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Recognition, attitudes and educational requirements toward forensic odontology among dental students in Shandong Province, China: a cross-sectional questionnaire-based study

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Abstract

Background Forensic odontology is an interdisciplinary subspecialty of dentistry that provides scientific evidence for judicial proceedings and human-remains identification. Empirical baseline data on dental students' perceptions of forensic odontology in mainland China are scarce. This study assessed cognition, attitudes and educational needs for forensic odontology among 482 dental students from one Shandong university providing evidence for interdisciplinary dental curriculum reform.

Methods An anonymous cross-sectional online questionnaire was distributed using convenience sampling. The survey tool was adapted from published international instruments. IBM SPSS Statistics 22.0 was used for analyses including Pearson's χ^2 test, Cochran-Armitage trend test, Mantel-Haenszel ordinal χ^2 test, and Spearman's rank-order correlation analysis.

Results Only 59.13 % of respondents identified forensic odontology as a dentistry subspecialty. Gender-associated cognitive disparities were found in perceptions of its applications and individual anatomical uniqueness (except for age estimation), with no significant grade-level differences. Documentaries, university-based lectures and online media were major information sources; 15.98 % reported no prior exposure to this discipline and 39.21 % faced barriers accessing relevant information. Over 85 % of participants acknowledged its linkage with dentistry and supported supplementary teaching. Whilst 84.44 % favored active learning and 42.12 % preferred integrated theory and practical training, merely 24.9 % expressed strong forensic-odontology-related career intention, indicating weak translation of learning motivation into professional aspiration. Moderate positive correlations existed between interdisciplinary-relevance perceptions, self-assessed knowledge and preliminary career intention, as well as between active-learning willingness, perceived occupational benefits and preliminary career intention.

Conclusion Though recognizing forensic odontology's practical value, Shandong dental students showed poor conceptual mastery and fragmented information access, alongside limited conversion from learning to career intention. Interdisciplinary teaching via electives and thematic lectures is recommended. Grade-stratified curricula, accommodation of gender-related cognitive gaps, enhanced practical training and improved educational and popular-science resources should advance interdisciplinary dental-talent development.

Keywords: forensic odontology; dental students; cognition; cross-sectional survey; medical education

1. Introduction

Forensic odontology is an interdisciplinary field that bridges dentistry and forensic medicine[1]. By exploiting the unique dental and maxillofacial characteristics to conduct age estimation, personal identification, bite-mark analysis and evaluation of dental malpractice, thereby providing critical scientific evidence for judicial investigations and disaster victim identification[2-4]. With the growing demand for robust, scientifically grounded evidence in judicial practice, the practical relevance of forensic odontology has become increasingly prominent[5,6].

Multiple international surveys conducted among dental students and practitioners have consistently revealed widespread gaps in forensic odontology knowledge and limited exposure to relevant training[7-10]. However, empirical baseline data - particularly questionnaire-based evidence targeting dental students in mainland China - remain scarce[11-13]. As future professionals in this domain, dental students represent a vital talent pool for forensic odontology. Assessing their current cognitive status, educational requirements, and career intentions is therefore essential for optimizing the interdisciplinary curriculum within dental education.

Accordingly, this study employed a cross-sectional, anonymous online questionnaire survey, enrolling dental undergraduates and postgraduates from one university in Shandong Province, China as the research subjects. The objectives were (1) to characterize students′ recognition, and attitudes toward forensic odontology; (2) to identify their educational needs and preferred teaching formats; and (3) to explore the factors associated with their intention to pursue a career in forensic odontology. The findings are expected to provide locally relevant, empirical evidence for the design of forensic odontology curricula in undergraduate and postgraduate dental programs across China and to broaden students′ career perspectives.

2. Materials and Methods

2.1 Study design

This anonymous, cross-sectional online questionnaire survey was conducted in September 2026 among undergraduate and postgraduate dental students enrolled at one university in Shandong Province, China. This study protocol was reviewed and approved by the Ethics Committee of Shandong Second Medical University (IRB Number: SDSMU2026YX211). Written informed consent was waived due to complete survey anonymity. Confirmation of voluntary participation, understanding of study aims, and acceptance of anonymized data processing were mandatory to commence the survey.

2.2 Participants

Inclusion criteria: Undergraduate and postgraduate students majoring in dentistry from the participating university in Shandong Province, China.

Exclusion criteria: Non-dental students and individuals who declined to take part in this investigation.

Questionnaires were distributed online via Wenjuanxing (QuestionStar) platform through class-level social media groups, using a convenience sampling approach. Built-in platform functions were applied to avoid duplicate questionnaire submissions. During data-cleaning procedures, incomplete and logically inconsistent responses were excluded, yielding a final analytic sample of 482 valid questionnaires. No a-priori sample-size calculation was performed before participant recruitment.

2.3 Questionnaire

The self-administered 22-item questionnaire was prepared in Chinese, adapted from previously published international survey instruments and tailored to the domestic dental-education setting in China[10,14,15]. The questionnaire covered five domains: sociodemographic information, knowledge regarding forensic odontology, perceptions, attitudes, learning willingness, and perceived educational needs. Question formats included single-choice items, Likert-type ordinal scales, multiple-response (check-all-that-apply) items, and a small set of open-ended supplementary questions. Neither pilot testing nor formal reliability and validity assessments were performed for this survey instrument. The complete questionnaire is available in Supplementary Materials.

2.4 Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 22.0. Categorical variables were summarized as frequencies (n) and percentages (%). For multiple-response(check-all-apply) items, the multiple-response sets procedure was utilized. Percentages for these items were calculated as the number of affirmative responses divided by the total analytic sample size(n=482); accordingly, the sum of percentages within a single item may exceed 100%. The multiple-response cross-tabulation χ^2 test was used to assess the overall response-option distribution for multiple-response items. Notably, this global test cannot identify statistical differences for individual response options. Pearson's χ^2 test was applied for comparisons of unordered categorical variables, with Bonferroni correction implemented to account for multiple subgroup comparisons. The Cochran-Armitage trend test was used to assess monotonic trends across ordered academic-year groups against binary or ordinal outcome variables. The Mantel-Haenszel ordinal χ^2 test was applied for group comparisons of ordinal response distributions.

