Hywel Dda	0.7	rural	5.9	27.0	21.0	15.9, 25.1
Powys	0.3	rural	7.5	31.8	24.3	18.5, 29.4
All Wales	1.5		14.5	35.4	20.9	18.8, 23.0
<i>Quintile of Deprivation</i>						
Least deprived			11.2	24.9	13.7	9.6, 17.2
Second least deprived			13.9	30.4	16.5	11.6, 20.7
Middle deprived			13.6	33.8	20.2	15.7, 24.1
Second most deprived			15.5	40.3	24.8	19.2, 29.6
Most deprived			20.2	45.4	25.2	18.6, 30.8

<sup>1</sup> Population density in persons per hectare calculated using Census 2011 data;

<sup>2</sup> Modified Wilson's method for difference in proportions (Newcombe 1998)

Table 2 also highlights population density of Health Boards in Wales. There seems to be a relationship between population density and prevalence of caries at age 3. Cardiff and the Vale of Glamorgan is made up of urban Cardiff, population density 24.7 persons per hectare and the Vale of Glamorgan, 3.8 persons per hectare. The same relationship is found here with caries prevalence at age 3 higher in Cardiff (16.6%) compared with the Vale of Glamorgan (0.0%).

Analysis of the proportion of 3-year-old children with caries into dentine of the deciduous incisors was undertaken by Local Health Board and quintile of deprivation. The all Wales prevalence of deciduous incisor caries was 4.5% (compared with 14.5% overall who had caries). Percentages of children affected by deciduous incisor caries ranged from 1.1% in Powys to 8.3% in Aneurin Bevan and from 2.8% in the second least deprived quintile to 10.2% in the most deprived quintile.

## Discussion

Ideally this analysis would have used data from a large cohort study collected at ages 3 and 5 but the resources available to the NHS oral health surveillance programme in Wales precluded this approach. There are 4-yearly surveys of 5-year-olds in state schools in Wales, with an expectation that all children will be in full-time education by age 5, but no similar expectation for 3-year-olds and attendance at nurseries. We have no means of being sure whether the 3-year-olds sampled in nursery and infant school settings for this survey are representative of the wider population in either urban or rural areas. The data from these two independent cross-sectional surveys generates the best picture we have to explore whether more caries into dentine presents between ages 3 to 5 than by age 3.

Currently Designed to Smile targets children once they are in nursery settings – from age 3. The general pattern of slightly less caries by age 3 (compared with that emerging from ages 3 to 5) is seen at the all-Wales

level, in the deprivation quintile data, and in most Health Boards. This was not the case in Cardiff, and in the rural Health Boards. In rural Health Boards the great majority of the decay into dentine is presenting later. A less stark but similar caries pattern, with lower caries levels recorded in rural areas, was found at age 5 in Scotland in 2007/8 (Levin *et al.*, 2010). The higher caries incidence in more densely populated Health Boards might be related to local availability of sugary food and drink in urban areas.

The practical implications of the findings in Wales are that in rural Hywel Dda and Powys the current programme has potential to push decay prevalence at age 5 below 10%. To achieve that goal in Cardiff the programme will need to target children well before age 3 with effective interventions appropriate for younger children. While two surveys of this type cannot explain why this pattern is different in Cardiff, they do highlight the need for earlier intervention there if decay experience is to be improved significantly. The prevalence of caries of the deciduous incisors in Wales was similar to that reported in the North West of England (PHE, 2014). Consideration is now being given as to how to target children aged under 3 with effective caries prevention interventions. It is likely that these will engage parents and their children from age 6 months initially through health visitors.

The graphical presentation in Figure 1 makes it easier to draw out some key messages from the data. The first is that it is obvious that in most Unitary Authorities in Wales there is more decay presenting between ages 3 and 5 than by age 3. The second is that any school/nursery-based tooth-brushing programme recruiting children at age 3 is ultimately limited in its potential impact on decay into dentine to the level of decay already present at age 3. The potential improvement after age 3 is a move down the y-axis. Earlier intervention will be needed to move down the x-axis, and should be considered for the Local Health Boards or Unitary Authorities with 20% or more children affected by decay into dentine at age 3.

## Conclusions

In most Local Health Boards in Wales the majority of decay into dentine presents between ages 3 and 5. This pattern is seen across quintiles of deprivation. The pattern for rural Health Boards is of low caries experience by age 3 which worsens by age 5. By contrast there is a large proportion of the decay at age 5 which is already present at age 3 in more urban health boards. In one Health Board, Cardiff and the Vale of Glamorgan, efforts to prevent decay need to commence before age 3. Findings from this analysis suggest need for earlier prevention activity in some Health Boards in Wales.

Graphical presentation of data on caries experience related to the specific time periods on the x and y axes makes it easier to draw out key messages from the data including where earlier intervention is needed and ultimate limits on the impact of an intervention targeted at the later age increment.

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