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Does participation in sports competitions enhance interprofessional teamwork among medical students? Evidence from a medical school curriculum experiment

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Abstract

Background Effective interprofessional teamwork is essential for the efficiency, safety and quality of healthcare system services and requires interprofessional education for medical students. Physical education is a simple and easy way to teach teamwork, which translates into team performance in the work environment. This study was conducted to examine the effectiveness of the physical education competition model, instead of the exams model, for improving teamwork skills among medical students.

Methods A quasiexperimental intervention design was used to measure the effect of a 16-week cheerleading programme on subjects' teamwork skills by completing a teamwork scale comprising four subdimensions, namely, personal characteristics, teamwork, leadership, and conflict management, before the start and at the end of the programme, and by comparing nonwinning to winning students to measure the effect of teamwork skills on team performance.

Results A total of 179 students completed the valid baseline and posttest (effective rate = 95.21%). The teamwork scale scores (B M = 4.81, R M = 5.05, $p < 0.001$) and 4 subdimension scores (personal characteristics $p = 0.002$, teamwork $p = 0.028$, leadership $p < 0.001$, conflict management $p < 0.001$) were statistically significant. Twenty-two of the 44 items in the scale improved significantly. The differences between students who won the competition and those who did not (N M=4.86, W M=5.14, $p < 0.01$) were statistically significant, with no significant differences in personal characteristics $p = 0.183$; significant differences in the 3 subdimensions of teamwork $p < 0.01$, leadership $p = 0.024$, and conflict management $p = 0.037$; and a significant increase in 13 out of 44 self-efficacy items on the scale.

Conclusions The "race for exams" physical education programme improved teamwork among medical students, and increased teamwork improved team performance. The "competition instead of examination" physical education programme provides a quantifiable method for improving interprofessional teamwork among medical students.

Keywords Interprofessional teamwork, Sports competitions, Modalities of the programme, Medical education, Medical students

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Background

Beginning with the Flexner Report in 1910, the power of science has brought about continuous changes in medical higher education to meet the needs of the world's health systems over time [1]. The roots of the conflict between medicine and nursing can be traced back to Nightingale and the early development of nursing in the UK [2]. With the increasing complexity of health, education, care settings, and healthcare systems, patient-centred care requires greater interprofessional collaboration among healthcare professionals. Interprofessional education (IPE) is an educational approach that can positively impact healthcare practices and patient outcomes; it originated in the United Kingdom and the United States in the 1960s and has since expanded to all regions of the world [3]. In 2010, the Lancet Commission defined competency-based education, IPE, and information technology education as core areas of development in the education of health professionals in the 21st century [4]. The World Health Organization (WHO) also issued the Framework for Action on Interprofessional Education and Collaborative Practice (2010), which emphasises preparation for practice through education [5]. After more than a decade of innovation, medical education has entered a period of profound change, with competency-based education "recognising the importance of inter-professionalism and teamwork" as essential to healthcare quality, safety and patient-centred care [6–8]. Health profession students should be prepared for practice through IPE. To this end, the IPE Collaborative has published five essential competency areas: roles and responsibilities, ethical practice, conflict resolution, communication, collaboration and teamwork [9]. Interprofessional communication and teamwork are recommended as key curriculum modules for healthcare students and professionals [10], and a high level of knowledge and skills training is required at all three stages for undergraduate [11], postgraduate [12] and clinical healthcare teams [13]. Interprofessional team training needs to start before licensure and continue into clinical practice [14]. Teamwork is one of the 13 core competencies of physicians, and interprofessional collaboration is critical across the medical education continuum [15]. Interprofessional collaboration education has a clear role in saving healthcare resources, improving patient outcomes, and enhancing service quality and performance [16]. It also reduces whistle blowing events in healthcare and prevents serious delays in treatment, medical errors and medical malpractice, which can lead to poor patient outcomes [17].

