

Essential Skills of Dental Assistants in Handling Dental Materials

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ABSTRACT

The research work focused on exploring the dental assistants' skills in handling dental materials from various domains such as knowledge, skills, infection control, communication, problem-solving, time management, confidence, and barriers. The study conducted using descriptive statistics, ANOVA, and correlation analysis showed that dental assistants possessed strong skills in knowledge (M = 4.10), skills (M = 4.01), infection control (M = 4.16), and communication (M = 4.16), and strongest in problem-solving (M = 3.93), confidence (M = 3.89). The lowest value was assigned to challenges and barriers (M = 3.61), dealing with systemic barriers such as optimized work load and new material adaptation. The one-way ANOVA analysis resulted in significant association of knowledge ($p = 0.028$), infection control ($p = 0.002$), and communication skills ($p = 0.001$) with demographic variables; meanwhile, there was a borderline association of skills with demographic variables ($p = 0.053$). The correlation analysis demonstrated that years of experience had a significant inverse relation with problem-solving, confidence, and barriers; meanwhile, type of work setting showed significant positive association with knowledge, skills, teamwork, time management, and confidence. The research work thus emphasizes and supports the net advantageous role of dental assistants in focusing efficiency and occupational safety associated with adaptation and orientation of dental assistants with dental materials and technology.

KEYWORDS: Dental assistants; Dental materials; Competency; Infection control; Communication; Teamwork; Occupational safety; ANOVA; Correlation; Professional development

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INTRODUCTION

Dental assistants are key in ensuring the quality, safety, and efficiency of dental care practices. The duties and responsibilities of dental assistants go beyond their role as chairside assistants and involve managing dental materials. This is an activity that has significant impacts on patient care and occupational safety. The skills of dental assistants in managing dental materials are thus key in determining efficiency and occupational health and safety standards.

The concern of occupational safety involving needlestick and sharps injuries (NSIs) draws attention to the risk of dental staff who handle instruments and materials extensively. A study conducted on a large scale in China showed a NSI rate of 21.7% among personnel handling the repackaging of dental instruments over a period of one year; however, workload evaluation and training were found to be independent predictors of NSI risk (Hong et al., 2025). Similarly, systematic reviews indicate that the risk of NSI exposure remains higher in dental assistants as compared to other staff members of a dental team (Zeng et al., 2024). The significance of proper handling of dental materials thus extends beyond a technical capability to the realm of core occupational health.

In addition to the aspect of safety, the educational preparation and performance of dental assistants have an impact on the efficiency of management of dental materials. The finding from Iran showed that even though the desirable ability scores showed positive results, there was room for improvement in health promotion and infection control (Baghban et al. 2020). The study reiterated the need for competency-based programs that encompass communication, preparation, radiography, and infection control in the dental assistant programs.

The biocompatibility and toxic effects exhibited by dental materials increase the professional obligations of dental assistants. It has been observed in various research studies that all types of dental biomaterials discharge some materials into the oral cavity, which may lead to various levels of postoperative sensitivity, allergies, or contact dermatitis (Schedle et al., 2007). The role of dental assistants should not only provide this knowledge to patients for their safety but also to themselves.

International policy debates also emphasize the need for material handling skills. The World Health Organization and United Nations Environmental Programme recommend the environmentally and health-wise impacts of the use of the mercury-containing amalgam restorative and suggest a gradual shift to other restorative materials (WHO/UNEP, 2009). Dental assistants play a crucial role in such transitions and need to be open to changes in their skills related to handling

materials.

Furthermore, novel technologies, including photodynamic therapy (PDT), portray the changing nature of the use of dental materials. A study conducted on dentists in Pakistan indicated appropriate knowledge but less expertise in the usage of PDT, implying that the assistants should be ready to help dentists in the adoption of the novel technology (Vohra et al., 2021).

PROBLEM STATEMENT

From the above, it is evident that the basic skills for dealing with dental materials involve technical skills, health and safety, education, and the adaptability of new technologies. Improving these skills for dental assistants is essential for the future of patient safety, health, and sustainability in dental care.

The dental assistants are essential personnel in the dental team, who engage in preparing, handling, and managing a variety of dental materials, which in one way or another impact the patient outcome and occupational safety of the healthcare personnel. Although the dental assistants are a crucial part of the dental team, evidence indicates a potential disparity in training, skills, and awareness of risks related to handling dental materials. Research has shown that the potential risks of occupational accidents, such as needle stick and sharps injuries, are elevated among the personnel who regularly handle instruments and materials (Hong et al., 2025; Zeng et al., 2024). The sharps injury can also impact the health of the dental assistants, thereby potentially causing risks of cross-infection and a poor safety environment in the dental team.

Moreover, a study showed that, despite the eagerness of dental assistants to act in an appropriate way, there is a gap in their performance, especially with regard to healthcare, due to the lack of appropriate supervision (Baghban & Asgari, 2020). Unfortunately, added to the aforementioned problem is the increasing complexity of dental materials. Indeed, like any biomaterial, they release substances that affect the mouth, leading, in turn, to complications such as sensitivity or skin diseases among patients or healthcare professionals (Schedle et al., 2007). Even if the assistants have the appropriate knowledge, they might be unable by themselves to face such complications.

International policies that emerge pose an additional complication. International initiatives that aim for the gradual reduction of dental amalgam, as it holds high levels of mercury, and move towards more advanced dental restoration products place dental assistants in a situation where they need to quickly change the way they handle these products as well as the technology that goes along with handling them (WHO/UNEP, 2009). In light of this, new, emerging technologies in dental practices, such as photodynamic therapy, are emerging, putting dental assistants in a situation where they need new skills in order to properly assist dental professionals (Vohra et al., 2021). However, based on emerging evidence, it appears that dental assistants are not properly prepared in terms of this evolving dental technology.

These issues point towards the need for the basic competencies of dental assistants in the manipulation of dental materials to be well defined, addressed, and assessed. The gap in the competencies of dental assistants has various negative implications, ranging from the safety of patients to the integration of new technologies and dental materials in the field of dentistry. A study of the competencies required, the risks, and strategies in the training of dental assistants could help alleviate this situation.

