A systematic review

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Review

A systematic review and meta-analysis of outcomes of interprofessional education for healthcare students from seven countries☆

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ABSTRACT

Aim: This study aimed to analyze the effectiveness of the learning outcomes of the interprofessional education (IPE) model for healthcare students.

Background: Interprofessional education (IPE) is an important teaching and learning model that involves two or more professions engaging or working together to improve the knowledge of healthcare students. However, the specific outcomes of IPE for healthcare students are unclear as only a few studies have reported them.

Design: A meta-analysis was conducted to draw broad conclusions on the impact of IPE on healthcare students' learning outcomes.

Methods: The CINAHL, Cochrane Library, EMBASE, MEDLINE, PubMed, Web of Science, and Google Scholar databases were searched for relevant articles in the English language. To investigate the effectiveness of IPE, a pooled estimate of knowledge, readiness for and attitude toward interprofessional learning, and interprofessional competence were analyzed using a random effects model. The methodologies of the studies evaluated were assessed using the Cochrane risk-of-bias tool for randomized trials, version 2. Sensitivity analysis was performed to ensure the rigor of the findings. STATA 17 was used to perform the meta-analysis.

Results: Eight studies were reviewed. IPE had a significant positive impact on healthcare students' knowledge (Standardized Mean Difference [SMD]: 0.43; 95% Confidence Interval [CI]: 0.21–0.66). However, its impact on readiness for and attitude toward interprofessional learning and interprofessional competence was nonsignificant and needs further investigation.

Conclusion: IPE enables students to develop their knowledge of healthcare. This study provides evidence that IPE is a better strategy for enhancing healthcare students' knowledge than traditional/discipline-specific teaching techniques.

1. Introduction

Interprofessional education (IPE) is an important teaching and learning model in which two or more professions interact or collaborate with each other (Marion-Martins and Pinho, 2020; Organization, 2010). The IPE model enables effective collaboration between various healthcare professions and provision of high-quality patient care in every dimension, including physical and mental health, social support, and financial status (Adamson et al., 2020; Gilles et al., 2020; O'Leary et al., 2020). It has a positive impact on healthcare teams and plays an important role in the implementation of healthcare practices (Ben Darlow et al., 2015a; Guraya and Barr, 2018; Homeyer et al., 2018). The IPE model is advantageous when collaboration between several healthcare professionals is necessary (Makino et al., 2022).

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Interprofessional education is a dynamic social process associated with student membership of IPE teams (Haugland et al., 2019). In IPE, participation in groups may have an impact on professional identity formation, including enhanced awareness of specific professional competencies and socialization of professional roles (Haugland et al., 2019). Collaboration promotes a holistic approach to practice and can improve service provision and quality of care. It is essential that students observe collaborative work replicated in the classroom so that they can learn to work collaboratively in the field (Darling-Hammond et al., 2019; Haugland et al., 2019). When students have the opportunity to study and learn from other disciplines, their understanding of their disciplinary duties and the roles of other disciplines and professions is enriched. In order to succeed in their profession, students must learn how to collaborate in both the classroom and the field (Darling-Hammond et al., 2019; Marion-Martins and Pinho, 2020). Therefore, the IPE model should be considered in and applied to healthcare education programs to prepare students for interprofessional teamwork.

Teamwork preparation from the beginning stages of healthcare education is challenging because it involves active learning and the complexities of collaboration with other professions to design the curriculum and learn and work together simultaneously in real-world situations (van Diggele, Roberts et al., 2020). Moreover, the challenges may include the lack of a range of appropriate professional health programs in schools, difficulty in designing a cross-discipline curriculum, insufficient benefits of IPE, the need for further training to apply the IPE model in teaching, increased teaching load, lack of financial support, and time limitations (Ahmady et al., 2020; Lash et al., 2014; Li et al.). A well-developed IPE model in healthcare education implies that each relevant profession has collaborated in the teaching and learning of the IPE program (Homeyer et al., 2018; van Diggele, Roberts et al., 2020). Such a program leads to enhanced hard skills, such as technical knowledge and practice skills, as well as soft skills, such as communication, teamwork, and attitude, which are also necessary for collaboration (Corrêa et al., 2022; Csavina et al., 2014). In addition, IPE may positively impact clinical work in real-world situations after graduation because several professional barriers may be overcome through the collaborative learning model (Homeyer et al., 2018; van Diggele, Burgess et al., 2020). The positive impacts of IPE include better quality of patient care, readiness for teamwork, and greater communication between healthcare professionals (Ahmady et al., 2020; IPE, 2017).