High-quality IPE and collaborative practice for healthcare professionals in the 21st century are crucial and indispensable for the full-time, continuing, and clinical education of medical students and healthcare

professionals. How to solve the problem of collaborative silos and improve the interprofessional collaboration and communication skills of future medical students has become a pressing issue. Studies have focused more on the pre- and postlicensing education of health professionals in clinical settings [18–20]. This approach provides excellent opportunities for the simulation training of students' communication skills and teamwork through simulation education [21, 22]. The necessary assessment of medical students for teamwork, training in teamwork and engaging students in interprofessional teamwork often lags behind education in professional knowledge [17]. Moreover, adding courses to the already dense schedule of the current medical school curriculum may prove difficult [8]. How to find effective, quantifiable ways to train and assess teamwork skills in undergraduate medical students is important. Providing medical students with an in-depth understanding of teamwork through designed interprofessional activities and hands-on experience of teamwork practice is important for improving the interprofessional collaboration skills of future healthcare professionals.

A common belief in sports is that team members must work well together for the team to be successful [23]. Sports provide excellent opportunities for medical students to acquire teamwork that is beneficial not only for individual health but also for team cohesion, teamwork, goal setting, emotional skills, leadership, interpersonal skills, and job performance [24–26]. Moreover, team cohesion in sports is considered an important variable in predicting collective efficacy [27], and increased team cohesion contributes to improved team performance [28]. One part of the study focuses on the effectiveness of teamwork in different sports, such as basketball [29], frisbee [30], and baseball [31], while the other part of the study develops members' teamwork skills by designing a unique curriculum model [32]. There is no doubt that teamwork is an important characteristic of effective teams and can explain the results of IPE [33]. Educators can succeed in making IPE successful, by engaging, creating, and modelling interprofessional collaboration [34]. A systematic review showed that sports participation may be a predictor of medical student success and is associated with teamwork, discipline, and resiliency and that athlete experience leads to later career performance, increased surgical skills and increased burnout [35]. To this end, we designed a 16-week physical education curriculum intervention experiment for medical students based on the latest Chinese physical education reform goals (teaching, practising, and competing) [36] and designed curriculum exams as competitions, which we call the "competition instead of exams" (CIE). course model. The participants responded to scales at baseline

and at the end of the competition to measure self-efficacy in teamwork skills.

The study interpreted improved levels of teamwork as the CIE programme’s effectiveness and team performance as competition results following the CIE programme. Two questions were addressed:

1. whether sports competitions can be effective practices for developing interprofessional cooperation skills among medical students;
2. whether teamwork competency is an important variable affecting team performance.

The purpose of this study was to verify whether participation in team-based sports competitions is a potential strategy to enhance interprofessional teamwork among medical students.

Methods

Experimental design

This project was supported by the Education Reform Project of Chongqing Municipal Education Commission, Chongqing Medical University, and Chongqing Medical College of Higher Education, China. The ethical review and informed consent, the educational reform project, course content, experimental design, the participant feedback process, team formation rules, possible discomfort during the course experiments, participant privacy protection, and participants’ freedom to refuse to participate or withdraw at any time were disclosed before the experiment. With informed consent, the participants were tested at baseline in week 1, the cheerleading competition was conducted in week 16, and the posttest was conducted 1 week after the competition (week 17). The subjects’ baseline and retest results were subsequently compared and evaluated. The benefit of the 1-week interval was to avoid interference in the competition context and to test the stability of the hypotheses. The course was divided into four phases with 12 tasks (Fig. 1).

(1) After providing informed consent, the students completed a baseline test of the scale. The subjects were freely formed into teams of 6–9 members, with each team including at least 4 or more disciplines.

Within the given time frame, participants selected the team name and the team captain, determined the team motto, and introduced themselves as a class team, which required information such as the team name, motto, and members’ names. The next 15 weeks of the course were devoted to teaching, practising and competing on a team basis.

(2) The teacher taught all the students from weeks 2 to 12. The cheerleading curriculum was promulgated by the Gymnastics Management Centre of the State General Administration of Sport of China [37]. The teacher reviewed and reinforced the content at the beginning and end of each class, with an emphasis on teamwork and role taking. In class and after-school practices, the teams promoted communication and emotional identity among members through autonomous interaction and creativity.

