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Journal of Dentistry

journal homepage: www.elsevier.com/locate/jdent

Awareness of possible complications associated with direct composite restorations: A multinational survey among dentists from 13 countries with meta-analysis

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ARTICLE INFO

Keywords:

Composite resin
Permanent dental filling
Dental restoration failure
Side effects
Questionnaire

ABSTRACT

Objectives: Resin-based composites (RBCs) evolved into favoured materials for teeth restorations, marking a significant change in dental practice. Despite many advantages, RBCs exhibit various limitations in their physical and chemical properties. Therefore, we assessed the dentists' awareness of possible complications after direct composite restorations and their opinions about this material.

Methods: The online questionnaire was created in English in May 2023. A 16-item survey was dedicated to general dentists and specialists. The first section included four questions related to demographic characteristics. The second section comprised twelve questions and focused on awareness of potential side effects of composite restorations, the most crucial advantages and disadvantages of composite resins, and the frequency of experienced clinical complications after the application of composite materials.

Results: A total of 1830 dentists from 13 countries took part in the survey. Dentists most often declared awareness of low adhesion to the dentine (77.5 %) and, most rarely, solubility in oral fluids (42.6 %). Aesthetics was identified as the main advantage of composite fillings (79 %), followed by the possibility of repair (59 %) and adhesion to enamel (57 %). Polymerisation shrinkage was a major disadvantage for most countries (70 % overall). Analysing the declared potential clinical complications for all countries, statistically significant findings were obtained for marginal discolouration (OR=2.982, 95 % CI: 1.321–6.730, *p*-value=0.009) and borderline significance for secondary caries (OR=1.814, 95 % CI: 0.964–3.415, *p*-value=0.065).

Conclusions: Dentists value aesthetics and repairability but are aware of shrinkage and experience discolouration. The issue of toxicity and solubility seems to be the least known to dentists.

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<https://doi.org/10.1016/j.jdent.2024.105009>

Received 10 March 2024; Received in revised form 1 April 2024; Accepted 18 April 2024

Available online 20 April 2024

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Clinical significance: Dentists should use RBCs with critical caution due to possible side effects. Despite the undoubted aesthetics of direct composite restorations, it is necessary to remember potential clinical complications such as marginal discolouration or secondary caries.

1. Introduction

Resin-based composites (RBCs), introduced in the 1960s, have evolved into universally favoured materials for anterior and posterior teeth restorations, marking a significant change in dental practice preferences [1,2]. Furthermore, direct light-activated composite resins have witnessed substantial enhancements in the last 25 years, with manufacturers continuously refining their formulations and components [3]. In a decade of minimally invasive dental procedures, RBCs have become the predominant choice for dental restorations, excelling as the most commonly used materials [4]. Their widespread adoption is attributed to their benefits of delivering functional restoration and aesthetically pleasing outcomes, minimised need for tissue removal compared to traditional treatments, and low cost compared to indirect materials [2,5].

The multi-functionality of this material and the relatively simple clinical procedure make the composite the material of the first choice in almost every dental office. However, it seems that the numerous advantages cannot compensate for the disadvantages of the composite. It must be highlighted that the adhesion of direct composite restorations to dentin using a bonding system remains a subject of ongoing scientific research due to its complexity and the challenges associated with achieving it, which is linked to reduced restoration durability [6,7].

Apart from that, composites exhibit various inherent limitations in their physical and chemical properties, such as polymerisation shrinkage, a comparatively high coefficient of thermal expansion, and a relatively low resistance to wear [8–10]. Of course, direct composite restorations require effective polishing. This procedure is essential as it promotes a smooth surface, minimising plaque accumulation, enhancing aesthetics, reducing the risk of material staining and wear, and ensuring the patient's comfort, contributing to long-term success and aesthetics of the restoration [11–13].

Moreover, RBCs require polymerisation, resulting in high polymerisation shrinkage and, consequently, contraction stress within the cavity [1,10]. This shrinkage usually falls within the range of 1.5 to 5 % for dental composites, along with shrinkage stresses in the composite material and at the interface between the composite and the bonded tooth [10,14]. It can weaken the bond between the tooth structure and the composite restoration and may lead to microleakage [15,16]. Microleakage may result in the infiltration of acids, enzymes, ions, and bacterial byproducts through the gap, leading to marginal discolouration, post-treatment sensitivity, secondary caries, and pulp defects [15,17].

In addition, RBCs, like all other restorative materials, undergo degradation over time, stemming from mechanical and physical factors like wear and abrasion or chemical degradation mechanisms such as enzymatic, hydrolytic, acidic or temperature-related breakdown [18–21]. Toxic substances released from composite resins in this manner may cause local and general body reactions and allergies [22–24].

