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Preparing Future Healthcare Professionals to Help Smokers Quit: A Mixed-Methods, Quasi-Experimental Evaluation of a Smoking Cessation Counseling Curriculum in Hong Kong

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Research Article

Keywords: smoking cessation counseling, interprofessional education, medical education, pharmacy education, health professions education, collaborative competence, experiential learning, mixed-methods research

Posted Date: October 30th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11391648/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Smoking cessation counseling (SCC) is an important competency for future health professionals. Interprofessional education (IPE) may strengthen readiness for collaborative practice, but its additional benefit within short-format SCC curricula remains uncertain. This study evaluated a structured SCC curriculum delivered in interprofessional MBBS–BPharm and uniprofessional MBBS–only formats.

Methods

This mixed-methods, quasi-experimental pre–post study included undergraduate medical and pharmacy students in the IPE cohort and medical students in the control cohort. Both cohorts received the same core SCC content and learning activities. SCC-related knowledge, attitudes, and practice confidence were assessed using a course-aligned measure adapted from an existing knowledge, attitudes, and practice questionnaire. Perceived collaboration-related competence was assessed using the Interprofessional Collaborative Competency Attainment Survey (ICCAS). Pre–post changes were examined among respondents with paired data. Post-tutorial ICCAS scores were compared between cohorts using analysis of covariance adjusted for baseline ICCAS. A focus group with five tutors contextualized the quantitative findings.

Results

The analytic sample included 213 students in the IPE cohort and 168 in the control cohort. The composite SCC-related outcome score increased by 0.35 standardized units (95% CI, 0.29 to 0.41; $p < 0.001$), with improvements in knowledge, attitudes, and practice confidence. ICCAS scores increased by 12.17 points (95% CI, 10.88 to 13.46; $p < 0.001$). Baseline-adjusted post-tutorial ICCAS scores did not differ significantly between the IPE and control cohorts (adjusted mean difference, 0.32 points; 95% CI, − 1.87 to 2.52; $p = 0.772$), and sensitivity analyses yielded consistent findings. Tutors perceived limited professional-role awareness, unequal representation of the two disciplines, and unfamiliarity among students as barriers to interprofessional interaction. Tutors nevertheless valued the experiential activities and supported further development of SCC-focused IPE.

Conclusions

The structured SCC curriculum was associated with immediate pre–post improvements in course-aligned SCC outcomes and perceived collaboration-related competence. Mixed MBBS–BPharm delivery was not associated with additional measurable ICCAS benefit compared with MBBS–only delivery. Tutor focus-group findings suggest that IPE-specific benefit may depend on clearer role differentiation, balanced and sustained interprofessional participation, and tasks requiring interdependent contributions from both disciplines.

1. Background

Tobacco smoking remains an important modifiable risk factor for non-communicable diseases (NCDs) and the single largest preventable cause of premature death worldwide (1), accounting for more than 7 million deaths annually according to current WHO estimates (2), and even in a relatively high-income setting, the burden is substantial. In 2023, approximately 577,300 people aged 15 years or older, representing 9.1% of the population in this age group, were daily conventional cigarette smokers. When all tobacco and related products were included, approximately 592,100 people (9.4%), were daily smokers (3). By 2025, the figure had declined to 548,100 people (8.6%) (3). Hong Kong has adopted active tobacco control targets, including a 30% relative reduction in current tobacco use by 2025 and a goal of lowering smoking prevalence toward 7.8% (4). By 2025, the prevalence of daily smoking had declined to 8.6%, indicating continued progress but the need to further strengthen the efforts to meet the stated target. Closing this remaining gap will require sustained population-level tobacco-control measures alongside effective identification and support of tobacco users within routine healthcare.

Tobacco cessation is therefore an integral component of international and local tobacco-control strategies (4–5). The World Health Organization's Framework Convention on Tobacco Control (WHO FCTC) established tobacco dependence treatment and cessation support as important components of comprehensive tobacco control (5). In line with the international commitment, Hong Kong's current tobacco control strategy and the Primary Healthcare Blueprint embed smoking cessation counseling (SCC) into routine primary care and position healthcare professionals as frontline agents of change (6). The contribution of the healthcare workforce is particularly important because healthcare encounters provide repeated opportunities to identify tobacco use, initiate counseling interventions, and connect tobacco users with behavioral, pharmacological, and referral support.

Despite this policy impetus, a persistent local implementation gap remains. International guidance recommends that healthcare providers routinely identify tobacco use and offer brief cessation advice. However, among persons aged 15 years or older who had consulted a healthcare professional in the preceding 12 months, only 31.7% in 2023 (7) and 32.2% in 2025 (3) reported having been asked about their smoking status during consultation. Thus, in both survey years, approximately two-thirds of respondents who had consulted a healthcare professional reported that they had not been asked about smoking status. Since identifying tobacco use is a necessary first step in providing cessation support, the persistently low reported enquiry rate suggests that opportunities to identify tobacco use and initiate appropriate support may have been missed. This gap between policy recommendations and reported practice reinforces the need to strengthen the healthcare workforce's capability and preparedness to incorporate SCC into routine care.

Strengthening SCC training may therefore help prepare future healthcare professionals to assess tobacco use consistently, deliver brief advice, evaluate nicotine dependence and readiness to quit, discuss pharmacological and non-pharmacological treatments, and arrange appropriate referral and follow-up.

Effective smoking cessation support is inherently multidisciplinary and often requires coordinated contributions from physicians, pharmacists, nurses, and other healthcare professionals across prevention, behavioral counseling, pharmacotherapy management, referral, and follow-up.

The World Health Organization identifies IPE as an important strategy for preparing a collaborative practice-ready health workforce capable of responding to increasingly complex health needs (8). IPE is particularly relevant in this context because it enables learners from two or more professions to learn with, from, and about one another, thereby supporting effective collaboration. The WHO clinical treatment guideline for tobacco cessation recommends evidence-based behavioral interventions and pharmacological treatments for adult smokers (9). It is intended for healthcare providers working in clinical and community settings where tobacco users may present and receive cessation support. In the local context, Hong Kong's Primary Healthcare Blueprint similarly recognizes medical doctors and community pharmacists as key contributors to primary healthcare, including medication consultation and multidisciplinary health promotion and education activities, such as smoking cessation (6). Together, these global and local policy directions make SCC a suitable context for IPE, particularly for training medical and pharmacy students to understand complementary roles in counseling, pharmacotherapy support, referral, and continuity of care.

Prior studies suggest that interactive smoking cessation counseling education, including peer role-play, standardized patient encounters, blended learning, multimodal teaching, and simulation-based approaches, is associated with improvements in selected learning outcomes such as SCC-related knowledge, attitudes, counseling self-confidence, self-efficacy, intention to provide cessation support, and observed counseling performance (10–14). Several health-professions education settings have implemented interprofessional and multidisciplinary tobacco-cessation education. Studies involving different combinations of medical, pharmacy, public health, pharmacy technician, physician assistant, and clinical psychology students reported positive changes in students' attitudes toward interprofessional learning, smoking cessation confidence, and perceptions of other professions' roles (15, 16). However, these studies were conducted outside Hong Kong and within different educational, professional, and healthcare contexts, limiting the direct transferability of their findings to Hong Kong's evolving multidisciplinary primary healthcare model. Furthermore, the added benefit of IPE within an SCC tutorial remains unclear, particularly whether mixed-discipline grouping produces measurable gains in collaboration-related competence beyond those generated by active, communication-oriented SCC learning activities.

