

1 **Ending the neglect of global oral health – time for radical action**

2

3

4 Richard G Watt,<sup>1\*</sup> Blánaid Daly,<sup>2</sup> Paul Allison,<sup>3</sup> Lorna M D Macpherson,<sup>4</sup>  
5 Renato Venturelli,<sup>1</sup> Stefan Listl,<sup>5</sup> Robert J Weyant,<sup>6</sup> Manu R Mathur,<sup>7</sup> Carol C Guarnizo-  
6 Herreño,<sup>8</sup> Roger Keller Celeste,<sup>9</sup> Marco A Peres,<sup>10</sup> Cristin Kearns,<sup>11</sup> Habib Benzian.<sup>12</sup>

7

8 <sup>1</sup> Department of Epidemiology and Public Health, UCL, 1-19 Torrington Place, London,  
9 WC1E 6BT, UK.

10 <sup>2</sup> Division of Child and Public Dental Health, Dublin Dental University Hospital, University  
11 of Dublin, Trinity College Dublin, Lincoln Place, Dublin 2, Ireland.

12 <sup>3</sup> Faculty of Dentistry, McGill University, 2001 McGill College, Montreal, Quebec H3A 1G1,  
13 Canada.

14 <sup>4</sup> Department of Dental Public Health, School of Medicine, Dentistry and Nursing, University  
15 of Glasgow, 378 Sauchiehall Street, Glasgow, G2 3JZ, UK.

16 <sup>5</sup> Department of Dentistry – Quality and Safety of Oral Healthcare, Radboud University  
17 Medical Center, Radboud University, Philips van Leydenlaan 25, 6525 EX Nijmegen, The  
18 Netherlands. And Section for Translational Health Economics, Medical Faculty, Heidelberg  
19 University, Im Neuenheimer Feld 400, 69120 Heidelberg, Germany.

20 <sup>6</sup> Department of Dental Public Health, University of Pittsburgh, 346 Salk Hall, 3501 Terrace  
21 Street, Pittsburgh, PA 15261, US.

22 <sup>7</sup> Public Health Foundation of India, Plot No. 47, Sector 44, Institutional Area  
23 Gurgaon, Haryana- 122002, India.

24 <sup>8</sup> Departamento de Salud Colectiva, Facultad de Odontología, Universidad Nacional de  
25 Colombia. Carrera 30 No. 45-03, Edificio 210, Oficina 301. Bogotá, Colombia.

26 <sup>9</sup> Department of Preventive and Social Dentistry, Federal University of Rio Grande do Sul,  
27 Porto Alegre, Brazil.

28 <sup>10</sup> Menzies Health Institute Queensland and School of Dentistry and Oral Health, Griffith  
29 University, Gold Coast, Queensland, Australia.

30 <sup>11</sup> Department of Preventive and Restorative Dental Sciences and Philip R. Lee Institute for  
31 Health Policy Studies, University of California San Francisco, San Francisco, California, US

32

33 <sup>12</sup> WHO Collaborating Center Evidence-based Dentistry and Quality Improvement, College  
34 of Global Public Health and College of Dentistry and College of Global Public Health, New  
35 York University, 433 First Avenue, New York, NY 10010, US.

36

37 \* Corresponding author.

38 Professor Richard G Watt

39 Department of Epidemiology and Public Health, UCL, 1-19 Torrington Place, London,

40 WC1E 6BT, UK. Email: r.watt@ucl.ac.uk

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

CONFIDENTIAL

75 ***Abstract***

76 Oral diseases are a major global public health problem affecting over 3.5 billion people.  
77 Dentistry however has failed to tackle this problem. A fundamentally different approach is  
78 now needed. In this second paper on oral health, we present a critique of dentistry  
79 highlighting its key limitations and the urgent need for system reform. In high-income  
80 countries (HIC) the current treatment-dominated, increasingly high-tech, interventionist and  
81 specialised approach, is failing to tackle the underlying causes of disease and is not  
82 addressing oral health inequalities. In low- and middle-income countries (LMIC) the  
83 limitations of “westernised” dentistry are most acute – dentistry is often unavailable,  
84 unaffordable and inappropriate to the majority of these populations, but particularly the rural  
85 poor. Rather than being isolated and separated from the mainstream health care system,  
86 dentistry needs to be more integrated with primary care services in particular. The global  
87 drive for universal health coverage (UHC) provides an ideal opportunity for this. Dental care  
88 systems should focus more on promoting and maintaining oral health and achieving greater  
89 oral health equity, rather than the interventionist treatment approach that currently dominates.  
90 Sugar, alcohol and tobacco use and their driving social and commercial determinants are the  
91 underlying causes of oral diseases, common risks shared with a range of other non-  
92 communicable diseases (NCDs). Coherent and comprehensive regulation and legislation is  
93 needed to tackle these shared risk factors. In this paper we focus on the need to reduce sugars  
94 consumption through the adoption of a range of upstream policies designed to combat the  
95 corporate strategies used by the global sugar industry to promote sugar consumption and  
96 profits. At present the sugar industry is influencing dental research, oral health policy and  
97 professional organisations through its well-developed corporate strategies. There is a pressing  
98 need to develop clearer and more transparent conflict of interest policies and procedures to  
99 limit and clarify the influence of the sugar industry on research, policy and practice.  
100 Combating the commercial determinants of oral diseases and other NCDs is a major policy  
101 priority.

102  
103  
104  
105  
106  
107  
108  
109

110 **Key messages**

- 111 • Dentistry continues to adopt a treatment-dominated, interventionist, technical and  
112 increasingly high-tech and specialised approach to care.
- 113 • Such an approach has failed to tackle the global burden of oral disease; radical reform  
114 of dental care systems is now urgently needed.
- 115 • Universal health coverage provides an opportunity for dental services to become  
116 better integrated in the wider health care system and to be more accessible and  
117 responsive to the oral health needs of the population.
- 118 • Provider payment systems should put more emphasis on incentivising prevention  
119 instead of rewarding restorative and interventionist dental care.
- 120 • A different preventive approach, focusing on population-wide impact, is also needed  
121 as the current individualistic clinical paradigm has failed to achieve sustained  
122 improvements in population oral health or to address persistent inequalities.
- 123 • Integrated public health policies are needed to tackle the shared common risks (free  
124 sugars, tobacco and alcohol use and their driving social and commercial determinants)  
125 of oral and other non-communicable diseases (NCDs).
- 126 • A range of highly developed corporate strategies are used by the global sugar industry  
127 to increase their sales and profits, and to undermine public health efforts to reduce  
128 free sugars consumption.
- 129 • There is a pressing need to develop clearer and more transparent conflict of interest  
130 policies and procedures to limit and clarify the influence of the sugar industry on  
131 dental research and oral health policy.

132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147

## ***Recommendations of this Series***

### *Epidemiology and oral health surveillance systems*

Standardised and comparable oral disease surveillance systems are needed to assess the full extent and nature of oral conditions globally. The use of a range of clinical epidemiological disease measures should be complemented with appropriate indicators that assess the wider impact of oral conditions. Established and commonly used oral health indicators should be aligned and integrated with NCD surveillance systems to allow for comparability with and monitoring of global NCD targets and Sustainable Development Goals (SDGs). The World Health Organisation has a key role in leading the development and strengthening of integrated oral health surveillance systems globally.

### *Reform of oral health care systems*

System-wide reform of oral health services is urgently needed. The reformed system needs to integrate with wider health care; incentivise and encourage the prevention and maintenance of oral health; utilise the skills and competencies of wider team of oral health care professionals and other health workers; deliver high-quality, evidence-based treatment; respond to the diverse needs of local populations and promote oral health equity. The growing international momentum towards Universal Health Coverage is a unique opportunity to integrate and reform oral health care.

### *Education and training of the future oral health workforce*

To achieve the goals and aspirations of a reformed oral health care system requires a suitably trained and skilled oral health workforce. Shifting the dentist-centred model of care delivery towards a team approach is essential. Integrated community-based models of training are required to ensure that the future workforce understand and are equipped to respond to population oral health needs and deliver high-quality, appropriate and evidence-based care.

### *Tackling oral health inequalities*

Oral health personnel have a professional and ethical responsibility to provide care in an equitable and fair fashion to meet the diverse needs of their patients and local communities. Oral health care systems need to be more inclusive, accessible and accommodating to

socially deprived and vulnerable groups. Further staff training, resources and closer liaison with support and specialist agencies will be needed to achieve improved oral health equity. Advocacy and wider policy change is also needed to address the broader social determinants of oral health inequalities that lie outside the remit of health systems.