The outcomes of the IPE teaching and learning model are positive, and include readiness for and attitude toward interprofessional learning, interprofessional competence, and knowledge (Ben Darlow et al., 2015a; Fusco et al., 2021a; Rosasco et al., 2021; Fatma Uslu-Sahan & Fusun Terzioglu, 2020). Previous meta-analyses of IPE studies demonstrated its effectiveness in healthcare, but did not show specific learning and collaborative competence outcomes (Guraya and Barr, 2018; Marion-Martins and Pinho, 2020). Other systematic reviews of IPE showed that the model benefited healthcare students by improving their attitudes toward and perceptions of collaboration between healthcare professions and in clinical decision-making, as well as having a positive impact on overall attitude, perceptions, and knowledge (Lapkin et al., 2013; Spaulding et al., 2021). Although many previous studies have demonstrated learning outcomes of IPE, the specific outcomes of the model for healthcare students are unclear as few studies to date have reported them. Thus, this systematic review and meta-analysis attempts to fill this gap and clarify the effects of the IPE approach on learning outcomes of healthcare students. The aim of this study was to synthesize and analyze the effectiveness of IPE learning outcomes, including healthcare students' readiness for and attitudes toward interprofessional learning, interprofessional competence, and knowledge of the IPE model.

2. Methods

2.1. Data sources, literature search, and selection criteria

This study adhered to the updated Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Statement 2020 for systematic review reporting (Page et al., 2021). The protocol of this study was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO): CRDXXXXXXXXXX.

Seven databases—CINAHL, Cochrane Library, EMBASE, MEDLINE, PubMed, Web of Science, and Google Scholar—were systematically searched from their inception to October 15, 2022. The following MeSH terms and keywords were used: "healthcare students" OR "nursing students" OR "medical students" OR "occupational therapy students" OR "physiotherapy students" OR "pharmacy students" AND "IPE" OR "interprofessional education" OR "inter-professional education" OR "interdisciplinary education" OR "interprofessional learning" AND "randomized controlled trial" OR "RCT" OR "randomization" OR "controlled trial" OR "randomized control trial." Two authors individually searched the databases and selected studies. Any disagreements arising during the process were resolved through group discussion until consensus was reached. The authors limited the research randomized trial or controlled trial to reduce the likelihood of confounding variables or bias. A study was eligible for inclusion in this review if the following criteria were met: (1) participants were healthcare students (no restrictions on age, gender, ethnicity, or years of education); (2) participants received IPE, traditional training, or other types of learning; and (3) the trial provided the means and standard deviations of the intervention and control groups. The studies that used hybrid learning techniques or protocol RCTs were not included.

2.2. Data extraction and quality assessment

The first author performed the data extraction, which the second author then double-checked. During the procedure, any discrepancies in the data were resolved through group discussion between the two authors until a consensus was reached. The following information was extracted from studies that met the inclusion criteria: citation of the trials considered; participant characteristics including the total number of participants, age of participants in the intervention and control groups, students' departments, and students' grades; and intervention characteristics including type of intervention in both groups, duration and frequency of the intervention, length of follow-up intervention, and measurement.

The Cochrane risk-of-bias tool for randomized trials, version 2 (RoB 2) and the Risk of Bias in Non-Randomized studies of Interventions (ROBINS-1), was used to assess the risk of bias in RCTs (Sterne et al., 2016; Sterne et al., 2019). The RoB-2 assessed the potential bias on the randomization process bias; period and carryover effects; effect of intervention assignment and effect of intervention adherence; missing outcome data; outcome measurement; and choice of the reported result. Further, the ROBINS-1 assessed potential bias on the confounding of the effect of intervention, selection of participants, intervention classification, deviations from intended intervention, missing data, measurement of the outcome, and reported missing data. A study was determined to have a high risk of bias if it was unable to address two of the domains during the assessment process. Therefore, such a study with a high risk of bias was omitted from the present study.

