

1 **TITLE PAGE**

2

3 **Title:** Knowledge and opinions of French dental students related to caries risk assessment and dental sealants  
4 (preventive and therapeutic)

5

6 **Authors:** Justine Le Clerc <sup>1</sup>, Marie-Agnès Gasqui <sup>2</sup>, Laurent Laforest <sup>3</sup>, Maxime Beurain <sup>4</sup>, Romain Céinos <sup>5</sup>,  
7 Florence Chemla <sup>6</sup>, Valérie Chevalier <sup>7</sup>, Pierre Colon <sup>8</sup>, Florence Fioretti <sup>9</sup>, Alexis Gevrey <sup>10</sup>, Olivia Kérouédan  
8 <sup>11</sup>, Delphine Maret <sup>12</sup>, Caroline Mocquot <sup>8</sup>, Canan Özcan <sup>13</sup>, Bruno Pelissier <sup>14</sup>, Fabienne Pérez <sup>15</sup>, Elodie Terrer <sup>16</sup>,  
9 Yann-Loïg Turpin <sup>17</sup>, Reza Arbab-Chirani <sup>18</sup>, Dominique Seux <sup>2</sup>, Sophie Doméjean <sup>19</sup>

10

11 **Affiliations**

12 <sup>1</sup> Univ Rennes, CHU Rennes (pôle odontologie), CNRS, ISCR (Institut des Sciences Chimiques de Rennes) - UMR  
13 6226, Rennes, France

14 <sup>2</sup> UFR d'Odontologie, Laboratoire des Multimatériaux et Interfaces, UMR CNRS 5615, Université Lyon 1, Lyon,  
15 France; Hospices Civils de Lyon, Département d'Odontologie Conservatrice, Lyon, France

16 <sup>3</sup> UFR d'Odontologie, Université Lyon 1, Lyon France

17 <sup>4</sup> UFR d'odontologie, Lille, France

18 <sup>5</sup> Université Côte d'Azur, UFR d'odontologie de Nice; Hôpital St Roch, pôle Odontologie, CHU de Nice; UMR  
19 7268, Anthropologie bio-culturelle, Droit Éthique et Santé (ADES), Aix-Marseille Université, France

20 <sup>6</sup> Faculté de chirurgie dentaire de l'université Paris Descartes; Service de médecine buccodentaire de l'hôpital  
21 Charles Foix, APHP Paris, France

22 <sup>7</sup> UFR d'odontologie de Brest, UBO, Brest ; CHRU de Brest; Institut de Recherche Dupuy de Lome, UMR CNRS  
23 6027, F-29200 Brest, France

24 <sup>8</sup> Université de Paris, Faculté dentaire, Hôpital Rothschild, Assistance Publique-Hôpitaux de Paris, France. Univ  
25 Lyon - Claude Bernard Lyon 1, UMR CNRS 5615, Laboratoire des Multimatériaux et Interfaces, F-69622  
26 Villeurbanne, France

27 <sup>9</sup> Faculté de Chirurgie Dentaire de l'Université de Strasbourg, Pôle de Médecine et Chirurgie Bucco-dentaires des  
28 Hôpitaux Universitaires, UMR INSERM 1260, Strasbourg, France

29 <sup>10</sup> UFR d'odontologie, Nancy, France

30 <sup>11</sup> Université de Bordeaux, UFR des Sciences Odontologiques, F-33076 Bordeaux, France; CHU de Bordeaux,  
31 Service de Médecine Bucco-dentaire, F-33076 Bordeaux, France; INSERM, Bioingénierie Tissulaire, U1026, F-  
32 33076 Bordeaux, France

33 <sup>12</sup> UFR d'odontologie, Toulouse, CHU de Toulouse, Laboratoire AMIS, UMR 5288 CNRS, Toulouse, France

34 <sup>13</sup> Département d'odontologie conservatrice, Université de Reims Champagne-Ardenne, UFR d'Odontologie,  
35 Reims, France

36 <sup>14</sup> UFR d'odontologie, Montpellier, France

37 <sup>15</sup> Département d'Odontologie Conservatrice-Endodontie, Univ Nantes, UFR Odontologie & CHU Nantes, PHU  
38 4 OTONN, 44042 Nantes, France

39 <sup>16</sup> UFR d'odontologie, Aix-Marseille Univ., IRD, MEPHI, IHU Méditerranée Infection, Marseille, France

40 <sup>17</sup> Univ Rennes, CHU Rennes (pôle odontologie), France

41 <sup>18</sup> UFR d'odontologie de Brest, UBO, Brest; CHRU de Brest; LaTIM UMR 1101 INSREM, Brest, France

42 <sup>19</sup> Département d'Odontologie Conservatrice, Univ Clermont Auvergne, UFR d'Odontologie; Centre de Recherche  
43 en Odontologie Clinique EA 4847, F-63100 Clermont-Ferrand, France; CHU Estaing Clermont-Ferrand, Service  
44 d'Odontologie, F-63001 Clermont-Ferrand, France

45

#### 46 **Author contributions**

47 Conceptualization: Sophie Doméjean and Dominique Seux

48 Methodology: Sophie Doméjean and Dominique Seux

49 Data collection: Justine Le Clerc, Marie-Agnès Gasqui, Laurent Laforest, Maxime Beaurain, Romain Ceinos,  
50 Florence Chemla, Valérie Chevalier, Pierre Colon, Florence Fioretti, Alexis Gevrey, Olivia Kérouédan, Delphine  
51 Maret, Caroline Mocquot, Canan Özcan, Bruno Pelissier, Fabienne Pérez, Elodie Terrer, Yann-Loïc Turpin, Reza  
52 Arbab-Chirani, Dominique Seux, Sophie Doméjean