#### *Moving upstream to maximise oral health improvement*

Individualistic, clinical and educational preventive approaches may achieve short-term benefits, but these soon fade unless the underlying causes of disease are tackled. Investment in upstream, coherent and integrated population-wide policies should be prioritised such as taxes on sugary drinks, stronger regulation on the advertising and promotion of sugary foods/drinks targeting children, the promotion of appropriate exposure to fluoride through toothpaste and water; as well as embracing a common risk factor approach to address tobacco use and harmful use of alcohol.

#### *Addressing commercial determinants of oral diseases*

Stricter regulation and legislation are needed to combat corporate strategies that threaten and undermine oral health and related NCDs. Based upon experience gained from tobacco control, dental professional organisations, academic institutions, individual researchers and policy makers should not accept any funding, sponsorship or support from the sugar industry. Clear and transparent procedures and policies need to be adopted to identify and mitigate any possible objective or perceived conflicts of interests.

#### *Research agenda*

Research focusing on oral diseases is often given low priority by research funding agencies. Given the global public health significance of oral diseases, more funding should in future be invested in this important area. Defining a global oral health research agenda would help to direct resources and efforts to addressing critical knowledge gaps including translational and implementation research. Future dental research should focus more on population oral health needs, particularly in LMICs and evaluate oral health improvement interventions that promote oral health equity. Cross-disciplinary research partnerships using a range of appropriate methodologies and study designs are essential.

#### *Global advocacy*

The neglect of oral health in the global and national health discourse should be addressed through multi-level advocacy efforts aiming to improve knowledge and awareness of the magnitude of the oral health challenges; create a culture of inclusiveness and recognition vis-à-vis oral conditions and various ways of addressing them in the context of existing policies and programmes (“oral health in all policies”), ensure alignment of efforts to prioritise oral conditions with international policies and frameworks (such as the SDGs, the WHO Global Action Plan on NCDs); and using existing momentum to promote oral health (such as the provisions related to oral health promotion in the UN Minamata Convention on Mercury).

148  
149  
150  
151  
152

CONFIDENTIAL

153 ***Introduction***

154 Despite significant scientific developments in our understanding of the pathogenesis and  
155 aetiology of oral diseases over recent decades, the global burden of oral conditions has  
156 persisted, and is indeed likely to worsen.<sup>1</sup> As outlined in paper one in this series, oral diseases  
157 affect over 3.5 billion people across the world, with untreated dental caries being the most  
158 prevalent health condition globally. In high-income countries where overall levels of caries  
159 have declined in the child population, the progressive and cumulative nature of the condition  
160 into adulthood and older age remains a major problem.<sup>2,3</sup> Stark socioeconomic inequalities in  
161 oral health mean that poorer and more vulnerable groups in society are particularly affected.  
162 Oral diseases continue to cause pain, infection and misery for vast numbers of people around  
163 the globe and the costs of dental treatment can have a major impact on household budgets<sup>4</sup>  
164 and wider health care systems.<sup>5</sup>

165  
166 In this paper we will present a critique of dentistry highlighting its key limitations and the  
167 urgent need for radical reform. The global perspective on dentistry presents three contrasting  
168 but interconnected realities. In high-income countries, the current treatment-dominated and  
169 increasingly technology-focused system of oral health care is trapped in an interventionist  
170 cycle failing to tackle the underlying causes of diseases and not meeting the needs of large  
171 proportions of the population. In many middle-income countries the burden of oral diseases is  
172 significant, but oral care systems are often underdeveloped and unaffordable to the majority  
173 of the population. In low-income countries the current situation is most bleak. Although the  
174 overall disease burden is still comparatively low, there are indications that oral diseases are  
175 increasing in prevalence.<sup>1</sup> With other competing demands on scarce resources, investment in  
176 oral health is very limited, making dentistry an unavailable and unaffordable luxury reserved  
177 for the well-off. Most disease therefore remains untreated in the majority of the population,  
178 but particularly the rural poor, having very limited access to dental care. To effectively tackle  
179 the global burden of oral diseases requires a fundamentally different approach. We argue that  
180 a system change is needed - more of the same will achieve little. This is particularly the case  
181 in low-income countries where the 'western' model of dentistry is unaffordable,  
182 unsustainable and inappropriate.<sup>6-8</sup> In addition to reform of dental services, we also highlight  
183 the urgent need to change the individualistic, downstream preventive approach that currently  
184 dominates, but which has failed to achieve significant population oral health gain or to  
185 effectively tackle inequalities. We particularly focus on the need for cohesive, comprehensive  
186 and integrated policy action to reduce free sugars consumption, a significant shared risk for

187 dental caries and other non-communicable diseases (NCDs). (Free sugars are defined as  
188 monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook  
189 or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice  
190 concentrates).<sup>9</sup> We recommend that bold action is needed to address the power and influence  
191 of the global sugar industry which uses a wide range of measures to promote their products  
192 globally, and to limit the impact of any public health efforts to reduce free sugars  
193 consumption. These commercial determinants of oral health highlight the urgent need for  
194 stronger regulation and legislation, and also the importance of developing clear and  
195 transparent conflict of interest policies to shield industry influence from dental research, oral  
196 health policy and professional dental organisations. The paper closes with a plea to step-up  
197 global advocacy efforts in the wider health and human development arena in order to end the  
198 widespread neglect of oral health globally.

199  
200 ***Limitations of dentistry – a system no longer fit for purpose***

201 Dentistry is in a state of crisis. Twenty-first century dentistry has largely failed to combat the  
202 global challenge of oral diseases.<sup>1,10,11</sup> This is not the fault of individual dental clinicians  
203 committed to caring for their patients. The philosophical approach, system and model of  
204 dental care delivery are at fault. (See appendix – panel 1).

205  
206 The dental profession and the practice of dentistry are still very much dominated by a  
207 treatment, interventionist and technical philosophy that reflects patterns and understanding of  
208 dental disease which were current over 80 years ago, and ultimately date back to the surgical  
209 origins of the profession.<sup>7,12</sup> This approach emphasises a biomedical and reductionist  
210 understanding of disease causation and a belief that treatment and high-tech intervention will  
211 ultimately restore oral health and “dental fitness”. The fundamental principles of dental  
212 training have remained broadly unchanged for decades. Although teaching on certain  
213 techniques and approaches has evolved, the “dental surgeon” paradigm persists, with dentists  
214 largely trained to intervene reactively (i.e. once the disease/problem, has started to manifest  
215 itself) and surgically (using a drill, scalpel and/or other instruments) rather than proactively  
216 and preventively. Dentist’s training prepares them to be “disease-centred” rather than patient-  
217 or “health-centred”.<sup>12,13</sup>

218  
219 For a variety of historical, professional, political and economic reasons, dentistry around the  
220 globe is largely provided by dentists working independently in the private sector in single-

221 handed or small group practices, often isolated from mainstream health services.<sup>7,14</sup>  
222 Increasingly, in many countries there has been a growth in large corporate bodies and  
223 insurance companies that provide health care including dentistry. These commercial, for-  
224 profit, organisations can provide high-quality care, but also need to ensure adequate returns  
225 on their investments for their shareholders, and therefore have a tendency for promoting  
226 excessive diagnostic testing and over-provision of treatment.<sup>10,15,16</sup> These commercial  
227 pressures and incentives fuel an interventionist approach and risk unnecessary, and  
228 inappropriate care. Treatment becomes incentivised and drives further treatment rather than  
229 health.