Spearman's rank-order correlation coefficient was calculated to evaluate associations between ordinal variables. A two-tailed $P < 0.05$ was defined as the threshold for statistically significance ($\alpha = 0.05$).

3. Results

3.1 Sociodemographic characteristics

In total, 482 valid analytic response were included in the final dataset, consisting of 436 undergraduate students and 46 postgraduate students. There were 172 male participants (35.68 %) and 310 female participants (64.32 %). Participants were distributed across academic years as follows: Year 1, n= 157 (32.57 %); Year 2, n=124 (25.73 %); Year 3, n=86 (17.84 %); Year 4, n= 28 (5.80 %); Year 5, n=41 (8.51 %); and postgraduate, n=46 (9.54 %) (Table 1).

Table 1 Sociodemographic characteristics of participants

Variable	Category	n	Percentage (%)
Gender	Male	172	35.68
	Female	310	64.32
Academic year	Year 1	157	32.57
	Year 2	124	25.73
	Year 3	86	17.84
	Year 4	28	5.8
	Year 4	41	8.5
	Postgraduate	46	9.6

Note: Percentages are calculated based on the total analytic sample (n= 482).

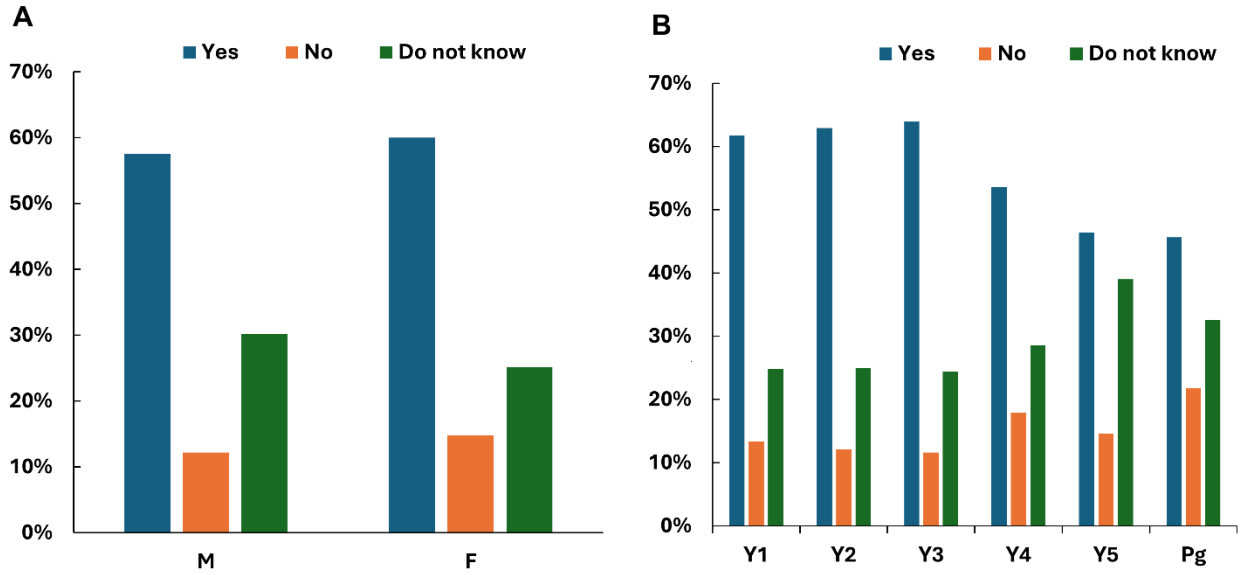
3.2 Perception of forensic-odontology as a distinct discipline

Only 59.13% participants recognized forensic odontology as a subspecialty of dentistry; while the remaining 40.87% responded "no" or "do not know" (Table 2). Pearson's χ^2 test revealed no statistically significant difference in recognition according to gender($P>0.05$) (Fig. 1A). No significant overall difference in response distribution was observed across academic years ($P = 0.133$). Responses were

116 subsequently dichotomized into “aware” (corresponding to the answer “yes”) and “unaware” (combining
117 “no” + “do not know”). The Cochran-Armitage trend test demonstrated a statistically significant linear
118 downward trend in awareness as academic year increased ($P = 0.0014$). Awareness stayed relatively
119 high at 61.78% - 63.95% among Year 1-3 students, yet decreased substantially to 45.65%-46.34% for
120 Year 5 and postgraduate students (Figure 1B).

121
122 **Table 2** Overall responses to perception-related questions concerning forensic odontology among dental students

Survey items	Responses category	N	Percentage(%)
Q1: Forensic odontology is a subspecialty of dentistry	Yes	285	59.13
	No	67	13.90
	Do not know	130	26.97
Q2: Forensic odontology assists in injury-related identification	Yes	423	87.76
	No	14	2.90
	Do not know	45	9.34
Q3: Forensic odontology assists in age estimation	Yes	438	90.87
	No	5	1.04
	Do not know	39	8.09
Q4: Forensic odontology assists in personal identification	Yes	423	87.76
	No	12	2.49
	Do not know	47	9.75
Q5: Forensic odontology supports abuse-related evidence collection (bite-mark assessment)	Yes	432	89.63
	No	9	1.87
	Do not know	41	8.51
Q6: Individual jaw structures are unique	Yes	411	85.27
	No	22	4.56
	Do not know	49	10.17
Q7: Individual lip prints are unique	Yes	422	87.55
	No	10	2.07
	Do not know	50	10.37
Q8: Individual palatal rugae are unique	Yes	396	82.16
	No	14	2.90
	Do not know	72	14.94
Q9: Advantages of teeth as forensic evidence (multiple-response item)	High hardness, resistance to decomposition, and DNA retrievability	441	91.49
	Individual-specific dental morphology	380	78.84
	Stale pattern of tooth development and wear for age estimation	397	82.37
	Dental restorations for victim identification	374	77.59
	Other（please specify）_____	2	0.41
	Do not know	25	5.19
Q10: Sources of forensic-odontology-related information (multiple-response item)	University courses / lectures	264	54.77
	Professional books / journals	205	42.53
	Documentaries	265	54.98
	Online media	243	50.41
	Explanations from experienced professionals or teachers	118	24.48
	Peer-to-peer communication	102	21.16
	Other（please specify）_____	2	0.41
	Never accessed relevant information	77	15.98
Q11: Preserving dental patient records is highly important	Agree completely	405	84.02
	Agree	67	13.90
	Disagree	5	1.04
	Strongly disagree	5	1.04



