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Extent of Differences in Dental Caries in Permanent Teeth Between Childhood and Adulthood in 26 Countries

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ABSTRACT

Objective: The first objective was to compare levels of caries in permanent teeth between children and adults and specifically, the extent to which the DMFT index was greater in adults than in children. The second objective was to assess whether large differences in levels of caries in permanent teeth between children and adults also existed in populations consuming fluoridated drinking water.

Methods: The analysis was based on published reports from 26 countries with comparable summary data on dental caries for different World Health Organization (WHO) index ages. Reports were obtained from two large electronic databases, the WHO Oral Health Country/Area Profile Programme (CAPP) and the Global Burden of Disease (GBD) 2010 Study.

Results: Very much higher levels of caries occurred in adults than in children in all 26 countries. For most countries, irrespective of the DMFT levels in 12-year-olds, the percentage difference in levels of DMFT between 12-year-olds and 35-44-year-olds was above 500% and the relative difference was 5 or more. Caries levels were also very much higher in adults than in children in all countries with high percentages of their population consuming fluoridated water.

Conclusion: Large differences in dental caries experience in permanent teeth were found between childhood and adulthood.

Keywords: dental caries, age, oral epidemiology

INTRODUCTION

The dominant strategy that dentistry has adopted worldwide is to promote surveillance, treatment and prevention efforts directed mainly at children, on the assumption that if caries can be prevented in children, the high burden of dental disease will be markedly reduced in all age groups.[3] That is reflected in the World Health Organization (WHO) international goals for improving oral health. They are set mainly for children aged 6 and 12 years olds.[1, 2] However, evidence from population-based longitudinal studies suggests that caries not only increases in adults, but is markedly higher than in children.[4,5] A recent age-period-and-cohort (APC) analysis, in four developed countries, demonstrated that this was indeed the case. Very much higher levels of caries occurred in adults than in children (age effects), despite some improvements in caries levels seen in recent years (period effects) and in new generations (cohort effects) [6]. The study used a synthetic cohort approach with data from four series of nationally representative cross-sectional surveys, conducted over the last 50 years, in England and Wales, United States, Japan and Sweden. The findings strongly suggest that even with low caries levels in children, there will nevertheless still be high levels of caries in adults [6]. The findings from th efour countries may not be applicable to populations throughout the world. There might be different patterns of caries by age, period and cohort in other developed countries or in developing countries at different stages in the demographic and epidemiological transitions. It was therefore considered worth assessing whether the findings from the four developed countries, could be generalized to a wider range of countries, including some with widescale water fluoridation.

The present study, by generalising findings to a larger set of developed and developing countries, sets out to explore the extent to which the caries burden in adults is greater than that in children. If the burden is much greater, this suggests that, even if caries can be prevented in childhood, the overall caries burden in the population will not be markedly reduced. The first objective was to compare levels of caries in children and adults, and specifically, the extent to which the DMFT index was greater in adults than in children. The second objective was to assess whether differences in levels of caries between children and adults exist in populations consuming fluoridated drinking water.

MATERIALS & METHODS

Data sources

The present analysis is based on reports from 26 countries with comparable summary data on caries experience for different World Health Organization (WHO) index ages [7]. The 26 reports included in the study were of national surveys conducted between 2000 and 2010 and where dental caries was measured at dentine level by clinical examinations [7] and expressed as the population mean for the sum of decayed (D), missing (M) and filled (F) teeth or DMFT index for both 12-years-old children and 35-44-years-old adults,. Twenty-three of the reports also provided DMFT data for other age groups.

The search strategy was built upon two large electronic databases, namely the WHO Oral Health Country/Area Profile Programme (CAPP) [8] and the systematic review on prevalence and incidence of dental caries carried out as part of the Global Burden of Disease (GBD) 2010 Study [9]. We only included countries for which we could verify information against published papers or survey reports, regardless of the language of the publication. The following 26 countries were therefore included: Australia, Austria, Belarus, Belgium, Brazil, Canada, China, Czech Republic, Denmark, Finland, Germany, Greece, Hong Kong, Iran, Ireland, Japan, Malaysia, Netherlands, New Zealand, South Korea, Spain, Tanzania, Thailand, Turkey, the United Kingdom and the United States.