230

231 There is a significant mismatch between the oral health needs of communities and the  
232 availability, location and type of dental services provided. Dentistry is largely a demand-led  
233 service, often poorly planned as a result of entrepreneurial choices, and is therefore poorly  
234 aligned to the oral health needs of the local population. In HMIC, young children, low-  
235 income families, marginalised groups such as homeless people and prisoners, and people  
236 living with disabilities are generally underserved<sup>17-21</sup>, whereas dental services often tend to  
237 be located in wealthy urban neighbourhoods where affluent “healthy” adults may be  
238 receiving unnecessary and often unneeded dental care – a perfect example of the inverse care  
239 law.<sup>22-24</sup> In many low-income settings the situation is far worse. Across much of Sub-Saharan  
240 Africa and many other low-income countries, dental services tend to be located in urban areas  
241 inaccessible to the majority of the rural poor. Individuals suffering from dental problems may  
242 need to travel far to reach a dentist, or need to resort to using local traditional street “dentists”  
243 and be exposed to the risks of using these unregulated providers of care.<sup>25</sup> Even though  
244 concepts for integrating basic oral health care in primary health care exist, they have failed to  
245 gain widespread traction, which further contributes to making access to even basic oral health  
246 care a major problem.<sup>26-28</sup> Coverage for oral health care in LMIC is generally lower than in  
247 HIC, with median estimations ranging from 35% in low-, 60% in lower-middle, 75% in  
248 upper-middle and 82% in high income countries.<sup>29</sup> Within countries, the poorest quintiles  
249 have the lowest coverage rates – in Lao, in south-east Asia coverage of the richest quintile is  
250 more than 8-times higher than for the poorest.<sup>29</sup>

251

252 The extent to which patients have to pay or co-pay for dental care and the manner in which  
253 dental care providers are reimbursed for their services have important bearings for the  
254 utilisation and quality of care.<sup>5</sup> Evidence from high-income settings such as that from the US

255 RAND Health Insurance Experiment has shown that individuals who have to co-pay more,  
256 tend to access less dental care.<sup>30</sup> Worldwide, there are substantial differences in patient co-  
257 payment rates for dental care<sup>31</sup> and this may limit access to and utilisation of care for people  
258 on lower incomes. Households in LMIC face a significantly higher risk of impoverishment or  
259 even falling below the poverty line, if they have incurred excessive out-of-pocket payments  
260 for dental care.<sup>4</sup>

261

262 The conventional types of provider payment in dentistry include fee-for-service, fixed salary  
263 and capitation payments.<sup>5,32</sup> Empirical evidence for the impacts of the various reimbursement  
264 schemes on dental care is relatively scarce.<sup>33</sup> Capitation and salary payments provide good  
265 incentives for cost-containment but impose risks of patient selection and/or under-treatment.  
266 Fee-for-service payments foster higher utilisation of care but may impede cost-containment.  
267 Recently, Chalkley and Listl identified significant increases in the provision of potentially  
268 harmful dental radiographs when dentists received fee-for-service rather than salary  
269 payments.<sup>34</sup>

270

271 There is little planning concerning the numbers or distribution of dentists and the wider oral  
272 health workforce, nor for the skill sets they require. Even though dentist-population ratios are  
273 only a crude measure of oral health care service availability and there is no correlation to  
274 disease levels, the numbers of dental personnel show stark variations across countries, as well  
275 as within countries.<sup>35,36</sup>

276

277 Some countries have recently seen significant increases in numbers of dental schools e.g. the  
278 USA<sup>37</sup>, Chile<sup>38,39</sup>, India<sup>40</sup>, Brazil<sup>41</sup> and Colombia<sup>42</sup>, many of which are private, for-profit  
279 institutions responding to competition and demand for dental courses, with no reflection on  
280 the needs of their local populations.<sup>43</sup> (Figure 1). The rapid increases in dentist-to-population  
281 ratios particularly seen in certain HMIC are likely to lead to an over-supply of dentists, risk  
282 of iatrogenic over-treatment and increasing rates of unemployment amongst dentists.<sup>44</sup>

283 Meanwhile, few of these increasing numbers of dentists move into rural and remote, and low  
284 dentist/population-ratio areas, so the vulnerable groups with greatest need for dental  
285 treatment remain without care. In many low-income countries few dental schools exist so the  
286 supply of dental personnel is very limited. A situation not helped by the “brain drain” of  
287 dentists moving to higher income countries where they can earn higher incomes, have better

288 career perspectives, can practice the high-tech dentistry they were taught at dental school and  
289 enjoy a better quality of life.<sup>35</sup>

290

291 Figure 1 here

292

293 Problems in dental training and the mismatch between need and provision of care are  
294 compounded by the expansion of specialist practices in dentistry.<sup>44</sup> In the UK for example,  
295 there are now 13 different dental specialities.<sup>45</sup> While there is no doubt that a proportion of  
296 patients have complex oral health needs requiring additional specialist skills, most oral health  
297 needs can be met by primary care dentists and there is some debate as to whether the  
298 expansion in specialist dental practices truly reflects and aligns with the oral health needs in  
299 the community.<sup>46</sup> The growth of specialist practice increases the cost of care and access is  
300 often sparse in areas of greatest need. The interface between primary and secondary dental  
301 care can be problematic in terms of equity, seamless care, effectiveness and efficiency.

302 <sup>47</sup>Additionally, eroding the role of primary dental care removes the stable “dental home”<sup>48</sup> for  
303 patients which is essential to ensure they receive appropriate preventive and continuity of  
304 care, something of particular relevance to children and adults with high risk of developing  
305 oral conditions, such as those living with disabilities and long-term conditions.

306

307 Unlike in medicine, in dentistry there is a only limited use of a wider professional team to  
308 deliver care.<sup>44</sup> This is partly a legacy of the “dental surgeon” paradigm, in which the dentist  
309 was seen as solely responsible for the diagnosis of disease and the provision of treatment.

310 Many dental schools around the world continue to produce dentists who are trained to treat  
311 and work in isolation rather than training a wider range of dental care professionals with  
312 different and complementary skills to address the oral care needs of their patients and local  
313 populations.<sup>43,44</sup> Treatment needs range from very simple preventive procedures (such as  
314 topical fluoride application), to complex treatments (such as implant retained prosthesis).

315 These can be delivered with greater efficiency, effectiveness and coverage by an oral health  
316 workforce with an appropriate and mixed skills set. Mid-level providers are also instrumental  
317 in increasing access to dental care in underserved and remote population groups. Indeed, in  
318 many settings, and particularly in LMIC, training a more community-oriented oral health  
319 workforce rather than dentists is a realistic solution to address the acute workforce shortages  
320 and access challenges.<sup>49</sup> The type of dental professional trained varies across different  
321 countries and jurisdictions but commonly consists of dental hygienists, dental therapists,

322 denturists, dental assistants/nurses and dental technicians amongst others. As with many other  
323 professional fields, discussions over scopes of practice and the independence of these  
324 different professional groups are often complex and fractious. The debate over which of these  
325 professionals can do what, under what circumstances, is often decided as a compromise  
326 between professional groups rather than with a view to the public's well-being or needs.<sup>50</sup>  
327 Despite advances made by the Cochrane Collaboration and other groups, the lack of evidence  
328 for many common dental procedures remains a major challenge. This may be illustrated  
329 using the example of dental caries. Management of caries has traditionally been to remove  
330 decay and place a filling, that regardless of the initial size of the cavity enters the tooth into a  
331 cycle of repeat restoration with increasing complexity, eventual failure and tooth loss.<sup>12,51-55</sup>  
332 This "restorative approach" fails to acknowledge that it is not possible to "treat away" caries,  
333 neither does it reflect contemporary understanding of the pathogenesis of caries.<sup>56-59</sup> Current  
334 clinical evidence demonstrates that caries is preventable, and once established, may also be  
335 reversible, if detected and addressed in the early stages.<sup>58-60</sup> New developments in adhesive  
336 dental materials mean that treatment of established disease, that includes appropriate use of  
337 topical fluorides,<sup>61,62</sup> may be managed with less destruction of tooth tissue<sup>58</sup> and less need for  
338 high technological and rehabilitative dentistry.<sup>12</sup> Indeed, since 2017 dental amalgam, the  
339 filling material central to this restorative approach is being phased down as part of the United  
340 Nations Minamata Convention on Mercury.<sup>63</sup> Other long established treatments used in  
341 routine dental practice are also being challenged because of the lack of evidence about their  
342 effectiveness.<sup>64-66</sup> Two pillars of clinical dental practice may serve as examples: the six-  
343 month dental recall and scale and polish for the management of gingival and periodontal  
344 diseases. The UK National Institute of Health Care Excellence found that there was no  
345 scientific basis to the six-month dental recall and recommended that recall intervals should  
346 instead be specifically tailored for each patient based on disease levels and disease risk.<sup>67</sup> A  
347 recently completed UK trial demonstrated no clinical benefit in providing either 6 or 12  
348 monthly scale and polishes.<sup>68</sup>

349

350 An additional shortcoming is the narrow and somewhat simplistic approach adopted to  
351 prevent oral diseases. The use of clinical preventive interventions such as topical fluorides to  
352 control caries<sup>59,60,69</sup> is proven to be highly effective, yet is often seen as a panacea and  
353 thereby losing sight of the fact that sugar consumption remains the primary aetiological factor  
354 in caries development. While topical fluorides are proven clinical preventive agents,<sup>69</sup> caries  
355 will still develop in the presence of free sugars above 10% of total energy intake.<sup>70</sup> Even

356 where exposure to fluoride is optimal, evidence suggests that free sugars exposures as low as  
357 2-3% of total energy may still carry a risk of caries.<sup>71</sup> The general approach to the prevention  
358 of caries has been individualistic and reductionist, focusing on educating patients and the  
359 public about individual risk behaviours in oral hygiene and nutrition, with little regard to  
360 where and how these behaviours develop and are shaped. This clinical approach to  
361 prevention has been unsuccessful at achieving long-term oral health gains or in tackling oral  
362 health inequalities.<sup>72-74</sup>

363

364 In summary, dentistry and oral health care systems need radical reform. The current outdated  
365 and treatment-focused approach is failing to meet the oral health needs of large segments of  
366 the population, and is totally inappropriate and unaffordable for low-income countries. A  
367 different approach is now needed.