Q12: Perceived correlation between dentistry and forensic odontology	Highly interconnected	420	87.14
	Somewhat interconnected	55	11.41
	Weakly interconnected	3	0.62
	No interconnection	4	0.83
Q13: Perceived barriers of obtaining systematic forensic-odontology-related information	Very easy	128	26.56
	Relatively easy	165	34.23
	Relatively difficult	165	34.23
	Very difficult	24	4.98
Q14: Self-assessed adequacy of forensic- odontology-related knowledge	Sufficient	83	17.22
	Moderate	171	35.48
	Limited	179	37.14
	Completely unknown	49	10.17

Note: Percentages were calculated based on the total analytic sample (N= 482). For multiple-response (check-all-that-apply) items Q9 and Q10, the sum of percentages may exceed 100 %.

Figure 1 Recognition of forensic odontology as a subspecialty of dentistry among participants. (A) Distribution of responses by gender (Pearson χ^2, $P = 0.349$) (B) Distribution of response by academic year (Pg= Postgraduate) (Cochran-Armitage trend test, two-tailed $P = 0.0014$). Statistical significance was defined as $P < 0.05$.

3.3 Awareness of practical applications and individual-identification features

Over 87% of participants recognized the utility of forensic odontology for injury-related identification, age estimation, personal identification and bite-mark analysis in abuse cases. Similarly, more than 82% respondents acknowledged the individual identification potential of mandibular morphology, lip prints and

palatal rugae (Table 2). Statistically significant gender differences were observed for six of these seven items, with the exception of bite-mark evidence in abuse cases ($P<\alpha'$). Males selected the “do not know” option at a substantially higher frequency than females, whereas negative (“no”) responses were rare in both sexes (Figure 2). No statistically significant overall differences across academic years were detected for all seven items. After dichotomizing responses into “aware” (i.e., “yes”) versus “unaware” (“no” + “do not know”), the Cochran-Armitage trend test revealed no significant linear trend across academic years (Supplementary Table 1).

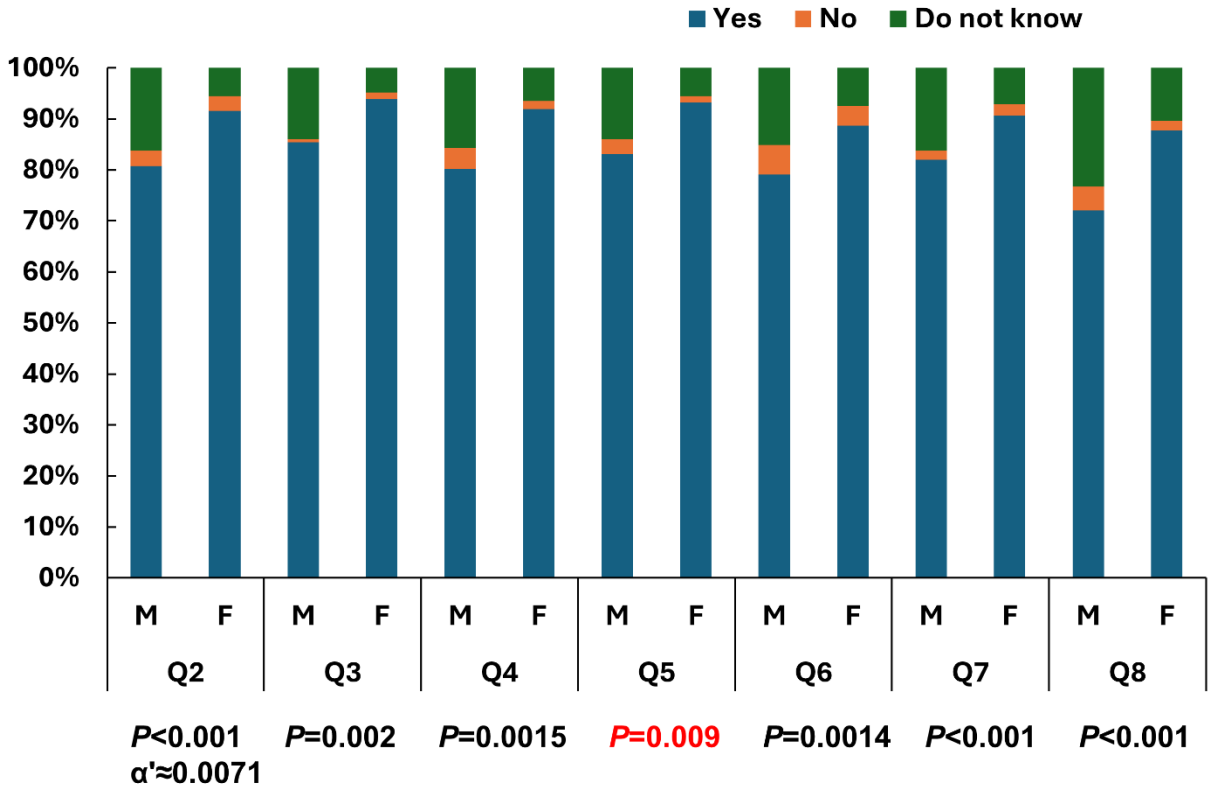


Figure 2. Inter-gender comparisons of responses regarding practical applications and individual identification features of forensic odontology, using 2 × 3 contingency table χ^2 test with Bonferroni correction (corrected significance level $\alpha' = 0.0071$). All items reached statistical significance except bite-mark assessment in abuse cases (Q5).