2.3. Statistical analysis

Meta-analyses, with a random effects model, of pooled effect size were performed using STATA 17. The mean and standard deviation (SD) of continuous outcome variables for each intervention and control group were combined to report the mean difference (MD) or standardized mean difference (SMD) (Andrade, 2020; Lin and Aloe, 2021; Lipsey and

Wilson, 2001), which employed a different scale to evaluate the same outcome (Cochrane Handbook 5.1, chapter 9/9.2.3.2 The Standardized Mean Difference). The outcomes included were readiness for interprofessional learning (Readiness for Interprofessional Learning Scale), interprofessional competencies (Team Skills Scale and Interdisciplinary Education Perception Scale), attitude toward interprofessional learning (Attitudes Toward Healthcare Teams Scale, Communication Skills Attitude Scale, and Interdisciplinary Education Perception Scale), and healthcare students' knowledge (Knowledge Test and Palliative Care Knowledge Test). Furthermore, the inverse variance index (I^2), with its 95% confidence interval (CI), was used to measure the heterogeneity of each outcome, with 25% indicating low, 50% indicating moderate, and 75% indicating high heterogeneity (Higgins et al., 2003). A forest plot was used to assess the pooled effect size. A funnel plot and Egger's test were employed to investigate publication bias (Egger et al., 1997; Lin and Chu, 2018). All stated *p*-values were two-sided, and $p < 0.05$ was deemed statistically significant for all analyses.

3. Results

3.1. Study selection

The seven databases and manual searching yielded a total of 162 studies. Thirty-nine studies were automatically deleted from EndNote X9 because they were duplicates. The remaining 123 studies were screened for title and abstract, and 89 were eliminated because the population was not healthcare students (n = 19); the intervention did not use IPE (n = 46); or the study was not an intervention study (i.e., it was a review or a qualitative, protocol, or observational study; n = 24). The full text of the remaining 34 studies was evaluated. During this process, 27 studies were removed because the population was not healthcare students (n = 2); the intervention did not use IPE (n = 2);

