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Knowledge and opinions of French dental students related to caries risk assessment and dental sealants (preventive and therapeutic)

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1 **TITLE PAGE**

2

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4 (preventive and therapeutic)

5

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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

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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 ~~c~~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 χ^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 (± 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 at 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

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

368

369 ***Informed consent***

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371

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