Both academic education and postgraduate commercial courses for dentists often focus on learning how to use the composite to obtain an aesthetic effect for the patient, forgetting other aspects of this material. So, do dentists know about possible clinical complications caused by the properties of RBCs? And do we know what dentists value this material for and what they consider its disadvantages? The literature does not provide clear answers to those questions. Our survey aimed to address a better understanding of the potential side effects related to direct composite restorations that dentists face in their daily practice.

2. Materials and methods

The questionnaire for dental practitioners was designed by Polish investigators (A.L. and K.N.). This multinational study was conducted between May and November 2023. Researchers from 23 countries on all continents were invited to participate by email. However, only 13 researchers from 13 countries (Germany, Poland, Portugal, Serbia, the Netherlands, Türkiye, Kazakhstan, Pakistan, Saudi Arabia, Uzbekistan, Egypt, Republic of South Africa, and Canada) on four continents (Europe, Asia, Africa, and North America) responded and accepted to participate. Each collaborating researcher took responsibility for securing ethical approval in their country, if necessary, ensuring strict adherence to their country-specific ethical standards throughout the study.

The final online form of the questionnaire was created in English in May 2023. In two countries (Serbia and Türkiye), this form was also available in the native language. A 16-item questionnaire was dedicated to general dentists and specialists, especially in conservative dentistry and endodontics. The unique survey URL link was disseminated across various social media channels and social platforms, including dental associations specific to each country. Each researcher sent a reminder at least two times to increase the response rate.

The questionnaire consisted of two sections. The first section included four questions related to demographic characteristics (country, gender, work experience, and specialisation). The second section comprised twelve questions and focused on awareness of potential side effects of composite restorations, the most crucial advantages and disadvantages of composite resins, and the frequency of experienced clinical complications after the application of composite materials. The questionnaire is attached as the supplementary material.

The statistical analysis was performed using MedCalc Statistical Software, version 22.014 (MedCalc Software Ltd., Ostend, Belgium) and Statistica Software, version 13.3 (Statsoft, Cracow, Poland). The results were presented as percentages of respondents' answers or odds ratios calculated separately for each country and depending on work experience. The qualitative variables were compared using Pearson's Chi-squared test. The pooled odds ratios were reported in forest plots. Due to the high values of I^2 , the random effects were selected. The significance level was set at $\alpha=0.05$. For proper analyses, the five-level questions were binary categorised ("never" or "rare" as "no", "usually", "often" or "always" as "yes"). Radar (spider) plots were visualised using Excel from Microsoft 365 (Microsoft Corporation, Redmond, Washington, USA).

3. Results

A total of 1830 dentists from 13 countries took part in the survey. Most respondents were from Kazakhstan ($n = 203$) and Poland ($n = 200$), and the least from the Netherlands ($n = 56$). Regarding gender, there was a slight predominance of women (52.8 %). Nearly 1/3 of respondents had more than 15 years of professional experience. Less than half were non-specialised dental practitioners, while more than 30 % of respondents specialised in conservative dentistry. Table 1 provides detailed demographic data.

Of the potential side effects (Table 2), respondents most often declared awareness of low adhesion to the dentine (77.5 %) and, most rarely, solubility in oral fluids (42.6 %). More than 90 % of Canadians and Egyptians reported low adhesion to dentine. Regarding solubility, 72 % of Canadians and only 26 % of Egyptians chose it. More than half of the respondents were aware of the other three side effects (high

Table 1
Detailed demographic data about respondents (n = 1830).

	n	%
Country		
Germany	138	7.5
Poland	200	10.9
Portugal	118	6.4
Serbia	154	8.4
the Netherlands	56	3.1
Turkiye	173	9.5
Kazakhstan	203	11.1
Pakistan	153	8.4
Saudi Arabia	138	7.5
Uzbekistan	191	10.4
Canada	100	5.5
Egypt	100	5.5
Republic of South Africa	106	5.8
Gender		
female	967	52.8
male	863	47.2
Work experience		
< 6 years	667	36.5
6–15 years	567	31.0
16–25 years	306	16.7
> 25 years	290	15.8
Specialisation		
no specialisation	823	45.0
conservative dentistry/endodontics	601	32.8
periodontology/oral surgery/maxillofacial surgery	136	7.4
pediatric dentistry	112	6.1
prosthodontics/orthodontics	133	7.3
radiology or other	25	1.4

roughness – 51.1 %, high thermal expansion – 56.7 % and release of methacrylates – 57.7 %). A similar analysis was carried out in the context of the impact of work experience on awareness of side effects (Table 3). Overall, dentists with the shortest experience (less than 6 years) were least aware of the possible side effects of composite materials, except for the solubility in oral fluids, which was least known to dental practitioners with the longest experience over 25 years.

