

The Impact of the COVID-19 Pandemic on Dental Education in the Czech Republic: Students' Perception of Hybrid Clinical Education and Psychosocial Impacts, a Retrospective Study

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Abstract: The COVID-19 pandemic significantly impacted educational methods worldwide, particularly in dental and general medicine education. This study retrospectively analyzes students' perceptions of hybrid theoretical and practical teaching in the Dentistry program during the pandemic at three medical faculties of Charles University in the Czech Republic. A total of 418 students were surveyed regarding their views on hybrid education, concerns about COVID-19, and the pandemic's psychosocial and academic effects. The study revealed notable differences based on faculty location, gender, year of study, language of instruction,

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and the phase of study affected. Students from smaller faculties (Hradec Kralove and Pilsen) preferred online education and did not report a significant reduction in lectures. Compensatory block teaching post-pandemic was effective but less preferred, especially among women. Men found online communication more challenging than women. Czech-speaking students rated online teaching more effective than those studying in English and compensated for clinical skill gaps by participating in more internships. Future online education methods should address the unique needs of these groups.

Introduction

Amid the COVID-19 pandemic, governments worldwide implemented various measures, including restrictions on freedom of movement, industry, and education. With standard face-to-face teaching rendered unfeasible, the entire educational system underwent a rapid transformation into an online format (Fine et al., 2022). This shift occurred within a matter of weeks, demanding substantial efforts from both students and teachers to adapt (Liu et al., 2021). Teaching methods transitioned to video-based seminars, pre-recorded lectures, or live presentations (Singh et al., 2021). While for some disciplines, especially those focused on theory, this shift primarily altered the mode of instruction without compromising content, fields emphasizing practical and manual skills experienced significant disruption (Chavarría-Bolaños et al., 2020; Schlenz et al., 2020). This was particularly notable in medical studies, including dentistry.

Standard dental education (Pre-pandemic education)

The Dentistry study program at Charles University in the Czech Republic spans five years and is offered separately in Czech and English languages. Each academic year comprises two 15-week terms: the winter term (October–January) and the summer term (February–May). These terms are interspersed with a four-week exam period, and the academic year concludes with a summer vacation. Prior to the COVID-19 pandemic, the dental curriculum at Charles University entailed two academic years of preclinical education, which encompassed face-to-face lectures and practical training on simulators. Subsequently, clinical teaching was provided in the 3rd through 5th years. Both clinical and preclinical subjects involved 15–30 hours of theoretical lectures and regular practical sessions known as “weekly repeated education” (WRE). Clinical practical sessions occurred throughout the term, spanning 1–2 full days per week, depending on the study year. Similarly, general medical subjects followed a comparable teaching structure.

Dental education during the COVID-19 pandemic (Pandemic education)

On March 11, 2020, the government imposed a complete restriction on students’ attendance, leading to the cancellation of clinical practical education for the summer

term. Within one week, face-to-face theoretical education was swiftly transitioned to an online format. This sudden change presented considerable challenges for both students and lecturers, not only due to the lack of familiarity with online teaching methods but also in terms of scheduling adjustments. Moreover, many lecturers and medical students were summoned to hospitals to assist the overloaded healthcare system.

In June 2020, recognizing the significance of restricted medical practical education, the government authorized the resumption of practical education at medical faculties. Practical classes were subsequently reintroduced in June and July 2020 in a significantly intensified form of block education (BE) to compensate for the previous. BE consisted of several consecutive phases (blocks), each dedicated solely to one subject, aimed at compensating for previous limitations.

From October 2020 to May 2021, practical classes resumed in a manner largely similar to pre-pandemic times, albeit with some reductions. Theoretical education remained exclusively online. The situation returned to normal in October 2021.

In summary, the teaching of dentistry was profoundly affected by the imposed restrictions, with a greater impact compared to other medical fields, such as general medicine, due to the dentistry study program's strong emphasis on acquiring practical skills.