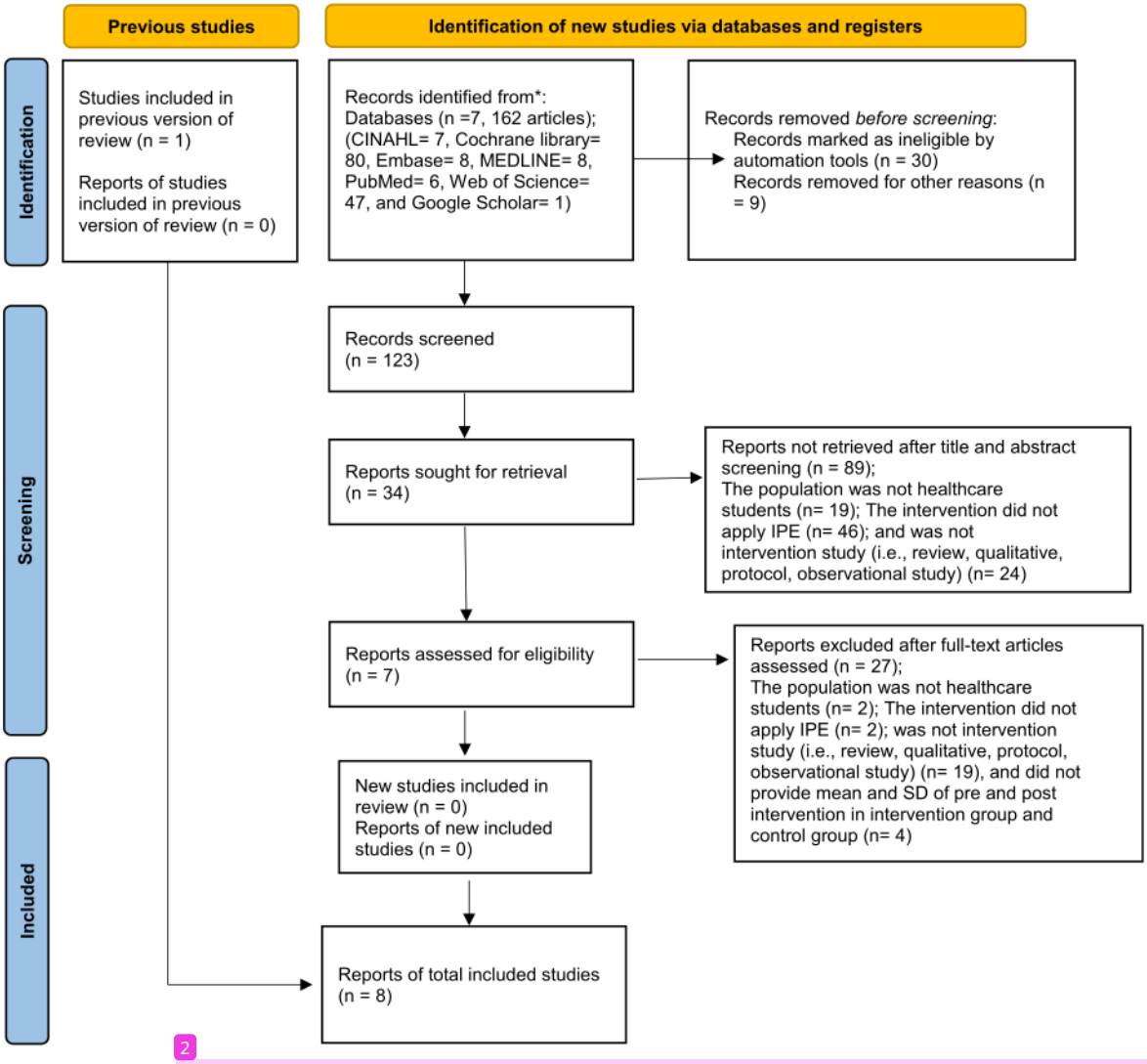


Fig. 1. PRISMA flowchart diagram. *Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers). * *If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools. *From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/.

they were not intervention studies (i.e., they were reviews or qualitative, protocol, or observational studies; n = 19); or they did not provide the pre- and post-intervention means and SDs for the intervention and control groups (n = 4). The final analysis used eight studies, including one from a prior evaluation (Corrêa et al., 2022; B. Darlow et al., 2015a; Fusco et al., 2021a; S. Hamada et al., 2020; Just et al., 2010; Rosasco et al., 2021; Swinnen et al., 2021b; Fatma Uslu-Sahan & Fusun Terzioglu, 2020). Fig. 1 illustrates the study selection procedure.

3.2. Study characteristics

The included studies were conducted in Brazil, New Zealand, USA, Japan, Germany, Belgium, or Turkey. The study population consisted of 948 healthcare students from several departments, such as nursing, physiotherapy, medicine, nutrition, pharmacy, physical therapy, and psychology. The study participants ranged in age from 21 to 27 years and were in their second to final year of college. The intervention group received an IPE program or curriculum, whereas the control group received a typical lecture, learning approach, or training. Table 1 summarizes the study's characteristics.

3.3. Risk of bias in studies

All the studies were determined to have a low risk of bias. However, there were some concerns about carryover effects in one study, which were perhaps due to publication bias. On the other hand, Egger's regression test revealed that the possible bias in the analyses was modest ($p > 0.05$; see Supplementary Document 2a; 2b).

3.4. Outcomes of IPE for healthcare students

3.4.1. Readiness for interprofessional learning

To assess the readiness for interprofessional learning of students in the IPE and control groups, a pooled analysis of three trials using random effects models was performed (Corrêa et al., 2022; B. Darlow et al., 2015a; S. Hamada et al., 2020). The SMD between groups was 0.72 (95% CI = −0.80 to 2.24, $I^2 = 12.0\%$), indicating that IPE did not significantly improve healthcare students' readiness for collaborative learning ($p = 0.35$; Figure 2.1). The influence of publication bias was small (Egger's test = 1.33, $p = 0.410$).

3.4.2. Interprofessional competence

To assess the interprofessional competence of healthcare students in the IPE and control groups, a pooled analysis of three trials using random effects models (Corrêa et al., 2022; B. Darlow et al., 2015a; Swinnen et al., 2021b) was performed. The SMD between groups was 0.17 (95% CI = −0.04 to 0.39, $I^2 = 0.0\%$), demonstrating that IPE had no significant effect on the development of interprofessional competencies of healthcare students ($p = 0.12$; Figure 2.2). The influence of publication bias was small (Egger's test = 0.31, $p = 0.808$).

3.4.3. Attitude

To assess the attitudes toward interprofessional learning of the healthcare students in the IPE and control groups, a pooled analysis of three trials using random effects models was performed (B. Darlow et al., 2015b; Rosasco et al., 2021; Fatma Uslu-Sahan & Fusun Terzioglu, 2020). The SMD between groups was 0.13 (95% CI = −0.86 to 1.12, $I^2 = 86.1\%$), demonstrating that IPE did not significantly improve healthcare student's attitude toward interprofessional learning ($p = 0.80$; Figure 2.3). The influence of publication bias was small (Egger's test = 0.37, $p = 0.774$).