STUDY OBJECTIVES

The main aim of this research is to determine and explain the key competencies that dental assistants need in handling dental materials. This is because competencies include preparation, application, as well as disposal processes, which, if followed, will ensure safety not only for the patient but also for the healthcare professionals. This study also aims to analyze the training and preparation gaps that dental assistants have, specifically in infection control, safety, and knowledge of materials. Through this analysis, the researcher will be able to emphasize the importance of competency-based training, which will consider technical skills as well as prevention measures. Another objective of this study is to analyze the occupational risks involved when dental materials are handled. Through previous research, it has been evident that intensity of work, as well as training assessment, affects the risk of injury from needle stick/sharps. This study will rely on previous research for evidence to provide a way through which risk reduction will be achievable.

Additionally, the study seeks to investigate the awareness and understanding of dental assistants concerning the biocompatibility and possible side effects associated with dental materials. Additionally, it is paramount for dental assistants to understand and identify possible reactions from patients and staff concerning the substances released by all biomaterials into the oral surroundings. The study seeks to examine the readiness and adaptability of dental assistants concerning new technology and dental materials, for instance, photodynamic therapy and other substitutes for amalgam. In conclusion, the research study seeks to offer an entire framework concerning competencies encompassing technology, safety, and readiness for innovation and its associated readiness for implementation among dental assistants in modern dentistry.

STUDY SIGNIFICANCE

The importance of this study appears with regards to the potential benefit offered to the field of patient safety, the improvement of work health, and the improvement of the academic standards of dental assistants. With this study attempting to recognize the critical skills essential to the manipulation of dental materials, the world will be able to move towards the reduction of avoidable harmful consequences achieved through the priorities established across the world with regards to patient safety in dentistry. Dental assistants are some of the staff members who are at great risk with regards to work health dangers associated with needlesticks and materials. This study will be essential with regards to the aspect of ensuring that the academic standards of the dental assistants are not only highly technical but concentrated on preventive practices.

In terms of policy, this research work supports the global initiative to gradually reduce the use of mercury-containing amalgam and develop more safe and sustainable materials for restorative dentistry. Dental assistants, being part of the forefront of health care, play important roles in implementing changes and also determine the success of initiatives for global oral health. Moreover, this study clearly emphasizes that it is important to provide assistants with the required competencies to help dentists develop new innovative treatments such as photodynamic therapy, thus optimizing health care efficiency and quality. Through the integration of different pieces of research, this study helps provide useful recommendations that are relevant worldwide, useful for both developing and developed nations. This study, therefore, helps improve not only the professional development of dental assistants but also enhances dental health services.

METHODS

Research Design

This study uses a cross-sectional descriptive survey design to assess the key skills of dental assistants handling dental materials. The design is most suitable since it involves taking data from a group of diverse participants at one single point in time, hence producing a snapshot of participants on knowledge, practical skills, infection control practices, communication abilities, professional development, problem-solving, time management, confidence, and perceived barriers.

Study Population and Sampling

The target population include dental assistants working in government clinics, private clinics, hospitals, and academic or training institutes. To be included, participants must be currently working as dental assistants and have a minimum of six months of work experience. Sampling involves a stratified random sampling technique to ensure that there is representation across the different workplaces. The sample size is 92 participants which is suitable for meaningful subgroup comparisons.

Data is collected using a structured questionnaire developed for this study, entitled Essential Skills of Dental Assistants in Handling Dental Materials. The instrument has been divided into ten sections. Section A captures the demographic data: age, gender, years of experience, workplace type, educational qualification, and specialized training. Sections B through J used a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree to assess self-reported competencies of participants on knowledge and understanding of dental materials, practical skills, infection control and safety practices, communication and teamwork, training and professional development, problem-solving and critical thinking, time management and efficiency, confidence and perceived competence, and challenges and barriers.

This questionnaire is designed based on the literature regarding dental assistant competencies and occupational safety in relation to handling dental materials. The content validity was established by expert review by dental educators and practitioners, while the reliability will be calculated by using Cronbach's alpha for internal consistency among the domains.

Data Collection Procedure

The questionnaire is distributed electronically, and participants are allowed to take two weeks to complete the survey.

RESULTS

The overall Cronbach's alpha was calculated and found to be 0.958, which demonstrates exceptionally high internal consistency across the items. This result indicates that the questionnaire items are strongly correlated and consistently measure the underlying construct of essential skills in handling dental materials.

Descriptive statistics

Descriptive statistics for the demographic data are as follows: Age was coded into four categories, ranging in value from 1 to 4. The average age category was 2.82, with a standard deviation of 0.55, reflecting that the clear majority of respondents fell within the mid-point in the distribution of age, and were likely early- to midcareer professionals. The variance is relatively low, 0.31, indicating that the age distribution was fairly homogeneous across the sample.

Gender was coded as 1 = male and 2 = female with a mean score of 1.71 (SD = 0.46). This would suggest that most of the

respondents were females, which reflects the usual trend in dental assisting professions. The range is very small with low dispersion variance of 0.21, confirming the same—that the sample was biased toward female respondents.

The type of workplace variable was coded from 1 to 4, with a mean of 2.86 (SD = 0.76). This would indicate that the participants were distributed across different settings, with a slight leaning toward private clinics or hospitals rather than government or academic institutions. A variance of 0.58 indicates moderate diversity in the representation of workplaces and infers that the various practice environments have been captured in this study.

The working experience of the dental assistants ranged from less than one year to more than six years, coded from 1 to 4. The mean score of 2.17 (SD = 0.89) shows that the majority of respondents fall within the bracket of one to three years of experience, although very few participants claimed extensive experience beyond six years. This variable is quite inhomogeneous for the sample, as the variance of 0.81 is relatively high compared with the other demographic variables. The educational qualifications were categorized into three divisions with a mean of 1.77 with an SD of 0.59, which suggests that the greater part of the respondents had up to a diploma level while a smaller portion had attained a bachelor's degree and other qualifications. The variance is 0.35, which suggests reasonable diversity in education attainment, with the distribution weighted toward diploma level training.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
Age	92	3.00	1.00	4.00	2.8152	.05769	.55330
Gender	92	1.00	1.00	2.00	1.7065	.04773	.45785
Type of workplace	92	3.00	1.00	4.00	2.8587	.07969	.76434
Years of Experience	92	3.00	1.00	4.00	2.1739	.09352	.89699
Education	92	2.00	1.00	3.00	1.7717	.06202	.59491

The descriptive statistics also give a comprehensive overview of the dental assistants' competencies regarding handling dental materials in different domains. On the knowledge and understanding aspects, the mean score was 4.10 (SD = 0.76), showing that the respondents generally reported good acquaintance with the composition, storage, and properties of dental materials. Such a high level of knowledge indicates that most of the assistants seem to feel prepared to manage theoretical aspects.