Exploratory ordinal coding was applied for items concerning mandibular morphology, lip-prints, and palatal-rugae, with response values assigned as follows: “yes” = 3, “no” = 2, “do not know” = 1. Moderate-weak positive correlations were observed between these coded scores and self-perceived knowledge adequacy (Spearman’s r_s = 0.221, 0.235, 0.268, respectively; all $P < 0.001$). It should be emphasized that assigning the lowest ordinal rank to the “do not know” response represents a subjective assumption: this response denotes a lack of relevant knowledge and does not equate to a lower level of understanding. These results are exploratory in nature and should not be interpreted as primary conclusions.

As for advantages of teeth as forensic evidence, the statement “High hardness, resistance to decomposition, and DNA retrievability of teeth” yielded the highest endorsement rate (91.49 %), whereas “dental restorations for victim identification” had comparatively lower recognition rate (77.59 %) (Table 2). Multiple-response cross-tabulation χ^2 test detected statistically significant overall differences in response patterns according to gender ($\chi^2 = 30.14$, $P < 0.001$) and academic years ($\chi^2 = 38.62$, $P = 0.007$) (Table 3).

Table 3 Perceptions of dental students regarding the advantages of teeth as forensic identification materials

Group	High hardness, resistance to decomposition, and DNA retrievability	Individual-specific dental morphology	Stale pattern of tooth development and wear for age estimation	Dental restorations for victim identification	Do not know	Other	*P*
Total *n* (%)	441(91.49)	380(78.84)	397(82.37)	374(77.59)	25(5.19)	2(0.41)	-
Male (*n*=172)	150(87.21)	123(71.51)	126(73.26)	122(70.93)	2(1.16)	17(9.88)	<0.001
Female (*n*=310)	291(93.87)	257(82.90)	271(87.42)	252(81.29)	0(0.00)	8(2.58)	
Year 1 (*n*=157)	143(91.08)	120(76.43)	128(81.53)	123(78.34)	0(0.00)	8(5.10)	0.007
Year 2 (*n*=124)	113(91.13)	100(80.65)	103(83.06)	98(79.03)	1(0.81)	6(4.84)	
Year 3 (*n*=86)	82(95.35)	71(82.56)	73(84.88)	67(77.91)	0(0.00)	2(2.33)	
Year 4 (*n*=28)	25(89.29)	22(78.57)	22(78.57)	20(71.43)	0(0.00)	3(10.71)	

Year 5 (*n*=41)	38(92.68)	35(85.37)	37(90.24)	33(80.49)	1(2.44)	3(7.32)
Postgraduate (*n*=46)	40(86.96)	32(69.57)	34(73.91)	33(71.74)	0(0.00)	3(6.52)

Note: Multiple-response cross-tabulation χ^2 test: gender χ^2=30.14, *P*<0.001; academic year χ^2=38.62, *P*=0.007. Percentages in each cell represent the number of participants selecting the given item divided by the sample size of each subgroup; row-wise percentage sums may therefore exceed 100%. This omnibus test reflects global pattern rather than difference for individual items.

Documentaries (54.98 %), university courses or lectures (54.77 %), and online media (50.41 %) emerged as the most frequently cited information sources. A minority of participants (15.98 %) reported never having accessed any forensic-odontology-related content (Table 2). Multiple-response cross-tabulation χ^2 test revealed statistically significant differences in the information-source response patterns according to gender（χ^2=24.71，*P*<0.001）and academic years（χ^2=48.26，*P*<0.001）(Table 4).

Table 4 Sources of forensic odontology-related information among dental students

Group	University courses / lectures	Professional books / journals	Documentaries	Online media	Experienced professionals /teachers' explanations	Peer-to-peer communication	Other	Never accessing	*P*
Total *n* (%)	264(54.77)	205(42.53)	265(54.98)	243(50.41)	118(24.48)	102(21.16)	2(0.41)	77(15.98)	-
Male (n=172)	94(54.65)	65(37.79)	78(45.35)	74(43.02)	40(23.26)	37(21.51)	1(0.58)	34(19.77)	*P*<0.001
Female (n=310)	170(54.84)	140(45.16)	187(60.32)	169(54.52)	78(25.16)	65(20.97)	1(0.32)	43(13.87)	
Year 1 (n=157)	95(60.51)	68(43.31)	88(56.05)	86(54.78)	49(31.21)	44(28.03)	0(0.00)	24(15.29)	*P*<0.001
Year 2 (n=124)	71(57.26)	54(43.55)	69(55.65)	67(54.03)	29(23.39)	28(22.58)	0(0.00)	18(14.52)	
Year 3 (n=86)	48(55.81)	42(48.84)	43(50.00)	41(47.67)	19(22.09)	13(15.12)	1(1.16)	9(10.47)	
Year 4 (n=28)	14(50.00)	15(53.57)	20(71.43)	16(57.14)	10(35.71)	8(28.57)	0(0.00)	5(17.86)	
Year 5 (n=41)	15(36.59)	13(31.71)	22(53.66)	17(41.46)	8(19.51)	6(14.63)	1(2.44)	11(26.83)	
Postgraduate (n=46)	21(45.65)	13(28.26)	23(50.00)	16(34.78)	3(6.52)	3(6.52)	0(0.00)	10(21.74)	

Note: Multiple-response cross-tabulation χ^2 test: gender χ^2=24.71, *P*<0.001); academic year χ^2=48.26, *P*<0.001. Percentages in each cell represent the number of participants selecting the given item divided by the sample size of each subgroup; row-wise percentage sums may therefore exceed 100%. This omnibus test reflects global pattern rather than difference for individual items.