3.4.4. Knowledge

To assess the knowledge of healthcare students in the IPE and control groups, a pooled analysis of two trials using random effects models was performed (Fusco et al., 2021a; Fatma Uslu-Sahan & Fusun Terzioglu, 2020). The SMD between groups was 0.43 (95% CI = 0.21–0.66, $I^2 = 0.0\%$), demonstrating that the IPE group had a higher knowledge score than the control group ($p < 0.001$; Figure 2.4).

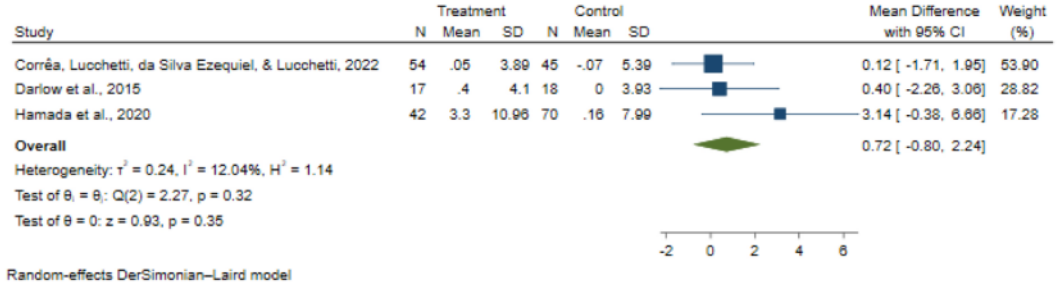
4. Discussion

This meta-analysis investigated the impact of IPE on the knowledge, readiness for and attitude toward interprofessional learning, and interprofessional competence of healthcare students. The pooled analysis showed that improved knowledge was the only significant IPE outcome for healthcare students. Other outcomes, such as readiness for and attitude toward interprofessional learning and interprofessional competence, were nonsignificant, which might be attributable to a lack of exposure to relevant and appropriate IPE strategies for healthcare students. The findings of three previous reviews differ from ours due to their participants being a mixture of healthcare students and health professionals (Spaulding et al., 2021) and the studies being narrative reviews (Lapkin et al., 2013; Spaulding et al., 2021), while our study focuses solely on healthcare students. Healthcare students differ from healthcare professionals in the intensity of their exposure to multidisciplinary collaboration and interaction on a regular basis. However, IPE research has evolved and now offers a wide range of methods, from classroom-based, virtual, experiential simulation-based, and clinical practice-based learning to workplace settings, which have been shown to be significant in enhancing students' healthcare readiness, attitude, and interprofessional competencies. To the best of our knowledge, this study is the first published systematic review with a meta-analysis of the effectiveness of IPE for healthcare students.

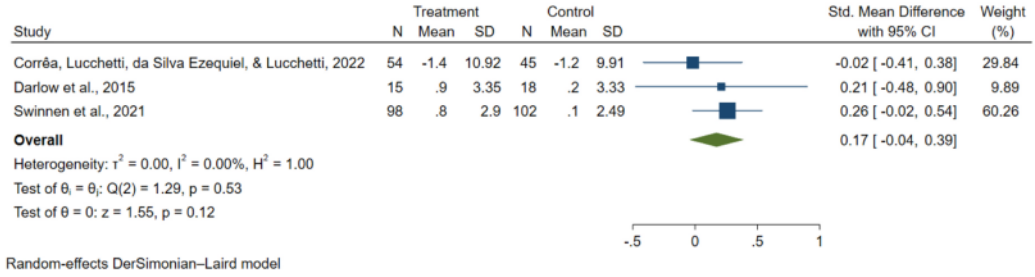
This study demonstrated that IPE significantly improved healthcare students' knowledge. This is the most consistent result of IPE systematic reviews within the last decade (Aldriwesh et al., 2022; Lapkin et al., 2011). Improved knowledge of interprofessional collaboration is one of the short-term impacts of IPE programs that is possible to achieve even through only a single learning method, such as simulation-based and case-based learning (Riskiyana et al., 2018; Sytsma et al., 2015). Furthermore, this study revealed a substantial increase in knowledge encompassing specific clinical topics, including general conceptual knowledge such as palliative care (Fusco et al., 2021; Uslu-Sahan and Terzioglu, 2020) and application knowledge related to sepsis management and post-hip operation care (Fusco et al., 2021; Uslu-Sahan and Terzioglu, 2020). A Canadian study reported that incorporating the IPE simulation method into their curriculum was a beneficial and efficient learning strategy for improving healthcare students' knowledge of stroke best practices (MacKenzie et al., 2017). A study from Finland involving nursing and medical students also demonstrated that interprofessional education increased knowledge about diabetes care (Kangas et al., 2023). Due to these benefits and positive impacts of IPE programs, especially in enhancing students' interprofessional knowledge and knowledge of specific clinical topics, many health education institutions have already incorporated the strategy into their curricula through various innovative learning approaches. A recent systematic review reported the improved incorporation of IPE into the curriculum in a number of countries in the West and Asia and in South Africa and the use of well-established methods, such as simulation, e-learning, and problem-based learning (Aldriwesh et al., 2022). Another recent systematic review found that more than 70% of institutions in the United States, Canada, Germany, Sweden, the United Kingdom, South Africa, Australia, Saudi Arabia, and Singapore have integrated IPE across the curriculum (Grace, 2021). These data suggest that the growth of IPE through various established methods is highly likely to improve students' knowledge and interprofessional learning.