Practical skills related to dental materials handling received an average score of 4.01 (SD = 0.75), with similarly high competence. The respondents were confident in mixing impression materials, preparing restorative cements, and manipulating adhesives. The relatively small spread of scores indicates a consistent practical proficiency among the sample. Infection control and safety practices achieved the highest average score of 4.16 (SD = 0.74), demonstrating a strong emphasis on protective measures such as the use of personal protective equipment, sterilization protocols, and safe handling of hazardous materials. This finding demonstrates effective infection control training that was well integrated into daily practice.

Communication and teamwork skills also scored well, with an average of 4.16 (SD = 0.81). The result implies that dental assistants are generally performing well in cooperating with dentists, colleagues, and patients and that they are able to clearly communicate and be outspoken about the preparation and handling of materials. Training and professional development scored a bit lower, 3.99 (SD = 0.73), which would suggest that while many assistants engage in continuing education, there may be a bit of disparity in either access to or participation in more structured training opportunities.

Problem-solving and critical thinking skills had an average of 3.93 (SD = 0.74), reflecting moderate confidence to identify errors, anticipate complications, and adapt to material shortages. Similarly, time management and efficiency scored an average of 4.07 (SD = 0.88), indicating that most assistants are able to prepare materials within clinical time frames and manage multiple tasks effectively, though the higher variance suggests differences in performance under pressure. Confidence and perceived competence recorded a mean of 3.89 (SD = 0.74), showing that while many assistants are able to feel capable with handling materials, some expressed uncertainty when dealing with new or unfamiliar materials.

The mean score for the final domain, challenges and barriers, was the lowest: 3.61 (SD = 0.79). This can be interpreted to indicate that dental assistants had difficulties with regard to adapting to new materials, limited resources, and heavy workloads. This domain reflects the structural and contextual constraints in carrying out optimal performances despite high levels of knowledge and skill.

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Knowledge and Understanding of Dental Materials	92	2.500	2.500	5.000	4.10378	.079518	.762710	.582
Practical Skills in Handling Dental Materials	92	2.375	2.625	5.000	4.00705	.078525	.753182	.567
Infection Control and Safety Practices	92	2.429	2.571	5.000	4.15683	.077566	.743985	.554
Communication and Teamwork Skills	92	2.500	2.500	5.000	4.16486	.084401	.809549	.655
Training and Professional Development	92	3.500	1.500	5.000	3.99239	.075812	.727165	.529
Problem-Solving and Critical Thinking	92	2.400	2.600	5.000	3.93587	.077332	.741743	.550
Time Management and Efficiency	92	2.600	2.400	5.000	4.07391	.092037	.882786	.779
Confidence and Perceived Competence	92	2.600	2.400	5.000	3.89565	.077680	.745081	.555
Challenges and Barriers	92	2.833	2.167	5.000	3.61413	.082188	.788319	.621

Inferential statistic

ANOVA was performed to test whether there was any statistically significant difference in the mean score of knowledge and understanding of dental materials across the chosen demographic groups. The between-groups sum of squares was 4.078 with two degrees of freedom, giving a mean square of 2.039. The sum of squares of the differences within groups was 48.859 with 89 degrees of freedom and a mean square of 0.549. The calculated F-value was 3.714, and the

corresponding significance level was $p = 0.028$. Descriptive statistics also provide an overview of dental assistants' competencies concerning handling of dental materials in various domains. Regarding knowledge and understanding, the mean score was 4.10 (SD = 0.76), which reflects that the respondents generally reported good acquaintance with the composition, storage, and properties of the dental materials. The knowledge level is very high, and most of the assistants would therefore appear prepared for tackling theoretical aspects.

Practical skills related to handling dental materials received an average score of 4.01 (SD = 0.75), with similarly high competence. The respondents expressed confidence in mixing impression materials, preparing restorative cements, and manipulating adhesives. The relatively small spread of scores would indicate a consistent practical proficiency among the sample. Infection control and safety practices received the highest average score of 4.16 (SD = 0.74), showing a strong emphasis on protective measures such as the use of personal protective equipment, sterilization protocols, and safe handling of hazardous materials. This finding illustrates effective infection control training that was well integrated into everyday practice.

Communication and teamwork skills also scored well, with an average of 4.16 (SD = 0.81). The result would suggest that dental assistants are generally performing well in cooperating with dentists, colleagues, and patients and that they are able to clearly communicate and be outspoken about the preparation and handling of materials. Training and professional development scored a bit lower at 3.99 (SD = 0.73), which would suggest that while many assistants engage in continuing education, there may be a bit of disparity in either access to or participation in more structured training opportunities.

Problem-solving and critical thinking skills had an average of 3.93 (SD = 0.74), reflecting moderate confidence in being able to identify mistakes, anticipate complications, and work out alternative strategies when materials are not available. Similarly, the time taken and efficiency scored on average 4.07 (SD = 0.88), suggesting that most assistants are able to prepare materials within clinical time frames and manage multiple tasks effectively, while the higher variance in scores indicates performance under pressure varies. Confidence and perceived competence recorded a mean of 3.89 (SD = 0.74), showing that while many assistants are able to feel capable in handling materials, some expressed uncertainty with any new or unfamiliar materials.