While initially viewed as a temporary compromise, online education gradually proved to be a valuable teaching method over time. However, to utilize it effectively, it is imperative to identify both its strengths and weaknesses (Flores et al., 2022). Thus, the aim of this study is to analyze students' perceptions of online theoretical and practical teaching in the Dentistry study program to enhance its future use in education.

Material and Methods

Design

This study was designed as a retrospective tricentric cross-sectional survey among dentistry students of the 2nd–5th study years in the academic year 2021/2022 at all medical faculties of Charles University: the Faculty of Medicine in Hradec Kralove, the Faculty of Medicine in Pilsen, and the First Faculty of Medicine in Prague. These schools represent three out of five faculties providing this programme in the Czech Republic. The evaluated period was from March 2020 to June 2021. Detailed information on individual study years is provided in Table 1. The invitation to voluntarily participate in the study was sent to all students who were involved in online education during the COVID-19 pandemic. The questionnaire was in paper form, anonymous and did not include any identifying personal information. No remuneration or benefits were provided for participants. The survey was approved by the Ethics Committee of the University Hospital Hradec Kralove (approval number: 202204P07, approved: April 11, 2022) and performed in line with the principles of the Declaration

Table 1 – Students' classification according to the actual year of the study, affected study years, and education phase

Year of study during the academic year 2021/2022	Study years affected by pandemic education	Study group mark	Preclinical education evaluation only	Preclinical and clinical education evaluation	Clinical education evaluation only
1	not evaluated	–	–	–	–
2	1	A	x		
3	1, 2	B	x		
4	2, 3	C		x	
5	3, 4	D			x

x – indicates study inclusion

of Helsinki. All participants were provided and agreed to an informed consent form that detailed the purpose and procedures of the study.

Sample size relevancy

All 595 2nd–5th year dentistry students were addressed with an invitation to this study. The minimum number of study participants was calculated as 234. Formula was used for the calculation using the online Netquest calculator (www.netquest.com/en/panel/sample-calculator/statistical-calculators).

Instrument

The questionnaire was developed in cooperation with clinical lecturers and students of dentistry by the authors. The students were asked questions regarding demographic data, COVID-19, and its impact on education. Although the answers to the questions were mandatory, not every respondent answered all questions, as students from Group A and B did not have clinical education during the pandemic (Table 1), and not all students suffered from COVID-19 infection.

The preliminary version of the survey was consulted with representatives from the respondents and adapted accordingly before proceeding to the reliability testing stage. The reliability was evaluated in a group of volunteer students who filled out the questionnaire twice in three weeks.

Data collection

The survey was distributed by the lecturers during post-pandemic face-to-face education. The questionnaires were filled in between April 18 and May 31, 2022.

Analysis

The data were sorted and analyzed in Microsoft Office Excel (version 2106 for Windows, Microsoft Corporation, Redmond, WA, USA). Statistical analysis was performed using an NCSS 2021 Statistical Software (NCSS, LLC, Kaysville, Utah,