Our study found that students' readiness for interprofessional learning was not significantly improved by IPE (Corrêa et al., 2022; Ben Darlow et al., 2015b; Shuhei Hamada et al., 2020), in contrast to a previous systematic review that found a significant enhancement in students' readiness for interprofessional collaboration after an IPE

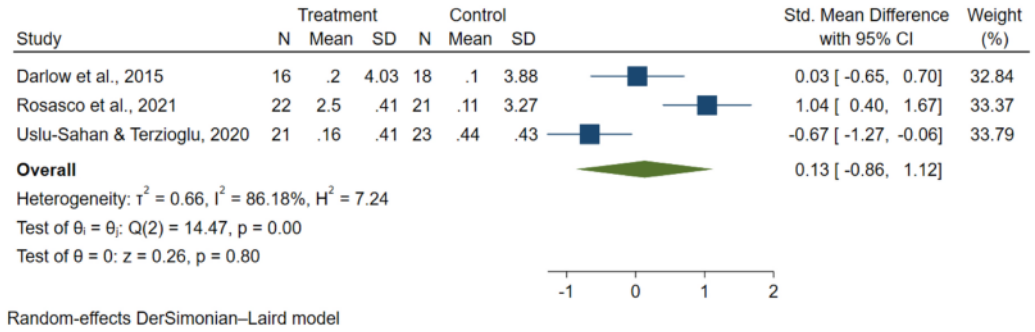
2.1 Readiness



2.2 Competence



2.3 Attitude



2.4 Knowledge

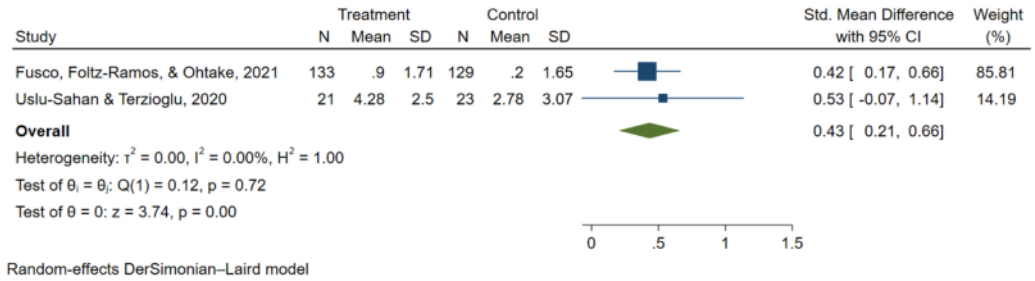


Fig. 2. Forest plot of IPE for healthcare students.

Table 1
Summary of included studies.