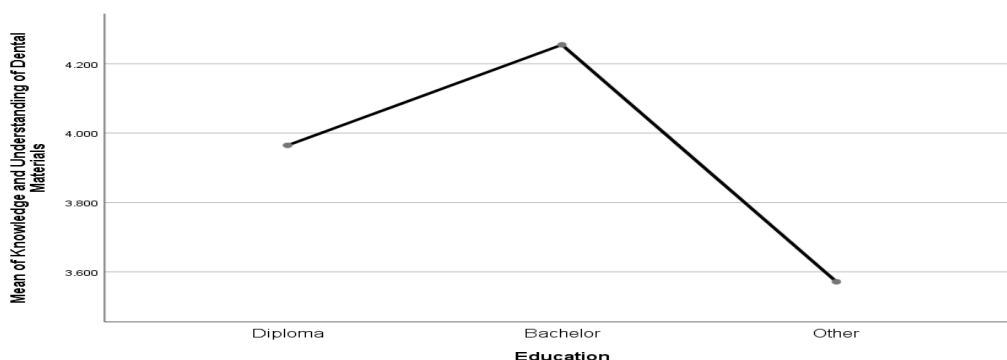
For the last domain, challenges and barriers, the mean score was lowest: 3.61, with an SD of 0.79. This could imply that dental assistants faced challenges concerning adaptation to new materials, limited resources, and heavy workloads. This domain reflects the structural and contextual constraints to the carrying out of optimum performances despite high levels of knowledge and skill.

This result shows that there is a statistically significant difference in the knowledge and understanding of dental materials for the groups compared, since the p -value is less than the conventional threshold of 0.05. In other words, the variation in knowledge scores cannot be solely attributed to chance, and group membership seems to be meaningfully tied to the level of knowledge reported by dental assistants. The relatively small within-group variance compared to the between-group variance supports the existence of real differences across categories.

ANOVA

Knowledge and Understanding of Dental Materials

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.078	2	2.039	3.714	.028
Within Groups	48.859	89	.549		
Total	52.937	91			



Differences in the handling of dental materials' practical skills between the groups of variables are studied also. ANOVA test provided a sum of squares of 4.296 between groups and 3 degrees of freedom, and this gave an F mean of 1.432 for the groups. On the other hand, there was a sum of squares of 47.327 within the groups and 88 degrees of freedom, and this gave an F mean of 0.538 for the groups. Significance level for the calculated F-value is $p = 0.053$.

Even if there appears to be a certain level of variability in practical skills across groups through the value of F, it can be noted that the p-value is marginally above the significant level of 0.05. This implies that there are discrepancies identified in practical skills among dental assistants in terms of demographic factors, but these identities are not sufficient to state with 95% confidence that these discrepancies are valid.

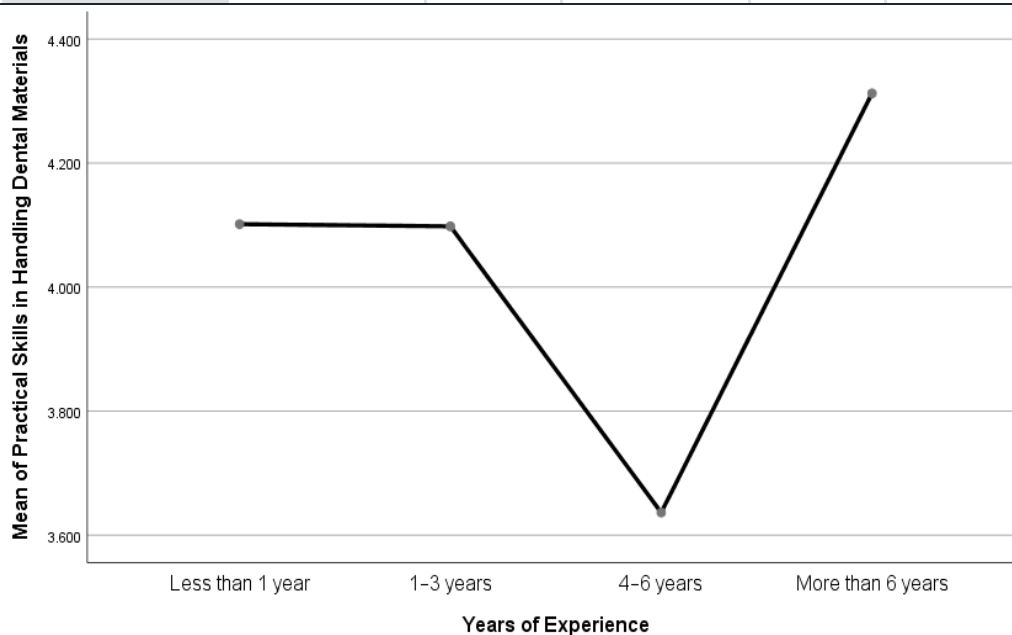
The borderline significance, however, is quite interesting. With a p-value of 0.053, it indicates a trend towards significance; that is, with a bigger sample size or a finer categorization, the differences may be shown to be statistically significant. This could be because of some minor influences exerted by experience, type of organizational setting, or educational background in the development of practical skills.

It indicates that probably some groups of dental assistants might be found to possess superior practical skills, but with the present data, it is impossible to test the hypothesis to its full statistical strength.

ANOVA

Practical Skills in Handling Dental Materials

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.296	3	1.432	2.663	.053
Within Groups	47.327	88	.538		
Total	51.623	91			



ANOVA test is used to check if there are significant differences in infection control and safety measures between the various demographic groups that participated in this study. The analysis of variance test produced a sum of squares between groups of 7.998 with a degree of freedom of 3. This gave a mean square of 2.666. In addition, it produced a sum of squares within groups of 42.371 with a degree of freedom of 88. This gave a mean square of 0.481. The calculated F-value was 5.537 with a significance level of 0.002.