53 Data entry: Sophie Doméjean, Dominique Seux and Marie-Agnès Gasqui

54 Formal analysis: Sophie Doméjean, Dominique Seux and Laurent Laforest

55 Writing - original draft preparation: Justine Le Clerc

56 Writing - review and editing: Sophie Doméjean, Dominique Seux, Laurent Laforest, Marie-Agnès Gasqui, Laurent  
57 Laforest, Maxime Beaurain, Romain Ceinos, Florence Chemla, Valérie Chevalier, Pierre Colon, Florence Fioretti,  
58 Alexis Gevrey, Olivia Kérouédan, Delphine Maret, Caroline Mocquot, Canan Özcan, Bruno Pelissier, Fabienne  
59 Pérez, Elodie Terrer, Yann-Loïc Turpin, Reza Arbab-Chirani

60 Supervision: Sophie Doméjean and Dominique Seux

61 All authors read and approved the final manuscript.

62

#### 63 **Corresponding author**

64 Sophie Doméjean

65 UFR d'Odontologie

66 2 rue de Braga, 63100 Clermont-Ferrand, France

67 E-mail: [sophie.domejean@uca.fr](mailto:sophie.domejean@uca.fr)

68 Tel: +33 6 63 04 71 43

69

#### 70 **Abstract**

71 **Objectives:** A national questionnaire study was performed to document knowledge and opinions of French dental  
72 students (FDSs) about minimal intervention (MI) in dentistry especially caries risk assessment (CRA) and dental  
73 sealants (DSs).

74 **Materials and Methods:** A questionnaire was administered to the fifth-year dental FDSs (n=1,370) from the 16  
75 French dental schools. Descriptive and statistical analyses were performed.

76 **Results:** The response rate was 84.5%. A large majority of respondents (87.8%) linked MI with minimally invasive  
77 dentistry and 77.4% considered MI as a concept based on prevention. About 80% stated they use CRA in clinical  
78 practice, mostly without any specific form. If 80.4% of the respondents would base their treatment plans on CRA,  
79 only 55.1% would regularly plan preventive regimens according to individual risk level. However, while 96.6%  
80 declared they perform preventive DSs, only 44.3% considered therapeutic sealants as a routine treatment. Although

81 75.1% of FDSs stated that they had sufficient learning and training related to CRA, 55.9% thought that they need  
82 further education about preventive and therapeutic DSs.

83 **Conclusion:** Although FDSs seem to be aware of the importance of CRA and preventive strategies, this study  
84 shows the need to harmonize the teaching in cariology according to the latest European recommendations.

85 **Clinical relevance:** A national questionnaire study showed variability towards knowledge and opinions of FDSs  
86 related to minimal intervention in cariology. This may impact care provisions in their future professional life  
87 showing the urgent need to harmonize the teaching of MI in cariology in France.

88

89 **Key-words**

90 • *Minimal intervention dentistry*

91 • *Caries risk assessment*

92 • *Dental sealants*

93 • *Dental students*

94 • *Questionnaire survey*

95

96 **Acknowledgements:** The authors thank Colgate® France for administrative support (printing and postal fees  
97 were sponsored by Colgate® France) and Laura Dupont-Butez for her help in data entry.

98 **Introduction**

99  
100 Minimal intervention in dentistry (MID) in general and in cariology in particular was first described in the literature  
101 with two major articles in the early 1990s [1, 2]. Indeed, Dawson and Makinson introduced an emerging movement  
102 in the late 1980s in UK, which denounced the inadequacy between patient needs and care provision in restorative  
103 dentistry. In 1992, the foundations of MID were thus laid as these two authors suggested that “Prevention”,  
104 “Remineralization”, “Minimal intervention” and “Reducing the rate of restoration placement” could be combined  
105 to achieve a less destructive form of dental treatment [2]. Since then, in the light of accumulated knowledge in  
106 cariology (histology, microbiology, pathophysiology, validated clinical procedures), this has led to the  
107 development of various diagnosis and treatment concepts [3-8]. The latest comprehensive practice guide Caries  
108 Care International [8] promotes a patient-centered, risk-based approach to caries management designed for dental  
109 practice. It advocates for a health outcomes-focused system that aims to maintain oral health and preserve tooth  
110 structure in the long term. In that context, this is obvious that caries risk assessment (CRA) as well as preventive  
111 and non-invasive cares (such as dental sealants (DSs)) are essential in caries management.

112 Questionnaire surveys were conducted in France to assess professional dental practice in terms of minimal  
113 intervention (MI) in caries management. In general, studies investigating various domains of caries management  
114 (CRA use, DSs placement, restorative threshold for both occlusal and approximal lesion and deep caries  
115 management) showed that MI is still insufficiently implemented in everyday clinical practice by French general  
116 dental practitioners (FGDPs) practicing in France [9-13] [1-5]. For example, Schwendicke et al showed that more  
117 than 65% of the respondents promote complete dentin excavation when selective excavation would have been  
118 indicated in deep carious lesions without any sign of pulpal involvement [5]. In the same way, Doméjean et al  
119 reported that caries risk assessment (CRA) was not part of their routine practice [4] and that FGDPs would prepare  
120 cavities and place restorations for lesions that could benefit from non-invasive strategies [2]. Regarding the use of  
121 dental sealants (DSs), even though the majority of FGDPs (90%) performed preventive DSs, less than half of them  
122 (42%) considered therapeutic DSs as a routine treatment for non-cavitated carious lesions [3]. It is known that  
123 changing professional practice takes time [14]-[6] and is subordinated to a range of factors related to financial  
124 considerations (such as remuneration or risk of losing incomes), patients demands and expectations, organizational  
125 factors (delegation possibility), GDPs personal attitudes (personal resistance and inertia to change) and, of course,  
126 to GDPs education (pre- and post-graduate) [15] [7]. It might be speculated that the gap between science and  
127 clinical practice described among FGDPs and worldwide [16] could find its origin in dental schools. In that  
128 context, the French national [16] [16] [16] [15] college of teachers in conservative dentistry (collège national des  
129 enseignants en odontologie conservatrice or CNEOC) started giving thought to what French dental students (FDSs)  
130 of the 16 French dental schools know about MI.