We also gathered national statistics on the extent of water fluoridation for the 26 countries. Data on water fluoridation was obtained from the British Fluoridation Society [10], expressed as the percentage of population with optimally fluoridated water (either artificially or naturally).

Statistical analysis

Dental caries levels in 12 and 35-44-year-olds were compared using both percentage difference, calculated as $(DMFT_{35-44}–DMFT_{12})*100/DMFT_{12}$, and relative difference, calculated as $(DMFT_{35-44}/DMFT_{12})$. For the subset of 23 countries which also reported caries data for adolescents (15 to 19 years) we created histograms of the caries distribution by age (12-, 15-19- and 35-44-year-olds).

To assess whether the extents of differences in DMFT between children and adults is universal, we created histograms of the caries distribution by age groups in countries where a high percentage of the population consumed fluoridated water. Those countries were: Australia (80%), Malaysia (76%), Ireland (73%), United States (66%), New Zealand (61%) and Canada (44%).

RESULTS

Very much higher levels of caries occurred in adults than in children in all 26 countries. Whereas the DMFT in 18 of the 26 countries had DMFT levels below 1.5 at 12 years of age, 14 of those with such

low scores for children had DMFT levels above 10 at 35-44 years. In all countries except South Korea, Thailand and Turkey, the percentage differences in levels of DMFT between 12- and 35-44-year-olds was above 500% and in all countries except South Korea and Thailand, the relative differences between the DMFT in 12- and 35-44-year-olds were 5 or more. These differences existed irrespective of the DMFT levels in the 12-year-olds (Table 1). The large differences between caries levels between children, adolescents and adults in the 23 countries with estimates for 12-, 15-19- and 35-44-year-olds are shown in Figure 1. Large differences in DMFT were found between childhood and adolescence and even larger differences between adolescence and adulthood.

Data from six countries where high percentages of the water supplies have been fluoridated for over 30 years (Australia, Malaysia, Ireland, United States, New Zealand and Canada) also had marked percentage differences from 768% to 1106% between the DMFT in 12- and 35-44-year-olds and relative differences of 8 or more between DMFT in children and adults (Table 1). In those six countries there was a striking gradient between the DMFT index by age and most of the caries experience was in adults, not in children (Figure 2).

DISCUSSION

In all 26 countries included in this study, a vastly increased problem of caries existed in adults than in children. This finding is in line with those from the Dunedin longitudinal study where adults had very much higher levels of caries than when they were children and that caries levels tracked into adult life despite widescale free access to dental care and preventive measures in childhood and adolescence [5,11]. The most important finding of the present study was the extent of the differences in DMFT between 12- and 35-44-year-olds. In most countries the percentage differences were over 500% and in seven of them it was 1000% or more. In 10 of the 26 countries the relative difference between children and adults was 10 or more, irrespective of the DMFT levels in the 12-year-olds. The present study also showed that there were large differences in DMFT between children and adults in populations consuming fluoridated water.

Some limitations of this study should be borne in mind when interpreting the findings. First, we focused on age effects on caries levels, without accounting for period and cohort effects, and using cross-sectional representative data. Thus, our estimates of caries increments were based on birth cohorts that were 23 to 32 years apart (12- and 35-44 year-olds). However, our previous APC

analysis using data from England and Wales, United States and Japan, three of the 26 countries included here, showed that period and cohort effects were relatively small compared to the effects of aging. What is more, there was a strong effect of age on caries experience, independent of period and cohort effects [6]. Furthermore, similar differences between age groups were noted when comparing the current estimates with those of the APC analysis for the above countries. That supports the validity of our findings. Second, we used the DMFT index as our primary outcome measure, which has a number of limitations [12]. However, the index has been used for over 75 years and is well established as the key measure of caries experience in dental epidemiology. Third, we focused our analysis on caries in permanent teeth. Therefore, we chose 12-year-olds as the index age for dental caries in childhood as data for that age Is widely availabile. It could be argued that the DMFT underestimates the caries experience of 12-year-olds because they have typically lost all of their primary teeth by that age and caries in the primary dentition probably accounts for much if not most of the problem with dental caries in childhood. However, our subgroup analysis of 23 countries with caries data on 15-19-year-olds, which provides a better representation of the 'true' caries status in permanent teeth among adolescents, also supports the large differences between adolescence and adulthood. Fourth, as our objective was to identify the extent of differences in caries experience by age rather than to explain the differences, our analysis was descriptive and did not include any confounders. However, it is difficult to think of any potential cofounder of the relationship between age and caries. Further studies, using individual-level data, should explore the drivers of changes in caries levels seen in the 26 countries.