3.4 Preservation of dental clinical records, perceived access difficulty and self-assessed knowledge level

The large majority of participants attached importance to the preservation of dental clinical records (84.02%). Likewise, 87.14% perceived dentistry and forensic odontology as highly interconnected. Overall, 39.21% of respondents reported barriers to acquiring systematic forensic-odontology-related knowledge, whereas merely 17.22 % rated their personal knowledge as sufficient. Accordingly, 82.78% of the participants self-assessed their knowledge as moderate, limited or completely unknown (Table 2).

Mantel-Haenszel ordinal χ^2 test revealed no gender-associated differences in attitudes toward dental-record preservation(P=0.097) or perceived barriers to knowledge acquisition (P=0.268) (Supplementary Fig 1AB). In contrast, statistically significant gender differences were observed for perceived interdisciplinary relevance between dentistry and forensic odontology (P<0.001) and self-assessed knowledge (Bonferroni-correction P<0.00625) (Fig 3AB): female participants were more likely to recognize stronger disciplinary connections, whereas male participants reported higher self-rated knowledge levels. Additional analyses investigated academic-year‑related trends for the four ordinal survey items. Cochran-Armitage trend tests detected no linear upward trend with increasing academic year for attitudes toward dental-record preservation and the perceived interdisciplinary relevance between dentistry and forensic odontology (all P > 0.05) (Supplementary Fig 1C). In contrast, both perceived barriers to knowledge acquisition and self-assessed knowledge showed significant declining trends among students in higher academic years (Fig 3C).

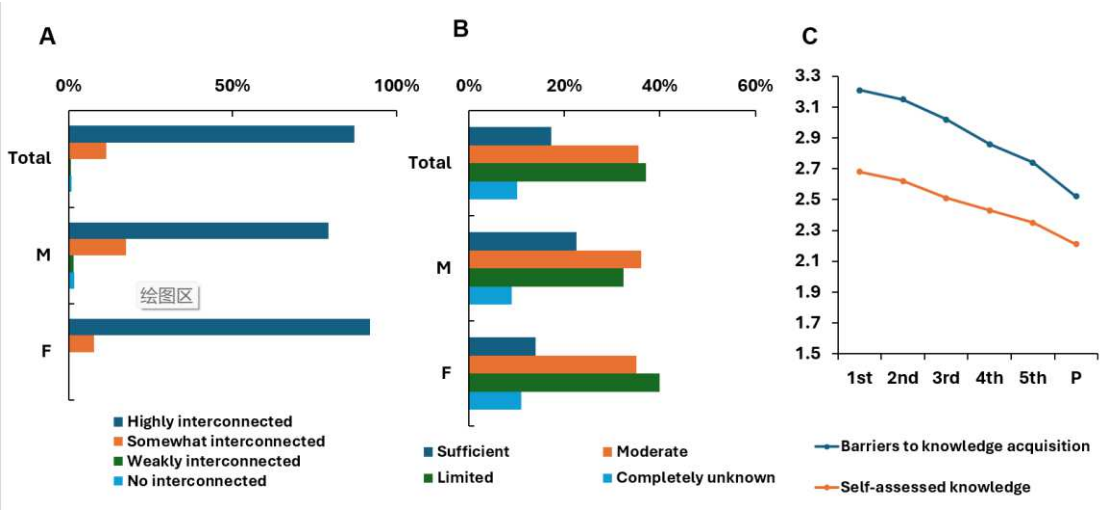


Figure 3 Dental-students′ perceptions of forensic odontology. (A) Gender-stratified responses for interdisciplinary relevance between dentistry and forensic odontology (Mantel-Haenszel ordinal χ^2 test, $P < 0.001$). (B) Gender-stratified self-assessed knowledge (Mantel-Haenszel ordinal χ^2 test, Bonferroni-corrected $P < 0.00625$). (C) Academic-year trends for knowledge-acquisition barriers and self-assessed knowledge (Cochran-Armitage trend test, both $P < 0.05$). Note: Panels A and B are 100 % stacked bar charts showing response composition.

Spearman's rank-order correlation analysis revealed a weak positive correlation between attitudes toward dental record preservation and self-assessed knowledge ($r_s = 0.112$, $P = 0.013$) (Fig 4). Perceived barriers to knowledge acquisition exhibited a weak negative correlation with self-assessed knowledge ($r_s = -0.155$, $P < 0.001$); namely, students who perceived greater difficulty accessing relevant resources reported lower self-assessed knowledge level. Self-assessed knowledge was moderately positively correlated with perceived interdisciplinary relevance and career intention ($r_s = 0.301$ and 0.332, respectively; both $P < 0.001$) (Figure 4).

	Q11	Q12	Q13	Q14	Q15	Q16	Q19	Q20
Q11	1			0.112*				
Q12		1		0.301***				0.381***
Q13			1	-0.155***				
Q14	0.112*	0.301***	-0.155	1				0.332***
Q15					1	0.527***		0.346***
Q16					0.527***	1	0.471***	0.381***
Q19						0.471***	1	0.423***
Q20		0.381***		0.332***	0.346***	0.381***	0.423***	1

Figure 4 Heat-map of Spearman rank-order correlation coefficients among the ordinal study variables. Note: Cell color denotes the magnitude of the Spearman correlation coefficient. * $P<0.05$, *** $P<0.001$. Q11: Attitudes toward dental-record preservation; Q12: Perceived interdisciplinary relevance between dentistry and forensic odontology; Q13: Perceived barriers to knowledge acquisition; Q14: Self-assessed forensic-odontology-related knowledge; Q15: Perceived need for supplementary the content of forensic odontology; Q16: Willingness for actively learning forensic-odontology-related knowledge; Q19: Perceived career-development benefits of forensic odontology for dental students; Q20: Intention to engage in forensic-odontology-related work.