368

369

### 370 ***Rethinking oral health care and improving population outcomes***

371

372 The described limitations of the prevailing dominant approach in dentistry (See appendix –  
373 panel 1) indicate their complexity, yet also reveal their inadequacy in reducing the global oral  
374 disease burden. From a public health perspective, this lack of global impact would seem to be  
375 a good starting point and motivator to consider major, even disruptive innovation in the way  
376 dentistry delivers care. In many HIC reform of oral health care systems is often in response to  
377 concerns over cost containment rather than more proactive efforts to improve quality of care.  
378 Where LMICs are establishing or strengthening oral health care systems, they often strive to  
379 follow the example of high-income countries by liberalising health care markets or reducing  
380 public health services. Public oral health care is often the first service to suffer as it is  
381 considered to be expensive and not essential, resulting in increased unmet oral health care  
382 needs.<sup>75-77</sup>

383

384 Key features of an ideal oral health care system have been postulated as follows: no divide  
385 between dental and general health care; emphasising health promotion and disease prevention;  
386 monitoring and responding to population needs; evidence-based, effective and cost-effective;  
387 as well as sustainable, equitable and universal; and empowering for individuals and  
388 populations.<sup>78</sup> The goal would be to achieve better and equitable oral health for all through oral  
389 health care being integral to a framework of universal health coverage (UHC), empowering

390 people in self-care, providing protection against health risks, and preventing them from  
391 inadequate out-of-pocket expenditures when accessing the required quality oral health care.

392

393 Looking at the current practice of dentistry, significant reforms in five key areas would be  
394 required to achieve these fundamental characteristics: 1) providing universally available  
395 essential oral health care services meeting the most common population needs; 2) innovative  
396 oral health workforce models and training; 3) an enabling health system governance context  
397 that facilitates a flexible continuum of patient-centered support with appropriate quality of  
398 services; 4) integrated surveillance, programme monitoring and implementation research to  
399 ensure appropriate health outcomes; and 5) shifting intervention focus to upstream  
400 population-wide policies. The implementation of any reforms needs to take into account the  
401 local context and population needs.

402

403 Universal oral health care (See Figure 2): The growing international momentum towards  
404 UHC is a unique opportunity to integrate oral health care.<sup>79,80</sup> Bold examples from Brazil  
405 (See appendix – panel 2) Thailand have shown that such major reforms are possible and yield  
406 positive oral health impacts. Concepts for decision-making are required to select  
407 interventions for essential oral health care interventions, which must include prevention and  
408 self-care. The WHO-endorsed *Basic Package of Oral Care*, which aimed to direct scarce  
409 resources for oral health towards evidence-based interventions addressing essential and  
410 common needs, must be reviewed and adapted in the light of implementation experience and  
411 recent evidence.<sup>26</sup> The concept of *Best Buy* interventions established by WHO to tackle  
412 NCDs should be expanded to include cost-effective priority interventions for the prevention  
413 and treatment of oral diseases. Appropriate Universal Oral Health Coverage (UOHC) tracer  
414 indicators need to be defined to measure all three dimensions of UHC – coverage, financial  
415 protection and service quality. Ideally, cost-effective and evidence-based essential services  
416 for the most common needs must be available for all segments of the population, with a pro-  
417 poor focus and delivered through primary health care; while more costly specialised services  
418 would be available at higher referral levels of the health care system. The balance between  
419 service availability and inclusion in essential UHC, delivery through the wider dental team,  
420 and appropriate financial protection needs to be locally determined.

421

422 Figure 2 here

423

424 Innovating the oral health workforce: Achieving UOHC requires appropriately-trained oral  
425 health care workers with relevant skill mix at all levels of service. This involves shifting the  
426 dentist-centered model of care towards a team approach, with non-dentist providers  
427 delivering the majority of essential care at the entry level of the primary health care system.  
428 More specialised services, provided by dentists and specialists in referral settings, should  
429 complement the care spectrum, with advanced care options. Such a model requires a new  
430 approach to dental education and training not conceptualised by pre-defined job descriptions  
431 or scopes of practice, but rather focusing on community needs and evidence-informed care  
432 pathways so that the required care can be flexibly provided in an integrated manner.<sup>81,82</sup> The  
433 focus of training will be on prevention and health promotion, including liaison and  
434 collaboration within integrated public health services and community colleagues working on  
435 upstream determinants, and referral for complex care.<sup>83</sup> Continuing professional  
436 development, on-the-job training and appropriate supervision should be mandatory, including  
437 training on professional ethics, public health values, social responsibility and avoidance of  
438 conflicts of interest.

439

440 Enabling health system context: Integrated, publicly-funded (oral) health care systems require  
441 infrastructure, financing, and governance structures that are all tailored to foster collaborative  
442 practice and quality services with maximum reach. Professional licensure and regulation  
443 must be able to accept overlapping, complementary and flexible scopes of practice to enable  
444 needs-based patient care. Payment and remuneration concepts favouring health outcomes,  
445 such as Pay-for-Performance systems, have shown some potential to improve quality and  
446 outcomes of care.<sup>84-86</sup> The share of services delivered by public and private providers can  
447 vary and change over time depending on country context, resources and political priorities.  
448 The priority for public spending should remain on providing and strengthening public (oral)  
449 health care services,<sup>87</sup> while private sector providers continue to provide specialist care for  
450 population segments able to afford the services or with relevant insurance coverage. Quality  
451 assurance measures, practice regulations and professional legislation must apply equally to  
452 both sectors to prevent differential service quality and the common patient perception that  
453 public services are of inferior quality.

454

455 Integrated surveillance, monitoring and implementation research: Evidence, service data and  
456 impact evaluations are essential to advocate for, conceptualise, manage, fine-tune and  
457 provide services at scale. Appropriate disease surveillance, integrated with NCD and other

458 appropriate surveillance contexts, using relevant existing or new indicators, must be in place.  
459 Priorities for oral health research should promote health service and implementation research,  
460 including health impact, economic, qualitative, social and mixed research methodologies, so  
461 that planners are able to assess programme performance comprehensively, particularly  
462 focusing on improving equity. Advocacy for inclusion of relevant oral health information in  
463 SDG monitoring and accountability in the context of NCDs should be encouraged.

464

465 Shifting intervention focus on upstream population-wide policies: Oral diseases and  
466 inequalities in oral health are caused by a complex array of individual, social, environmental,  
467 economic, political and commercial determinants, mostly shared with other NCDs. Although  
468 this is increasingly acknowledged across the dental profession globally,<sup>88,89</sup> the predominant  
469 response continues to prioritise downstream interventions. These focus on delivering clinical  
470 preventive measures and traditional health education aiming at behaviour change. The  
471 evidence, however, shows that such approaches are effective only in the short term<sup>72,73,90,91</sup>  
472 and may increase, rather than decrease socioeconomic inequalities in oral health.<sup>92-94</sup> A  
473 bolder and more radical preventive approach is now needed. More of the same will achieve  
474 little and is indeed unaffordable in most LMIC. Integrated and coordinated strategic  
475 upstream, mid-stream and downstream policies are required that tackle the underlying social  
476 and commercial causes of oral diseases. These approaches need to be integrated with the  
477 broader NCD prevention agenda and require multi-sectorial working beyond the confines of  
478 dental services, and indeed health care systems. Placing (oral) health in all policies requires  
479 effective advocacy to achieve broader societal change. Interventions should be tailored to the  
480 needs of communities and delivered in a proportionate manner to ensure oral health equity.