The finding that the DMFT was very much higher in adults than children may not be surprising, as caries is cumulative and chronic in nature and the DMFT measures past and present caries experience. However, the fact that the DMFT is a cumulative index does not mean it cannot remain relatively stable over time, indicating that little or no caries has developed. This study suggests that there was considerable caries development between 12 and 35-44 years of age. Adults are a caries-active group, with incidence rates which are at least as great as that of children and adolescents [4,13-16]. Our findings also support the view that caries is occurring later than in previous decades [17].

There is no doubt that fluoride in drinking water reduces dental caries in children and adults [18,19]. The dominant strategy that dentistry has adopted worldwide is to promote the use of fluoride in toothpaste, varnishes or water. Programmes are directed at children on the assumption that if caries can be

prevented in them the high burden of the disease will be markedly reduced throughout the lifecourse [20,21]. Whilst that approach has reduced the levels of caries in children and adolescents, the overall effect appears to be limited, as evidenced by the large differences in caries levels among age groups in countries with high percentages of the population consuming fluoridated water and using toothpaste containing fluoride. An explanation for why there are high numbers of teeth affected by caries in adults despite the low levels of caries in children and adolescents is that fluorides, the main reason given for the caries decline in children [22,23], does not appear to increase the resistance of enamel enough to control the demineralising effects of acids produced from dietary sugars. Fluorides may be slowing down the progression of the sub-clinical caries process more than in previous decades when fluoride toothpastes were not so widely used, and thereby delaying the clinical manifestation of caries as a cavity until later in the lifecourse [24]. But the caries process continues, because the determining factor, sugars, has not been adequately controlled.

Based on findings presented here on large caries differences between childhood and adulthood in several countries around the world, some with organised dental prevention programmes directed at children, and high levels of use of fluoride toothpastes, more attention should be directed at preventing caries at all stages of the lifecourse and at addressing the social determinants of non-communicable diseases [25,26].

In conclusion, this study shows that there are large differnences in dental caries of permanent teeth between 12- and 35-44-year-olds. The caries burden is markedly greater in adults than in children.

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Table 1. National estimates for DMFT index for 12 and 35-44 year olds in selected countries

Country[a]	12-year-olds	35-44-year-olds	Percentage difference[b]	Relative difference[c]
Tanzania	0.30	2.90	867	9.7
China	0.53	4.51	751	8.5
Finland	0.70	20.62	2846	29.5
Germany	0.70	14.50	1971	20.7
Hong Kong	0.80	7.40	825	9.3
Denmark	0.89	16.70	1776	18.8
Australia	0.95	10.70	1026	11.3
Canada	1.02	12.30[d]	1106	12.1
Austria	1.04	14.70	1313	14.1
UK	1.10	11.57	952	10.5
Malaysia	1.12	12.10	980	10.8
Spain	1.12	6.75	503	6.0
US	1.19	10.33	768	8.7
New Zealand	1.20	12.28	923	10.2
Belgium	1.30	10.30	692	7.9
Ireland	1.30	15.00	1054	11.5
Netherlands	1.30[e]	12.00	823	9.2
Japan	1.40	12.28	777	8.8
Thailand	1.55	6.74	335	4.3
Iran	1.90	14.80	679	7.8
Turkey	1.90	10.80	468	5.7
Greece	2.05	14.06	586	6.9
Brazil	2.07	16.75	709	8.1
South Korea	2.08	5.21	150	2.5
Belarus	2.14	13.11	513	6.1
Czech Republic	2.96	17.91	505	6.1

[a] Data obtained from the latest national dental health survey in each country
[b] Calculated with the formula: $(DMFT_{35-44}–DMFT_{12})*100/DMFT_{12}$
[c] Calculated with the formula: $(DMFT_{35-44}/DMFT_{12})$
[d] Data corresponds to age group 35 to 49 years
[e] Data corresponds to 11 year olds