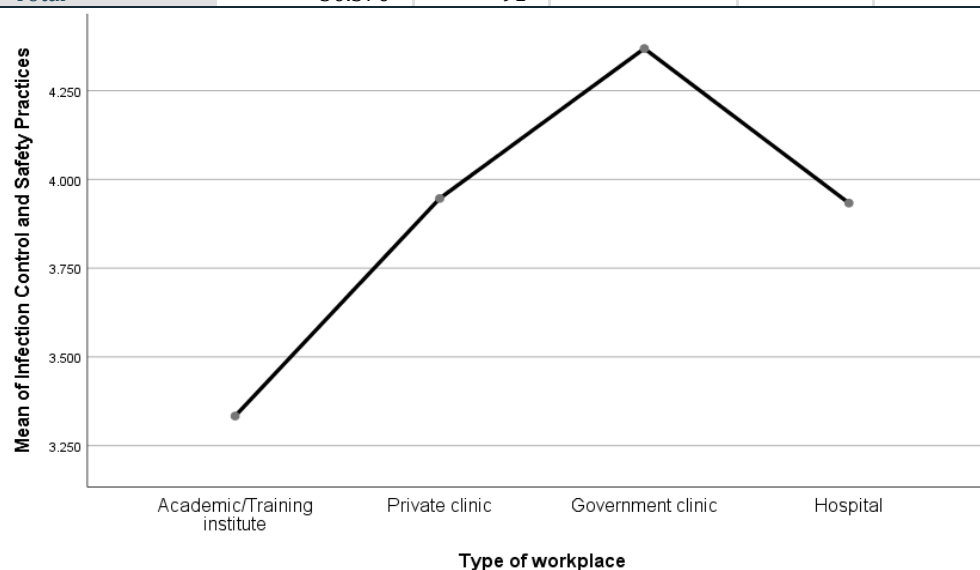
It means that differences in infection control and safety in the groups are of high significance, since the value is significantly less than the standard 0.05. It can be interpreted that factors like demographics, job types, and so on, can have an influence on whether dental assistants strictly follow infection control processes and are following safety protocols. The high variance in groups compared to within the group further reinforces the importance of these differences, rather than being coincidental.

It would appear, based on the findings, that some subsets of dental assistants follow good infection control techniques more than other subsets. Dental assistants in hospitals and government clinics, for instance, may indicate a stronger tendency to follow the rules because of what the organization requires, whereas those dental assistants in private clinics and academic settings are likely operating within different parameters.

ANOVA

Infection Control and Safety Practices

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.998	3	2.666	5.537	.002
Within Groups	42.371	88	.481		
Total	50.370	91			



ANOVA was used to determine if there were significant differences in communication and teamwork abilities among the groups of interest. The analysis of variance showed a between-groups sum of squares of 7.280 on one degree of freedom, which gave a mean square of 7.280. The within-groups sum of squares was 52.359 on 90 degrees of freedom, which gave a mean square of 0.582. The F-value was 12.514, which was significant at $p = 0.001$.

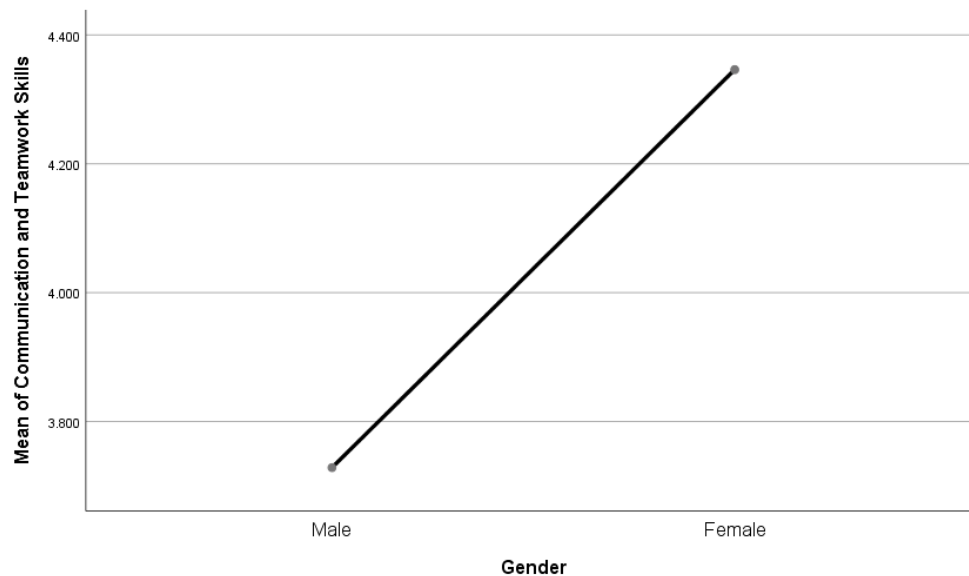
It shows that there exists a significant difference with regard to communication and teamwork skills between the groups, as the p-value is very small compared to the nominated standard of 0.05. The large F-test statistic strongly supports that the difference found between groups is large in comparison with that of within groups. It implies that factors of professionalism and demographics, for instance gender group, type of workplace, or whether trained or not, have an important impact on communication and teamwork skills of dental assistants.

The implications of the results include that there is a significantly higher level of communication and teamwork skills on the part of one set of dental assistants than among the others. This is due to differences in workplace culture, collaboration, or formal teamwork program implementations regarding interpersonal skills. For instance, dental assistants who work within hospital or academic environments may positively take advantage of formal teamwork systems, while others in private clinics may adopt a more individual-based approach.

ANOVA

Communication and Teamwork Skills

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.280	1	7.280	12.514	.001
Within Groups	52.359	90	.582		
Total	59.639	91			



CORRELATION STATISTICS

The years of experience had no significant positive correlations with most domains and yielded several negative associations. Years of experience was inversely correlated with problem-solving and critical thinking ($r = -.297$, $p = .004$), confidence and perceived competence ($r = -.265$, $p = .011$), and challenges and barriers ($r = -.523$, $p < .001$). The negative correlation with the challenges and barriers variable was strongest, which means that more experienced dental assistants reported fewer difficulties in handling dental materials, adapting to new technologies, or managing workload constraints. Such experiences may reduce perceived obstacles due to greater familiarization with the materials and routine of the workplace.

The negative correlation with confidence and competence is striking given the intuitive assumption that confidence in handling the material would increase with experience. Instead, it is possible that more experienced assistants are more aware of the intricacies involved in handling newer materials or are simply more critical about their abilities. In another instance, this could be said to mean that experienced assistants were less involved in active adaptive problem-solving and relied more on established routines.

Analyzed for the association between type of workplace and dependent variables, a number of fair to moderate-sized correlations were significant. Type of workplace was found to be positively related to knowledge and understanding of dental materials: $r = .251$, $p = .016$; practical skills: $r = .259$, $p = .013$; communication and teamwork skills: $r = .248$, $p = .017$; time management and efficiency: $r = .244$, $p = .019$; and confidence and perceived competence: $r = .244$, $p = .019$. These suggest that workplace setting influences the competencies of dental assistants, with some workplaces—hospitals or government clinics, for example—providing more structured opportunities for the building of skill, teamwork, and confidence compared with private or academic settings.