In general, aesthetics was identified as the main advantage of

composite fillings (79 %), followed by the possibility of repair (59 %) and adhesion to enamel (57 %) – Fig. 1. Only for the Portuguese and Dutch, aesthetics did not come first, being overtaken by the other two main advantages mentioned. Depending on the country, the top three also included other advantages of composites - for Turks, smart procedure; for Uzbeks, durability; and for Serbs, multitasking.

In contrast, polymerisation shrinkage was a major disadvantage for most countries (70 % overall) – Fig. 2. In Egypt, it was practically on par with post-operative sensitivity, and in Uzbekistan, it was second to multistep procedure. On the other hand, in Kazakhstan, the polymerisation shrinkage was in the penultimate place only before toxicity. Three other disadvantages were reported with similar frequency – discolouration (54 %), post-operative sensitivity (53 %) and multistep procedure (50 %), followed by the risk of wear (39 %).

Analysing the declared complications related to composite fillings for all countries (Table 4), statistically significant odds were obtained for marginal discolouration and borderline significance for secondary caries (OR 2.982, 95 % CI 1.321–6.730, p-value 0.009, OR 1.814, 95 % CI 0.964–3.415, p-value 0.065, respectively) – Fig. 3A and B. The marginal discolouration was most common in Pakistan (OR 31.947, 95 % CI 17.066–59.806), and by far the reverse trend was least expected in Kazakhstan and Uzbekistan (OR 0.145, 95 % CI 0.094–0.224, OR 0.266, 95 % CI 0.174–0.406, respectively). Similarly, secondary caries was most frequently reported by Pakistanis, Dutch and Poles (OR 9.159, 95 % CI 5.452–15.384, OR 9.000, 95 % CI 3.826–21.171, OR 5.994, 95 % CI 3.892–9.232, respectively), and most rarely by Kazakhs and Serbians (OR 0.145, 95 % CI 0.094–0.224, OR 0.533, 95 % CI 0.339–0.838, respectively).

A significant inverse relationship was found for pulp inflammation and increased plaque accumulation (OR 0.412, 95 % CI 0.233–0.729, p-value 0.002, OR 0.492, 95 % CI 0.276–0.875, p-value 0.016, respectively), especially in Kazakhstan, where these complications were the rarest (OR 0.091, 95 % CI 0.057–0.144, OR 0.101, 95 % CI 0.064–0.160, respectively) – Figs. 3C and 3D. In contrast, a significant chance of increased plaque accumulation was reported in the Netherlands and Uzbekistan (OR 4.457, 95 % CI 2.016–9.851, OR 1.844, 95 % CI 1.229–2.767, respectively), and pulp inflammation in Egypt (OR 1.907,

Table 2
Declared awareness of the potential side effects of direct composite restorations depending on country.

Country	all	high roughness		high thermal expansion		low adhesion to dentine		release of methacrylates		solubility in oral fluids	
Germany	138	44	31.9 %	52	37.7 %	88	63.8 %	102	73.9 %	46	33.3 %
Poland	200	106	53.0 %	114	57.0 %	174	87.0 %	116	58.0 %	90	45.0 %
Portugal	118	64	54.2 %	66	55.9 %	102	86.4 %	72	61.0 %	66	55.9 %
Serbia	154	64	41.6 %	132	85.7 %	95	61.7 %	47	30.5 %	67	43.5 %
the Netherlands	56	38	67.9 %	32	57.1 %	44	78.6 %	38	67.9 %	30	53.6 %
Turkiye	173	104	60.1 %	112	64.7 %	146	84.4 %	118	68.2 %	87	50.3 %
Kazakhstan	203	93	45.8 %	85	41.9 %	145	71.4 %	84	41.4 %	66	32.5 %
Pakistan	153	76	49.7 %	99	64.7 %	131	85.6 %	96	62.7 %	59	38.6 %
Saudi Arabia	138	58	42.0 %	66	47.8 %	106	76.8 %	58	42.0 %	54	39.1 %
Uzbekistan	191	95	49.7 %	112	58.6 %	128	67.0 %	129	67.5 %	72	37.7 %
Canada	100	68	68.0 %	68	68.0 %	92	92.0 %	80	80.0 %	72	72.0 %
Egypt	100	70	70.0 %	54	54.0 %	94	94.0 %	70	70.0 %	26	26.0 %
Republic of South Africa	106	56	52.8 %	46	43.4 %	74	69.8 %	46	43.4 %	44	41.5 %
p-value		<0.001		<0.001		<0.001		<0.001		<0.001	
Total	1830	936	51.1 %	1038	56.7 %	1419	77.5 %	1056	57.7 %	779	42.6 %

Table 3
Declared awareness of the potential side effects of direct composite restorations depending on work experience.