131 A study, which is the first of its kind in France, was thus undertaken to investigate the knowledge and opinions of  
132 FDSs at a national level about several areas of MI in cariology, namely CRA, DSs (preventive and therapeutic),  
133 restorative threshold and strategies for approximal and occlusal lesions, and deep carious lesion management. The  
134 present manuscript focuses on the first two above-mentioned areas i.e. CRA and DSs.

135  
136 **Material and methods**

137 A questionnaire survey was administered during spring 2018 to the fifth-year FDSs from the 16 French

138 dental schools. This project is institutionally supported by the ~~Collège National des Enseignants en Odontologie~~  
139 ~~Conservatrice (CNEOC; French national association of teachers in conservative dentistry)~~. The printing and  
140 postal-mailing costs were sponsored by Colgate® France.

#### 141 **Population study and questionnaire administration**

142 The study involved all fifth-year (penultimate year before graduation) FDSs (n=1,370 in 2018) from the  
143 16 French dental schools (Bordeaux, Brest, Clermont-Ferrand, Lille, Lyon, Marseille, Montpellier, Nancy, Nantes,  
144 Nice, Paris Descartes, Paris Diderot, Reims, Rennes, Strasbourg and Toulouse).

145 A compilation of five questionnaires that had been previously used for surveys among FGDPs and French  
146 university teachers [9-13, 17][1-5, 8] was auto-administrated (paper format – 18 pages) to the FDSs in a specific  
147 session organized in each of the 16 French dental schools. It consisted of several question formats (yes/no  
148 questions, closed-ended questions with forced choice or multiple allowable answers and open-ended questions  
149 with open-ended written); five different parts can be identified and can be divided in the following sections:

- 150 ▪ Section 1: demographic characteristics of the respondents (birth year and gender); and a question related  
151 to the reading of scientific articles about MI in cariology in addition to academic lectures and tutorials;
- 152 ▪ Section 2: 13 questions related to CRA [12][4];
- 153 ▪ Section 3: 16 questions related to preventive and therapeutic DSs [11][3];
- 154 ▪ Section 4: 17 questions related to restorative threshold for approximal and occlusal carious lesions, to  
155 two clinical cases of minor or questionable occlusal lesions (based on occlusal views and radiographs)  
156 and to beliefs about selected aspects of caries diagnosis / treatment [9, 10, 17][1-2, 8];
- 157 ▪ Section 5: 13 questions related to deep carious lesion management (including three clinical cases) [13][5].

158 The content of the different sections is detailed in the principles articles [9-13, 17][1-5, 8].

#### 159 **Capture and analysis of data**

160 Data were entered into Excel spread sheets by four people (three dentists (MAG, DS, SD) and a Master  
161 student (LDB)). Descriptive and statistical analyses were performed with SPSS® (IBM SPSS Statistics Version  
162 19). A  $\chi^2$  test was used to assess the associations between responses related to, on the one hand, CRA, DSs,  
163 restorative threshold/strategies for approximal and occlusal lesions and deep carious lesion management and, on  
164 the other hand, gender and additional reading of scientific articles about MI in cariology. Univariate and  
165 multivariate logistic regressions (LRs) were performed; odd ratios (ORs) and their 95% confidence intervals  
166 (95%CI) were calculated to correlate the use of CRA in everyday practice and the sociodemographic  
167 characteristics of the respondents. The level of significance was placed at 5% for all analyses. Only factors with  
168 univariate p-value <0.20 were included in the multivariate models.

169 The present paper only focuses on the results related to sections 1 and 2, namely CRA and preventive and  
170 therapeutic DSs. The following subgroups were used for statistical analysis:

- 171 ▪ Question on the importance of different factors in treatment planning for adult patients: “not or marginally  
172 important” (grade 1) *versus* “moderately important” (grade 2) *versus* “very to extremely important”  
173 (grade 3);
- 174 ▪ Question on the respondents’ opinions about general concerns related to preventive and therapeutic DSs:  
175 “disagreement (partial or total)” (grade 1) *versus* “neutral” (grade 2) *versus* “agreement (partial or total)”  
176 (grade 3).

178 **Results**

179 All of the 16 French dental schools participated to the survey. A total of 1,158 fulfilled questionnaires  
180 were collected, leading to a response rate of 84.5% (from 32.9 to 100%). The respondent population was composed  
181 of 53.5% of women (n=619) and 46.5% of men (n=539). The average age of the participants, at the time of the  
182 study, was 24.5 ( $\pm 2.12$ ) year-old (min. 21 – max. 44). Approximately one third of the respondents (35%) had  
183 already read publications about MI in cariology. Men were more likely to read scientific articles than women  
184 ( $p=0.032$ ).