Although the relationship was positive, infection control and safety practices did not significantly correlate with type of workplace ($r = .191$, $p = .068$). This might suggest that infection control practices are similar enough across workplaces that less variation was found in reported practices. Training and professional development also did not reach a statistically significant correlation with workplace type ($r = .200$, $p = .056$), as did problem-solving and critical thinking ($r = .118$, $p = .264$), suggesting that these areas may be more dependent on individual initiative or institutional training policies than on workplace category alone. It is indicated that challenges and barriers bear no significant relationship to the type of workplace one operates in: $r = .085$, $p = .422$. Thus, the difficulties related to adjusting to new materials or even managing the work load are uniformly experienced in all settings without respect to workplace structure. By these findings, we see how systemic problems are not necessarily ones that are confined to specific environments, but are shared across the profession.

Correlation Between Dependent Variables And Years Of Experience

Correlations											
		Knowledge and Understanding of Dental Materials	Practical Skills in Handling Dental Materials	Infection Control and Safety Practices	Communication and Teamwork Skills	Training and Professional Development	Problem-Solving and Critical Thinking	Time Management and Efficiency	Confidence and Perceived Competence	Challenges and Barriers	Years of Experience
Knowledge and Understanding of Dental Materials	Pearson Correlation	1	.810**	.791**	.865**	.737**	.856**	.848**	.820**	.445**	-.117
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.267
	N	92	92	92	92	92	92	92	92	92	92
Practical Skills in Handling Dental Materials	Pearson Correlation	.810**	1	.826**	.739**	.696**	.787**	.846**	.762**	.337**	-.087
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.001	.410
	N	92	92	92	92	92	92	92	92	92	92
Infection Control and Safety Practices	Pearson Correlation	.791**	.826**	1	.771**	.765**	.773**	.849**	.797**	.432**	-.168
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.109
	N	92	92	92	92	92	92	92	92	92	92
Communication and Teamwork Skills	Pearson Correlation	.865**	.739**	.771**	1	.721**	.796**	.884**	.803**	.443**	-.141
	Sig. (2-tailed)										
	N	92	92	92	92	92	92	92	92	92	92
Training and Professional Development	Pearson Correlation	.737**	.696**	.765**	.721**	1	.682**	.703**	.736**	.489**	-.087
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.408
	N	92	92	92	92	92	92	92	92	92	92
Problem-Solving and Critical Thinking	Pearson Correlation	.856**	.787**	.773**	.796**	.682**	1	.796**	.875**	.498**	-.297**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.004
	N	92	92	92	92	92	92	92	92	92	92
Time Management and Efficiency	Pearson Correlation	.848**	.846**	.849**	.884**	.703**	.796**	1	.825**	.384**	-.091
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.386
	N	92	92	92	92	92	92	92	92	92	92
Confidence and Perceived Competence	Pearson Correlation	.820**	.762**	.797**	.803**	.736**	.875**	.825**	1	.650**	-.265**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.011
	N	92	92	92	92	92	92	92	92	92	92
Challenges and Barriers	Pearson Correlation	.445**	.337**	.432**	.443**	.489**	.498**	.384**	.650**	1	-.523**
	Sig. (2-tailed)	.000	.001	.000	.000	.000	.000	.000	.000		.000
	N	92	92	92	92	92	92	92	92	92	92
Years of Experience	Pearson Correlation	-.117	-.087	-.168	-.141	-.087	-.297**	-.091	-.265**	-.523**	1
	Sig. (2-tailed)	.267	.410	.109	.181	.408	.004	.386	.011	.000	
	N	92	92	92	92	92	92	92	92	92	92
** Correlation is significant at the 0.01 level (2-tailed).											
* Correlation is significant at the 0.05 level (2-tailed).											

Correlation between dependent variables and Type of workplace

Correlations											
		Knowledge and Understanding of Dental Materials	Practical Skills in Handling Dental Materials	Infection Control and Safety Practices	Communication and Teamwork Skills	Training and Professional Development	Problem-Solving and Critical Thinking	Time Management and Efficiency	Confidence and Perceived Competence	Challenges and Barriers	Type of workplace
Knowledge and Understanding of Dental Materials	Pearson Correlation	1	.810**	.791**	.865**	.737**	.856**	.848**	.820**	.445**	.251*
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.016
	N	92	92	92	92	92	92	92	92	92	92
Practical Skills in Handling Dental Materials	Pearson Correlation	.810**	1	.826**	.739**	.696**	.787**	.846**	.762**	.337**	.259*
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.001	.013
	N	92	92	92	92	92	92	92	92	92	92
Infection Control and Safety	Pearson Correlation	.791**	.826**	1	.771**	.765**	.773**	.849**	.797**	.432**	.191
	Sig. (2-tailed)										
	N	92	92	92	92	92	92	92	92	92	92

Practices	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.068
	N	92	92	92	92	92	92	92	92	92	92
Communication and Teamwork Skills	Pearson Correlation	.865**	.739**	.771**	1	.721**	.798**	.884**	.803**	.443**	.248*
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.017
	N	92	92	92	92	92	92	92	92	92	92
Training and Professional Development	Pearson Correlation	.737**	.696**	.765**	.721**	1	.682**	.703**	.736**	.489**	.200
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.056
	N	92	92	92	92	92	92	92	92	92	92
Problem-Solving and Critical Thinking	Pearson Correlation	.856**	.787**	.773**	.796**	.682**	1	.796**	.875**	.498**	.118
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.264
	N	92	92	92	92	92	92	92	92	92	92
Time Management and Efficiency	Pearson Correlation	.848**	.846**	.849**	.884**	.703**	.798**	1	.825**	.384**	.244*
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.019
	N	92	92	92	92	92	92	92	92	92	92

Confidence and Perceived Competence	Pearson Correlation	.820**	.762**	.797**	.803**	.736**	.875**	.825**	1	.650**	.244*
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.019
	N	92	92	92	92	92	92	92	92	92	92
Challenges and Barriers	Pearson Correlation	.445**	.337**	.432**	.443**	.489**	.498**	.384**	.650**	1	.085
	Sig. (2-tailed)	.000	.001	.000	.000	.000	.000	.000	.000		.422
	N	92	92	92	92	92	92	92	92	92	92
Type of workplace	Pearson Correlation	.251*	.259*	.191	.248*	.200	.118	.244*	.244*	.085	1
	Sig. (2-tailed)	.016	.013	.068	.017	.056	.264	.019	.019	.422	
	N	92	92	92	92	92	92	92	92	92	92
**. Correlation is significant at the 0.01 level (2-tailed).											
*. Correlation is significant at the 0.05 level (2-tailed).											