481

### 482 *Sugar reduction strategies*

483 From being a somewhat fringe topic, sugar is now a mainstream global public health priority.  
484 Informed by comprehensive and detailed reviews of the international scientific evidence on  
485 the role of free sugars on weight gain and dental caries,<sup>70,95</sup> national and international  
486 nutrition guidelines now advocate for population-wide reduction in free sugars  
487 consumption.<sup>9,96,97</sup> WHO recommends for both children and adults reducing free sugars to  
488 less than 10% of total energy intake and a further conditional recommendation that sugar  
489 should be less than 5% of total energy.<sup>9</sup> In most countries around the world, free sugars  
490 consumption is considerably higher than the WHO recommendation, particularly amongst  
491 children and young people, and low-income and disadvantaged groups. A major concern is

492 also the high level of sugars in commercial baby foods (Panel and figure 3). To achieve the  
493 WHO guideline will require an ambitious, systematic and coherent sugar reduction  
494 strategy.<sup>97-99</sup> Upstream policies include international trade agreements on sugar production  
495 quotas, price subsidies, minimum price and trade mechanisms. Other upstream policies  
496 include industry action in the reformulation of products to reduce their sugar content (similar  
497 to what has been achieved in salt reduction), government taxes or levies on sugary products  
498 (a 20% price increase is most effective), improved labelling of products to enable consumers  
499 to make informed choices, and restriction of the marketing and promotion of sugary foods  
500 and drinks, especially to children. Midstream strategies include restrictions on retailers  
501 selling high-sugar foods and drinks at checkouts, ending price promotions on sugary products  
502 (“buy one, get one free offers”), and a reduction in portion sizes of sugary foods and drinks  
503 sold in cinemas and other public spaces. Public sector organisations should not be supporting  
504 the sales of sugary products to their users and staff, and finally mandatory food guidelines  
505 should be introduced in preschools and schools which should include tighter restrictions on  
506 free sugars. Voluntary agreements with industry to reduce sugar consumption have failed.<sup>100-</sup>  
507 <sup>102</sup> Regulatory and legislative mechanisms are now needed with specific quantifiable targets  
508 set and independent monitoring processes established. Upstream sugar reduction policies  
509 need to be evaluated using appropriate methods and should include oral health outcomes.

510

511 Panel and Figure 3 here

512

513 Significant progress has been made with the introduction of sugar taxes/levies on sugar  
514 sweetened beverages (SSBs) in over 59 countries.<sup>103</sup> Data from Mexico highlight that pricing  
515 policies on SSBs have an effect on reducing sales and consumption, and a reduction in levels  
516 of overweight.<sup>104,105</sup> The positive outcomes resulting from the pricing policies have  
517 particularly benefitted low-income groups who generally consume higher quantities of  
518 SSBs.<sup>105</sup> The introduction of a national sugar levy can also have a major influence on  
519 industry in reformulating their products reducing the sugar content to avoid price increases as  
520 seen in the UK. It is important to recognise however that pricing policies alone cannot deal  
521 with the sugar related epidemic, a package of coherent policies are needed. The dental  
522 profession has an important role to play in supporting the implementation of WHO  
523 guidelines to reduce sugar consumption. However undeclared and opaque conflicts of interest  
524 between the sugar industry and certain dental organisations and academic institutions need to  
525 be addressed (see accompanying Comment).

526

527 **Better political priority for oral health – role of global advocacy**

528 In view of the described significant burden and impacts of oral diseases, the inadequate  
529 health system responses and the proposed concepts for reform, a global roadmap or action  
530 plan may be a logical next step, with global advocacy as a key strategy to move from  
531 concepts to action. So far, oral health advocates and professional organisations have  
532 repeatedly highlighted the neglect of global oral health, without offering a realistic vision  
533 about how oral health for half of the world’s population can be sustainably improved. On the  
534 contrary, the discourse of neglect has been so deeply internalised that often it appears to be  
535 the only and central challenge for oral health globally. The priority accorded to oral health is  
536 indeed inadequate in many contexts; symptoms and consequences of neglect are manifold.

537

538 The ensuing debate, however, is often rather limited and re-active, focusing on justifying  
539 more resources towards expanding current oral health care models, thus doing more of the  
540 same. This points to a key weakness hampering effective advocacy – a clear objective to  
541 argue for or against something is required. The narrow focus of advocating a higher priority  
542 for oral health may have deflected resources and efforts from generating a broad consensus  
543 among key sector stakeholders about a joint problem definition, agreement on population-  
544 level interventions, and approaches to reform and strengthen oral health systems. The current  
545 state of global oral health is hence not only a result of external factors such as competing  
546 disease priorities or lack of resources, but also related to inadequate coalescence and  
547 leadership among global oral health actors, further widening the disconnect with the wider  
548 global health mainstream.<sup>106</sup>

549

550 The processes and politics behind changing global health priorities has been studied and key  
551 elements for change have been identified.<sup>107</sup> Today, the situation is far from the bold priority  
552 that oral health received in 1994, when the WHO declared the first-ever “International Year  
553 of Oral Health”, following-up on the declaration of global goals for oral health by the year  
554 2000.<sup>108–110</sup> Since then, the WHO’s Global Oral Health programme was scaled-down from a  
555 well-staffed unit to a single position at headquarter level. Such changes were subsequently  
556 mirrored by WHO member states who also limited their oral health resources or did not even  
557 establish national oral health programmes. The ongoing organisational reform of WHO may  
558 be an advocacy opportunity to correct the under-resourced situation of oral health at WHO  
559 headquarters and regional levels.

560

561 Oral health is part of the basic human right to health and integral to sustainable human  
562 development – key notions of a rights-based approach to global advocacy.<sup>35</sup> Promoting oral  
563 health positively contributes to overall development by easing the disease, economic and  
564 social burden caused by oral conditions. (Figure 4).

565

566 Figure 4 here

567

568 The global health agenda continues to provide many opportunities for advocacy, yet they  
569 need to be monitored, filtered and seized upon (See appendix – panels 3-5). More recently,  
570 the commercial determinants have seen increasing attention, and the various interlinkages  
571 with other determinants of health have been highlighted. Together with other international  
572 health frameworks they provide opportunities for impactful advocacy, benefiting not only  
573 oral health but also NCDs and sustainable development at large.

574

575

### 576 ***Conclusion***

577 Oral diseases are a major global public health problem. The current public health and health  
578 system responses are largely inadequate, inequitable, and costly, leaving billions of people  
579 without access to even basic oral health care. Simple, cost-effective and equitable  
580 interventions exist, as well as population-wide upstream policy measures to reduce risks that  
581 are common to NCDs and oral diseases. Setting public health, oral health professional, health  
582 system, education and training, research and policy priorities on a path towards Universal  
583 Oral Health Coverage requires sustained and concerted political support and engagement of  
584 all stakeholders, including patients and communities. Achieving such convergence of efforts  
585 needs bold leadership, solid evidence, innovative policies and openness to a global change  
586 agenda on all levels. As the world intensifies efforts to reach the Sustainable Development  
587 Goals within the coming decade, oral health can no longer be left behind and requires urgent  
588 and decisive action.

589

590 (word count – 5,037 words)

591

592

593 **Contributors**

594 All authors jointly formulated the major concepts of this paper and approved the final  
595 version. RW, BD, PA, SL, HB, and CK initially drafted and edited sections of this paper. RW  
596 and CCG-H analysed the growth in commercial baby foods in selected countries, and BD,  
597 RV, RKC and CCG-H assessed changes in dental schools in selected countries. LMDM,  
598 RKC and MP specifically made critical revisions to the text for important scientific content.  
599 RGW and HB provided overall supervision. All authors provided information and references  
600 for this paper.

601

602 **Declaration of interests**

603 The authors have stated explicitly that there are no conflicts of interest in connection with this  
604 article. The authors alone are responsible for the views expressed in this paper, and they do  
605 not necessarily represent the views or policies of the institutions with which they are  
606 affiliated.

607

608 **Acknowledgements**

609 The authors would like to acknowledge Rob Beaglehole for his initial input and discussions  
610 for these papers.

611

612 **List of figures and panels**

613 Figure 1: Expansion of private dental schools in Chile, Brazil and Columbia between 2002  
614 and 2016.

615 Figure 2: Oral health care in Universal Oral Health Health Coverage

616 Figure 3: Compound annual growth rate of sales of commercial baby foods between 2004  
617 and 2017.

618 Figure 4: Oral health in the wider context of sustainable development.

619 Panel: Commercial baby foods – a sugary start in life

620

621 **List of appendices**

622 Panel 1: Limitations of oral health care – a system in need of reform

623 Panel 2: Universal Oral Health Care – experience from Brazil

624 Panel 3: Improving access, affordability and quality of fluoride toothpaste as an essential  
625 public health tool

626 Panel 4: Advocacy in action – experience from New Zealand on tackling sugary drinks

627 Panel 5: Advocacy opportunities for global oral health

628

CONFIDENTIAL

***Panel: Commercial baby foods – a sugary start to life***

The global commercial baby food market is estimated to be worth over US\$37 billion in 2010 with Europe, US and Asia holding the major share of the market. However emerging economies are expected to see high growth in sales.<sup>111</sup> Analysis of sales data in selected countries show high growth rates between 2004 and 2017 particularly in China, United Arab Emirates, Russia, Vietnam, Peru, and Indonesia, although sales have also risen steadily in Czech Republic, Colombia, Brazil and South Africa (Figure 2).