Work experience	all	high roughness		high thermal expansion		low adhesion to dentine		release of methacrylates		solubility in oral fluids	
< 6 years	667	313	46.9 %	357	53.5 %	482	72.3 %	372	55.8 %	268	40.2 %
6–15 years	567	305	53.8 %	335	59.1 %	455	80.2 %	326	57.5 %	269	47.4 %
16–25 years	306	169	55.2 %	189	61.8 %	252	82.4 %	182	59.5 %	138	45.1 %
> 25 years	290	149	51.4 %	157	54.1 %	230	79.3 %	176	60.7 %	104	35.9 %
p-value		0.039		0.045		<0.001		0.478		0.004	
Total	1830	936	51.1 %	1038	56.7 %	1419	77.5 %	1056	57.7 %	779	42.6 %

Main advantages of composite restorations

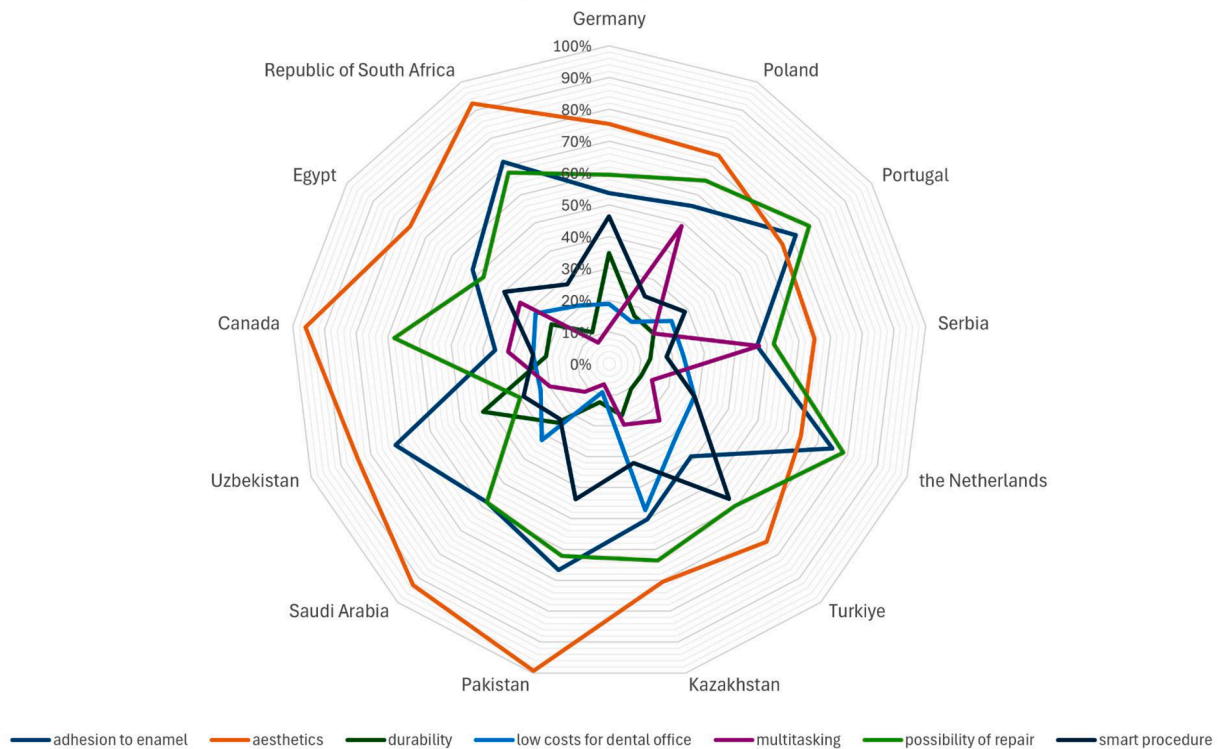


Fig. 1. Main advantages of composite restorations.