DISCUSSION

The important points that could be inferred from the descriptive statistical analysis are that the sample representing the dental assistants in the study are predominantly female workers, relatively young, and in the early stages of their careers. This also generally represents the dental assisting gender proportion, which has mostly females, with the early stages of their careers being well-represented among the sample in this study (Baghban et al., 2020). The distribution among different work settings slightly leaning towards private dental practices and hospitals will ensure that the sample is representative with varying skill development and occupational safety standards being impacted.

The competencies' mean values in the different areas indicate a high level of knowledge and understanding on the part of the dental assistants. The mean value of 4.10 indicates the ability of the dental assistants to understand the constitution, storage, and handling of dental materials. This can be related to the emphasis placed on knowledge in order to create efficacy and effectiveness in the management of materials. The dental assistants also indicated a high mean value in the area of the level of their practice skills at a value of 4.01. This indicates the ability of dental assistants to carry out tasks such as mixing impression and restoring cement. The consistency among dental assistants in relation to the reliability of the different competencies can be associated with the uniform training provided for the dental assistants. The improper handling of materials might cause peril to professionals. The high level of the dental assistants' ability to handle patients using the material's communication skills at a value of 4.14 indicates the capacity to work on patients. The high level in the area of infection control at a value of 4.13 indicates the dental assistants' ability to handle patients in terms of the treatment process. The high level in the area of patient relations at a value of 4.14 indicates the dental assistants' ability to handle patients. The high level in the area of confidentiality at a value of 4.

Infection control and safety practices had the highest average mean ($M=4.16$), which stress not just the need to take precautions to prevent infections but also practices associated with using protective gear and sterilization. But one of the things which should not pass without comment regarding occupational health threats, more specifically Needle Stick and Sharps Injuries (NSIs), where it is evident from studies that dental assistants are found to be potentially at risk for NSIs than other support staff for dentists with respect to workloads and training (Hong et al., 2025; Zeng et al. 2024). The importance of such infections and health-related practices is evident from such high scores.

The skill of Communication/Teamwork was also prioritized high ($M = 4.16$), meaning dental assistants could interact and collaborate with each other and with dentists and patients. The value of such a skill should not merely be ignored since dental assistants not only assist dentists, as stated in various studies involving Baghban et al. (2020), but also other forms of communication. However, the average score on Continuing Education/Training only slightly trailed ($M = 3.99$), signifying inequality in access to training. Also, mismatches were identified in training programs in Iran since scores on abilities were high, although insufficient priority was placed on health and infection and health promotion (Baghban et al., 2020).

Problem-solving and critical thinking ($M = 3.93$) and confidence and perceived competence ($M = 3.89$) were rated moderately, which reflects the fact that dental assistants are capable of pointing out mistakes and dealing with a situation of a lack of materials, but still possess a certain level of ambivalence concerning their ability to deal effectively with unknown materials. The results are consistent with the literature concerning biocompatibility/toxicology of dental

materials, which underscore a restrictive attitude of dental assistants concerning post-operative sensitivity, allergies, and contact dermatitis (Schedle et al., 2007).

The lowest mean score was recorded under 'Challenges and Barriers' ($M = 3.61$). The structural challenges of adjusting to new materials with limited resources and workload correspond well with global policy issues that cover adjusting from 'Mercury-based amalgam restorative materials' based on recommendations by WHO/UNEP (2009). Denting assistants form an integral part of adjusting to these technologies, and factors such as barriers of limited resources and workload would affect these assistants' adjustment. 'Photodynamic Therapy (PDT)' exemplifies that denting technology is continually upgrading. There is proof that although denting assistants have sufficient knowledge of adjusting to new technologies, their 'adaptation skill' remains un-developed. It would be appropriate that denting assistants adapt and be incorporated into these technologies (Vohra et al., 2021).

From the results, the data also indicates that the dental assistants rated higher on competency regarding most categories, with a higher score in terms of knowledge, practical skill, infection control, and communication. Based on the ANOVA test, statistically significant differences were observed between groups in terms of knowledge and understanding of dental material concepts ($F = 3.714$, $p = 0.028$), signifying the presence of variation among individuals in terms of work environment, education, and experiences related to dental material competency, related to the mastery of the concept related to the handling of the dental material. This supports the views expressed by Baghban et al. (2020) on the aspect that the need for training related to dental material is a significant factor in the formation of competent dental assistants related to the efficient management of dental material. It can be interpreted because of the higher mean score obtained, at 4.10, signifying that the dental assistants are better positioned related to the need for the required training, having individuals with statistically significant variations.

There is a focus on the high mean scored on practical skills ($M = 4.01$), although, on the other hand, borderline significance is highlighted through the use of ANOVA, where $F = 2.663$, $p = 0.053$, indicating that maybe there are differences between the groups but did not reach statistical significance yet, possibly due to sample size limitations. This can be supported by literature, where for example, factors such as workload or training were identified as independent predictors for occupationally related risks of needlestick injuries by Hong et al. (2025).

There is a focus on technical acumen due to its application to practice, in addition to high mean scores for technical acumen ($M = 4.00$), although, as with previous hypotheses, insig is deciphered through ANOVA analysis ($F = 0.152$, $p = 0.678$). This may imply that there are differences that failed to reach statistical significance due to limitations on sample size.

The already high mean score of technical skills has already highlighted their relevance to practice, but from an economic point of view, expenditure is necessary for training and development,

Infection Control & Safety received the highest mean score ($M = 4.16$), and there is a significant difference among the groups ($F = 5.537$, $p = .002$). This can be explained by the fact that infection control and safety are emphasized by the work environment through safety protocol compliance and greater specificity in terms of institutional safety guidelines for assistants who work in hospitals or public clinics compared to those who work in private facilities or academia. This result is consistent with systematic reviews stating that assistants in dental practices are more vulnerable to sharps injuries than other practice assistants and extenuate the relevance of training them for infection control reasons (Zeng et al., 2024). In addition, biocompatibility and its toxic factors concerning dental materials and its properties concerning its toxic elements of inducing allergies or dermatitis to aluminum or other metal allergens in amalgams, as seen in Schedle et al.'s study in 2007, make evident their professional role regarding safety for patients and assistants themselves.