Commercial baby foods are generally highly processed products often containing high sugar levels. A very recent European Commission Report of over 4200 commercial baby foods and drinks sold across Europe revealed that 41% of products analysed contained free sugars.<sup>112</sup> Free sugars were particularly found in baby biscuits and rusks, baby cereals, baby juices and drinks, baby fruit products, desserts and yogurts and baby snacks. An Australian study has recently reported that nearly a quarter (23%) of 12-14 month old babies had consumed free sugars above the 5% WHO recommended level, and that the major source of sugars came from commercial baby foods (27%), cereal based products (20%) and yogurts (10%).<sup>113</sup> The consumption of sweetened commercial baby foods is a major concern as this presents a significant risk for early childhood caries, encourages infants to develop a preference for sweetness and may contribute to overweight in later childhood.

629

630

631

632 References

- 633 1. Kassebaum NJ, Smith AGC, Bernabé E, et al. Global, Regional, and National Prevalence, Incidence,  
634 and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990–2015: A Systematic  
635 Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. *J Dent Res* 2017;**96**:380-387.
- 636 2. Steele J, Clark J, Rooney E, Wilson, T. NHS Dental Services in England: An Independent Review Led  
637 by Professor Jimmy Steele. London; NHS. 2009.
- 638 3. Bernabe E, Sheiham A. Age, period and cohort trends in caries of permanent teeth in four developed  
639 countries. *Am J Public Health* 2014;**104**:e115-21.
- 640 4. Bernabé E, Masood M, Vujicic M. The impact of out-of-pocket payments for dental care on household  
641 finances in low and middle income countries. *BMC Public Health* 2017;**17**:109.
- 642 5. Birch S, Listl S. The Economics of Oral Health and Health Care. Max Planck Institute for Social Law  
643 and Social Policy Discussion Paper No. 07-2015. 2015. Available from:  
644 <https://ssrn.com/abstract=2611060> (accessed Oct 20, 2018).
- 645 6. Yee R, Sheiham A. The burden of restorative dental treatment for children in Third World countries. *Int*  
646 *Dent J* 2002;**52**:1-9.
- 647 7. Baelum V, Van Palestein Helderma W, Hugoson A, Yee R, Fejerskov O. A global perspective on  
648 changes in the burden of caries and periodontitis: implications for dentistry. *J Oral Rehabil*  
649 2007;**34**:872-906.
- 650 8. van Palenstein Helderma WH, Groeneveld A, van der Heijden GJ, van Loveren C, Holmgren CJ,  
651 Benzian H. Adequate evidence to challenge the paradigm of dental caries prevention in early age? *Am J*  
652 *Public Health* 2015;**105**:e5-6.
- 653 9. World Health Organization. Guideline: Sugar Intake for Adults and Children. Geneva; WHO. 2015.
- 654 10. Cohen L, Dahlen G, Escobar A, Fejerskov O, Johnson N, Manji F. Dentistry in crisis: time to change.  
655 La Cascada Declaration. *Aust Dent J* 2017;**62**:258-260.
- 656 11. Vujicic M. Our dental care system is stuck. *J Am Dent Assoc* 2018;**149**:167-169.
- 657 12. Fejerskov O, Escobar G, Jøssing M, Baelum V. A functional natural dentition for all - and for life? The  
658 oral healthcare system needs revision. *J Oral Rehabil* 2013;**40**:707-722.
- 659 13. Mills I, Frost J, Cooper C, Moles DR, Kay E. Patient-centred care in general dental practice--a  
660 systematic review of the literature. *BMC Oral Health* 2014;**14**:64.
- 661 14. Holst D, Sheiham A, Petersen P. Regulating entrepreneurial behaviour in Oral Health Services. In:  
662 Saltman R, Busse R, Mossialos E, (eds). Regulating Entrepreneurial Behaviour in European Health Care

- 663 Systems. Philadelphia: Open University Press; 2002.
- 664 15. Bader JD, Shugars DA. What do we know about how dentists make caries-related treatment decisions?  
665 *Community Dent Oral Epidemiol* 1997;**25**:97-103.
- 666 16. Hayashi M, Haapasalo M, Imazato S, et al. Dentistry in the 21st century: challenges of a globalising  
667 world. *Int Dent J* 2014;**64**:333-342.
- 668 17. Anders PL, Davis EL. Oral health of patients with intellectual disabilities: A systematic review. *Spec*  
669 *Care Dent* 2010;**30**:110-117.
- 670 18. Daly B, Newton T, Batchelor P, Jones K. Oral health care needs and oral health-related quality of life  
671 (OHIP-14) in homeless people. *Community Dent Oral Epidemiol* 2010;**38**:136-144.
- 672 19. Freitas DJ, Kaplan LM, Tieu L, Ponath C, Guzman D, Kushel M. Oral health and access to dental care  
673 among older homeless adults: results from the HOPE HOME study. *J Public Health Dent*. Published  
674 September 2018. DOI: 10.1111/jphd.12288
- 675 20. Kisely S, Quek L-H, Pais J, Laloo R, Johnson NW, Lawrence D. Advanced dental disease in people  
676 with severe mental illness: systematic review and meta-analysis. *Br J Psychiatry* 2011;**199**:187-193.
- 677 21. Walsh T, Tickle M, Milsom K, Buchanan K, Zoitopoulos L. An investigation of the nature of research  
678 into dental health in prisons: a systematic review. *Br Dent J* 2008;**204**:683-689.
- 679 22. Tudor Hart J. The inverse care law. *Lancet* 1971;**297**:405-412.
- 680 23. Oberoi S, Gautam G, Oberoi A, Yadav R. Inverse care law still holds for oral health care in India  
681 despite so many dental graduates: Where do we lack? *J Indian Assoc Public Heal Dent* 2017;**15**:181.
- 682 24. Dehmoobadsharifabadi A, Singhal S, Quiñonez C. Investigating the “inverse care law” in dental care: A  
683 comparative analysis of Canadian jurisdictions. *Can J Public Heal* 2017;**107**:538.
- 684 25. Benzian H, Jean J, Helderma W van P. Illegal oral care: more than a legal issue. *Int Dent J*  
685 2010;**60**:399-406.
- 686 26. Frencken JE, Holmgren CJ, van Palenstein Helderma WH. Basic Package of Oral Care (BPOC).  
687 Nijmegen; 2002. Available from: <http://www.chdentalinstitute.org/images/bpoc.pdf> (accessed Oct 10,  
688 2018).
- 689 27. Chher T, Hak S, Courtel F, Durward C. Improving the provision of the Basic Package of Oral Care  
690 (BPOC) in Cambodia. *Int Dent J* 2009;**59**:47-52.
- 691 28. Kumar S, Ravishankar N, Sumit K, Saran A. Basic package for oral care: relevance and implementation  
692 strategies in Indian scenario: a review. *Int J Basic Appl Med Sci* 2013;**3**:166-170.