185 **CRA**

186 Interestingly, 81.1% of respondents stated they use CRA in clinical practice, most of them without any  
187 specific form (73.5%). The reasons for not using CRA are listed in Table 1. Lack of time appears to be the most  
188 important factor identified (67.7%) followed by lack of teaching during undergraduate education (30.9%) and  
189 insufficient knowledge on CRA (23.5%). Among those who answered they do not assess the caries risk of their  
190 patients, 73.6% would appreciate the delegation of this task to other dental personnel i.e dental hygienists (69.9%)  
191 or other GDPs (3.7%), when 12% would not delegate CRA (14.4% having no opinion). Men were more likely  
192 than women to denounce the problem of billing and reimbursement as barriers to the CRA use ( $p=0.037$ ). Table 2  
193 shows the results of the univariate and multivariate LRs investigating the correlation between the use of CRA and  
194 sociodemographic data. The LR shows that respondents who considered initial training on CRA as sufficient were  
195 more likely to perform CRA than the others (OR: 2.46; 95 % CI: 1.79–3.37;  $p$ -value $<0.001$ ).

196 If 80.4% of the respondents would base their individual treatment plans on CRA, only 55.1% would  
197 regularly plan preventive regimens according to risk level. Respondents who are more likely to establish individual  
198 preventive strategies based on CRA are MI scientific article readers ( $p=0.028$ ). Table 3 shows a summary of  
199 preventive treatments proposed by respondents: DSs (83.4%), fluoride (F) varnish application (69%) and F  
200 toothpaste > 1,500ppm prescription (41.6%) were the most cited options. FDSs who already read scientific  
201 publications about MI were more likely to indicate > 1,500ppm F toothpaste ( $p=0.046$ ), CPP/ACP (for casein  
202 phosphopeptide - amorphous calcium phosphate) agents ( $p<0.001$ ) and F gel professional application ( $p=0.001$ )  
203 than the others. Almost 80% (n=905) of the respondents declared combining regularly from two to four preventive  
204 options.

205 Table 4 summarizes the hierarchy of factors being considered in a CRA in adult patients. The three most  
206 cited factors considered as important were: current oral hygiene (87.4%), patient's motivation (45%) and the  
207 presence of active carious lesion (37%). The three most cited factors considered as irrelevant were: reimbursement  
208 (73.7%), dentist's subjective assessment (53.2%) and patient's age (31.6%). Table 5 indicates the results of the  
209 uni- and multi-variate LRs performed to investigate the associations between the use of CRA in adults and factors  
210 considered as being important. In multivariate analysis, current diet was, by far, the factor with the strongest  
211 statistical association with CRA use (OR: 1.80; 95% CI: 1.25–2.59;  $p$ -value: 0.0014). Considering reimbursement  
212 and patient's comprehension of the causes were other significantly related factors ( $p=0.0393$  and  $p=0.0497$ ,  
213 respectively).

214 Table 6 shows the factors that are considered by FDSs to be important for the treatment plan in adults.  
215 The three most cited factors were as follows: current oral hygiene (95.7%), patient motivation (91.9%) and the  
216 regularity of patient visits (75.6%). The respondent sociodemographic characteristics appeared to influence their  
217 answers. For example, women are more likely to designate the presence of several large restorations, the presence

218 of dental appliances, the patient comprehension of the causes of caries and the regularity of patient visits as  
219 important factors ( $p=0.045$ ;  $p=0.005$ ;  $p<0.001$  and  $p=0.007$ , respectively). FDSs who read articles on MI also  
220 mentioned the presence of active carious lesion ( $p=0.041$ ), the current use of F toothpaste ( $p=0.001$ ) and the current  
221 diet ( $p<0.001$ ) as main factors in a treatment plan for adults more likely than the others.

#### 222 ***Understanding/perception of the term “MI” in cariology***

223 Table 7 provides an overview of the understanding/perception of the term “MI” in cariology. A large  
224 majority of respondents (87.8%) linked MI with minimally invasive dentistry while 77.4% considered it as a  
225 concept based on prevention. Women were more likely to answer that MI is based on prevention ( $p=0.013$ ) and  
226 that MI could be implemented into private practice ( $p<0.001$ ). Moreover, 6.4% reported that they did not exactly  
227 know what MI in cariology means.

#### 228 ***Preventive and therapeutic DSs***

229 While 96.6% of the respondents declared they perform preventive DSs (PDSs), only 44.3% considered  
230 therapeutic DSs (TDSs) as a routine treatment. FDSs who read articles on MI were more likely to perform TDSs  
231 ( $p<0.001$ ) than the others. The lack of formation, the risk of progression of pre-existing carious lesion and the lack  
232 of recommendations appeared to be the main reasons for not considering TDSs in their panel of caries management  
233 strategies (Figure 1). Table 8 summarizes the respondents’ degree of agreement regarding six statements about  
234 DSs: 76.4% considered there are strong evidence on the effectiveness of DSs to prevent dental caries and 92.4%  
235 were aware that DSs placement implies a follow-up.

236 Table 9 shows the preferences of the respondents for PDSs and TDSs in terms of patient profile (age and  
237 caries risk level) and the choice of material. Composite resin is the preferred material (PDSs: 60.6%; TDSs: 37%),  
238 especially for respondents who read articles on MI ( $p<0.001$ ). Almost 85% (especially women  $p=0.042$  and  
239 respondents who read articles on MI  $p=0.018$ ) combined PDSs with other preventive measures – based on the age  
240 of patient (Table 10).

#### 241 ***DSs and task delegation***

242 Almost half of the respondents (48.8%) would appreciate the possibility of task delegation to other dental  
243 personnel. Respondents who read articles on MI were more likely to refuse task delegation ( $p=0.043$ ).

#### 244 ***National recommendations and need for further education toward CRA and DSs***

245 Only 26.1% of the respondents seemed to be familiar with the French national recommendations of the  
246 French High Authority for Health (HAS). While 75.1% stated they had sufficient education towards CRA, 55.9%  
247 reported the need for further education on PDSs and TDSs.