3.5 Learning willingness and educational requirements

Overall, 86.10% of participants supported integrating forensic odontology training into dental curricula, while 84.44% were willing to actively participate in relevant learning. Although 92.40% perceived forensic odontology beneficial to dental students' career development, merely 24.90 % reported a strong intention to pursue forensic-related careers (Table 5).

Table 5 Participants' attitudes toward forensic-odontology education, preferred learning content and teaching modalities

Items	Responses option	n	Percentage (%)
Q15: Perceived need for supplementary the content of forensic odontology	Strongly agree	175	36.31
	Agree	240	49.79
	Neutral	40	8.30
	Disagree	27	5.60
Q16: Willingness for actively learning forensic-odontology-related knowledge	Strongly willing (hope for systematic learning)	189	39.21
	Willing (to learn for interest)	218	45.23
	Neutral (neither active nor resistant)	54	11.2
	Unwilling (no interest and irrelevant to career planning)	21	4.36
Q17: Preferred core content of forensic-odontology courses (multiple-response item)	Basic theories of forensic odontology	312	64.73
	Techniques for personal identification and age estimation	321	66.6
	Identification of dental and maxillofacial injuries	306	63.49
	Analysis of typical cases	299	62.03
	Practical operational skills	218	45.23
	Career development prospects	167	34.65
	Other (please specify)	2	0.41
Q18: Preferred teaching formats	Lecture-based teaching	85	17.63
	Case-analysis-based teaching	109	22.61
	Integrated theory and practical training	203	42.12
	Lectures by forensic experts	82	17.01
	Other (please specify)	3	0.62
Q19: Perceived career-development benefits of forensic odontology for dental student	Strongly helpful	238	49.35
	Helpful	207	42.95
	Slightly helpful	28	5.81
	Not helpful	9	1.87
Q20: Intention to engage in forensic-odontology-related work	Strong intention	120	24.9
	Some intention and willingness to learn further	263	54.56
	No intention, focus on clinical dentistry	64	13.28
	Unsure and not currently considering it	35	7.26

Note: Q17 is a multiple-response item. Percentages were calculated as the number of participants selecting each option divided by the total sample size; the sum of percentages may therefore exceed 100%.

Mantel-Haenszel ordinal χ^2 test were conducted for Q15, Q16, Q19 and Q20. Following Bonferroni correction for multiple-comparisons, a statistically significant gender-associated difference in ordinal response distribution was only identified for Q20. No significant gender differences were detected for Q15, Q16 and Q19. Likewise, Cochran-Armitage trend tests revealed no significant linear association between academic year and response patterns for these four items (Supplementary Table 2).

Regarding preferred learning contents, the most frequently selected topics were "personal identification and age estimation" (66.60%), "basic theories of forensic odontology" (64.73%), "identification of dental and maxillofacial injuries" (63.49%) and "analysis of typical cases" (62.03%). Multiple-response cross-tabulation χ^2 test revealed statistically significant overall differences in patterns of preferred

learning content between gender groups(P=0.001) and across academic year groups (P=0.002) (Table 6).

Table 6 Preferred forensic-odontology course content among dental students

Group	Techniques for personal identification and age estimation	Basic theories of forensic odontology	Identification of dental and maxillofacial injuries	Analysis of typical cases	Practical operational skills	Career development prospects	Other	*P*
Total n (%)	321(66.60)	312(64.73)	306(63.49)	299(62.03)	218(45.23)	167(34.65)	2(0.41)	-
Male (n=172)	100(58.14)	113(65.70)	103(59.88)	92(53.49)	67(38.95)	56(32.56)	2(1.16)	0.001
Female (n=310)	221(71.29)	199(64.19)	203(65.48)	207(66.77)	151(48.71)	111(35.81)	0(0.00)	
Year 1 (n=157)	106(67.52)	105(66.88)	94(59.87)	101(64.33)	84(53.50)	62(39.49)	0(0.00)	0.002
Year 2 (n=124)	81(65.32)	80(64.52)	86(69.35)	78(62.90)	58(46.77)	44(35.48)	1(0.81)	
Year 3 (n=86)	56(65.12)	58(67.44)	55(63.95)	47(54.65)	25(29.07)	20(23.26)	0(0.00)	
Year 4 (n=28)	22(78.57)	19(67.86)	17(60.71)	19(67.86)	14(50.00)	11(39.29)	0(0.00)	
Year 5 (n=41)	30(73.17)	23(56.10)	29(70.73)	28(68.29)	21(51.22)	18(43.90)	0(0.00)	
Postgraduate (n=46)	26(56.52)	27(58.70)	25(54.35)	26(56.52)	16(34.78)	12(26.09)	1(2.17)	

Note: Multiple-response cross-tabulation χ^2 test was applied. Gender comparison: χ^2=21.63, P=0.001; academic year: χ^2=34.17, P=0.002. A P value<0.05 was considered statistically significant. Percentages for each subgroup were calculated as the number of participants selecting the option divided by the total sample size of that subgroup, and the sum within each subgroup may exceed 100%.

Integrated theory and practical training is the most preferred teaching modality, selected by 42.12% of participants, followed by case-analysis-based teaching (22.61%), lecture-based teaching (17.63%), lectures by forensic experts (17.01%). A statistically significant difference in the composition of preferred teaching modalities was identified between gender groups (P=0.002). Males tended to favor lecture-based teaching, whereas females preferred integrated theory-and-practice training. No statically significant difference across academic year groups was observed for teaching-mode preference (P=0.565) (Table 7).