- 693 29. Hosseinpoor AR, Itani L, Petersen PE. Socio-economic Inequality in Oral Healthcare Coverage. *J Dent*  
694 *Res* 2012;**91**:275-281.
- 695 30. Newhouse JP, and the Insurance Experiment Group. Free for All? Lessons from the Rand Health  
696 Insurance Experiment. Cambridge: Harvard University Press; 1993.
- 697 31. OECD. Health at a Glance 2013: OECD Indicators. 2013. Available from:  
698 <https://www.oecd.org/els/health-systems/Health-at-a-Glance-2013.pdf> (accessed Oct 15, 2018). ISBN  
699 978-92-64-20502-4
- 700 32. Grytten J. Payment systems and incentives in dentistry. *Community Dent Oral Epidemiol* 2017;**45**:1-11.
- 701 33. Brocklehurst P, Price J, Glenny A-M, et al. The effect of different methods of remuneration on the  
702 behaviour of primary care dentists. *Cochrane Database Syst Rev* 2013.
- 703 34. Chalkley M, Listl S. First do no harm – The impact of financial incentives on dental X-rays. *J Health*  
704 *Econ* 2018;**58**:1-9.
- 705 35. FDI World Dental Federation. The Challenge of Oral Diseases - a Call for Global Action. The Oral  
706 Health Atlas 2nd Edition. Geneva; FDI. 2015.
- 707 36. Pereira F, de Mendonça I, Werneck R, Moysés S, Gabardo M, Moysés S. Human Development Index,  
708 Ratio of Dentists and Inhabitants, and the Decayed, Missing or Filled Teeth Index in Large Cities. *J*  
709 *Contemp Dent Pract* 2018;**19**:1363-1369.
- 710 37. American Dental Education Association. Snapshot of Dental Education 2017-2018. Washington DC;  
711 ADA. 2017.
- 712 38. Venturelli Garay RE, Watt RG. Review and analysis of Chilean dental undergraduate education:  
713 curriculum composition and profiles of first year dental students. *Hum Resour Health* 2018;**16**:48.
- 714 39. Cartes-Velásquez RA. Exponential growth of dental schools in Chile: effects on academic, economic  
715 and workforce issues. *Braz Oral Res* 2013;**27**:471-477.
- 716 40. Jaiswal AK, Srinivas P, Suresh S. Dental manpower in India: changing trends since 1920. *Int Dent J*  
717 2014;**64**:213-218.
- 718 41. Saliba NA, Moimaz SAS, Garbin CAS, Diniz DG. Dentistry in Brazil: its history and current trends. *J*  
719 *Dent Educ* 2009;**73**:225-231.
- 720 42. Jaramillo JA, Pulido JHT, Castro Núñez JA, Bird WF, Komabayashi T. Dental education in Colombia. *J*  
721 *Oral Sci* 2010;**52**:137-143.
- 722 43. Frenk J, Chen L, Bhutta Z a., et al. Health professionals for a new century: Transforming education to  
723 strengthen health systems in an interdependent world. *Lancet* 2010;**376**:1923-1958.

- 724 44. Glick M, Monteiro O, Seeberger GK, et al. FDI Vision 2020 : shaping the future of oral health. *Int Dent*  
725 *J* 2012;**62**:278-291.
- 726 45. UK General Dental Council. Specialist lists. Available from: [https://www.gdc-](https://www.gdc-uk.org/professionals/specialist-lists)  
727 [uk.org/professionals/specialist-lists](https://www.gdc-uk.org/professionals/specialist-lists) (accessed Nov 05, 2018).
- 728 46. Mosedale R, Batchelor P. Dental Specialist Lists: Are They Necessary? *Prim Dent Care* 2012;**19**:111-  
729 115.
- 730 47. Morris A, Burke F. Primary and secondary dental care: the nature of the interface. *Br Dent J*  
731 2001;**191**:660-664.
- 732 48. American Academy of Pediatric Dentistry. Policy on the Dental Home. *Pediatr Dent* 2016;**38**:25-26.
- 733 49. Kandelman D, Arpin S, Baez RJ, Baehni PC, Petersen PE. Oral health care systems in developing and  
734 developed countries. *Periodontol 2000* 2012;**60**:98-109.
- 735 50. Canadian Academy of Health Sciences. Improving Access To Oral Health Care For Vulnerable People  
736 Living In Canada. Ottawa; CAHS.2014.
- 737 51. Brantley CF, Bader JD, Shugars DA, Nesbit SP. Does the cycle of reresoration lead to larger  
738 restorations? *J Am Dent Assoc* 1995;**126**:1407-1413.
- 739 52. Elderton RJ. Clinical Studies Concerning Re-Restoration of Teeth. *Adv Dent Res* 1990;**4**:4-9.
- 740 53. Burke FJT, Lucarotti PSK. Ten-year outcome of crowns placed within the General Dental Services in  
741 England and Wales. *J Dent* 2009;**37**:12-24.
- 742 54. Lumley PJ, Lucarotti PSK, Burke FJT. Ten-year outcome of root fillings in the General Dental Services  
743 in England and Wales. *Int Endod J* 2008;**41**:577-585.
- 744 55. Burke FJT, Lucarotti PSK. Ten year survival of bridges placed in the General Dental Services in  
745 England And Wales. *J Dent* 2012;**40**:886-895.
- 746 56. Featherstone JDB, Domejean-Orliaguet S, Jenson L, Wolff M, Young DA. Caries risk assessment in  
747 practice for age 6 through adult. *J Calif Dent Assoc* 2007;**35**:703-707, 710-713.
- 748 57. The American Academy of Pediatric Dentistry (AAPD). Guideline on Caries-Risk Assessment and  
749 Management for Infants, Children, and Adolescents. 2014. Available from:  
750 [https://www.aapd.org/media/Policies\\_Guidelines/BP\\_CariesRiskAssessment.pdf](https://www.aapd.org/media/Policies_Guidelines/BP_CariesRiskAssessment.pdf) (accessed Nov 05,  
751 2018).
- 752 58. Banerjee A, Doméjean S. The contemporary approach to tooth preservation: minimum intervention (MI)  
753 caries management in general practice. *Prim Dent J* 2013;**2**:30-37.

- 754 59. Fejerskov O. Concepts of dental caries and their consequences for understanding the disease.  
755 *Community Dent Oral Epidemiol* 1997;**25**:5-12.
- 756 60. Fejerskov O. Changing Paradigms in Concepts on Dental Caries: Consequences for Oral Health Care.  
757 *Caries Res* 2004;**38**:182-191.
- 758 61. Marinho VC, Higgins J, Logan S, Sheiham A. Fluoride toothpastes for preventing dental caries in  
759 children and adolescents. *Cochrane Database Syst Rev* 2003:CD002278.
- 760 62. Marinho VC, Higgins JP, Sheiham A, Logan S. Combinations of topical fluoride (toothpastes,  
761 mouthrinses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and  
762 adolescents. *Cochrane Database Syst Rev*. 2004;(1):CD002781
- 763 63. Fisher J, Varenne B, Narvaez D, Vickers C. The Minamata Convention and the phase down of dental  
764 amalgam. *Bull World Health Organ* 2018;**96**:436-438.
- 765 64. Bader JD. Challenges in quality assessment of dental care. *J Am Dent Assoc* 2009;**140**:1456-1464.
- 766 65. Bader JD. Stumbling into the Age of Evidence. *Dent Clin North Am* 2009;**53**:15-22.
- 767 66. Sheiham A. Is there a scientific basis for six-monthly dental examinations? *Lancet* 1977;**310**:442-444.
- 768 67. National Institute for Health and Care Excellence (NICE). Dental Checks: Intervals between Oral  
769 Health Reviews. Clinical Guideline 19, October 2004. London; 2004. Available from:  
770 <https://www.nice.org.uk/guidance/cg19> (accessed Oct 15, 2018).
- 771 68. Clarkson JE, Ramsay CR, Averley P, et al. IQuaD dental trial; improving the quality of dentistry: a  
772 multicentre randomised controlled trial comparing oral hygiene advice and periodontal instrumentation  
773 for the prevention and management of periodontal disease in dentate adults attending dental pri. *BMC*  
774 *Oral Health* 2013;**13**:58.
- 775 69. Public Health England. *Delivering Better Oral Health: An Evidence-Based Toolkit for Prevention. Third*  
776 *Edition.*; 2017.
- 777 70. Moynihan PJ, Kelly SAM. Effect on Caries of Restricting Sugars Intake. *J Dent Res* 2014;**93**:8-18.
- 778 71. Sheiham A, James WPT. Diet and Dental Caries. *J Dent Res* 2015;**94**:1341-1347.
- 779 72. Kay EJ, Locker D. Is dental health education effective? A systematic review of current evidence.  
780 *Community Dent Oral Epidemiol* 1996;**24**:231-235.
- 781 73. Watt RG, Marinho VC. Does oral health promotion improve oral hygiene and gingival health?  
782 *Periodontol* 2000 2005;**37**:35-47.
- 783 74. Harris R, Gamboa A, Dailey Y, Ashcroft A. One-to-one dietary interventions undertaken in a dental