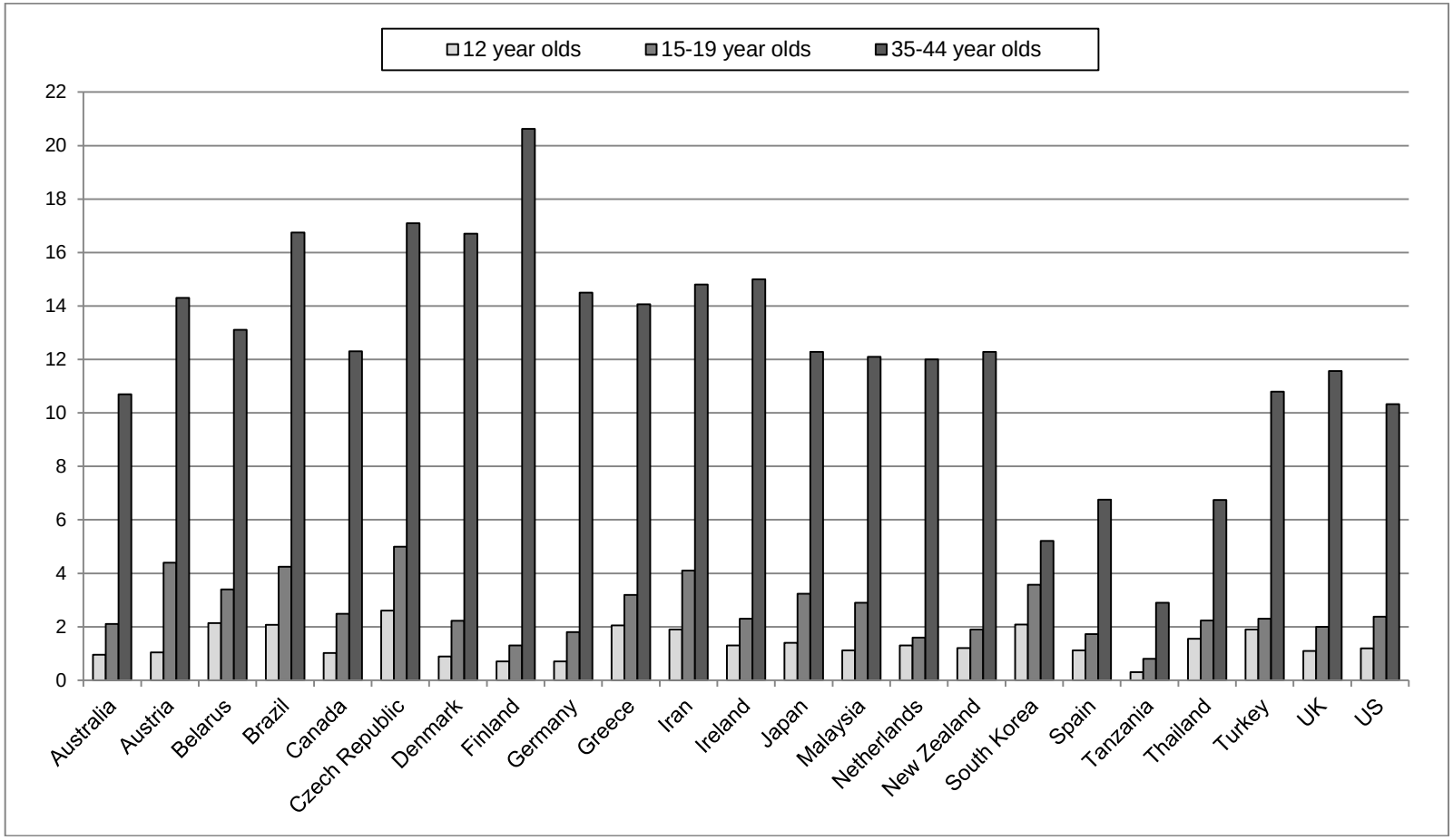

Figure 1. National estimates for DMFT index for 12-, 15-19- and 35-44-year-olds in selected countries (Australia, Belarus, Czech Republic, Denmark, Germany, Greece, Ireland, Netherlands, Spain, South Korea, Thailand, Turkey, the US and the UK reported data for 15-year-olds; Finland for 17-year-olds; Tanzania and Austria for 18-year-olds; New Zealand for 15-17-year-olds; and Canada, Malaysia, Japan, Iran and Brazil for 15-19-year-olds).