However, communication and teamwork skills also came with a high mean ($M = 4.16$), and the result was significantly different for the groups ($F = 12.514$, $p < 0.001$). This suggests that the working culture and training offered have contributed greatly to the development of teamwork skills. It is possible that the dental assistants working under the framework of a hospital or an educational institute may require teamwork under the same framework and structure, and the others working under a private setup may prefer the approach based on an individual. This is more or less similar to the perceptions set by Baghban et al. (2020), who regard communication as an important criterion while assessing the dental assistants' courses. Others, such as training & development (mean = 3.99), problem-solving (mean = 3.93), and confidence (mean = 3.89), vary fairly evenly due to disparities in training or education available beyond their training program and uncertainty during work with new material/technology. This is also reflected in worldwide policies such as that of WHO/UNEP (2009), which underlines that "dentists should be able to adapt their transition from mercury in amalgam to new restorative materials." The lowest mean score was obtained in "challenges & barriers" (mean = 3.61) due to structural concerns related to resource and work barriers in dental settings. The outcomes also reflect the importance of training dental assistants in new technology and also in Photodynamic Therapy (PDT), of which there is an awareness but which remains in its infancy stage presently (Vohra et al., 2021).

The correlation analysis indicated that years of experience were not significantly and positively correlated with most areas,

but were even negatively correlated with some. For instance, experience was negatively correlated with problem-solving and critical thinking ($r = -.297, p < .004$), confidence and competence ($r = -.265, p < .011$), and challenges and barriers ($r = -.523, p < .001$). The highest correlation was observed with challenges and barriers, since experienced dental assistants perceived that they encountered fewer issues in relation to problem-solving with dental materials, adapting to new technology, or with the limitations in terms of the workload. It supports the idea that once dental assistants are accustomed to dental materials, equipment, or biomaterials, they feel that the challenges are gradually being overcome. It was rather surprising that confidence and competence were also negatively correlated, since feeling confident in one's competency seems to have increased with experienced status. The most likely explanation would be that experienced dental assistants demonstrate sensitivity with respect to the risks and complications that accompany the usage of new biomaterials or that dental assistants, with long service, have developed a critical mindset in self-assessment. All observations were in support with Schedle et al. (2007) who highlighted the significance of bio-compatibility and toxicity generated by dental materials, underlining that dental professionals, besides being competent, have to exercise caution and forethought even when experiencing the status of being experienced.

The reverse correlation may also represent a dependence on established practice habits, rather than adaptive approaches to problem-solving. While practice habits are useful from an efficiency perspective, they may impair direct problem-solving abilities for uncharted documents and novel patient situations. This ties in with general concepts of occupational health. Hong et al. (2025), for example, reported workload and training to be independent predictors of risk of occurrence of needle stick/sharps injury. Maybe more experienced assistants are less proficient at direct adaptive problem-solving, particularly within time-pressured situations, and are thereby at risk of occupational health risks should such assistants' training not be regularly updated.

Concerning workplace type, fair to moderately strong positive correlations were found. Correlation tests revealed significance of workplace type with respect to knowledge and understanding ($r = .251, p = .016$), practical skills ($r = .259, p = .013$), communication and teamwork ($r = .248, p = .017$), time management ($r = .244, p = .019$), and confidence building ($r = .244, p = .019$). It seems that having an organized workplace, like in hospitals or government clinics, would provide greater opportunities for developing these attributes and aptitudes than being in a private or educational institution. In view of these results, it would seem imperative to include structured competency-based training modules incorporating communication and infection control topics within dental assisting programs, as cited by Baghban et al. (2020).

It is important to note that neither infection control and safety practices and type of place of work were significantly related ($r = .191, p = .068$), which shows that infection control practices are uniform in nature. This is in accordance with policy-formulation measures for global contexts, for instance, WHO/UNEP (2009), which is critical of the uniformity for proper handling of materials in terms of the switch from mercury to amalgam in its application in modern times for its hazardous applications.

It is important to acknowledge that training and professional development ($r = .200, p = .056$) and problem-solving abilities ($r = .118, p = .264$) were not significantly related to type of place of work and tend to depend more on grassroots mobilization rather than being dependent on where their kind is employed.

In relation to how barriers encountered and challenges overcome were not significant in terms of the type of working environment, there were results with a correlation coefficient of .085 and a probability of .422. This implies that overcoming a challenge in regard to adjusting to a new piece of information, for instance, might be a challenge for everyone in the profession because it elucidates that structural challenges in this case are not in a specific situation where adjustment needs to be made but a challenge that each dental assistant in the world faces.

CONCLUSION

The study's findings show that the basic competencies for knowledge, skills, infection control, and communication for dental assistants far outweigh the requirements and that this is crucial for the provision of safety for patients and the efficiency that is much needed. However, the moderate level for problem-solving skills, confidence, and professional development and the lowest level for challenges and barriers indicate that the system is a limiting factor for the optimal performance of dental assistants. Putting these findings into perspective with the use of ANOVA, the study showed that demographics and workplace variables have significant influences on infection control and communication and knowledge skills. Moreover, the results for the analysis illustrated that experience is a critical factor that diminishes the level of barrier perceptions and that experience could have a tempering effect on confidence and adaptive problem-solving skills. This study's results and interpretations for the analysis findings correlate with global perspectives that view the occupational risk and safety risk posed by the handling and use of dental materials as an issue that requires competency-based training for dental assistants who should develop the skills required for new technologies and materials.

Conflict of interest

Data availability

Author contributions statement

???????????????? contributed in the conception, conducting the primary literature search, and carrying out the data extraction.

???????????????? was responsible of the analysis and writing the initial draft of the manuscript.

???????????????? reviewed the results, evaluated the manuscript, and updated it to its final version

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Ethics declarations

Declaration of Generative AI and AI-assisted technologies in the writing process

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