To address this educational and implementation gap, this mixed-methods quasi-experimental study evaluated SCC-related learning outcomes and perceived collaboration-related competence among undergraduate medical (MBBS) and pharmacy (BPharm) students of the LKS Faculty of Medicine, the University of Hong Kong. The SCC curriculum reflected Hong Kong's preventive, coordinated, person-centered, and multidisciplinary primary healthcare model (6). It was delivered in two formats: an interprofessional MBBS–BPharm format and an uniprofessional MBBS-only format. Both cohorts followed the same teaching content and timelines to complete the SCC tasks, which addressed tobacco-use assessment, nicotine dependence, readiness to quit, structured counseling frameworks, pharmacological and non-pharmacological cessation support, referral, and follow-up.

2. Study Objectives

2.1 Primary objective

The primary objective was to evaluate the structured SCC curriculum by examining pre–post changes in course-aligned SCC knowledge, attitudes, practice confidence, and perceived collaboration-related competence. The primary comparative analysis examined whether the IPE format was associated with higher baseline-adjusted post-tutorial ICCAS scores than the MBBS-only format.

2.2 Exploratory objectives

The exploratory objectives were to compare outcomes between MBBS and BPharm students within the IPE cohort and to use tutor feedback to identify factors that may have influenced the quality and depth of interprofessional interaction.

3. Methods

3.1 Study design

The study employed a mixed-methods, quasi-experimental pre–post design to evaluate SCC-related learning outcomes and perceived collaboration-related competence among MBBS and BPharm students. All students received the same core SCC teaching materials and completed the same principal learning activities according to the same timeline. Overall, we first examined within-participant changes in SCC-related knowledge, attitudes, practice confidence, and perceived collaboration-related competence across both cohorts. The between-cohort analysis then examined whether the IPE cohort had higher post-tutorial ICCAS scores than the control cohort after adjustment for baseline ICCAS scores.

3.2 Sampling, eligibility and recruitment

We used a convenience sampling approach, in which all undergraduate medical (MBBS) and pharmacy (BPharm) students from the Li Ka Shing Faculty of Medicine, The University of Hong Kong, who attended the scheduled SCC tutorial sessions were eligible and invited to participate. The IPE cohort consisted of mixed groups of Year 1 MBBS and Year 2 BPharm students, whereas the control cohort consisted of Year 1 MBBS students only. The IPE cohort received the core SCC curriculum in mixed MBBS–BPharm groups, whereas the control cohort received the same curriculum in a uniprofessional MBBS-only format.

Before data collection, we informed potential participants about the study's purpose and scope through an introductory video on the learning platform and reiterated key information at the start of the tutorial. Potential participants were given sufficient time to read the participant information sheet and provide informed consent before the tutorial commenced. The researchers distributed the pre- and post-tutorial hard-copy questionnaires during the scheduled

teaching sessions. Three researchers not involved in teaching or student assessment handled the study briefing, consent collection, questionnaire collection, data cleaning, and statistical analysis. The questionnaires were used for research purposes only and were not graded.

3.3 Sample-size rationale

The sample size was determined by the number of eligible students enrolled in the scheduled teaching cohorts during the study period. All eligible students were invited to participate. Recruitment was therefore not based on a formal a priori sample-size calculation. The final analytic sample included 213 students in the IPE cohort and 168 students in the control cohort.

3.4 Cohort allocation and delivery format

Allocation between cohorts was determined by tutorial scheduling across cohorts.

3.5 SCC tutorial structure

The SCC tutorial was designed with reference to Hong Kong's primary healthcare model and current smoking cessation counseling guidelines (17, 18).

Before the tutorial, students completed a short, recorded lecture on global and local tobacco control policies and tobacco and nicotine products, including conventional cigarettes, e-cigarettes, heated tobacco products, and emerging alternatives. Students were also provided with preparatory references covering nicotine withdrawal symptoms, nicotine dependence assessment using validated tools, readiness to quit, secondhand and thirdhand smoke risks, local smoking cessation resources, structured counseling frameworks, and pharmacological and non-pharmacological options for tobacco cessation. These materials were intended to establish a shared knowledge foundation before the in-class tutorial. This approach aligns with flipped classroom (FC) models in medical education, where pre-class materials establish foundational knowledge and in-class time is reserved for active learning, discussion, and application. Systematic review evidence suggests that flipped-classroom approaches are associated with improved knowledge outcomes and student satisfaction compared with traditional teaching methods (19).

Before attending the course, students were assigned to teams and completed a group worksheet based on a staged smoking cessation case scenario. All teams completed the same core worksheet tasks, applying smoking cessation counseling frameworks to patient assessment, advice-giving, nicotine dependence assessment, readiness to quit, 5R-based motivational discussion (Relevance, Risks, Rewards, Roadblocks, and Repetition), pharmacotherapy considerations, and local referral options.

During the tutorial, all students participated in the same core learning activities, including case-based discussion, role-play counseling activities, patient care planning, tutor-facilitated discussion, and debriefing. The role-play cases required students to practice Very Brief Advice; the 5A's framework (Ask, Advise, Assess, Assist, and Arrange) (20); harm-reduction counseling; assessment of nicotine dependence and readiness to quit; pharmacotherapy education; teach-back; referral planning; and follow-up arrangements.

Both cohorts received the same core teaching content and completed the same principal learning activities. Within the IPE cohort, mixed MBBS–BPharm groups were encouraged to integrate discipline-specific perspectives into these shared tasks, including pharmacy input on nicotine replacement therapy technique education and side-effect management. The IPE format was intended to provide opportunities for interprofessional discussion, role clarification, shared reasoning, and collaborative care planning.

3.6 Measurement instruments

Data were collected using a questionnaire comprising demographic items, an adapted SCC-related outcome measure, the 20-item Interprofessional Collaborative Competency Attainment Survey (ICCAS), and a supplementary global change item. Demographic items included gender, year of study, discipline, prior SCC training, and smoking status. SCC-related outcomes included knowledge, attitudes, and practice confidence. Perceived collaboration-related competence was assessed using the ICCAS before and immediately after the tutorial. ICCAS Q21 was administered after the tutorial as a supplementary global item assessing self-rated improvement and was not included in the 20-item ICCAS total score.

(i) SCC-related knowledge, attitudes, and practice confidence

SCC-related knowledge, attitudes, and practice confidence were assessed using a course-aligned measure adapted from the revised questionnaire on knowledge, attitudes, and practice relating to smoking cessation guidelines developed by Shalihin et al. (21). The original questionnaire assessed knowledge, attitudes, and self-reported practice related to smoking cessation guidelines, including items informed by the 5A's and 5R's frameworks. In the present study, we modified the knowledge items to align with the SCC curriculum while retaining a focus on core counseling principles, including the 5A's and 5R's frameworks. Because the respondents were students rather than practicing healthcare professionals, the original self-reported practice domain was reframed as practice confidence, assessing students' confidence in performing SCC-related counseling actions. The adapted questionnaire was therefore treated as a course-aligned outcome measure rather than a fully validated measure of clinical practice.

The knowledge domain included 5 true/false items, with 1 point awarded for each correct response, for a total score ranging from 0 to 5. The attitude domain consisted of 5 Likert-scale items, with responses to negatively worded items reverse-coded before calculating the domain score. The practice-confidence domain assessed students' confidence in performing SCC-related counseling actions. Higher scores indicated greater knowledge, more positive attitudes, and greater perceived practice confidence.