Main disadvantages of composite restorations

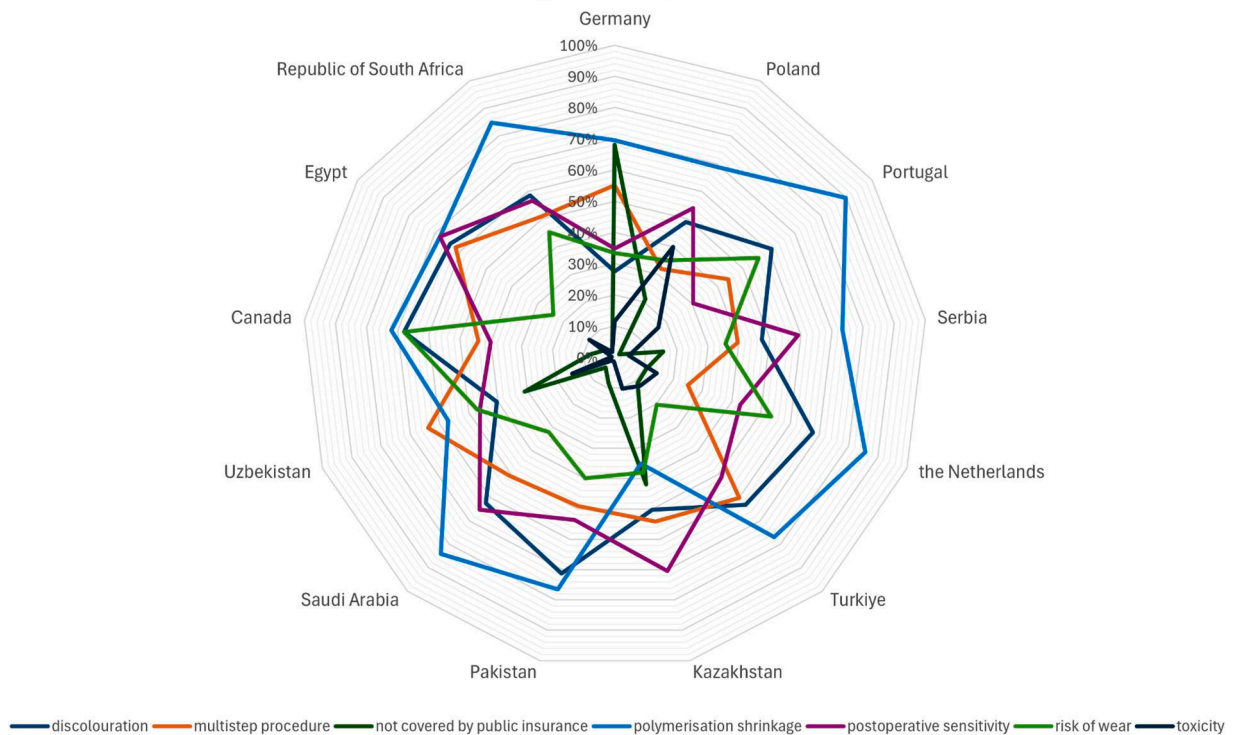


Fig. 2. Main disadvantages of composite restorations.

95 % CI 1.088–3.344). Moreover, based on Fig. 3E, complications in the form of weakening of the hard tissues were significantly more frequent in two countries - Egypt and Poland (OR 3.160, 95 % CI 1.774–5.631, OR

2.250, 95 % CI 1.508–3.357, respectively).

Interestingly, no significant differences were found between work experience groups in experiencing complications following the direct

Table 4
The pooled odds ratios describing chance for clinical complications after direct composite restorations depending on country.