- 784 setting to change dietary behaviour. *Cochrane Database Syst Rev* 2012:CD006540.
- 785 75. Masters R, Anwar E, Collins B, Cookson R, Capewell S. Return on investment of public health  
786 interventions: a systematic review. *J Epidemiol Community Health* 2017;**71**:827-834.
- 787 76. Zavras D, Zavras AI, Kyriopoulos I-I, Kyriopoulos J. Economic crisis, austerity and unmet healthcare  
788 needs: the case of Greece. *BMC Health Serv Res* 2016;**16**:309.
- 789 77. Calzón Fernández S, Fernández Ajuria A, Martín JJ, Murphy MJ. The impact of the economic crisis on  
790 unmet dental care needs in Spain. *J Epidemiol Community Health* 2015;**69**:880-885.
- 791 78. Tomar SL, Cohen LK. Attributes of an ideal oral health care system. *J Public Health Dent* 2010;**70**:S6-  
792 S14.
- 793 79. Fisher J, Selikowitz H-S, Mathur M, Varenne B. Strengthening oral health for universal health  
794 coverage. *Lancet* 2018;**392**:899-901.
- 795 80. Mathur MR, Williams DM, Reddy KS, Watt RG. Universal Health Coverage. *J Dent Res* 2015;**94**:3S-  
796 5S.
- 797 81. Albino JEN, Inglehart MR, Tedesco LA. Dental Education and Changing Oral Health Care Needs:  
798 Disparities and Demands. *J Dent Educ* 2012;**76**:75-88.
- 799 82. Association of Canadian Faculties of Dentistry. ACFD Educational Framework for the Development of  
800 Competency in Dental Programs. 2016. Available from: [https://acfd.ca/wp-content/uploads/ACFD-  
801 Educational-Framework-for-the-Development-of-Competency-in-Dental-Programs\\_2016.pdf](https://acfd.ca/wp-content/uploads/ACFD-Educational-Framework-for-the-Development-of-Competency-in-Dental-Programs_2016.pdf) (accessed  
802 Nov 8, 2018).
- 803 83. Tubert-Jeannin S, Jourdan D. Renovating dental education: A public health issue. *Eur J Dent Educ*  
804 2018;**22**:e644-e647.
- 805 84. Lidert K. Brazil: Bolsa Familia Program: Scaling-up Cash Transfers for the Poor. MfDR Principles in  
806 Action: Sourcebook on Emerging Good Practices. Washington DC; 2005. Available from:  
807 <http://www.mfdr.org/sourcebook/6-1Brazil-BolsaFamilia.pdf> (accessed Nov 05, 2018).
- 808 85. The World Bank. Project Appraisal Document: Brazil Bolsa Familia Project. Report No. 28544-BR.  
809 Washington DC; 2004. Available from:  
810 <http://documents.worldbank.org/curated/en/792901468770374532/Brazil-Bolsa-Familia-Project>  
811 (accessed Nov 05, 2018).
- 812 86. Eichler R. Can “Pay for Performance” Increase Utilization by the Poor and Improve the Quality of  
813 Health Services? Washington DC: Center for Global Development; 2009.
- 814 87. Ramji S, Quiñonez C. Public preferences for government spending in Canada. *Int J Equity Health*

- 815 2012;**11**:64.
- 816 88. Sgan-Cohen HD, Evans RW, Whelton H, et al. IADR Global Oral Health Inequalities Research Agenda  
817 (IADR-GOHIRA®). *J Dent Res* 2013;**92**:209-211.
- 818 89. FDI World Dental Federation. Sugars and Dental Caries: A Practical Guide to Reduce Sugars  
819 Consumption and Curb the Epidemic of Dental Caries. Geneva; FDI. 2016. Available from:  
820 [https://www.fdiworlddental.org/sites/default/files/media/resources/sugar\\_toolkit-fdi-2016.pdf](https://www.fdiworlddental.org/sites/default/files/media/resources/sugar_toolkit-fdi-2016.pdf) (accessed  
821 Sept 15, 2018).
- 822 90. Yevlahova D, Satur J. Models for individual oral health promotion and their effectiveness: a systematic  
823 review. *Aust Dent J* 2009;**54**:190-197.
- 824 91. Public Health England. Local authorities improving oral health: commissioning better oral health for  
825 children and young people: an evidence-informed toolkit for local authorities. 2014;66. Available from:  
826 [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/32150](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/321503/CBOHMaindocumentJUNE2014.pdf)  
827 [3/CBOHMaindocumentJUNE2014.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/321503/CBOHMaindocumentJUNE2014.pdf) (accessed Aug 21, 2018).
- 828 92. Schou L, Wight C. Does dental health education affect inequalities in dental health? *Community Dent*  
829 *Health* 1994;**11**:97-100.
- 830 93. National Institute for Health and Clinical Excellence (NICE). Behaviour Change at Population,  
831 Community and Individual Levels. NICE Public Health Guidance 6.. London; NICE. 2007.
- 832 94. Qadri G, Alkilzy M, Franze M, Hoffmann W, Splieth C. School-based oral health education increases  
833 caries inequalities. *Community Dent Health* 2018;**35**:153-159.
- 834 95. Te Morenga L, Mallard S, Mann J. Dietary sugars and body weight: systematic review and meta-  
835 analyses of randomised controlled trials and cohort studies. *BMJ* 2012;**346**:e7492.
- 836 96. Scientific Advisory Committee on Nutrition. Report on Carbohydrates and Health. London; SACN.  
837 2015.
- 838 97. Public Health England. Sugar Reduction: The Evidence for Action. London; PHE. 2015
- 839 98. UK Health Forum. Options for Action to Support the Reduction of Sugar Intakes in the UK. London;  
840 2014. Available from: <http://www.ukhealthforum.org.uk/prevention/pie/?EntryId43=35927> (accessed  
841 Sept 16, 2018).
- 842 99. James WPT. Taking action on sugar. *Lancet Diabetes Endocrinol* 2016;**4**:92-94.
- 843 100. Moodie R, Stuckler D, Monteiro C, et al. Profits and pandemics: prevention of harmful effects of  
844 tobacco, alcohol, and ultra-processed food and drink industries. *Lancet* 2013;**381**:670-679.
- 845 101. McKee M, Stuckler D. Realising an election manifesto for public health in the UK. *Lancet*

- 846 2015;**385**:665-666.
- 847 102. Lobstein T. Sugar: a shove to industry rather than a nudge to consumers? *Lancet Diabetes Endocrinol*  
848 2016;**4**:86-87.
- 849 103. World Cancer Research Fund International. Building Momentum: Lessons on Implementing a Robust  
850 Sugar Sweetened Beverage Tax. London; WCRF. 2018.
- 851 104. Barrientos-Gutierrez T, Zepeda-Tello R, Rodrigues ER, et al. Expected population weight and diabetes  
852 impact of the 1-peso-per-litre tax to sugar sweetened beverages in Mexico. Huerta-Quintanilla R, ed.  
853 *PLoS One* 2017;**12**:e0176336.
- 854 105. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. In Mexico, Evidence Of Sustained Consumer  
855 Response Two Years After Implementing A Sugar-Sweetened Beverage Tax. *Health Aff* 2017;**36**:564-  
856 571.
- 857 106. Benzian H, Hobdell M, Holmgren C, et al. Political priority of global oral health: an analysis of reasons  
858 for international neglect. *Int Dent J* 2011;**61**:124-130.
- 859 107. Maher A, Sridhar D. Political priority in the global fight against non-communicable diseases. *J Glob*  
860 *Health* 2012;**2**:020403.
- 861 108. Akpabio SP. Achieving Oral Health by the Year 2000. In: Lambo T.A., Day S.B. (eds) Issues in  
862 Contemporary International Health. Springer, Boston, MA. 1990.
- 863 109. Zillén PA. 1994--the World Year of Oral Health. *FDI World* **3**:13-15.
- 864 110. Aggeryd T. Goals for oral health in the year 2000: cooperation between WHO, FDI and the national  
865 dental associations. *Int Dent J* 1983;**33**:55-59.
- 866 111. Internal Markets Bureau. Global Pathfinder Report: Baby Food Market Indicator Report. Ottawa; 2011.  
867 Available from: [http://publications.gc.ca/collections/collection\\_2011/agr/A74-1-18-2011-eng.pdf](http://publications.gc.ca/collections/collection_2011/agr/A74-1-18-2011-eng.pdf)  
868 (accessed Sep 15, 2018).
- 869 112. Grammatikaki E, Wollgast J, Caldeira S. Feeding Infants and Young Children. An Analysis of National  
870 Food-Based Dietary Guidelines and Specific Products Available in the EU Market. EUR 29395 EN.  
871 Luxembourg; Publications Office of the European Union, 2018. DOI:10.2760/218102, 2018.
- 872 113. Devenish G, Ytterstad E, Begley A, Do L, Scott J. Intake, sources, and determinants of free sugars  
873 intake in Australian children aged 12-14 months. *Matern Child Nutr* October 2018:e12692.

874

875

876  
877  
878

879

880

CONFIDENTIAL