To create the composite SCC-related outcome score, we standardized the knowledge, attitude, and practice-confidence domain means at both time points using the corresponding pooled baseline mean and standard deviation across both cohorts. The 3 standardized domain scores were then averaged, giving

each domain equal weight. The composite score was constructed for this study and should be interpreted as a summary of course-aligned SCC outcomes rather than a previously validated KAP scale.

(ii) Interprofessional Collaborative Competency Attainment Survey

Perceived collaboration-related competence was assessed before and immediately after the tutorial using the validated 20-item Interprofessional Collaborative Competency Attainment Survey (ICCAS) (22, 23). The ICCAS assesses self-reported competencies associated with interprofessional collaborative practice across 6 domains: communication, collaboration, roles and responsibilities, collaborative patient- and family-centered care, conflict management and resolution, and team functioning. Each item was rated on a 5-point Likert scale, and items were summed to produce a total score ranging from 20 to 100, with higher scores indicating greater perceived collaboration-related competence. The original validation study demonstrated high internal consistency, with Cronbach's α values ranging from 0.94 to 0.98 (23). A subsequent replication validation supported a single-factor structure and the use of an overall ICCAS score, with a Cronbach's α of 0.96 (22).

A separate global change item, ICCAS Q21, was administered after the tutorial to assess respondents' perceived overall change in interprofessional collaborative ability. For supplementary analysis, responses were dichotomized as "improved" for ratings of 4 or 5 and "not improved" for ratings of 1 to 3. Q21 was not included in the 20-item ICCAS total score.

3.7 Data cleaning and scoring

Three researchers imported, screened, and combined data from the IPE and control cohorts for analysis. Blank cells and non-standard missing-value entries, including "N/A" responses and "#VALUE!" errors, were recorded as missing. Before imputation, missingness was generally low; complete paired ICCAS scores were unavailable for 2.58% of respondents, while prior SCC training and the ICCAS global change item had 2.33% and 1.81% missingness, respectively.

Missing categorical demographic values were imputed using the mode, while missing values for year of study were imputed using the median. For the ICCAS, attitude, and practice-confidence item sets, person-mean imputation was performed only when respondents had completed at least 80% of the items within the relevant scale. ICCAS total scores were calculated by summing up the 20 items, yielding a possible score range of 20 to 100. Knowledge scores ranged from 0 to 5, with 1 point awarded for each correct response. Attitude scores were calculated after reverse-coding negatively worded items, and practice-confidence scores were calculated by summing up the relevant confidence items.

3.8 Quantitative analysis

Baseline demographic characteristics were summarized using frequencies and percentages for categorical variables and means with standard deviations for continuous variables. Between-cohort differences in categorical variables were assessed using chi-square tests or Fisher's exact tests, as appropriate. Fisher's exact test was used when expected cell counts were small. Year of study was compared between cohorts using Welch's t-test.

As both cohorts received the same core SCC curriculum, overall pre–post changes in SCC-related outcomes and ICCAS were assessed among respondents with available paired data using paired *t*-tests. The between-cohort analysis compared post-tutorial ICCAS scores using analysis of covariance (ANCOVA), adjusting for baseline ICCAS scores. The homogeneity-of-regression-slopes assumption was assessed by including a cohort-by-baseline ICCAS interaction term. A sensitivity model additionally adjusted for gender, year of study, prior SCC training, and smoking status.

Additional sensitivity analyses included an unadjusted comparison of ICCAS change scores between cohorts using Welch's *t*-test, which was selected because it is robust to unequal group sizes and does not assume equal variances; a baseline-adjusted logistic regression analysis of self-rated improvement on ICCAS Q21. All statistical tests were two-sided, and we considered $p < 0.05$ statistically significant.

Exploratory analyses within the IPE cohort compared outcomes between MBBS and BPharm students. Baseline scores and change scores were compared using Welch's *t*-tests. Within-discipline, pre–post changes were assessed using paired *t*-tests. We compared post-tutorial ICCAS and composite SCC-related outcome scores using ANCOVA, adjusted for the corresponding baseline score. Discipline-by-baseline interaction terms were examined to assess the homogeneity-of-regression-slopes assumption. Because these analyses were exploratory, we interpreted the findings cautiously. To account for multiple testing, p values were adjusted using the Benjamini-Hochberg procedure separately within each family of two exploratory between-discipline comparisons presented in Supplementary Table S2, Panel C. This procedure controls the false discovery rate within each family of related comparisons.

3.9 Qualitative analysis

After completing all tutorial sessions, we conducted a focus group discussion with the 5 tutors who delivered the SCC tutorials. The tutors were not members of the research team. All participants received information about the study, provided informed consent, and consented to audio recording. The recording was transcribed verbatim. The transcript was reviewed and coded to identify recurring patterns relevant to the study objectives and to contextualize the principal quantitative findings. The resulting themes focused on professional-role awareness, group dynamics, experiential learning activities, and the perceived value and future development of SCC-focused IPE.

3.10 Use of artificial intelligence-assisted technology

Microsoft Copilot was used to support language editing and improve clarity during manuscript preparation. All suggestions were critically reviewed and revised by the authors, who take full responsibility for the accuracy, integrity, and final content of the manuscript.

4. Results

A total of 432 undergraduate students, comprising Year 1 MBBS students (N = 390) and Year 2 BPharm students (N = 42) were eligible and invited to participate. Of the 432 questionnaires distributed, 381 were returned and included in the final analytic sample, yielding a response rate of 88.2%. The final sample comprised 213 students in the IPE cohort and 168 students in the control cohort. The IPE cohort included 179 MBBS students and 34 BPharm students. Participant flow through the study is presented in Fig. 1.

4.1 Cohort characteristics

The final analytic sample consisted predominantly of MBBS students (91.1%) and BPharm students (8.9%). All BPharm students were included in the IPE cohort and represented 16.0% of respondents within that cohort. Overall, 55.1% of respondents were male, 42.3% were female, and 2.6% preferred not to disclose their gender. Respondents were predominantly in the early years of their programs, with a mean year of study of 1.09 years (SD = 0.29) for all students. Most respondents were non-smokers (99.2%), and 96.3% reported no prior smoking cessation counseling training.

No statistically significant differences were observed between the IPE and control cohorts in gender distribution, prior SCC training, or smoking status. However, discipline and year of study differed between cohorts, reflecting the intended cohort composition: the IPE cohort included both MBBS and BPharm students. In contrast, the control cohort consisted entirely of MBBS students. The higher mean year of study in the IPE cohort reflected the inclusion of Year 2 BPharm students. Table 1 summarizes respondent characteristics.