Table 7 Preferred teaching modalities for forensic odontology courses among dental students

Group	Integrated theory and practical training	Case-analysis-based teaching	Lecture-based teaching	Lectures by forensic experts	Other	*P*
Total n (%)	203(42.12)	109(22.61)	85(17.63)	82(17.01)	3(0.62)	-
Male (n=172)	61(35.47)	40(23.26)	45(26.16)	24(13.95)	2(1.16)	0.001
Female (n=310)	142(45.81)	69(22.26)	40(12.90)	58(18.71)	1(0.32)	

Year 1 (*n*=157)	69(43.95)	40(25.48)	26(16.56)	22(14.01)	0(0.00)	0.565
Year 2 (*n*=124)	53(42.74)	28(22.58)	23(18.55)	18(14.52)	2(1.61)	
Year 3 (*n*=86)	37(43.02)	18(20.93)	18(20.93)	13(15.12)	0(0.00)	
Year 4 (*n*=28)	10(35.71)	5(17.86)	5(17.86)	8(28.57)	0(0.00)	
Year 5 (*n*=41)	19(46.34)	7(17.07)	5(12.20)	10(24.39)	0(0.00)	
Postgraduate (*n*=46)	15(32.61)	11(23.91)	8(17.39)	11(23.91)	1(2.17)	

Note: Pearson's χ^2 test was used for group comparisons. Gender comparison: χ^2=16.80, *P*=0.002; academic year comparison: χ^2=18.35, *P*=0.565. A *P* value <0.05 was considered statistically significant. Percentages represent the proportion of respondents selecting each option within each subgroup; the sum of percentages for each subgroup equals 100%, as this was a single‑response item.

Spearman rank correlation analysis revealed that perceived need for supplementary the content of forensic odontology moderately positively correlated with willingness for active learning (r_s = 0.527, P < 0.001). Willingness for active-learning exhibited moderately positive correlations with perceived career benefit (r_s = 0.471, P < 0.001) and career intention (r_s = 0.381, P < 0.001). Greater perceived career benefit was associated with stronger career intention (r_s = 0.423, P < 0.001). The full Spearman rank correlation matrix for all ordinal variables is presented in Figure 4.

4. Discussion

This cross-sectional questionnaire survey enrolled 482 dental students recruited from one university in Shandong Province, China. Overall, participants demonstrated a strong appreciation of the judicial value of forensic odontology. Nevertheless, their conceptual understanding of the discipline remained limited, their knowledge acquisition relied on fragmented information sources, and a pronounced gap was evident between a high willingness to learn and a relatively low career intention. These findings align with some international reports while diverging from others, underscoring the need for curriculum reforms tailored to the specific educational context in China.

Forensic odontology is invaluable under many conditions primarily due to the distinct nature of oral hard tissue and anatomical characteristics[16]. Awareness of this subspeciality of dentistry is essential with the dental community. In China, few universities provide formal, standalone courses for forensic

odontology. Our results demonstrated that only 59.13% of participants correctly identified forensic odontology as a subspecialty within dentistry. This proportion, drawn from students, is comparable to findings reported from Saudi Arabia (62.5%) [17]and higher than data from Egypt (47.5%) [10]. Notably, awareness of this disciplinary classification decreased significantly as academic year advanced, a trend that stands in marked contrast to most international studies[17,18]. However, recognition of practical applications and anatomical identification features of forensic odontology remained stable across academic years. A plausible explanation relates to the lack of dedicated forensic odontology modules within current undergraduate dental curricula in China. Junior students typically acquire only superficial exposure through introductory lectures or popular science resources. As training progresses and the curriculum progressively focuses on clinical stomatology in later undergraduate years, this interdisciplinary concept fades from memory. Despite this decline in conceptual knowledge, students retain the capacity to evaluate forensic odontology applications, presumably based on their foundational dental anatomy knowledge and clinical training. As this is a cross-sectional study, only associations-not causal relationships-can be inferred between academic year and declining disciplinary awareness. Evidence from international dental education further supports this interpretation: student awareness tends to decline when forensic odontology instruction transitions from compulsory to an elective status, highlighting the essential role of formal curriculum delivery[9].

Over 87% participants acknowledged forensic-odontology applications for injury evaluation, age estimation, personal identification and bite-mark analysis; while more than 82% endorsed the identification utility of dental, lip-print and palatal-rugae features. Together, these results demonstrate broad recognition of the social and judicial value of forensic-odontology[19-21]. Nevertheless, marked

gender differences were observed across several knowledge items: male respondents were more likely to choose the response option “do not know / uncertain”, indicating gender-related variation in information uptake and self-assessment patterns that should be considered when designing curriculum design. Recognition of teeth as retrievable sources of DNA and their decay-resistant properties was highest (91.49%), whereas awareness of dental restorations and dentures as potential identification marks was comparatively low (77.59%). Consistent with our results, many dentists and students prioritize radiographic images while overlooking restorative records for individual identification [7,20]. This parallel finding highlights that dental education needs to emphasize the forensic importance of clinical dental records, rather than focusing solely on identification technique itself.

Documentaries, online media and university lectures served as the primary knowledge sources for forensic odontology. A total 15.98% of participants had never been exposed to forensic odontology previously, and 39.21% reported barriers to acquiring systematic knowledge. This pattern echoes observations from other developing countries[17]: dental students most obtain information via internet and popular media rather than formal textbooks or structured academic teaching, which leads to fragmented and potentially biased understandings of the discipline. Notably, 82.78% participants self-rated their own knowledge as insufficient, further demonstrating the lack of dedicated, structured forensic odontology training within domestic undergraduate dental curricula.

A substantial majority of participants (84.02%) recognized the critical importance of preserving comprehensive dental clinical records. Dental records serve as core ante-mortem data for victim identification in forensic odontology; without standardized, complete, and well-maintained dental documentation, forensic odontological techniques cannot be applied effectively[6,17,22]. While

international studies report that dental students commonly possess good theoretical awareness of dental record-keeping, practicing dentists frequently fail to follow standard documentation protocols under heavy clinical workload pressure[5,23,24]. Although our participants recognized the theoretical importance of dental records, they limited clinical experience points to a potential disconnect between conceptual understanding and real-world application- a mismatch that may become more pronounced after graduation. Therefore, dental education must combine theoretical teaching with hands-on, competency-based training focused on standardized forensic dental documentation.