248

#### 249 ***Discussion***

250 The purpose of this study, the first of its kind in France and in the world, was to provide an overview of the  
251 knowledge and opinions of French fifth-year dental students related to CRA and DSs. Studies were previously  
252 carried out to assess the teaching of cariology in Europe [18][9] and in Oceania [19][10], but, to our knowledge,  
253 no publications were interested in what FDSs, following courses on MI, learn and remember. The logistical part  
254 of this study (questionnaire printing and mailing) was supported by Colgate®, but the results were independently  
255 analysed by the authors. As the questionnaire only concerned the learning outcomes, no approval of ethical  
256 committees was required according to the French regulation. The 16 French dental schools, all supported by the  
257 French State (there are no private dental schools in France), took part in the survey and it can be hypothesized that,

258 as the response rate is about 85%, the results are highly representative of the knowledge and opinions of all French  
259 fifth-year dental students at the time of the study. Disparities in response rates between schools could be denounced  
260 as a potential bias in the interpretation of the results. Those disparities are related to the fact that, in some schools,  
261 the presence of students at the questionnaire administration session was not compulsory. Thus, the non-responses  
262 were not linked to the content of the questionnaire and the lack of interest toward MI but only to the irregular  
263 school attendance of a fraction of the student population, varying from school to school. In that context, it can be  
264 hypothesized that the non-responses do not induce any bias in the interpretation of the results and that the present  
265 results are highly representative of the knowledge and practices of FDSs. A comparison between schools was not  
266 expected, as the aim of the study was to collectively analyse the knowledge of all future dental French practitioners  
267 and not to establish a ranking of schools. Nevertheless, this study does present some limitations. The dental course  
268 in France lasts six years and it could have been more pertinent to administrate the questionnaire to final year FDSs  
269 as MI in cariology is taught all along the course. Nevertheless, it would have been impossible to simultaneously  
270 organise sessions for the questionnaire administration (or within a reasonable period of time to avoid questionnaire  
271 diffusion and potential discussions/responses through social networks) to final year FDSs in all schools. Indeed,  
272 the presence of the FDSs on site may vary dramatically from one school to another due to an internship (similar  
273 to vocational training) in private practice that takes place during this final year. Some authors denounced that there  
274 is little correlation between respondents' stated intervention strategies as reported in questionnaire surveys and  
275 their therapy decisions in clinical practice [20-22]. Nevertheless, others argued that if questionnaire surveys are  
276 not able to measure the respondents' clinical decisions, they give a good idea of their treatment philosophies [23,  
277 24]. The present results thus help to understand FDSs knowledge toward CRA and dental sealants in order to  
278 modify teaching content and approaches accordingly.  
279 The questionnaire used in the present survey consisted of a compilation of questionnaires that had been previously  
280 used for surveys among FGDPs and French university teachers [9-13, 17]. Validation of the questionnaires was  
281 not undertaken since their objective was to describe the knowledge, opinions and practices of dental professionals  
282 concerning various MI domains. This differs from questionnaires where the aim is to diagnose a disease, to screen  
283 patients according to a specific medical condition or to assess quality of life where validation is necessary.  
284 Construct validity of each original questionnaire was, however, evaluated to some extent by pilot-testing the  
285 questionnaires like stipulated in the princeps articles [9-13, 17]. Minor problems in the understanding and  
286 interpretation of some questions were discussed amongst the investigators and slight modifications to the  
287 questionnaire were made. Validation in terms of test-retest reliability of the questionnaire was not evaluated since  
288 it was considered that once the questionnaire has been administered, respondents might seek further information  
289 about some topics covered in the questionnaire, which, in turn, might subsequently change their opinions and  
290 practices. Linguistic validity was not required since the questionnaires were developed in French.

291  
292 It is comforting to notice that a large majority of FDSs (81.1%) stated they regularly conduct CRA, which is  
293 recognized to be the cornerstone of MI treatment planning [25, 26][11, 12]. However, similarly to FGDPs, very  
294 few FDSs based their CRA on the use of a specific form [12, 27-29][4, 13-15]. Despite the criticism about the  
295 lack of clear-cut validation of the proposed protocols/models, CRA forms are intended to help practitioners in  
296 managing a treatment plan strategy suitable for each patient [25, 30][11, 16][25]. CRA forms also allow a more  
297 objective and standardized collection of information, which could help gathering lots of epidemiological data in



298 French hospital dental services, as it has been done at UCSF dental school for more than a decade [31, 32][17, 18].  
299 Moreover, like FGDPs [12][4], FDSs consider current oral hygiene (87.4%) and patient's motivation (45%) as  
300 critical factors in a CRA for adult patients. Similar findings were reported in questionnaire studies among US and

301 Japanese dentists [29, 33][15, 19][28].

302 Like FGDPs, lack of time appears to be the most important factor identified among FDSs for not using CRA  
303 (FGPs: 67.2%; FDSs: 67.7%) [12][4]. However, it is surprising to note that 54.4% also mentioned the lack of  
304 teaching and insufficient knowledge on CRA as reasons for not using CRA in everyday practice, knowing that  
305 CRA should be properly implemented in dental curriculum like suggested in the latest (at the time of the study)  
306 European curriculum recommendations in cariology [34, 35].

307 Most of respondents would appreciate a task  
308 delegation to other dental personnel like dental hygienists but unfortunately the profession of dental hygienists is  
309 still not recognised in France. Like FGDPs, some FDSs also denounce the problem of reimbursement (19.4%) as  
310 barriers to the use of CRA at a regular basis [11, 12][3, 4]. Indeed, the Common Classification of Medical Acts  
311 (Classification Commune des Actes Médicaux or CCAM), which defines codification and billing of fees for  
312 procedures performed in dental practices in France, does not include a code for CRA while the national  
313 recommendations (HAS) encourage CRA in daily routine [20][36]. Regrettably, while the periodontal assessment  
314 has a classification code, the absence of CRA in the CCAM illustrates the lack of consideration of this critical step  
315 in the caries prevention, which should be a major public health concern.