No	Author,year/ Country	Study design	Participants				Intervention types		Frequency/ Duration of intervantion	Follows-up length (month)	Outcomes
			Total	Mean age (IG/ CG)	Students Department	Grade (IG/CG)	Intervention group	Control group			
1	Corrêa, Lucchetti, da da da Silva Ezequiel, and Lucchetti (2022)/ Brazil	Randomized controlled trial	99	22.70 (5.09)/ 22.02 (2.59)	Nursing, physiotherapy, medicine, nutrition and psychology	NA	Interprofessional (Active strategy group)	Received Lecture strategy	4 h/ week/ 12 week period	6 months	Interprofessional learning, perception and team skills
2	Darlow et al., 2015/ New Zealand	Prospective controlled study design	83	21.0 (22.8)/ 21.6 (23.4)	Discipline of dietetics medicine, physiotherapy and radiation	5th and final year (DS), 4th year of a 6year (MS) 4th/ final year (PT) 3rd and final year (RT)	Interprofessional education program	Received usual discipline specific curriculum	Over 4 week period/ 11 h program	N/A	Attitude toward health care, interprofessional learning, team skills, long-term condition management
3	Fusco, Foltz-Ramos, and Ohtake (2021)/ USA	Randomized controlled trial	262	NA	Nursing, pharmacy, physical therapy	Senior nursing, 3rd year (PS), 2nd year (PT)	Interprofessional education program	Received In-person simulation	30 min	Post-intervention	Interprofessional skills
4	Hamada et al. (2020)/ Japan	Randomized controlled trial	112	21.1 (3.4)/ 20.4 (1.6)	Medical, nursing, occupational therapy, radiological, physical therapy	2nd year (MS)/ 2nd year (NS, OT, RT, PT students)	Interprofessional education program (multiprofessional group)	Uniprofessional group	N/A	N/A	Interprofessional learning
5	Just, Schnell, Bongartz, and Schulz (2010)/ Germany	Randomized controlled trial	40	NA	Medical and nursing	3rd year undergraduate (MS AND NS)	Interprofessional curriculum	Received written material of IPE curriculum	12 teaching hours/ 2 days	Post-intervention	Clinical behaviour
6	Rosasco et al. (2021)/ USA	Prospective, block randomized-controlled survey study	43	24.9 (2.65)/ 27.5 (4.62)	Medical, nursing, nutrition, paramedicine, and pharmacy	NA	Interprofessional training	Received traditional training	120 min	N/A	Communication skill attitude, self-efficacy
7	Swinnen et al., 2021/ Belgium	Randomized controlled trial	225	21.7 (4.3)/ 20.8(2.9)	Medicine, nursing, physiotherapy, and nutrition-dietetics	2nd year- (MS), 2nd year (NS), 3rd year (PT)	Interprofessional education	Discipline specific	N/A	N/A	Interdisciplinary education perception
8	Uslu-Sahan and Terzioglu (2020)/ Turkey	Comparative randomized controlled tial	84	21.89 (2.85)/ 22(0.95)	Medical, nursing, nutrition-dietician and social work	4th year (MS), 3rd year (NS)	Different simulation methods (HFS, HS and HFS+HS)	Received only Interprofessional gynecologic oncology palliative care training (IP Gyn-Onc PCT)	16 h, 2 days/ 2 weeks	3 months	Knowledge, perceptions and teamwork attitude of health professional

NA, Not Available; DS, Dietetics student; MS; Medical student; NS, Nursing Student; PT, Physiotherapy; OT, Occupational Therapy; RT, Radiation Therapist

program was delivered through structured team-based learning (TBL) (Burgess and McGregor, 2022). In addition, a study from Hong Kong, which involved 801 undergraduate healthcare and social care students from two universities, reported a significant improvement in readiness after the implementation of interprofessional TBL (Chan et al., 2017). Of three studies evaluating student readiness, only one used TBL (S. Hamada et al., 2020) and the other two used a course-based learning method (Corrêa et al., 2022a; Darlow et al., 2022). This indicates that the lower the adoption of TBL in IPE programs, the lower the potential for significant improvement in healthcare students' readiness. A qualitative study also found that interprofessional TBL enhanced the learning experiences of students through interactive learning with other healthcare students (Ho et al., 2021). The application of TBL in IPE has emerged as a result of the understanding that it is an effective strategy for ensuring healthcare students are ready for the workplace, especially for providing patient care in a cooperative team environment.

This study also demonstrated a nonsignificant impact of IPE on healthcare students' attitudes toward interprofessional learning. However, the different IPE learning techniques used in the studies to assess attitudes to interprofessional learning might have impacted the significance of students' attitudes toward cooperation and teamwork. A recent systematic analysis found that simulation-based learning has become one of the most popular IPE techniques for improving healthcare students' attitudes toward interprofessional learning (Berger-Estilita et al., 2020). More recent studies have also found significant positive attitudes after the use of simulation-based learning in different health study programs, such as occupational therapy, speech pathology, dietetics (Mills et al., 2020), medicine, nursing (Burford et al., 2020; Wu et al., 2022), and pharmacy (Yu et al., 2018). In this review, only one study used interprofessional simulation, i.e., high-fidelity simulation and a hybrid simulation group (Fatma Uslu-Sahan & Fusun Terzioglu, 2020). Our findings indicate that non-simulation-based learning is inadequate for improving attitudes toward teamwork compared to simulation-based training. This evidence suggests that students' attitudes toward interprofessional learning could be influenced by the active IPE techniques used, such as simulation-based learning, and that previous IPE courses or simply exposure to clinical observations is not sufficient.