Country	marginal discolouration			secondary caries			pulp inflammation			plaque accumulation			weakening of hard tissues		
	OR	95 % CI	weight	OR	95 % CI	weight	OR	95 % CI	weight	OR	95 % CI	weight	OR	95 % CI	weight
Germany	1.690	1.050-2.720	7.75	1.902	1.180-3.069	7.76	0.125	0.073-0.213	7.66	0.144	0.085-0.245	7.68	0.167	0.099-0.280	7.67
Poland	5.994	3.892-9.232	7.79	5.994	3.892-9.232	7.82	1.174	0.793-1.737	7.91	1.083	0.732-1.603	7.91	2.250	1.508-3.357	7.88
Portugal	5.188	2.981-9.030	7.68	3.274	1.922-5.579	7.68	0.305	0.179-0.520	7.67	1.226	0.735-2.043	7.71	0.816	0.489-1.360	7.69
Serbia	3.848	2.399-6.170	7.75	0.533	0.339-0.838	7.79	0.093	0.055-0.158	7.68	0.160	0.098-0.262	7.74	0.170	0.104-0.279	7.78
the Netherlands	3.240	1.496-7.019	7.43	9.000	3.826-21.171	7.07	1.778	0.841-3.758	7.20	4.457	2.016-9.851	7.10	0.751	0.357-1.579	7.13
Turkiye	4.856	3.082-7.653	7.77	0.977	0.641-1.489	7.84	0.643	0.421-0.983	7.86	0.440	0.286-0.677	7.85	1.072	0.703-1.634	7.85
Kazakhstan	0.145	0.094-0.224	7.79	0.145	0.094-0.224	7.82	0.091	0.057-0.144	7.80	0.101	0.064-0.160	7.81	0.119	0.076-0.185	7.81
Pakistan	31.947	17.066-59.806	7.60	9.159	5.452-15.384	7.70	0.607	0.386-0.953	7.82	0.833	0.532-1.304	7.82	1.082	0.691-1.693	7.80
Saudi Arabia	3.098	1.896-5.061	7.74	2.735	1.681-4.451	7.74	1.060	0.661-1.699	7.78	0.250	0.152-0.412	7.73	0.466	0.288-0.754	7.75
Uzbekistan	0.266	0.174-0.406	7.79	0.979	0.656-1.463	7.86	0.220	0.143-0.339	7.85	1.844	1.229-2.767	7.89	1.429	0.955-2.138	7.88
Canada	6.612	3.566-12.259	7.61	1.620	0.927-2.831	7.63	0.151	0.082-0.280	7.50	0.151	0.082-0.280	7.50	0.444	0.252-0.783	7.58
Egypt	3.160	1.774-5.631	7.66	1.620	0.927-2.831	7.63	1.907	1.088-3.344	7.61	0.524	0.299-0.919	7.61	3.160	1.774-5.631	7.55
Republic of South Africa	6.418	3.530-11.667	7.63	1.701	0.988-2.929	7.66	0.588	0.341-1.012	7.65	0.588	0.341-1.012	7.65	0.685	0.399-1.176	7.63
Total (random effects)	2.982	1.321-6.730	0.009	1.814	0.964-3.415	0.065	0.412	0.233-0.729	0.002	0.492	0.276-0.875	0.016	0.647	0.369-1.132	0.127

composite restorations, such as pulp inflammation, hard tissue weakening and plaque accumulation (Table 5). However, in the case of marginal discolouration and secondary caries, dentists with less than 15 years of work experience were significantly more likely to be faced with these clinical complications.

4. Discussion

Questionnaire-based studies are prevalent in healthcare research because they can simultaneously provide a lot of interesting information from many centres. Previous surveys about composites found in the literature most often relate to either teaching of composite placement and operative techniques, teaching of repair, or clinical practice of repair versus replacement [25-29]. Our survey results confirmed the common opinion that dentists value composite most for its aesthetics. As is known, composite fillings allow teeth restoration in the anterior region without altering the natural appearance of the reconstructed teeth [10,30]. The second advantage appreciated by our respondents was the possibility of repair. Similarly, Al-Negrish concluded that the main reason for the first-time placement of composite restorations is primary caries, and the main reason for their repair is secondary caries [25].

Another advantage indicated by dentists was adhesion to enamel. The relatively high resistance to occlusal forces and good adhesion to enamel (using a bonding system) make composite fillings versatile and suitable for reconstructing posterior teeth, where the filling is exposed to high occlusal forces [1,2,31,32]. In contrast, in our survey, 77 % of respondents are aware of the low adhesion to dentin as the potential side effect of RBCs.

Our respondents rated the durability of the composite very well, which is confirmed by other studies. Extensive research indicates the enduring clinical performance of composite restorations, showcasing annual failure rates ranging from 1 % to 4 % [32,33] influenced by factors such as caries risk, occlusal stress, and socioeconomic considerations [2]. Posterior resin composite restorations especially show excellent survival, with annual failure rates of 1.8 % at five years and 2.4 % after ten years of service [32].

Multitasking and smart procedure were rated relatively low. Multitasking is not just about different classes of cavities. Researchers indicate the use of nanocomposites not only for rebuilding enamel and dentin but also for dentin-pulp regeneration, pulp capping, enamel substitution, periodontal ligament regeneration, periodontal drug delivery, and so forth [34].

Do dentists' clinical observations contradict scientific research? This issue certainly requires further analysis. Low prices were also not the most crucial criterion for dentists, and dentists may be used to the high operating costs of their offices.

By far, the most significant disadvantage of direct composite restorations noticed by our respondents is polymerisation shrinkage, which is the same as marginal discolouration and post-operative sensitivity. In their study, Akbar et al. obtained similar results reported by their respondents. Post-operative sensitivity (84 %) and polymerisation shrinkage (73 %) were the major problems related to direct composite restorations [26].