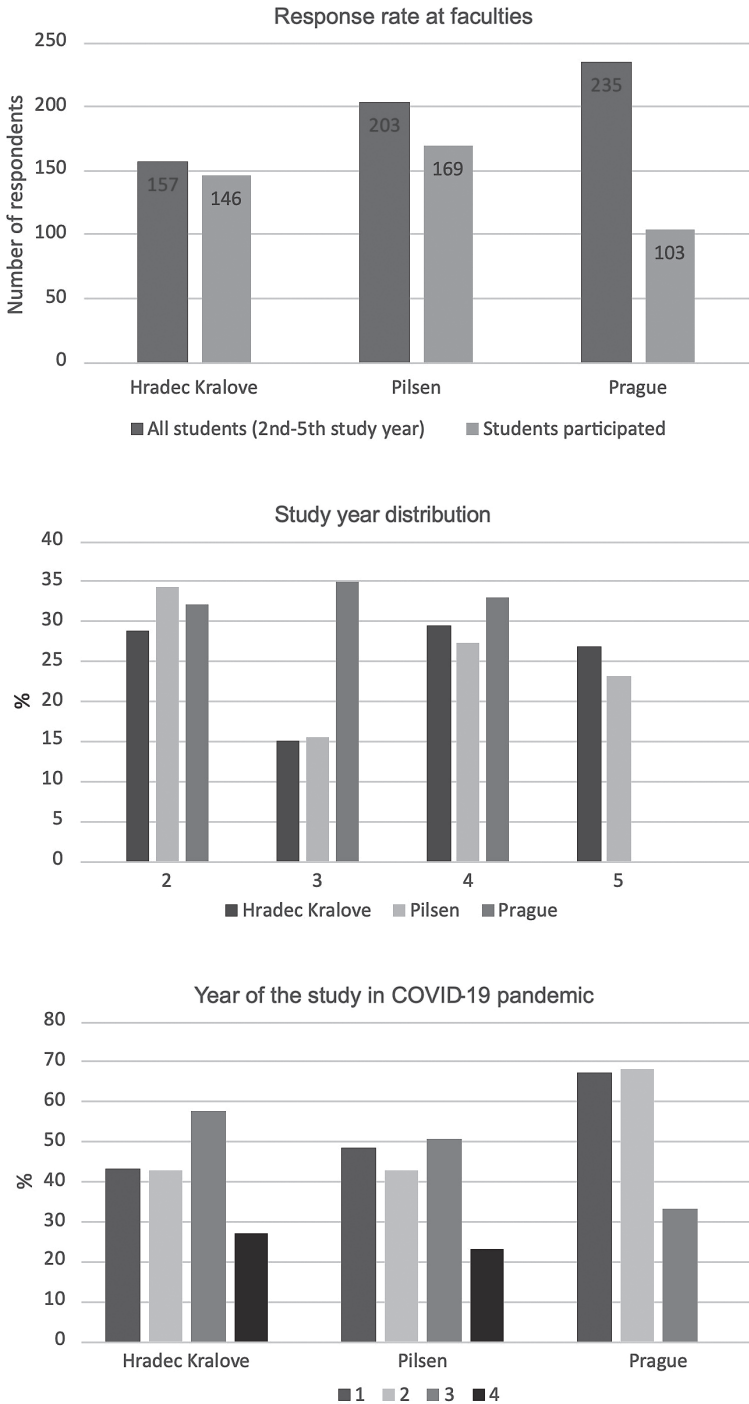


Figure 1 – Response rate at faculties, study year distribution, and year of the study during COVID-19 pandemic.

USA, [nces.com/software/ncss](https://nces.ed.gov/ipeds/data/ncss/)). Data are presented by counts and percentages. Median and interquartile range are given to describe age. The chi-square test and Fisher's exact test were used to evaluate the association between factors. Nonparametric tests Mann-Whitney, Kolmogorov-Smirnov, and Kruskal-Wallis analysis of variance were used to evaluate the impact of age on answers. The level of statistical significance was set to $\alpha = 0.05$.

Results

Demographic data

Response rate and center distribution

Out of the 595 students invited to participate, 418 completed the questionnaire, yielding a response rate of 70.21%. However, the response rate varied across the participating faculties: 93% (146 out of 157 students) in Hradec Kralove, 83.2% (169 out of 203 students) in Pilsen, and 43.83% (103 out of 235 students) in Prague (Figure 1). The study results hold statistical significance as the minimum required number of participants, i.e., 234, was surpassed.

Sex and age distribution

Among the 418 respondents, males comprised 28.47% ($n=119$) and females 71.53% ($n=299$). The mean age was 22.82 years, with a minimum age of 19 years and a maximum age of 38 years. These distributions of sex and age among participants reflect the characteristics of the study population.

Study year and study language distribution

The distribution of participants' study year at the time of the survey is illustrated in Figure 1. 88.52% of students studied in the Czech language ($n=370$), whereas 11.48% of students studied in English ($n=48$).