(3) In week 13, the teachers explained the rules of the International Cheer Union (ICU) Cheerleading Competition to all teams to guide and standardise the teams’ cheerleading choreography [38]. During weeks 13–15, the teams choreographed their competition entries, with teachers providing guidance to make the teams’ entries more consistent with the competition rules and more creative. Captains were encouraged to exercise leadership, and team members played an integral and important role in the process of classroom learning, creative choreography, and competition assessment, working together for the competition.

(4) The Cheerleading Competition was held during week 16. Twenty-five teams participated in the competition, and 12 teams won awards (2 first-place, 4 second-place, and 6 third-place, *n*=86). Thirteen teams did not win awards (*n*=102). The competition was conducted in strict accordance with the ICU competition rules, with ten judges removing the highest and lowest scores to calculate the total score for ranking [37]. A posttest of the scale was administered after an interval of one week (week 17) to assess the impact of the CIE curricular reforms on teamwork competency and the relationship between teamwork competency and team performance

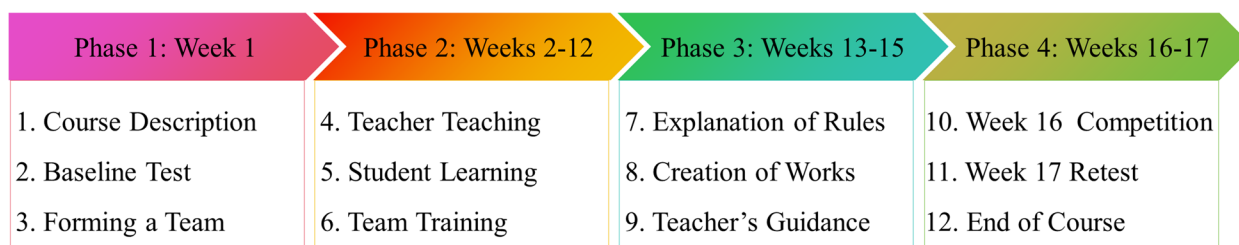


Fig. 1 Curriculum programme "Competitions instead of exams

Table 1 Basic information

		Genders(n= 188)									
		Male					Famale				
n		12	18	19	20	21	22	23	27	14.36	10
%		6.39	2.66	25.53	59.04	11.17	0.53	0.53	14.36	1.06	5.31
Age(n=188)		17	5	48	111	21	1	1	21	2	35
n		1	2.66	25.53	59.04	11.17	0.53	0.53	11.17	1.06	18.61
%		0.53	2.66	25.53	59.04	11.17	0.53	0.53	11.17	1.06	18.61
Major(n=188)		clinical medicine	rehabilitation	laboratory medicine	public health	pharmacognosy	Chinese medicine	nursing	basic medicine	paediatrics	
n		68	3	16	21	6	27	35	2	10	
%		36.17	1.60	8.51	11.17	3.20	14.36	18.61	1.06	5.31	

by comparing the baseline and retest scores of all respondents across the four subdimensions.

Experimental Objects

The design of the course meets the requirements of the Chinese Ministry of Education's Basic Standards for Physical Education in Higher Schools [39]. The students who participated in the experiment chose the cheerleading course in the course selection system, taking into account their interests. Considering the programme characteristics of the sport of cheerleading, there tends to be more female students. Students with contraindications for exercise were not included in the experiment (implemented in accordance with the regulations governing the physical education programme of Chongqing Medical University, 2022). The advantage of the cheerleading course is that cheerleading is a team sport, and cheerleading is closely related to character quality traits such as discipline, cooperation, leadership and sportsmanship [40]. A total of 197 sophomores took the cheerleading course and formed five classes. A total of 189 people volunteered to participate in the intervention experiment, while the remaining eight students participated in normal lectures and did not participate in the tests or cheerleading competitions, and one withdrew, resulting in 188 participants completing the experiment. Nine invalid questionnaires were excluded (exclusion criteria: 1. the time taken to complete the questionnaire was less than 1 min, which is far below the minimum standard for the time required to complete the questionnaire; 2. the use of reverse questions to screen the questionnaires for validity), and 179 valid questionnaires were obtained for the retest (Effective rate=95.21%). Basic participant information included sex, whether the participant was an only child, age, and discipline (Table 1). The participant disciplines were generally consistent with the medical school setting.