This study found that the competencies in interprofessional collaboration were not significantly different between healthcare students in intervention and control groups. According to the Interprofessional Education Collaborative (IPEC), interprofessional competencies in healthcare include comprehensive application of knowledge, abilities, values, and attitudes (Brashers et al., 2019; Reeves et al., 2016). Our other nonsignificant findings—for readiness and attitude—might have contributed to the nonsignificant difference in competencies in interprofessional collaboration, as these competencies consisted not only of knowledge but also of attitude and readiness. According to our findings, even though the IPE program does not significantly affect student's interprofessional collaboration competencies, three of the studies considered in the meta-analysis indicate that experience of interacting with other healthcare students may improve self-perceived competency more than the IPE teaching strategy (Corrêa et al., 2022; Darlow et al., 2022; Swinnen et al., 2021a). Several studies have found significant improvements in interprofessional collaboration competencies following the use of IPE experiential learning methods, such as practice-based learning and clinical placement (Al-Jayyousi et al., 2021; Naumann et al., 2018; O'Neil-Pirozzi et al., 2019) and workplace learning (McKinlay et al., 2021; Miselis et al., 2022; Nwaesei et al., 2019). Health education institutions should adopt the experiential learning IPE method to facilitate the healthcare student's need for experience of multidisciplinary interaction and collaboration. Furthermore, a recent cohort study involving over 2300 students from 16 professions found that a new comprehensive multi-step education model in IPE (involving online didactic-team icebreaker activity, skills practice station, professional huddle, interprofessional simulation, and debrief) significantly improved competency, knowledge, and attitudes of healthcare students (Brown et al., 2022). This combination of active and conventional methods of IPE provides a promising, safe, and practical future IPE strategy for healthcare students to make them ready to enter the real workplace in the future.

This study has significant implications for nurse educators and researchers in nursing education, emphasizing the integration of evidence-based IPE strategies through interprofessional courses to enhance students' knowledge and promote collaboration. It aligns with the notion that IPE is an academic strategy for nursing educators (Bressler and Persico, 2016). It also facilitates future nurses' ability to provide equitable healthcare to diverse populations globally (Oerther et al., 2023). Researchers should investigate factors impacting readiness for interprofessional learning; explore the effectiveness of IPE techniques—particularly simulation-based learning—on students' attitudes; and develop comprehensive multi-step IPE models to improve students' competency, knowledge, and attitudes. Collaborative efforts between educators and researchers are crucial for advancing nursing education and promoting effective interprofessional practice.

5. Limitations

Although this review adds to the knowledge on efficient IPE strategies for healthcare students, it has some limitations. Substantial heterogeneity was discovered in the pooled result for attitude, which might be attributable to the pooled SMD obtained from only three studies. Furthermore, differences in participant characteristics (e.g., age, student grade, and student department) and treatments (e.g., length, type of intervention, etc.) might have introduced bias into the results. Therefore, further trials and effective guidelines for using IPE in healthcare training are required. Furthermore, the five core competencies of the IPE 2016 update—values/ethics, roles/responsibilities, interprofessional communication, teams, and teamwork—were not the review's primary focus. This suggests that more thorough RCTs of IPE, specifically for healthcare students, are required.

6. Conclusion

This study demonstrates that IPE is an effective approach to enhance healthcare students' knowledge. Although applicable IPE strategies can advance healthcare knowledge, further research is required to fully understand how IPE affects interprofessional competence and readiness for and attitude toward interprofessional learning. The impact of IPE on prospective outcomes (i.e., values/ethics, roles/responsibilities, interprofessional communication, teams, and teamwork) also needs examining with more thorough RCTs. Investigations of the long-term impacts IPE on healthcare education are also needed.

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CRediT authorship contribution statement

Study conception and design: IDS, FHC, Data collection: IDS, SS, Data analysis and interpretation: IDS, DET, Drafting of the article: IDS, DET, Critical revision of the article: All authors.

Declaration of Competing Interest

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

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.nepr.2023.103683.

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