Year of the study in COVID-19 pandemic

The year of the study during the COVID-19 pandemic is shown in Figure 1. As the pandemic affected the academic years 2019/2020 and 2020/2021, it affected the students differently depending on the course of their studies. For some students, two years of study were affected, and the designation of students according to study years can be confusing. Thus, the students were marked as Groups A–D (Table 1). Group A ($n=133$, 31.8%) includes students who started their education in 2020, and only their 1st academic year education was affected by the restrictions. Group B ($n=84$, 20.1%) represents students whose first and second study years were affected. Group C ($n=123$, 29.4%) represents students whose second and third study years were affected. Group D ($n=78$, 18.7%) represents students whose third and fourth study years were affected.

COVID-19 infection and vaccination among the dentistry students

A total of 46.15% (n=192) of students reported being infected with COVID-19. Out of them, 157 students (81.77%) stated that they were infected with COVID-19 once, 24 (12.5%) twice, and one student (0.53%) was infected three times. COVID-19 infection and vaccination among Czech dentistry students were described in detail in a previous study published in 2022 (Schmidt et al., 2022).

Clinical education

A total of 47.61% (n=199) of respondents attended clinical education during the pandemic. The results for the clinical education are described in the following subsections. Students' perception comparison of clinical theoretical and practical education is provided in Table 2.

Table 2 – Students' perception comparison of clinical theoretical and practical education. Results are in percentages

Compared to pre-pandemic education	Strongly agree	Some-what agree	Neither agree nor disagree	Some-what disagree	Strongly disagree
The number of online lectures was strongly reduced	6.06	21.21	14.65	40.40	17.68
Equal efficiency	32.16	39.20	3.52	21.11	4.02
Online lectures were saving my time	64.32	29.65	1.51	4.52	0.00
I preferred online lectures during the pandemic	39.80	36.22	7.14	12.24	4.59
I prefer online lectures in future	17.68	26.26	12.63	29.29	14.14
Asking questions via chat had equal effectivity	20.20	32.83	6.57	31.82	8.59
Missed visible examples of working procedures during online education	15.66	33.33	14.65	29.29	7.07
Amount of information received was equal in online education and face-to-face education	37.19	41.71	6.03	12.56	2.51
My attention during online education was the same compared to face-to-face education	27.64	33.67	8.54	19.60	10.55
The number of practical classes was strongly reduced	29.65	35.18	12.06	19.60	3.52
BE is equally effective as WRE	4.62	13.33	20.00	37.95	24.10
I prefer BE practical classes more than WRE	2.54	5.08	8.63	27.41	56.35

BE – block education; WRE – weekly repeated education

Number, effectiveness, and preference of online clinical lectures

In Hradec Kralove, only 12.00% of students perceived a strong reduction in clinical theoretical lectures during the pandemic compared to the pre-pandemic period. Conversely, in Pilsen, this figure was 55.88%, and in Prague, it stood at 26.92% ($p < 0.0001$). Students affected by pandemic restrictions solely during clinical years (Group D) felt a greater reduction in the number of lectures (46.27%) compared to those affected during both preclinical and clinical studies (Group C) (22.55%, $p = 0.0012$).

Regarding the perception of teaching efficiency, 77.11% of Czech students considered online teaching to be as efficient as face-to-face teaching. However, among international students, only 53.85% shared this opinion, with a statistically significant difference ($p = 0.012$). Additionally, during the pandemic, online lectures were preferred over face-to-face lectures by 85.26% of Czech students and 61.54% of international students ($p = 0.0103$). Moreover, 97.6% of Czech students and 82.76% of international students reported that online lectures saved them time ($p = 0.0042$).

Asking questions via chat, insufficient visible examples of working procedures, amount of information received, attention during online theoretical clinical education
Questions via chat during lectures were recognised more favorably by females than males. Specifically, 61.72% of females found this communication equally effective as face-to-face communication, while only 45.61% of males shared this opinion. This difference was statistically significant ($p = 0.0412$).