Test scales

This study used and adapted the Teamwork Competency Scale (TCS) [41–47], comprising 3 parts with 59 questions. The first part includes basic personal information (questions 1–7, including gender, age, place of origin, profession, etc.); the second part includes 44 questions in the 4 dimensions of human personality traits, teamwork, leadership and conflict management, and this is the core of the test tool. A 7-point Likert-type scale (questions 8–51) was used, with scores ranging from 1 to 7 indicating "Strongly Disagree" to "Strongly Agree", and higher scores indicating greater teamwork competencies. Higher scores indicate better teamwork. The third part is subjective situational judgement (questions 52–59), which tests respondents'

responses to different scenarios to understand their correct judgement of the scenarios, balance the team members' interests, coordination and communication skills, etc. The third part is subjective situational judgement (questions 8–51), which tests the responses of respondents to different scenarios, coordination and communication skills, etc. The respondents completed the scale on China's largest online questionnaire system, Questionnaire Star (<https://www.wjx.cn/>).

The total KOM value of the scale was 0.923, the KMOs for the four subdimensions (personality traits, teamwork, leadership, and conflict management) were 0.640, 0.945, 0.950, and 0.827, respectively, and the Bartlett's test of dispersion showed significance ($p < 0.001$). Validity of the questionnaire: The factor loadings for the subscales were as follows: 0.457–0.705 for personality traits, 0.509–0.812 for teamwork, 0.571–0.839 for leadership, and 0.593–0.797 for conflict management. Scale reliability: The Cronbach's α for the total scale was 0.889, and the Cronbach's α s for the personality traits, teamwork, leadership, and conflict management subscales were 0.448, 0.950, 0.921, and 0.795, respectively. The scales used in the present study had good validity and reliability.

Statistical methods

Variables are described via frequency (n) and percentage (%); t tests were used to compare significant differences between the pre- and postcompetition groups and between the winning and nonwinning groups. All the statistical data were analysed via SPSS V28.0 (IBM Corp., Armonk, NY, USA), and a P value < 0.05 was considered statistically significant.

Analysis of results

The CIE program model enhances medical students' teamwork and team performance

The mean scores on the CTE curriculum model intervention were 4.81 (4.10–5.47) on the pretest and 5.05 (4.31–5.58) on the posttest, with significant differences in the total scores ($P < 0.001$). The four subdimensions of personal characteristics, teamwork, leadership, and conflict management were significantly different before and after the CTE intervention ($P = 0.002$, $P = 0.028$, $P < 0.001$, $P < 0.001$), and 22 of the 44 total items were significantly improved. There was a significant difference ($P < 0.01$) in the total scores on the posttest between the winning students, who scored 5.14 (4.48–5.66), and the nonwinning students, who scored 4.86 (4.11–5.43). There was no significant difference in personal characteristics ($P = 0.183$), but there were significant differences in the three dimensions of teamwork, leadership, and conflict management

Table 2 Results of teamwork scale tests before and after CIE Curriculum Model Intervention