315 DSs are part of the panel of primary and secondary prevention [37, 38][21, 22]; PDSs and TDSs are respectively  
316 indicated for caries initiation prevention in sound surfaces (ICDAS 0) in deep pits and fissures or for non-invasive  
317 management of non-cavitated carious lesions (ICDAS 1-3 and even ICDAS 1-4 for some authors). The state of  
318 evidences behind DSs is robust [39-44][23-28]. The present results show that almost all FDSs (96.6%) declared  
319 placing PDSs as a regular preventive option. Nevertheless, only less than half of FDSs (44.3%) considered TDSs  
320 placement. Similar findings were previously reported for GDPs practicing in France [11][3]. Indeed, while 90%  
321 of FGDPs regularly perform PDSs, only 42% of them think about TDSs as preventive options. Lack of knowledge  
322 and risk of further lesion progression appear to be the most cited reasons (respectively 32.3 % and 20.2%) that  
323 explain the non-use of TDSs by the future practitioners studying in France. In contrast to the USA, where TDSs  
324 are part of the best practice recommendations, the HAS has not ruled on TDSs yet although it supports non-  
325 invasive strategies for non-cavitated carious lesions [37, 38][21, 22]. Unlike PDSs, there is no classification code  
326 in the CCAM for TDSs, which does not encourage GDPs to integrate these treatment options in their clinical  
327 practice. Instead, the lack of a classification code promotes the use of more invasive restorations for non-cavitated  
328 carious lesions, which are reimbursed by the French social security system and complementary health insurances.

329 Although three quarters of respondents stated that the undergraduate education related to CRA is  
330 sufficient, more than half of them reported some lacks towards both PDSs and TDSs. Worryingly, only 26.1%  
331 declared being familiar with the current national recommendations. In other countries, similar surveys  
332 administered to dental students and practitioners showed that respondents had a suitable theoretical knowledge  
333 about pit and fissure sealants; however, these studies also showed that there is a gap between their knowledge and  
334 the implementation of these preventive options in their clinical practices [45, 46][29, 30].

335 These results highlight several problems regarding particularly the undergraduate education stream of  
336 cariology, which appears to require further improvements. Similarly, continuing education, which has been  
337 introduced for several years in France, is mandatory for health professionals. As the subjects of training are not

338 imposed and are selected by GDPs themselves depending on their preference, it is alarming to note that only 37%  
339 of them were interested in MI in 2015 [44][12]. Many reasons can explain this situation in Europe and especially  
340 in France. Changes in practitioners' attitudes about MI will only be achieved if clear information about the  
341 scientific rationale of CRA, the availability of easy-to-use CRA tools and evidence-based recommendations  
342 emerge [34][47]. Indeed, giving specific and simple guidelines to students and faculty members to accurately  
343 assign the caries risk levels for their patients could help them to improve CRA [48][32]. Admittedly, our study is  
344 a French example but there is little doubt that the same conclusions may be drawn in most of European countries;  
345 similar studies are thus needed to compare dental students' knowledge and practices within countries and confirm  
346 this hypothesis.

347  
348 Changing traditional practices into new concepts must involve common actions [15, 49][7, 33]. First of  
349 all, disparities concerning the teaching and practice of cariology that exist between French dental schools may lead  
350 to variations in FDS knowledge and treatment modalities. To address this problem, the college of teachers in  
351 conservative dentistry (CNEOC) could suggest concrete measures for example writing a teachers' guide for dental  
352 curriculum, to standardize the education of MI in cariology in all French dental schools, according to the proposals  
353 of the European Core Curriculum for Cariology [18, 34, 35, 50][9, 34-36]. Moreover, the objectives of the French  
354 (HAS) and European recommendations could also be redefined in order to favour evolutions of the health care  
355 system and reimbursement modalities (CCAM) towards an objective of caries prevention and to reconsider MI  
356 strategies as major public health concerns.