There was also a disparity in the perception of online clinical teaching between Czech and international students. While 68.87% of Czech students maintained their attention during online classes at the same level as during face-to-face classes, only 50% of international students reported the same ($p = 0.046$). Moreover, 54.36% of Czech students and 80.00% of international students missed more visible examples during online teaching compared to face-to-face teaching ($p = 0.032$).

Additionally, perceptions of online clinical teaching varied based on the place of study. The lack of visible examples of working procedures during online teaching compared to face-to-face teaching was reported by 75.00% of respondents in Prague, 62.86% in Hradec Kralove, and 45.07% in Pilsen ($p = 0.0122$).

The number of practical classes, the effectiveness of block education, and preference of block practical classes

On average, 64.83% of respondents reported a strong reduction in the number of clinical cases. This perception was significantly higher in Group C, where 86.86% of students shared this opinion ($p = 0.0018$). Block education was more preferred in Hradec Kralove (32.86%) compared to Pilsen (18.64%) and Prague (3.7%), respectively ($p = 0.0058$). Regarding the efficiency of block practical education, 33.33% of men considered it to be as effective as weekly repeated education, while

Table 3 – COVID-19 infection fear and protective measures used during the pandemic clinical practical education, and substitution for lost clinical classes during the pandemic. Results are in percentages

During practical classes	Strongly agree	Some-what agree	Neither agree nor disagree	Some-what disagree	Strongly disagree
I was afraid of COVID-19 infection	3.54	18.69	5.56	42.42	29.80
The protective measures were sufficient	35.86	44.95	11.11	6.57	1.52
I substituted for the lost clinical classes by out-of-school practice (e.g., internships in private dental offices)	22.68	37.11	3.61	25.26	11.34

only 18.02% of females shared this opinion. This difference between sexes was statistically significant ($p=0.0378$).

Fear of COVID-19 infection, protective measures used during practical clinical classes, and substitute of lost clinical classes with dental practitioners

The fear of COVID-19 infection and protective measures utilized during clinical practical education amid the pandemic, along with substitutions for lost clinical classes, are presented in Table 3. International students expressed higher concern about contracting COVID-19 during clinical classes compared to their Czech counterparts (45.83 vs. 20.25%, respectively; $p=0.0058$).

Overall, 64.85% of Czech students and 40.91% of international respondents indicated compensating for the reduction of practical classes with internships in private dental offices ($p=0.0298$). Furthermore, students from Group D, affected by the pandemic only during clinical studies, were more inclined to make up for lost clinical classes with internships in private dental offices (74.29%) compared to students from Group C (25.71%, $p=0.0076$).

Psychosocial impacts of the COVID-19 pandemic

Table 4 presents the impact of the COVID-19 pandemic on social contact, motivation, stress, and discipline. The findings reveal that a significant majority of Czech and international students reported a loss of contact with lecturers due to online education (72.73 and 50.49%, respectively; $p=0.0443$). This sentiment was shared by 71.57% of males and 50.0% of females ($p=0.0002$).

Students in Group A demonstrated better adaptation to online education compared to those in higher years. While 31.94% of Group A students experienced a loss of motivation, this figure rose to 42.78% among older students (Groups B–D) ($p=0.0308$). Moreover, stress due to online education was reported by 17.93% of Group A students and 27.84% of older students (Groups B–D) ($p=0.0251$).