Scale statement	B M(n=179)	R M(n=179)	t	P	N M(n=93)	W M(n=86)	t	P
I consider myself to be outgoing and enthusiastic	4.31	4.63	-1.840	0.067	4.62	4.71	-4.31	0.668
I see myself as fussy and argumentative	3.31	3.19	-0.948	0.344	3.05	3.29	-1.171	0.245
I see myself as reliable and self-disciplined	4.31	4.59	-2.547	0.012	4.50	4.55	-0.226	0.822
I see myself as anxious and easily distracted	4.35	4.17	-1.257	0.210	4.03	4.21	-0.733	0.466
I see myself as someone who tries new experiences	4.84	5.07	-2.203	0.029	5.06	5.10	-0.279	0.781
I see myself as someone who keeps quiet	4.48	4.56	-1.006	0.315	4.57	4.56	-0.62	0.951
I see myself as lively and warm	4.9	5	0.913	0.362	4.91	5.10	-1.196	0.235
I see myself as disorganised and careless	3.32	3.21	-0.999	0.319	3.15	5.09	-10.362	*
I see myself as calm and emotionally stable	4.1	4.68	-4.615	*	4.67	4.73	-0.338	0.736
I see myself as traditional and unoriginal	3.56	3.47	-0.312	0.756	3.51	3.44	0.340	0.735
Dimension 1 score	4.10	4.31	-4.259	0.002	4.21	4.48	-1.443	0.183
I enjoy bringing team members together	4.74	4.95	-1.595	0.112	4.71	5.15	-2.237	0.028
I enjoy sharing ideas with others in order to complete a task	5.37	5.44	-0.747	0.456	5.33	5.49	-1.050	0.297
I recognise the achievements of team members	6.1	5.91	1.741	0.083	5.84	5.95	-0.844	0.401
I enjoy helping team members	5.64	5.65	-0.699	0.485	5.52	5.76	-1.510	0.135
I value different perspectives in order to enhance my understanding of different issues and problems	5.72	5.64	0.103	0.918	5.59	5.76	-1.062	0.291
I give appropriate feedback to team members	5.56	5.72	-1.647	0.101	5.56	5.72	-1.450	0.151
I believe that the exchange of ideas between team members can lead to creative solutions	6.03	5.88	1.293	0.198	5.81	5.94	-0.850	0.398
I always co-operate with other team members	5.02	5.41	-3.492	*	5.31	5.50	-1.116	0.267
I enjoy team activities	4.56	4.9	-2.726	0.007	4.83	5.10	-1.250	0.215
I am inspired by the views and ideas of others	5.46	5.62	-1.554	0.122	5.46	5.62	-0.488	0.627
I contribute to the definition of team goals	5.25	5.66	-3.771	*	5.34	5.74	-1.254	0.213
I respect the opinions of team members	6.01	5.85	1.510	0.133	5.56	5.90	-0.611	0.543
I encourage team members to have confidence in each other	5.64	5.73	-1.150	0.251	5.64	5.87	-1.739	0.086
Team members provide emotional support to each other	5.45	5.77	-3.112	0.02	5.45	5.83	-0.832	0.408
Dimension 2 Score	5.47	5.58	-2.037	0.028	5.43	5.66	-8.360	*
I enjoy being the leader of a team or project	3.68	4.41	-4.792	*	3.23	4.64	-3.932	*
I know how to get the rest of the team to see things my way	3.94	4.87	-6.596	*	4.92	4.92	-5.003	*
I can persuade my peers to do anything	3.36	4.23	-6.552	*	3.15	4.34	-4.920	*
I believe I am a good leader	4.02	4.67	-4.740	*	4.48	4.85	-4.159	*
I am comfortable providing constructive criticism	4.37	4.97	-5.002	*	4.96	5.01	-3.109	0.003
I consider the facts carefully to persuade my peers	5.1	5.62	-0.886	0.377	5.16	5.30	-1.729	0.087
I try to influence my peers	4.6	4.93	-2.125	0.035	4.86	5.00	-1.988	0.050
I am able to suggest alternative solutions to problems	4.92	5.26	-3.469	*	5.17	5.30	-3.269	0.002
My arguments are constructive	4.68	5.2	1.471	0.143	4.14	5.21	-4.037	*
I can support my peers with personal experience	5.03	5.27	-4.183	*	5.21	5.34	-1.743	0.085
Dimension 3 Score	4.37	4.94	-7.782	*	4.53	4.99	-2.715	0.024
I am a good listener	5.74	5.66	-0.396	0.692	5.67	5.70	-0.191	0.849
I am open to different opinions	5.74	5.59	-1.685	0.094	5.58	5.66	-0.583	0.561
I will consider the interests of other members	5.79	5.71	5.644	*	5.66	5.86	-1.410	0.162
I adapt well to change	5.08	5.52	5.342	*	5.52	5.58	-0.383	0.703
I am flexible in my role within the team	4.92	5.28	-3.211	0.002	5.29	5.33	-0.203	0.840
I believe there is only one "best" solution	2.73	3.65	-6.428	*	3.97	3.44	2.134	0.036
I don't like to be challenged	3.83	4.16	-2.381	0.018	3.33	3.90	1.992	0.050
I understand that each member of the team is different	6.07	5.75	2.813	0.005	5.71	5.81	-0.740	0.461
I think of my team members first	4.78	5.04	-2.911	0.004	4.03	5.09	-0.320	0.749
I always try to find the best way to resolve conflicts between team members	5.41	5.54	-1.762	0.080	5.56	5.57	-0.070	0.944
Dimension 4 Score	5.01	5.19	-4.768	*	4.98	5.25	-2.454	0.037
Total Score	4.81	5.05	-4.877	*	4.86	5.14	-4.321	<0.01