Table 1
Respondent characteristics by cohort

Variable	All students in SCC curriculum (N = 381)	IPE cohort (n = 213)	Control cohort (n = 168)	p value
Gender	Female: 161 (42.3%); Male: 210 (55.1%); Prefer not to say: 10 (2.6%)	Female: 92 (43.2%); Male: 117 (54.9%); Prefer not to say: 4 (1.9%)	Female: 69 (41.1%); Male: 93 (55.4%); Prefer not to say: 6 (3.6%)	0.566
Year of study, mean (SD)	1.09 (0.29)	1.16 (0.37)	1.00 (0.00)	**< 0.001**
Discipline	BPharm: 34 (8.9%); MBBS: 347 (91.1%)	BPharm: 34 (16.0%); MBBS: 179 (84.0%)	BPharm: 0 (0.0%); MBBS 168 (100.0%)	**< 0.001**
Prior SCC training	No: 367 (96.3%); Yes: 14 (3.7%)	No: 204 (95.8%); Yes: 9 (4.2%)	No: 163 (97.0%); Yes: 5 (3.0%)	0.712
Smoking status	Ex-smoker: 2 (0.5%); Non-smoker: 378 (99.2%); Current smoker: 1 (0.3%)	Ex-smoker: 0; Non-smoker: 213 (100.0%); Current smoker: 0	Ex-smoker: 2 (1.2%); Non-smoker: 165 (98.2%); Current smoker: 1 (0.6%)	0.085

Note. Values are presented as *n* (%) unless otherwise indicated. Year of study is presented as mean (SD). Categorical variables were compared using chi-square tests or Fisher's exact tests, as appropriate. Fisher's exact test was used for smoking status because of sparse cell counts. Year of study was compared using Welch's *t*-test. SCC=smoking cessation counseling; BPharm=Bachelor of Pharmacy; IPE=interprofessional education; MBBS=Bachelor of Medicine and Bachelor of Surgery. Demographic characteristics are presented after the prespecified imputation of missing values described in Section 3.7.

Baseline ICCAS scores were similar between the IPE and control cohorts (mean [SD], 70.47 [13.77] vs 69.85 [13.30]; $p = 0.658$), indicating no evidence of a substantial baseline difference in the primary outcome. Baseline knowledge, practice-confidence, and composite SCC-related outcome scores were also similar between cohorts. However, baseline attitude scores were slightly higher in the IPE cohort than in the control cohort (19.93 [2.71] vs 19.33 [2.51]; mean difference, 0.61 points; $p = 0.024$). Baseline outcome scores are presented in Supplementary Table S1.

4.2 Overall pre–post outcomes

As both cohorts received the same core SCC tutorial content, overall pre–post analyses were conducted to evaluate changes in SCC-related outcomes and perceived collaboration-related competence among respondents with available paired data. The composite SCC-related outcome score increased by 0.35 standardized units from pre- to post-tutorial (95% CI, 0.29 to 0.41; $p < 0.001$). Knowledge, attitudes, and practice confidence also improved significantly. ICCAS total scores increased significantly from pre- to post-tutorial, with a mean improvement of 12.17 points (95% CI, 10.88 to 13.46; $p < 0.001$). Between-cohort differences in ICCAS were examined separately in the primary comparative analysis. Table 2 summarizes overall pre–post changes.

Table 2
Overall pre–post changes in SCC-related outcomes and perceived collaboration-related competence

Outcome	n	Pre mean (SD)	Post mean (SD)	Change mean (95% CI)	p value
Composite SCC-related outcome score	379	0.00 (0.70)	0.35 (0.75)	0.35 (0.29 to 0.41)	**< 0.001**
Knowledge score	380	4.49 (0.85)	4.62 (0.72)	0.13 (0.06 to 0.20)	**< 0.001**
Attitude score	381	19.67 (2.64)	19.99 (3.31)	0.33 (0.08 to 0.58)	0.010
Practice-confidence score	380	43.02 (9.36)	50.25 (8.94)	7.23 (6.29 to 8.18)	**< 0.001**
ICCAS total score	376	70.03 (13.44)	82.20 (12.64)	12.17 (10.88 to 13.46)	**< 0.001**

Note. Values are presented as mean (SD) unless otherwise indicated. Change scores represent post-tutorial minus pre-tutorial scores. Pre–post comparisons were conducted using paired *t*-tests. The composite SCC-related outcome score was calculated by averaging the standardized knowledge, attitude, and practice-confidence domain scores. ICCAS = Interprofessional Collaborative Competency Attainment Survey.

The distributions of paired respondents' pre- and post-tutorial ICCAS total scores and composite SCC-related outcome scores are shown in Fig. 2.

Boxplots show the distribution of pre- and post-tutorial scores. Horizontal lines within the boxes represent medians, and diamonds represent means. Both outcomes increased significantly from pre- to post-tutorial based on paired *t*-tests ($p < 0.001$).

4.3 Between-cohort analysis of collaboration-related competence

To examine whether the IPE format was associated with additional improvement in collaboration-related competence, post-tutorial ICCAS scores were compared between cohorts using ANCOVA adjusted for baseline ICCAS scores. The adjusted mean difference favored the IPE cohort but was small and not statistically significant (adjusted mean difference, 0.32 points; 95% CI, − 1.87 to 2.52; $p = 0.772$). The cohort-by-baseline ICCAS interaction was not statistically significant ($p = 0.293$), indicating no evidence that the homogeneity-of-regression-slopes assumption had been violated.

The findings were consistent across sensitivity analyses. After additional adjustment for gender, year of study, prior SCC training, and smoking status, the adjusted mean difference remained non-significant (1.27 points; 95% CI, − 1.02 to 3.56; $p = 0.275$). An unadjusted comparison of ICCAS change scores showed almost identical mean improvements between cohorts ($p = 0.996$). Similarly, a baseline-adjusted logistic regression analysis of self-rated improvement on ICCAS Q21 found no statistically significant between-cohort difference (odds ratio, 1.35; 95% CI, 0.74 to 2.45; $p = 0.326$). The primary and demographically adjusted between-cohort analyses are summarized in Table 3.

Table 3
Baseline-adjusted between-cohort analyses of post-tutorial ICCAS scores

Analysis	Estimate	95% CI	p value
ANCOVA, baseline-adjusted	0.32	−1.87 to 2.52	0.772
ANCOVA additionally adjusted for demographic characteristics	1.27	−1.02 to 3.56	0.275

Note. Estimates represent adjusted mean differences in post-tutorial ICCAS scores for the IPE cohort relative to the control cohort. The primary ANCOVA model adjusted for baseline ICCAS score. The sensitivity model additionally adjusted for gender, year of study, prior SCC training, and smoking status.

The focus group discussion findings contextualized the quantitative results and explored implementation factors that may have influenced the quality and depth of interprofessional interaction during the tutorial.

4.4 Exploratory discipline comparison within the IPE cohort

Exploratory analyses compared MBBS and BPharm students within the IPE cohort. At baseline, BPharm students had lower ICCAS and composite SCC-related outcome scores than MBBS students. ICCAS scores improved significantly within both disciplines, increasing by 12.82 points among MBBS students and 8.79 points among BPharm students. However, the between-discipline difference in ICCAS change was not statistically significant (mean difference for BPharm relative to MBBS, − 4.03 points; 95% CI, − 9.35 to 1.30; $p = 0.134$). After adjustment for baseline ICCAS, BPharm students had lower post-tutorial ICCAS scores than MBBS students (adjusted mean difference, − 6.65 points; 95% CI, − 10.55 to − 2.74; $p < 0.001$). Neither the between-discipline difference in composite-score changes nor the baseline-adjusted post-tutorial composite-score difference was statistically significant. Full results are presented in Supplementary Table S2.

4.5 Qualitative findings

Four themes were identified from the tutor focus-group discussion.