Our respondents also indicated that the multistep procedure was a disadvantage of this material. This finding is entirely understandable and is reflected in scientific research. Over the last few years, we have observed a strong trend towards shortening the procedure, e.g. single-bottle bond instead of etchant, primer and bond, restoration material for applying in one thick layer instead of several thinner ones, strong and fast polymerisation lamp (3 s. instead 40 s. exposure) or one-step polishing system. Arandi et al., in their survey among dentists, found that despite explicit guidelines and instructions, dentists do not follow adhesive procedures. When it comes to polishing, there's also a variety of methods [12,35,36].

The risk of wear is certainly a disadvantage of composite materials. Studies reported that the filler volume fraction plays a critical role in the

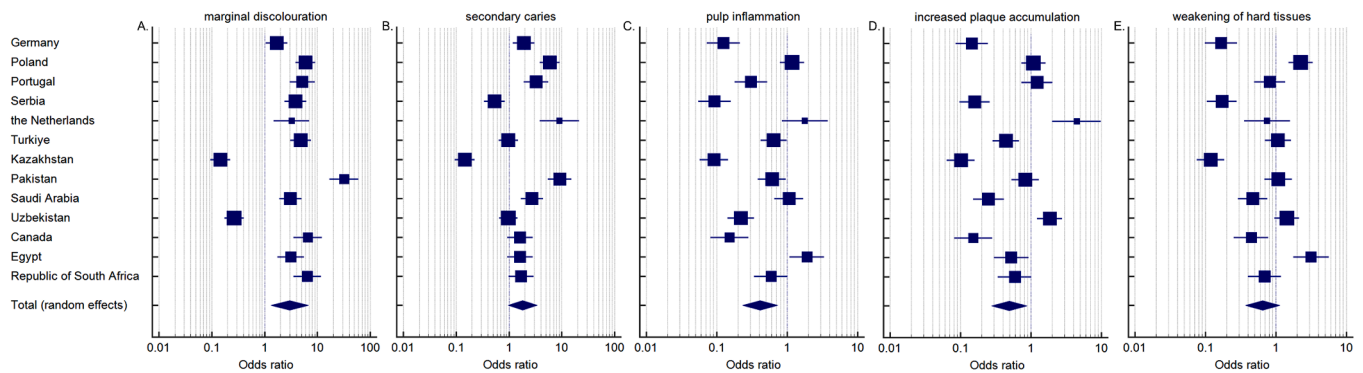


Fig. 3. Forest plots presenting the pooled odds ratios for clinical complications after direct composite restorations: A. marginal discolouration, B. secondary caries, C. pulp inflammation, D. plaque accumulation, E. weakening of hard tissues.

wear resistance of conventional resin composites, and a higher filler volume fraction was reported to reduce the level of wear [37]. In clinical situations, the rigid fillers transmit occlusal stress into the more flexible resin matrix. This phenomenon may lead to stress concentrations at the filler–resin matrix interface, filler dislodgment and resin matrix exposure, leading to wear [38,39]. Although the wear resistance of composite materials depends on their type and composition, it is higher than that of glass ionomer cements, which are particularly susceptible when additional chemical degradation occurs [21,40].

Toxicity did not rank high in our survey. More than half of the respondents are also mindful of the possibility of releasing methacrylates. Dentists seem to trust composites manufacturers and do not seriously consider the potential toxicity of fillings. However, it is known that the use of composite fillings can lead to pulp inflammation, which may result from the composite's toxicity and local release of toxic methacrylate and dimethacrylate monomers: BisGMA, TEGDMA, UDMA, HEMA, BisEMA [1,5,6]. These side effects occur mainly in the case of incomplete polymerisation of the composite material. Unpolymerised monomers from the resin-based composite can permeate the pulp directly at the exposed area and diffuse through the dentinal tubules. In conjunction with dentinal fluid flow, this process induces cytotoxic effects on pulp cells, leading to pulp inflammation and post-operative tooth sensitivity [17,41,42].

Thermal expansion of composites is a very current topic. Dentists do not seem to inform patients about the need to eat and drink only at room temperature when placing RBC restorations. Scientific research confirms that expansions and contractions resulting from temperature changes (e. g., coffee with ice cream) develop stresses at the tooth–restorative interface, which may lead to microleakages forming at the restoration's margins. The penetration of acid and microorganisms can result in the patient's experience of sensitivity and, ultimately, secondary caries. Pulp damage can result from toxic products liberated by microorganisms. Staining can occur at the restoration margin from debris accumulation [43,44].

More than half of the dentists declared that they were aware of the high roughness of the composite. It may be a consequence of many factors, but the polishing technique mentioned earlier has the most significant influence. It seems that this stage may often be shortened or, even worse, omitted by dentists, which may result in the complications they observe [45].