357

358 **COMPLIANCE WITH ETHICAL STANDARDS**

359

360 ***Conflict of Interest***

361 The authors declare that they have no conflict of interest.

362

363 ***Funding***

364 Printing and postal fees were sponsored by Colgate® France)

365

366 ***Ethical approval***

367 All procedures fulfil French regulations related to questionnaire surveys in an educational environment.

368

369 ***Informed consent***

370 Not applicable

371

- β72 **REFERENCES**
- 373 1. Dawson AS, Makinson OF (1992) Dental treatment and dental health. Part 1. A review of studies in  
374 support of a philosophy of Minimum Intervention Dentistry. *Aust Dent J* 37:126-132.
- 375 2. Dawson AS, Makinson OF (1992) Dental treatment and dental health. Part 2. An alternative philosophy  
376 and some new treatment modalities in operative dentistry. *Aust Dent J* 37:205-210.
- 377 3. Mount GJ, Hume WR (1998) A new cavity classification. *Aust Dent J* 43:153-159.
- 378 4. Mount GJ (2007) A new paradigm for operative dentistry. *Aust Dent J* 52:264-270.
- 379 5. Mount GJ, Ngo H (2000) Minimal intervention: advanced lesions. *Quintessence Int* 31:621-629.
- 380 6. Mount GJ, Ngo H (2000) Minimal intervention: early lesions. *Quintessence Int* 31:535-546.
- 381 7. Pitts N, Ismail AI, Martignon S, Ekstrand K, Douglas GV, Longbottom C (2004) ICCMS guide for  
382 practitioners and educators. <https://www.iccms-web.com/uploads/asset/59284654c0a6f822230100.pdf>  
383 Accessed April 9, 2020.
- 384 8. Martignon S, Pitts NB, Goffin G, Mazevet M, Douglas GVA, et al (2019) CariesCare practice guide:  
385 consensus on evidence into practice. *Br Dent J* 227:353-362.
- 386 9. Doméjean-Orliaguet S, Tubert-Jeannin S, Riordan PJ, Espelid I, Tveit AB (2004) French dentists'  
387 restorative treatment decisions. *Oral Health Prev Dent* 2:125-131.
- 388 10. Doméjean S, Maltrait M, Espelid I, Tveit A, Tubert-Jeannin S (2015) Changes in occlusal caries lesion  
389 management in France from 2002 to 2012 - a persistent gap between evidence and clinical practice. *Caries*  
390 *Res* 49:408-416.
- 391 11. Hélie B, Holmgren C, Gaillot L, Doméjean S (2016) Scellements préventifs et thérapeutiques -  
392 Connaissances et pratiques des omnipraticiens français. *Inf Dent* 37:20-28.
- 393 12. Doméjean S, Léger S, Simon A, Boucharel N, Holmgren C (2017) Knowledge, opinions and practices of  
394 French general practitioners in the assessment of caries risk: results of a national survey. *Clin Oral*  
395 *Investig* 21:653-663.
- 396 13. Schwendicke F, Stangvaltaite L, Holmgren C, Maltz M, Finet M, et al (2017) Dentists' attitudes and  
397 behaviour regarding deep carious lesion management: a multi-national survey. *Clin Oral Investig* 21:191-  
398 198.
- 399 14. Haugejorden O (1988) Adoption of fluoride-based caries preventive innovations in a public dental  
400 service. *Community Dent Oral Epidemiol* 16:5-10.
- 401 15. Watt R, McGlone P, Evans D, Boulton S, Jacobs J, et al (2004) The facilitating factors and barriers  
402 influencing change in dental practice in a sample of English general dental practitioners. *Br Dent J*  
403 197:485-489.
- 404 16. Schwendicke F, Doméjean S, Ricketts D, Peters M (2015) Managing caries: the need to close the gap  
405 between the evidence base and current practice. *Br Dent J* 219:433-438.
- 406 17. Tubert-Jeannin S, Doméjean-Orliaguet S, Riordan PJ, Espelid I, Tveit AB (2004) Restorative treatment  
407 strategies reported by French university teachers. *J Dent Educ* 68:1096-1103.
- 408 18. Schulte AG, Pitts NB, Huysmans MC, Splieth C, Buchalla W (2011) European Core Curriculum in  
409 Cariology for undergraduate dental students. *Eur J Dent Educ* 15 Suppl 1:9-17.
- 410 19. Loch C, Liaw Y, Metussin AP, Lynch CD, Wilson N, et al (2019) The teaching of posterior composites:  
411 A survey of dental schools in Oceania. *J Dent* 84:36-43.

**Commenté [sd1 ]:** 1 Meyer-Lueckel H, NJM, Breschi L, Buchalla W, Ceballos L, Doméjean S, et al (2019) EFCD Curriculum for undergraduate students in Integrated Conservative Oral Healthcare (ConsCare). *Clin Oral Investig* 23:3661-3670.

- 412 20. Kay EJ, Nuttall NM, Knill-Jones R (1992) Restorative treatment thresholds and agreement in treatment  
413 decision-making. *Community Dent Oral Epidemiol* 20:265-268.
- 414 21. Kay EJ, Nuttall NM (1994) Relationship between dentists' treatment attitudes and restorative decisions  
415 made on the basis of simulated bitewing radiographs. *Community Dent Oral Epidemiol* 22:71-74.
- 416 22. Mileman PA, Mulder E, van der Weele L (1992) Factors influencing the likelihood of successful  
417 decisions to treat dentin caries from bitewing radiographs. *Community Dent Oral Epidemiol* 20:175-180.
- 418 23. Mejare I, Sundberg H, Espelid I, Tveit B (1999) Caries assessment and restorative treatment thresholds  
419 reported by Swedish dentists. *Acta Odontol Scand* 57:149-154.
- 420 24. Tveit AB, Espelid I, Skodje F (1999) Restorative treatment decisions on approximal caries in Norway.  
421 *Int Dent J* 49:165-172.
- 422 25. Doméjean S, Banerjee A, Featherstone JDB (2017) Caries risk / susceptibility assessment: its value in  
423 minimum intervention oral healthcare. *Br Dent J* 223:191-197.
- 424 26. Fontana M, Gonzalez-Cabezas C (2019) Evidence-based dentistry caries risk assessment and disease  
425 management. *Dent Clin North Am* 63:119-128.
- 426 27. Riley JL, 3rd, Qvist V, Fellows JL, Rindal DB, Richman JS, et al (2010) Dentists' use of caries risk  
427 assessment in children: findings from the Dental Practice-Based Research Network. *Gen Dent* 58:230-  
428 234.
- 429 28. Riley JL, 3rd, Gordan VV, Ajmo CT, Bockman H, Jackson MB, et al (2011) Dentists' use of caries risk  
430 assessment and individualized caries prevention for their adult patients: findings from The Dental  
431 Practice-Based Research Network. *Community Dent Oral Epidemiol* 39:564-573.
- 432 29. Riley JL, 3rd, Gordan VV, Ajmo CT, Bockman H, Jackson MB, et al (2015) Dentists' use of caries risk  
433 assessment and individualized caries prevention for their adult patients: Findings from The Dental  
434 Practice-Based Research Network. *Tex Dent J* 132:18-29.
- 435 30. Featherstone JD (2003) The caries balance: contributing factors and early detection. *J Calif Dent Assoc*  
436 31:129-133.
- 437 31. Doméjean S, Featherstone JDB, White JM (2011) Validation of the CDA CAMBRA caries risk  
438 assessment - a six-year retrospective study. *J Calif Dent Assoc* 39:709-715.
- 439 32. Chaffee BW, Featherstone JD (2015) Long-term adoption of caries management by risk assessment  
440 among dental students in a university clinic. *J Dent Educ* 79:539-547.
- 441 33. Kakudate N, Sumida F, Matsumoto Y, Yokoyama Y, Riley JL, 3rd, et al (2015) Dentists' decisions to  
442 conduct caries risk assessment in a Dental Practice-Based Research Network. *Community Dent Oral*  
443 *Epidemiol* 43:128-134.
- 444 34. Bottenberg P, Ricketts DN, Van Loveren C, Rahiotis C, Schulte AG (2011) Decision-making and  
445 preventive non-surgical therapy in the context of a European Core Curriculum in Cariology. *Eur J Dent*  
446 *Educ* 15 Suppl 1:32-39.
- 447 35. Buchalla W, Wiegand A, Hall A (2011) Decision-making and treatment with respect to surgical  
448 intervention in the context of a European Core Curriculum in Cariology. *Eur J Dent Educ* 15 Suppl 1:40-  
449 44.
- 450 36. HAS (2005) Appréciation du risque carieux et indications du scellement prophylactique des sillons des  
451 premières et deuxième molaires permanentes chez les sujets de moins de 18 ans. <https://www.has->