Theme 1: Limited awareness of professional roles constrained collaboration

Year 1 MBBS students and Year 2 BPharm students had limited understanding of other professions' roles and scopes of practice. One tutor observed that, in addition to the limited time available to build rapport within the IPE cohort, "the MBBS students don't actually know the role of pharmacy students". When referral was needed during the role-play activities, students were uncertain about the relevant smoking cessation referral pathways. This uncertainty about professional roles constrained collaboration. Another tutor remarked, "They [students] are not quite sure what contribution [role] will be in this [tasks]", and added, "They could be given more opportunities to share kind of what they know". These gaps in students' knowledge and understanding of other disciplines' roles in smoking cessation reduced recognition of discipline-specific contributions and limited meaningful collaborative work during the tutorial.

Theme 2: Group composition and unfamiliarity affected interprofessional engagement

The discipline distribution was approximately 1 BPharm student to 4 MBBS students, and the predominance of MBBS students may have influenced interaction within the IPE groups. This imbalance reflected differences in cohort size. Tutors observed that BPharm students could become isolated within their groups. One tutor explained, "…the four of them know each other so well that they dominate the discussion; You kind of just know which one is BPharmacy, without even actually [checking], because they're kind of like a bit isolated".

Tutors also observed discipline-based clustering during discussions, which appeared to be related to students' limited familiarity with learners from other disciplines before and at the beginning of the tutorial. One tutor noted, "They had not met each other before the tutorial" and described prompting introductions: "I kind of nudge them and be like, oh, okay, so we have a new joiner. Can we introduce each other…" Another tutor affirmed that "the group dynamic is very important because they are not familiar with the [other] student". These observations suggest that structuring activities to support early rapport-building may strengthen interprofessional interaction and group collaboration.

Theme 3: Experiential activities supported active learning

Experiential activities, including role-play, case-based discussion, and development of a patient care management plan, supported student engagement in the tutorial. During the role-play activity, one student assumed the role of a patient who smoked using a provided script, while other students conducted the interview. A tutor observed, "They enjoyed that role-play activity, pretending that they're the patient and also the doctor asking them questions." Although role-play supported active engagement, interprofessional collaboration may have been constrained by the predominance of MBBS students and limited understanding of other disciplines' scopes of practice, as described in Themes 1 and 2. Tutors suggested using more authentic, time-limited clinical scenarios. One tutor asked, "In real-life, how much time a doctor has for a patient when they show up in a clinic? A doctor asks 'do you smoke?', and if yes, what is the pathway…" Other tutors similarly identified realistic smoking cessation referral processes and care pathways as important focal points for learning about professional roles within an IPE curriculum.

Theme 4: Tutors valued the future potential of SCC-focused IPE

Tutors recognized smoking cessation as a multidisciplinary issue and viewed IPE as important for preparing students to work across professions in future practice. One tutor identified an opportunity to broaden participation: "Social workers, psychologists, something like that, right? So, I think there's a huge potential of including professionals from different specialties, not just the medical, but perhaps from social science. Social workers, will have another kind of perspective." Another tutor asked, "what would the continuity of care be within a smoking cessation counseling for a patient?" A further comment that "students may not know well how difficult it is to stop smoking" reinforced the perceived need for multidisciplinary smoking cessation education. Collectively, the tutors' observations highlighted the limitations of a physician-centered model and the importance of coordinated interprofessional care in smoking cessation management.

In summary, tutors observed that students frequently engaged within their own disciplines and often had limited understanding of the roles and responsibilities of other health professions. Unequal discipline representation and unfamiliarity among students further constrained interprofessional interaction. Nevertheless, role-play, case-based discussion, tutor feedback, and debriefing were well received and were perceived to support active learning. Although barriers to interprofessional interaction were identified, tutors strongly endorsed the need for a multidisciplinary approach to smoking cessation counseling. Suggested refinements included more realistic smoking cessation scenarios, clearer profession-specific roles, explicit referral pathways, and structured opportunities for students from different disciplines to get to know one another. These changes may strengthen interprofessional learning and better prepare students for collaborative smoking cessation practice.

5. Discussion

5.1 Principal findings

This mixed-methods, quasi-experimental study evaluated a structured SCC curriculum delivered through an IPE format involving mixed MBBS–BPharm groups and a uniprofessional MBBS-only format. Across respondents, the curriculum was associated with significant pre-post improvements in SCC-related knowledge, attitudes, practice confidence, and perceived collaboration-related competence. After adjustment for baseline ICCAS scores, post-tutorial ICCAS scores did not differ significantly between cohorts. The conclusion was unchanged after additional demographic adjustment and across change-score and self-rated improvement.

These findings support the educational value of the shared experiential SCC curriculum while indicating that mixed MBBS–BPharm delivery was not associated with additional measurable ICCAS benefit in this short-format implementation. The findings therefore distinguish between outcomes associated with the shared curriculum and the incremental value of its IPE delivery format.

The tutor focus-group findings contextualized the quantitative results by identifying limited professional-role awareness, unequal discipline representation, and unfamiliarity among students as barriers to meaningful interprofessional interaction.

5.2 Interpretation of SCC-related learning outcomes

The significant improvements in SCC-related knowledge, attitudes, and practice confidence suggest that the curriculum supported course-aligned learning. The preparatory materials and in-class activities required students to apply the 5A's, 5R's, Very Brief Advice, nicotine-dependence and readiness-to-quit assessment, pharmacotherapy principles, referral, and follow-up planning. These findings are consistent with prior tobacco and smoking cessation education studies reporting improvements or positive associations in selected outcomes following peer role-play, standardized-patient encounters, online or blended

learning, and virtual simulation (10 – 14). However, the adapted practice domain assessed confidence rather than observed practice. Findings should therefore be interpreted as increased perceived readiness to provide SCC, not demonstrated clinical competence.

5.3 Interpretation of overall improvement in collaboration-related competence

The overall improvement in ICCAS should be interpreted in relation to the collaborative demands embedded within the SCC curriculum. Although ICCAS assesses perceived interprofessional collaborative competence, students in both cohorts participated in communication-intensive activities requiring peer discussion, counseling role-play, shared reasoning, patient-centered advice, care planning, teach-back, and reflection. The staged cases included counseling a patient who was not ready to quit, co-developing a care plan for a patient preparing to quit, and considering individual, family, social, and system-level influences on relapse.

These activities overlap with ICCAS domains including communication, collaboration, roles and responsibilities, conflict management, and team functioning. Overall ICCAS improvement may therefore partly reflect engagement in structured collaborative learning activities within the shared SCC curriculum, rather than exposure to mixed discipline grouping alone. This interpretation is plausible because MBBS-only respondents also participated in group discussion, role-play, shared care planning, and tutor-facilitated debriefing.

Nevertheless, ICCAS is self-reported, and the pooled pre–post design cannot isolate which curriculum components contributed to the observed change. The findings should therefore be interpreted as improvement in perceived collaboration-related competence following the curriculum, rather than definitive evidence of improved collaborative performance.

5.4 Interpreting the absence of additional measurable IPE benefit

The absence of a statistically significant adjusted between-cohort difference should not be interpreted as evidence that IPE has no educational value. Rather, it indicates that, in this implementation, mixed MBBS–BPharm delivery was not associated with additional measurable ICCAS benefit beyond that associated with the shared SCC curriculum. Several possible explanations warrant consideration.