Our study showed high consistency of responses - awareness of the roughness of the composite translated into a high frequency of observed discolouration of direct composite restorations. Our respondents also observed a significant percentage of secondary caries in the case of these restorations. This problem has been known since the introduction of composite material. According to Nedeljkovic et al., up to 72 % of fillings may show clinical symptoms of secondary caries. Its genesis is multifactorial and complicated [46,47]. Moreover, thicker biofilms around resin composite than glass ionomer restorations, accompanied

by significantly higher levels of lactic acid-producing bacteria, contribute to the complexity of caries around restorations even more [46,48].

Other complications, such as pulp inflammation, plaque accumulation, tooth weakness and fracture, were mentioned least frequently by our respondents. These findings could be related to the survey's limitations and the possibility of selecting only three indications. The study results are so attractive that the authors plan further research, limiting the topics and specifying the questions.

4.1. Limitations

Among the limitations of our study, we should mainly emphasise the participation bias. Due to the way the survey was disseminated, it may be feared that dentists interested in conservative dentistry and younger practitioners who use social media more often participated. The original online questionnaire was available only in English (with the exception of the translated version in Serbia and Turkiye), which generally limited its accessibility to English speakers. In this way, the results may not fully reflect the level of awareness of dentists in the respective countries. Moreover, owing to the nature of dissemination, the response rate to the survey cannot be evaluated, weakening the study validity. Also, we did not collect information about the dentists' places of work, and there was no division into private and insurance clinics. Therefore, the socioeconomic status of patients and their expectations could not be taken into account. It turned out to be challenging to analyse the question about dental composite in public insurance treatment. In many countries, the situation is unclear, and there is no clear answer regarding the level of treatment reimbursement. The requirements of the healthcare system may significantly impact the choice of the composite material or alternative material (e.g. amalgam or glass ionomer cement). The number of dentists who responded to the survey differed depending on the country, so in some cases, the relatively low sample size may be considered a limitation. However, it should be noted that representatives of the medical professions do not seem willing to participate in survey research, but the international cooperation network we are creating is still being developed. We hope to expand the scope of cooperation with further research.

5. Conclusions

In our opinion, dentists treat resin-based composite material with increasing caution. It turns out that aesthetics is not everything - stability and durability of the direct restoration are also important. Our survey results clearly showed that dentists do not accept composite material uncritically. They are highly aware of possible clinical complications, and, importantly, they have their observations.

Table 5
The pooled odds ratios describing chance for clinical complications after direct composite restorations depending on work experience.

Work experience	marginal discolouration			secondary caries			pulp inflammation			plaque accumulation			weakening of hard tissues		
	OR	95 % CI	weight	OR	95 % CI	weight	OR	95 % CI	weight	OR	95 % CI	weight	OR	95 % CI	weight
< 6 years	2.189	1.759–2.724	25.76	3.045	2.436–3.805	25.40	0.388	0.311–0.484	32.13	0.517	0.416–0.643	31.96	0.745	0.601–0.924	36.70
6–15 years	4.475	3.487–5.742	25.41	1.519	1.202–1.919	25.33	0.357	0.280–0.454	29.16	0.531	0.419–0.672	29.40	0.571	0.451–0.722	30.76
16–25 years	1.369	0.996–1.882	24.49	0.833	0.606–1.144	24.68	0.531	0.385–0.732	20.06	0.353	0.254–0.489	19.53	0.657	0.478–0.904	16.74
> 25 years	1.602	1.154–2.223	24.34	0.698	0.503–0.968	24.59	0.342	0.244–0.479	18.66	0.432	0.310–0.602	19.12	0.607	0.437–0.843	15.80
Total (random effects)	2.169	1.299–3.621	0.003	1.290	0.665–2.503	0.451	0.394	0.332–0.467	<0.001	0.467	0.393–0.556	<0.001	0.651	0.571–0.741	<0.001

CRedit authorship contribution statement

Anna Lehmann: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Kacper Nijkowski:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jakub Jankowski:** Writing – original draft, Methodology, Investigation, Data curation. **David Donnermeyer:** Investigation. **Paulo J. Palma:** Investigation. **Milan Drobac:** Investigation. **João Filipe Brochado Martins:** Investigation. **Fatma Pertek Hatipoğlu:** Investigation. **Indira Tulegenova:** Investigation. **Muhammad Qasim Javed:** Investigation. **Hamad Mohammad Alharkan:** Investigation. **Olga Bekjanova:** Investigation. **Sylvia Wyzga:** Investigation. **Moataz-Bellah Ahmed Mohamed Alkhawas:** Investigation. **Rutendo Kudenga:** Investigation. **Ömer Hatipoğlu:** Investigation. **Anna Surdacka:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.jdent.2024.105009](https://doi.org/10.1016/j.jdent.2024.105009).

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