- 452 sante.fr/jcms/c\_240379/fr/appreciation-du-risque-carieux-et-indications-du-scellement-prophylactique-  
453 des-sillons-des-premieres-et-deuxiemes-molaires-permanentes-chez-les-sujets-de-moins-de-18-ans  
454 Accessed April 9, 2020.
- 455 37. Beauchamp J, Caufield PW, Crall JJ, Donly KJ, Feigal R, et al (2009) Evidence-based clinical  
456 recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association  
457 Council on Scientific Affairs. *Dent Clin North Am* 53:131-147.
- 458 38. Beauchamp J, Caufield PW, Crall JJ, Donly K, Feigal R, et al (2008) Evidence-based clinical  
459 recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association  
460 Council on Scientific Affairs. *J Am Dent Assoc* 139:257-268.
- 461 39. Borges BC, de Souza Borges J, Braz R, Montes MA, de Assuncao Pinheiro IV (2012) Arrest of non-  
462 cavitated dentinal occlusal caries by sealing pits and fissures: a 36-month, randomised controlled clinical  
463 trial. *Int Dent J* 62:251-255.
- 464 40. Wright JT, Tampi MP, Graham L, Estrich C, Crall JJ, et al (2016) Sealants for preventing and arresting  
465 pit-and-fissure occlusal caries in primary and permanent molars: A systematic review of randomized  
466 controlled trials-a report of the American Dental Association and the American Academy of Pediatric  
467 Dentistry. *J Am Dent Assoc* 147:631-645 e618.
- 468 41. Ahovuo-Saloranta A, Forss H, Walsh T, Nordblad A, Makela M, et al (2017) Pit and fissure sealants for  
469 preventing dental decay in permanent teeth. *Cochrane Database Syst Rev* 7:CD001830.
- 470 42. Frencken J (2019) Is preventing micro-cavities in dentine from progressing with a sealant successful? *Br*  
471 *Dent J* 226:590-594.
- 472 43. Hong M, Vuong C, Herzog K, Ng MW, Sulyanto R (2019) Sealed primary molars are less likely to  
473 develop caries. *J Am Dent Assoc* 150:641-648.
- 474 44. Munoz-Sandoval C, Gambetta-Tessini K, Giacaman RA (2019) Microcavitated (ICDAS 3) carious lesion  
475 arrest with resin or glass ionomer sealants in first permanent molars: A randomized controlled trial. *J*  
476 *Dent* 88:103163.
- 477 45. Ealla KKR, Kumar AN, Turagam N, Sooraparaju SG, Yerrapothu RMR, et al (2018) Knowledge analysis  
478 of pit and fissure sealants among the dental students of South India. *J Int Soc Prev Community Dent*  
479 8:508-512.
- 480 46. Al-Maweri SA, Al-Jamaei AA, Halboub ES, Al-Soneidar WA, Tarakji B, et al (2016) Fissure sealants:  
481 Knowledge and practice of Yemeni dental practitioners. *Eur J Dent* 10:234-238.
- 482 47. Innes NP, Frencken JE, Schwendicke F (2016) Don't know, can't do, won't change: barriers to moving  
483 knowledge to action in managing the carious lesion. *J Dent Res* 95:485-486.
- 484 48. Young DA, Alvear Fa B, Rogers N, Rechmann P (2017) The effect of calibration on caries risk  
485 assessment performance by students and clinical faculty. *J Dent Educ* 81:667-674.
- 486 49. McGlone P, Watt R, Sheiham A (2001) Evidence-based dentistry: an overview of the challenges in  
487 changing professional practice. *Br Dent J* 190:636-639.
- 488 50. Meyer-Lueckel H, Opdam NJM, Breschi L, Buchalla W, Ceballos L, et al (2019) EFCD Curriculum for  
489 undergraduate students in Integrated Conservative Oral Healthcare (ConsCare). *Clin Oral Investig*  
490 23:3661-3670.