First, the duration and intensity of IPE exposure may have been limited. The IPE component was embedded in a single 90-minute tutorial, which may have limited opportunities for students to build familiarity, clarify professional roles, and engage in sustained interprofessional reasoning. However, the optimal duration or “dose” of IPE has not been established, and duration alone is unlikely to determine effectiveness. A systematic review found that IPE studies varied considerably in settings, teaching methods, assessment approaches, and outcomes, with mixed findings on the development of collaborative skills and limited evidence on longer-term effects (24). Implementation research further suggests that implementation quality and teaching-level factors such as professional socialization, the learning context, and faculty development may influence IPE outcomes (25). These findings support building on the structured elements already incorporated into the SCC curriculum and examining whether greater exposure or more explicit integration of medical and pharmacy contributions further strengthens interprofessional learning outcomes.

Second, both cohorts completed an active, communication-oriented curriculum. Role-play, peer discussion, patient care planning, referral planning, and debriefing may have supported perceived collaboration-related competence in both delivery formats, thereby reducing the ability to detect an incremental effect of mixed-discipline delivery. This interpretation is consistent with the significant overall improvement in ICCAS and the nearly identical unadjusted ICCAS changes observed between cohorts. Nevertheless, the present analysis cannot determine the specific or combined contribution of individual curriculum components to the observed ICCAS improvement.

Tutor focus-group findings suggest that, although the SCC tutorials engaged students through interactive and experiential learning activities, insufficient professional-role awareness, time constraints, and unequal representation of MBBS and BPharm students may have limited interprofessional group cohesion. Consistent with IPE principles, tutors emphasized that effective collaboration requires learners to understand other disciplines' contributions and work within team-based care models. These findings suggest that implementation conditions and early-year learners' characteristics may have influenced the depth of interprofessional interaction.

Taken together, these findings indicate that the shared SCC curriculum provided a strong foundation for communication-oriented and collaborative learning, while the additional contribution of mixed-discipline delivery may require more targeted design and evaluation. The findings therefore have implications for both SCC education and future IPE curriculum development.

5.5 Implications for SCC and IPE curriculum design

The findings have several implications for IPE curriculum design and SCC training.

First, the significant improvements in SCC-related knowledge, attitudes, practice confidence, and perceived collaboration-related competence provide support for a structured, experiential SCC curriculum that combines preparatory learning with opportunities for application. In the present curriculum, staged patient cases, counseling role-play, patient care planning, referral planning, and debriefing enabled students to apply SCC frameworks in realistic scenarios rather than relying exclusively on didactic instruction. The curriculum design aligns with previous studies on tobacco and smoking cessation counseling education that evaluated peer role-play, standardized-patient encounters, online or blended learning, and virtual simulation. Across these studies, improvements or positive associations were reported for selected learner outcomes, including knowledge, attitudes, counseling confidence or self-efficacy, intention to provide cessation support, perceived competence, and observed counseling performance (10–14).

This design may offer a feasible approach to preparing undergraduate health professions students to initiate tobacco-use assessment, provide brief and comprehensive advice, support cessation planning, and identify appropriate referral pathways. However, longer-term and performance-based evaluation is needed to determine whether these self-reported gains translate into sustained or observable SCC competence.

Second, the findings highlight the need to distinguish collaborative learning activities from IPE-specific learning. Communication, peer reasoning, care planning, and reflection can occur in both uniprofessional and interprofessional groups. Consequently, improvement in ICCAS following a communication-oriented curriculum should not automatically be attributed to the IPE format. IPE involves learners from 2 or more professions learning with, from, and about one another to enable effective collaboration (8); its additional educational contribution should therefore arise specifically from cross-professional interaction and the integration of complementary professional expertise (24). Future evaluations of similar initiatives should explore the outcomes expected from mixed-discipline learning—such as improved understanding of professional roles, integration of complementary expertise, interprofessional communication, and interdependent team decision-making—and select measures that are sufficiently sensitive to detect these outcomes (26).

Third, mixed-discipline grouping may be better understood as a foundation for IPE rather than a complete educational strategy itself. The present curriculum already incorporated shared tasks and opportunities for medical and pharmacy contributions. Future iterations could build on this foundation by increasing interprofessional exposure, making profession-role exchange more explicit, and adding shared deliverables that require contributions from both disciplines. For example, students could be required to develop an integrated cessation plan in which medical and pharmacy contributions to assessment, behavioral support, pharmacotherapy counseling, referral, and follow-up are explicitly documented and jointly justified.

Finally, SCC provides a locally relevant context for preparing healthcare students for Hong Kong's preventive, person-centered, and multidisciplinary primary healthcare model. The *Primary Healthcare Blueprint: Supplement* recognizes community pharmacists as important contributors to primary healthcare and describes their participation alongside other professionals in medication consultation, health promotion, and health education activities, including smoking cessation (6). Hong Kong's smoking cessation services similarly involve multiple professional contributions across tobacco-use assessment, behavioral counseling, pharmacotherapy, referral, and follow-up, while local community pharmacy models incorporate readiness assessment, personalized cessation planning, NRT education, ongoing support, and referral to medical or other professionals when required.

Against this policy and service context, this study provides relevant evidence on using an undergraduate medical–pharmacy SCC curriculum to support multidisciplinary primary healthcare workforce preparation. The curriculum translates local tobacco-control and primary-healthcare priorities into educational activities that require students to assess tobacco use, provide brief advice, consider behavioral and pharmacological support, formulate referral and follow-up plans, and contribute to patient-centered cessation planning. It therefore illustrates how public health in higher education may help bridge the gap between policy expectations for multidisciplinary primary healthcare and the capabilities required of the future workforce. However, whether these curriculum-associated improvements translate into sustained collaborative behavior or improved service delivery requires longitudinal and performance-based evaluation.

6. Strengths

This study has several strengths. First, it provides practical implementation insights into designing and evaluating a structured, experiential SCC curriculum. The curriculum combined preparatory learning with staged patient cases, counseling role-play, patient care planning, teach-back, referral planning, and debriefing. These activities gave students repeated opportunities to apply SCC frameworks such as Very Brief Advice, the 5A's, the 5R's, harm-reduction counseling, pharmacotherapy considerations, and follow-up planning in realistic patient scenarios.

Second, the study evaluated the curriculum from both counseling and collaboration perspectives. Course-aligned SCC-related outcomes captured changes in knowledge, attitudes, and practice confidence, while ICCAS assessed perceived collaboration-related competence. This dual-outcome approach reflected the multidimensional nature of SCC, which requires not only knowledge of cessation frameworks but also communication, patient-centered counseling, shared reasoning, and care planning.

Third, including a mixed MBBS–BPharm cohort and an MBBS-only cohort enabled the study to distinguish outcomes associated with the shared SCC curriculum from the potential incremental contribution of interprofessional delivery. Because both cohorts received the same core content and completed the same principal learning activities, the comparison focused on whether mixed-discipline delivery provided additional collaboration-related benefits beyond the communication-oriented curriculum itself.

Fourth, the findings offer insight into how curriculum design may support perceived collaboration-related competence. Students in both cohorts participated in peer discussion, role-play, care planning, and tutor-facilitated debriefing, and ICCAS scores improved across the overall sample. Although the study could not isolate the contribution of individual curriculum components, the findings suggest that structured, communication-oriented SCC activities may support perceived collaborative competence in both uniprofessional and interprofessional learning environments.

Finally, the relatively large analytic sample and multiple sensitivity analyses strengthened the study's methodological robustness. The primary baseline-adjusted ICCAS analysis was supplemented by additional demographic adjustment, an unadjusted change-score comparison, and a baseline-adjusted analysis of self-rated improvement. The consistency of findings across these approaches indicates that the overall interpretation was not dependent on a single statistical model or outcome definition.