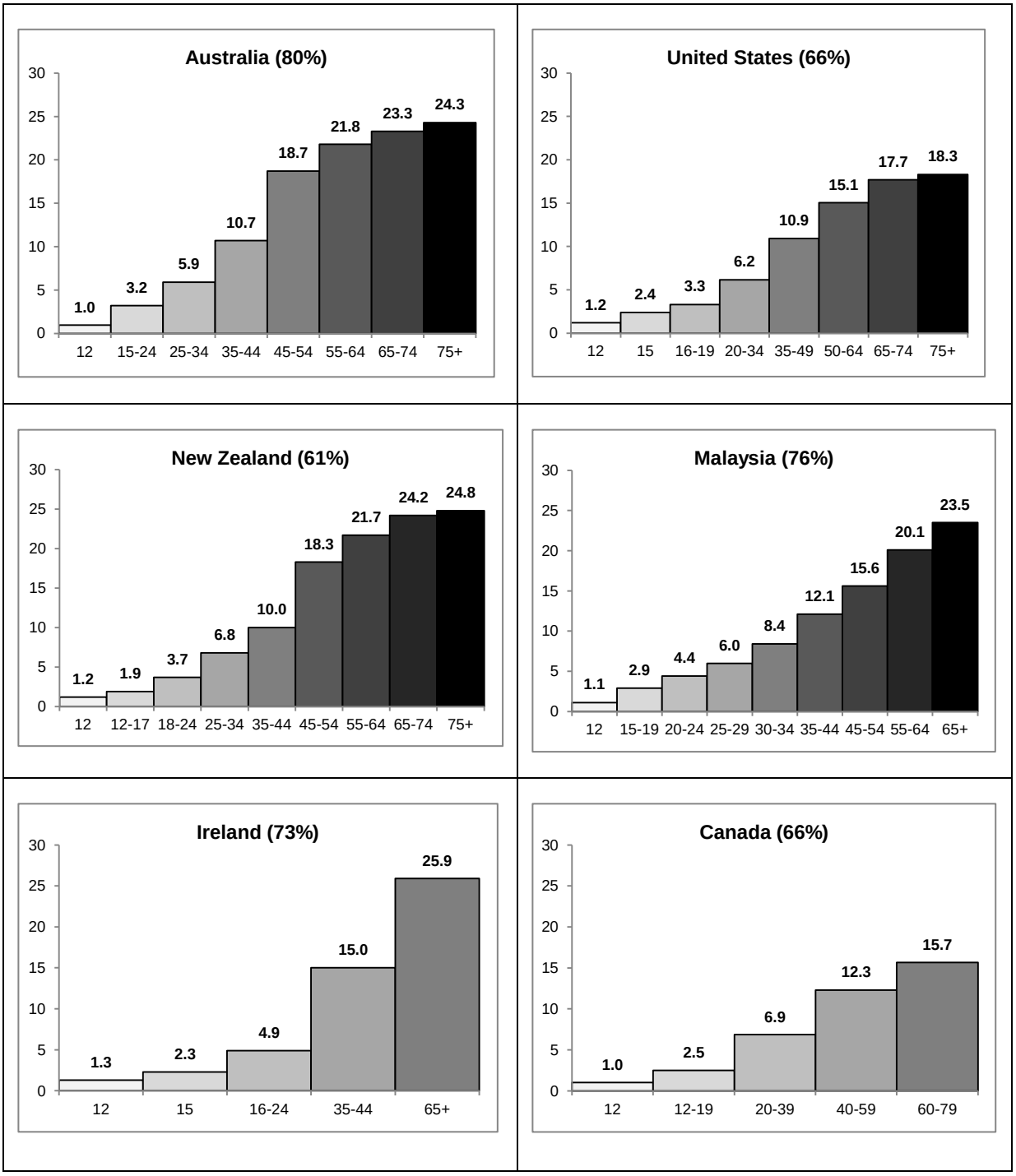

Figure 2. National estimates for DMFT index by age groups in countries with high percentages of their water supplies fluoridated. Values between brackets refer to the percentage of the population covered with fluoridated water (either artificially or naturally).