Table 4 – The impact of the COVID-19 pandemic on social contact, motivation, stress, and discipline. Results are in percentages

Due to pandemic education	Strongly agree	Some-what agree	Neither agree nor disagree	Some-what disagree	Strongly disagree
Missed social contact with lecturers	11.78	36.30	14.42	26.92	10.58
Missed social contact with classmates	47.96	34.53	4.56	7.67	5.28
Lost motivation	9.40	23.86	10.60	36.63	19.52
Felt more stressed	6.97	12.74	13.46	40.38	26.44
Lost discipline and daily routine	9.16	21.69	8.67	36.63	23.86

Table 5 – The impact of the COVID-19 pandemic on medical decision-making, professional communication, and study extension. Results are in percentages

Due to pandemic education	Strongly agree	Some-what agree	Neither agree nor disagree	Some-what disagree	Strongly disagree
Lost ability of medical decision-making	2.41	12.29	33.49	37.59	14.22
Lost ability of professional communication	4.08	19.66	17.75	35.49	23.02
Preferred study extension	0.72	7.67	7.43	32.37	51.80

Notably, the loss of discipline was significantly lower among Group A students (26.94%) compared to students in other years (40.86%) ($p=0.0042$). Group C students exhibited the highest loss of motivation, standing at 45.54%. Regarding discipline loss, students from Prague, Pilsen, and Hradec Kralove reported percentages of 44.68, 31.08, and 29.20%, respectively ($p=0.0340$).

Impact of the COVID-19 pandemic on medical decision-making, professional communication, and study extension

The impact of the COVID-19 pandemic on medical decision-making, professional communication, and study extension is outlined in Table 5. Among the findings, the loss of professional communication ability was least reported by Group A (22.67%) compared to students in higher years (35.09%), with a statistically significant difference ($p=0.0112$). Notably, Group C students reported the highest percentage of loss in professional communication skills (37.96%).

Concerning study extension, international students showed a greater preference for an eventual study extension (25.71%) compared to Czech students (7.41%)

($p=0.0019$). Additionally, students whose studies were impacted only during the clinical part (Group D) expressed a higher preference for study extension compared to those impacted during both preclinical and clinical parts (Group C) (15.94 and 7.57%, respectively; $p=0.0282$).

Furthermore, the main challenge identified for future online education, by 46.02% of respondents, was ensuring the recording and replaying of lessons.

Discussion

Clinical education

Evaluating education during a pandemic is crucial to identify the shortcomings of implemented educational practices. Clinical teaching, in particular, relies heavily on hands-on training of clinical skills, making it challenging to replicate via online teaching methods. As evident from our study, students are keenly aware of this limitation, with only 43.94% of respondents supporting the online teaching of clinical subjects in the future.

Perceptions of online clinical teaching varied significantly across faculties and were influenced by the teaching language. The disparity between Czech and international students may stem from the fact that neither lecturers nor students are native English speakers, making the explanation of practical procedures more challenging in both the online format and due to language limitations.

Male students reported encountering more communication problems during education via chat compared to their female counterparts, for whom using chat posed no communication barrier. Additionally, a mere 7.62% of respondents preferred online teaching for clinical subjects. This preference could be attributed to the greater need for extensive hands-on training in acquiring clinical skills.

Czech students compensated for the lack of clinical skills by engaging in more internships in dentists' offices. In contrast, international students utilized this compensation method less, possibly due to language barriers. Furthermore, students in higher grades were more proactive in attempting to replace lost clinical classes, likely because they were closer to graduation and felt a greater sense of urgency in acquiring clinical skills.

Restricted face-to-face education impacted both the quality and quantity of theoretical lectures as well as practical education (Brondani and Donnelly, 2020; Karaaslan et al., 2020). Our study findings align with those of other researchers. Binshehab and Ingle (2021) found that half of the undergraduate and postgraduate participants ($n=200$) preferred a combination of face-to-face and online education, citing its time-saving nature and its usefulness for exam revision when recorded. Noor et al. (2022) highlighted students' preference for face-to-face learning due to its provision of better communication opportunities. Alfallaj et al. (2021) similarly concluded that recorded online education could not fully substitute for