7. Limitations

Several limitations should be acknowledged. First, this study used a quasi-experimental pre–post study design with convenience sampling at a single institution. Eligible students were recruited through scheduled SCC teaching sessions, and allocation between cohorts was determined by tutorial scheduling rather than random assignment. These features may have introduced selection bias, limited cohort comparability, and reduced the generalizability of the findings to other institutions, disciplines, year levels, or educational settings. To mitigate these limitations, both cohorts received the same core SCC curriculum, and the primary between-cohort analysis was restricted to ICCAS, the outcome most directly aligned with the difference in delivery format.

Second, the cohorts differed in discipline composition and year of study because all BPharm respondents were included in the IPE cohort and were Year 2 students, whereas the control cohort comprised Year 1 MBBS students only. Although these differences reflected the intended cohort structure, residual confounding may have influenced the between-cohort comparison. Nevertheless, baseline ICCAS scores were similar between cohorts; the primary ANCOVA adjusted for baseline ICCAS, and a sensitivity model additionally adjusted for gender, year of study, prior SCC training, and smoking status. The consistency of findings across these models supports the overall interpretation, although unmeasured confounding cannot be excluded.

Third, participants self-reported the quantitative outcomes immediately after the curriculum. The study therefore assessed short-term changes in perceived competence and course-aligned learning outcomes, rather than long-term retention, transfer to clinical practice, or actual changes in professional behavior. ICCAS measures perceived collaboration-related competence, while the adapted practice domain assessed confidence in performing SCC-related actions. The results should consequently not be interpreted as evidence of objectively demonstrated collaborative or counseling competence.

Fourth, the SCC-related outcome measure was adapted from an existing KAP questionnaire and modified to align with the curriculum. In particular, the original self-reported practice domain was reframed as practice confidence. Although this adaptation better aligned with the course content and target learner population, we did not independently establish the psychometric properties of the adapted measure in the present sample. Therefore, the SCC-related findings should be interpreted as course-aligned changes in knowledge, attitudes, and perceived readiness, rather than performance on a fully validated measure of clinical practice.

Fifth, the study did not include objective performance-based research outcomes, such as independently rated standardized-patient encounters, Objective Structured Clinical Examination (OSCE) assessments, structured observation of interprofessional teamwork, or rubric-scored counseling performance. Although the curriculum incorporated role-play and patient care planning, these activities were not analyzed as research outcomes to separate course assessment from research participation and minimize assessment-related bias. Future studies could incorporate independent assessors, non-graded performance rubrics, and clear separation between research evaluation and course grading to determine whether self-reported gains translate into observable SCC and collaborative competence.

Sixth, the sample size was determined by the available teaching cohorts rather than by an a priori calculation based on a prespecified minimally important between-cohort difference in ICCAS. The non-significant adjusted comparison should therefore not be interpreted as demonstrating equivalence between the delivery formats or as evidence that IPE had no effect. The 95% confidence interval for the adjusted mean difference ranged from − 1.87 to 2.52 ICCAS points, indicating that the findings were compatible with small effects in either direction. Although consistency across the primary and sensitivity analyses strengthens the overall interpretation, a small incremental effect of mixed-discipline delivery cannot be excluded. Future studies should define an educationally meaningful between-cohort difference prospectively and use this to inform sample-size planning.

Seventh, the exploratory comparisons between MBBS and BPharm students within the IPE cohort should be interpreted cautiously. The BPharm subgroup was considerably smaller than the MBBS subgroup, resulting in unequal group sizes and reduced precision for estimates involving BPharm students. Furthermore, discipline was closely associated with year of study and may also have reflected differences in prior educational exposure, professional socialization, and familiarity with SCC-related content. Consequently, the baseline-adjusted difference in post-tutorial ICCAS scores cannot be attributed solely to professional program and should be considered hypothesis-generating. These exploratory findings require confirmation in studies involving larger and more balanced discipline groups.

Finally, the qualitative component was exploratory and comprised a single focus group with tutors involved in curriculum delivery. The limited number and range of participants may have constrained the breadth of perspectives represented, while tutors' involvement in implementation may have influenced their accounts. Tutor perspectives may also differ from those of students and may not fully capture how medical and pharmacy students experienced mixed-discipline interaction. Therefore, the qualitative findings should be interpreted as contextual and hypothesis-generating rather than as causal explanations for the quantitative results. Future evaluations should incorporate student perspectives, a broader range of facilitators, and direct observation of interprofessional interaction to provide a more comprehensive understanding of curriculum implementation.

8. Conclusions

This mixed-methods, quasi-experimental study evaluated a structured SCC curriculum delivered through an interprofessional MBBS–BPharm format and a uniprofessional MBBS-only format.

Across respondents, the curriculum was associated with significant improvements in SCC-related knowledge, attitudes, practice confidence, and perceived collaboration-related competence. These findings provide preliminary support for a structured, experiential approach combining preparatory learning, staged patient cases, counseling role-play, patient care planning, referral planning, and debriefing to prepare health professions students for SCC practice.

After adjustment for baseline ICCAS scores, mixed MBBS–BPharm delivery was not associated with additional measurable collaboration-related benefit compared with MBBS–only delivery. This finding should not be interpreted as evidence that IPE lacks educational value. Rather, the communication and collaborative learning activities embedded in the shared curriculum may have supported perceived collaboration-related competence in both cohorts, thereby reducing the detectable incremental contribution of mixed-discipline delivery.

SCC provides a locally relevant platform for preparing future health professionals for Hong Kong's preventive, person-centered, and multidisciplinary primary healthcare model. Future SCC-IPE curricula could build on the present design by examining whether greater interprofessional exposure, clearer role differentiation, and shared interdependent tasks make profession-specific contributions more visible and measurable. Longer-term follow-up and

independent performance-based assessments are also needed to determine whether improvements in practice confidence and perceived collaborative competence translate into sustained, observable SCC counseling and collaborative practice.

Abbreviations

ANCOVA
Analysis of covariance
BPharm
Bachelor of Pharmacy
CI
Confidence interval
HREC
Human Research Ethics Committee
ICCAS
Interprofessional Collaborative Competency Attainment Survey
IPE
Interprofessional education
KAP
Knowledge, attitudes, and practice
MBBS
Bachelor of Medicine and Bachelor of Surgery
NRT
Nicotine replacement therapy
SCC
Smoking cessation counseling

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Human Research Ethics Committee (HREC), the University of Hong Kong, under reference number EA260139. All participants received information about the study and provided written informed consent before participation. Participation was voluntary and did not affect students' assessment, grades, academic standing, or access to learning activities. The questionnaires were used for research purposes only and were not graded. To minimize role-related bias and perceived coercion, independent researchers who were not involved in teaching or student assessment conducted the study briefing, consent collection, questionnaire collection, data cleaning, and statistical analysis. Teaching staff did not access identifiable student responses. Responses were collected anonymously before analysis.

Consent for publication

Not applicable. The manuscript does not contain identifiable individual-level information.

Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available because they contain student-level and qualitative data, and public disclosure may compromise participant confidentiality. De-identified data may be available from the corresponding author upon reasonable request, subject to approval by The University of Hong Kong and the relevant ethical and data-governance requirements. In accordance with the approved data-management plan, the data will be retained securely for 3 years following publication of the first paper arising from the study.