A pronounced discrepancy emerged between educational interest and professional commitment: although 86.10% of participants supported the integration of forensic odontology into the core curriculum, and 84.44% expressed willingness to engage in related learning activities, only 24.90% reported a strong career intention. Comparable trends have been reported in surveys conducted in Saudi Arabian[17], where students demonstrated receptivity to didactic lectures and short-term training yet showed marked reluctance towards sustained engagement in forensic odontology practice. Nevertheless, formally designated and independent specialist positions in forensic odontology remain scarce in China; most dentists participate in this field on an ad hoc or part-time basis, with ambiguous career pathways and limited prospects for professional advancement, which partly explains the low translation of learning willingness into career intention. Accordingly, the Spearman correlation analysis suggested better knowledge and conceptual understanding corresponded to higher career intention, implying that systematic teaching provision could enhance local practitioners′ intention to a certain extent.

Drawing on insights from both domestic and international literature, common challenges confronting dental education in developing countries can be summarized as follows: (1)Forensic odontology has not

been established as an independent discipline within dental curricula, resulting in fragmented and inconsistent teaching content; (2)Dental practitioners often underestimate or overlook the forensic significance of clinical documentation; (3)Systematic continuing education and specialized training in forensic odontology remain scarce; and (4) Clear career development pathways are lacking, leading to insufficient talent reserve.

Based on the findings of the present study, the following evidence-informed recommendations are proposed:

First, forensic odontology modules should be integrated into undergraduate dental education through elective courses and thematic lectures. These offerings should adopt a balanced pedagogical approach—emphasizing foundational theory, analysis of representative judicial cases, and hands-on practical training. Priority topics should include standardized forensic dental records, age estimation methodologies, bite mark analysis, and oral manifestations of abuse. Given that the integrated theory and practical training model is consistently preferred by students, curriculum design should align with this preference. Furthermore, teaching materials and classroom activities should be optimized to reflect students′ highest-rated learning modalities while explicitly accounting for gender-related cognitive differences.

Second, dedicated instruction on the forensic-legal value of dental records should be strengthened. Although clinical courses typically emphasize record-keeping for longitudinal patient care, supplementary instruction should explicitly highlight the critical role of dental archives in disaster-victim identification,

medical disputes and child-abuse investigations. To support consistency and reliability, templates designed with forensic integrity in mind should be widely promoted and adopted.

Third, targeted workshops and science communication initiatives should be organized for senior undergraduate and graduate dental students. These activities aim to correct misconceptions about forensic odontology perpetuated by sensationalized portrayals in entertainment media, thereby fostering a more accurate and nuanced professional understanding.

Fourth, transparent and accessible information regarding career trajectories in forensic odontology should be provided, including concrete descriptions of real-world practice models—for instance, dentists' roles in forensic expert testimony, multidisciplinary disaster response teams, and official identification units—to bridge the gap between academic motivation and long-term professional engagement.

Strengths and limitations

Strengths: This study represents one of the relatively few large-sample, cross-sectional surveys investigating perceptions of forensic odontology among dental undergraduates and postgraduates in China, thereby providing baseline empirical evidence to inform domestic interdisciplinary dental education reform.

Limitations: Nevertheless, several limitations of this study warrant consideration. First, owing to its cross-sectional design, the present study can only identify associations and cannot establish causal relationships. Accordingly, the observed association between higher academic year and lower awareness does not imply that academic year directly causes reduced awareness.

Second, convenience sampling was employed, and participants were recruited exclusively from one university in Shandong Province, China. Accordingly, the study findings may not be fully generalizable to dental student populations across China. Furthermore, self-reported online questionnaire data carries an inherent risk of reporting bias.

Third, the questionnaire was adapted from existing international literature without preliminary pilot testing or formal reliability and validity evaluation. Numerical coding of the "do not know" responses for several items was conducted solely for exploratory analysis and involved subjective judgement.

Fourth, no formal sample-size calculation was performed prior to participant recruitment, which may limit the statistical robustness of the present analyses.

Despite these limitations, this work provides a reliable baseline reference for subsequent multicenter national surveys. Further research should adopt nationwide multicenter stratified sampling, develop standardized domestically adapted questionnaires with verified reliability and validity, and implement longitudinal cohort studies before and after educational interventions. Such prospective designs can effectively evaluate the actual impacts of systematic forensic odontology training on students' professional cognition, learning willingness, and career intentions.

Conclusion

Dental students in Shandong Province, China demonstrated high recognition of the practical value of forensic odontology; nevertheless, they showed deficiencies in conceptual understanding of this discipline and relied on fragmented sources for knowledge acquisition. Only limited translation from

learning willingness to actual career intention was observed. It is recommended that interdisciplinary forensic odontology teaching should be introduced via elective courses and thematic lectures, with grade-stratified curriculum design that accounts for gender-related cognitive differences. Practical training should be strengthened, and popular-science resources as well as teaching materials should be optimized.

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Authors' contributions

Zhang Hongxia and Yu Li conceived the idea of study and experimental design and data collection. Guo Zhangyu and Zhou Fenghua performed data pretesting and statistical analysis. Chu Yupeng and Ji Honghai wrote the paper. Zheng Jie revised the paper. All authors reviewed the paper, gave final approval, and agreed to be accountable for all aspects of the work.

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Data Availability

The dataset(s) supporting the conclusions of this article are included within the article and its additional files.

Declarations

Ethics approval and consent to participate

The study received ethical approval from the Research and Ethics Committee of Shandong Second Medical University (IRB Number: SDSMU2026YX211). All experiments were performed in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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