attending traditional classrooms. Despite the fact that other authors esteemed the combination of physical and online classes as the future trend of dental education, multiple studies declared that dental undergraduate students' practical skills have decreased during the pandemic (Chakraborty et al., 2020; Agius et al., 2021; Chang et al., 2021b; Generali et al., 2021). A scoping review by Bughrara et al. (2023) found no consensus on whether online learning was preferable to traditional classroom learning among medical students. Hassan et al. (2022) concluded that restricted or canceled clinical education negatively impacted medical students' manual skills and clinical competencies. Other authors have also noted the unsuitability of fully transitioning dental teaching to an online format. Vražić et al. (2022) concluded that while online education in dentistry could replace educational formats such as lectures and seminars, it could not fully substitute for practical teaching. Despite these findings, other authors recognized the combination of physical and online classes as the future trend in dental education, especially (Badovinac et al., 2021; Chang et al., 2021a; Chang et al., 2021b). Additionally, an additional challenge for future online education is online examination, such as online virtual objective structured clinical examinations, which still have limitations and may not be the ideal way to evaluate students' skills, as concluded by Liu et al. (2021) and Donn et al. (2021).

The impact of the COVID-19 pandemic on psychosocial students' status and study

The COVID-19 pandemic has not only affected perceived study outcomes but also the mental health of students. The results of our study provide additional insights depending on the characteristics of student groups. While students generally lacked contact with lecturers, this issue was more pronounced among international students and those who lived alone. The underlying reason may be social isolation, particularly for international students who lack family or social support networks in the Czech Republic.

A systematic review by Bolatov et al. (2021), evaluating the conclusions of 47 studies, found higher levels of stress, depression, and anxiety among medical students during the pandemic compared to pre-pandemic times. Similar findings were reported by Binrayes et al. (2022), who noted stress among dentistry students due to sudden loss of contact with classmates and teachers, as well as increased parental supervision during the COVID-19 pandemic.

Furthermore, the results varied based on gender. A significantly larger proportion of female students reported adverse effects of online education on their mental health compared to male students. Although similar gender-based results have been described by other authors, we were unable to identify the exact reason for this difference (Hamad et al., 2022).

Additionally, it was found that students in higher grades reported a higher rate of lapses in discipline. This may be attributed to the fact that, compared to lower years,

students in higher years were more accustomed to an intensive face-to-face form of study. The transition to a less intensive online form of study could, therefore, lead to a sense of loss of commitment and discipline. However, this feeling varied across individual faculties, indicating that the style and intensity of online teaching play a crucial role in maintaining discipline. A similar conclusion was drawn by Melgaard et al. (2022), who reported that online education impacted students' procrastination with regard to academic duties due to the lack of self-regulation. Chi et al. (2021) also concluded that students' discipline, motivation, and mental health were negatively affected during the COVID-19 pandemic.

Study limitations

The authors wish to highlight the following limitations. Firstly, the study does not encompass the perspectives of dentists who already-graduated before the initiation of the questionnaire survey. This limitation arose from the inability to contact already graduated students due to the unavailability of private e-mail addresses in the university database. Another constraint is the lower response rate among international students compared to Czech students, as well as the complete absence of responses from 5th-year students in Prague. During the questionnaire distribution, students at this faculty were undergoing preparations for final state exams, subsequent to which they concluded their studies and departed from the faculty, contributing to the lack of responses.

Conclusion

Students considered online education as one of the future teaching methods for dental education. They perceived its efficiency to be on par with face-to-face education. However, students missed social contact with classmates and lecturers and reported that online education is insufficient for clinical subjects, leading them to compensate for this deficiency with increased out-of-school practice. Furthermore, students reported that compensatory intensified teaching in the post-pandemic period (block teaching) was effective but less preferred than the classic pre-pandemic teaching form, particularly for women. Online education was perceived differently based on the place of study, sex, or teaching language. Ratings of online teaching varied across faculties, favoring faculties with lower student numbers. Men perceived online communication as more difficult than women, and students studying in the lecturers' non-native language (English) considered online teaching less effective than students studying in the lecturers' native language (Czech). Future educational policies should consider these insights to enhance the integration of online methods while ensuring the essential hands-on experience in clinical subjects is preserved.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author, on reasonable request.

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