Competing interests

The authors declare that they have no competing interests.

Funding

No external funding was received for this study.

Acknowledgements

The authors thank the medical and pharmacy students who participated in the study and the tutors who contributed to the delivery and evaluation of the smoking
cessation counseling curriculum. The authors also acknowledge colleagues from the School of Public Health and the Department of Pharmacology and Phar

Authors' contributions

RW contributed to the study conceptualisation, curriculum development, investigation, project administration, data analysis, interpretation of the findings, and preparation of the original manuscript. JL contributed to data management, data analysis, validation of the quantitative findings, and interpretation of the results. BM contributed to the qualitative analysis and interpretation of the focus-group findings. ET contributed to the development and implementation of the pharmacy component of the curriculum and interpretation of the findings. DV supervised the study and contributed to its methodology, interpretation of the findings, and critical revision of the manuscript. All authors critically reviewed and approved the final manuscript and agreed to be accountable for the work.

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Figures

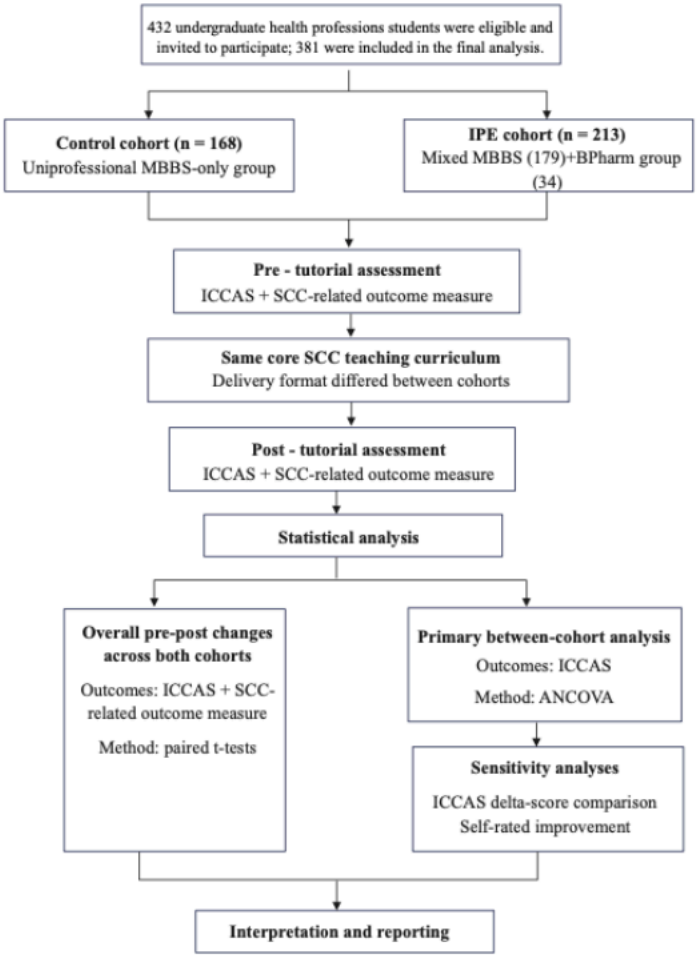


Figure 1

Participant flow through the study

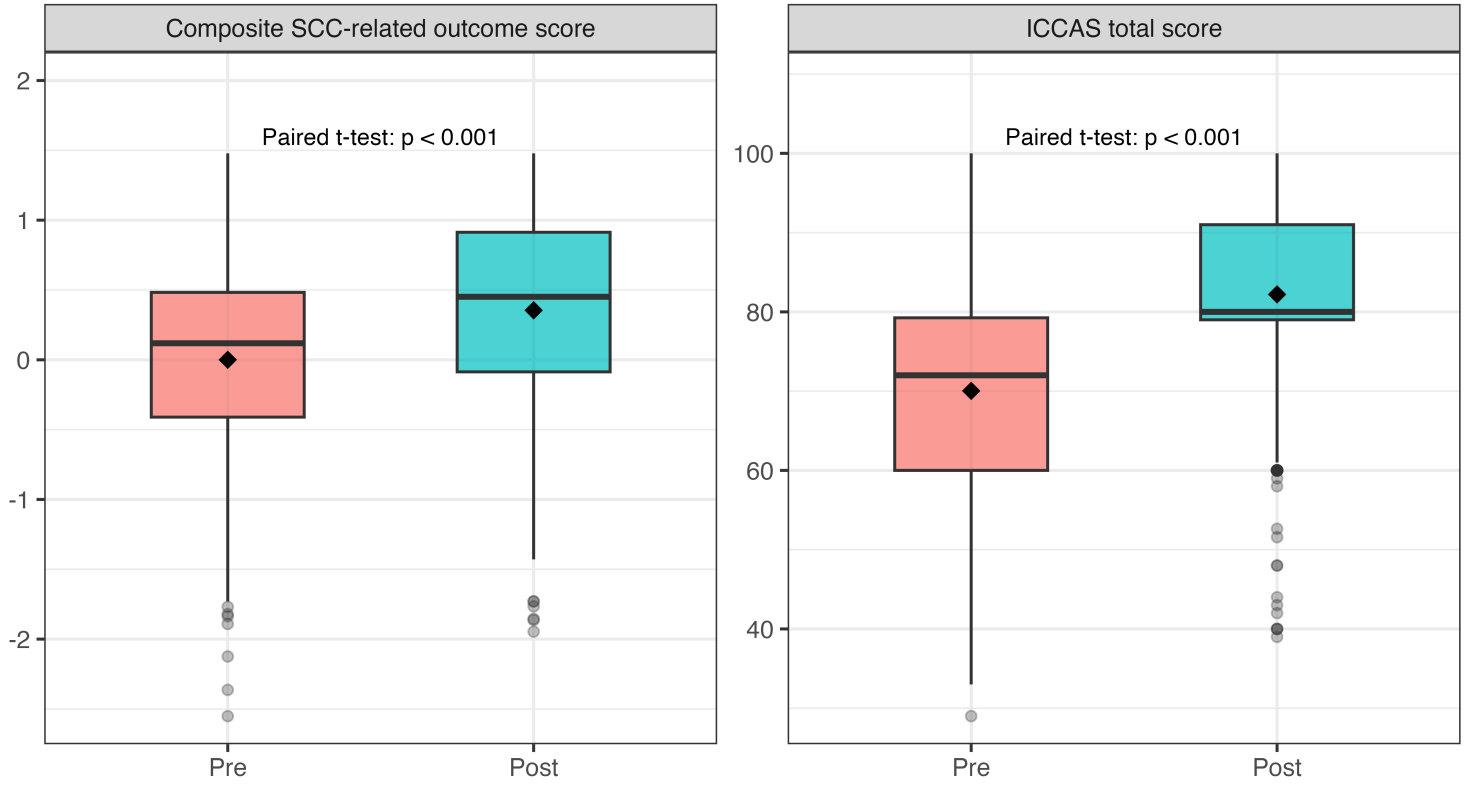


Figure 2

Distributional shift in ICCAS total and composite SCC-related outcome scores from pre- to post-tutorial across paired respondents.

Boxplots show the distribution of pre- and post-tutorial scores. Horizontal lines within the boxes represent medians, and diamonds represent means. Both outcomes increased significantly from pre- to post-tutorial based on paired *t*-tests ($p < 0.001$).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryinformation.docx