BM Baseline test mean, RM Re-testing mean, NM Non-winning teams mean, WM Winning Teams mean

* P<0.001

($P < 0.001$, $P = 0.024$, $P = 0.037$). Thirteen of the 44 total items were significantly more abundant (Table 2). The findings suggest that the CTE curriculum model has a positive effect on medical students' teamwork ability and that teamwork ability is positively correlated with team performance.

The CIE program model effectively improves medical students' teamwork skills

The CTE programme model was found to have a positive effect on students' interpersonal characteristics (B M=4.10, R M=4.31; $p = 0.002$). There was a particularly significant improvement in "I consider myself to be calm and emotionally stable" ($p < 0.001$). Furthermore, CTE course participation significantly increased subjects' self-efficacy for teamwork (B M=5.47, R M=5.58; $p < 0.028$). A significant pre–post difference was found for the questions "I always work with other team members" and "I contribute to the determination of team goals" ($P < 0.001$). The CIE programme model had the most pronounced effect on leadership (B M=4.36, R M=4.001). 4.36, R M=4.99; $p < 0.001$). Eight of the 10 questions were significantly different ($p < 0.05$), especially the 7 questions related to being in charge, influencing others, persuading peers, being a good leader, accepting criticism, providing solutions, and providing empirical support ($p < 0.001$). An important point in team relationships is how to communicate effectively, care for team members, coordinate team relationships, unite team centripetal force, and maximise team effectiveness in conflict situations [48]. Through pre- and postcomparisons, we found that all the respondents were significantly better able to adopt appropriate strategies to resolve conflicts or disagreements between team members (B M=5.01, R M=5.19; $p < 0.001$). The CTE programme had a positive impact on medical students' conflict management, demonstrating excellent assertiveness in the 3 dimensions of considering the interests of other team members, adapting to the environment, and providing solutions ($p < 0.001$). The results of the four subdimensions suggest that the CIE curriculum model is an effective way to improve medical students' teamwork skills.

Award-winning students in the CIE program model have better teamwork skills than nonaward-winning students do

Based on the positive effect of sports competition on teamwork, it was further verified whether it is also an important variable affecting team performance. The study compared the posttest data of award-winning and nonaward-winning students to verify whether improved teamwork skills have a positive effect on team performance. There was no difference between the winning and nonwinning students in terms of personal characteristics

(N M=4.21, W M=4.48; $p = 0.186$). However, there was a significant change in the response to the question "I consider myself to be disorganised and careless", which can be interpreted as more disciplined members of the winning team. In the teamwork dimension, the winning students were more aware of teamwork than the nonwinning students (N M=5.43, W M=5.66; $p < 0.001$). The effect of competition on student leadership was equally significant (N M=4.53, W M=4.99; $p = 0.024$). In the conflict management dimension, award-winning students had better conflict management skills than the nonaward-winning students (N M=4.98, W M=5.25; $p < 0.037$). The CIE programme has a positive impact on conflict management among medical students, with high-achieving students being more receptive to others who present different perspectives ($P < 0.050$).

Discussion

There is no doubt that teamwork is crucial in all aspects of our lives (e.g., hospitals, sports teams, crew members, businesses, and even families). Psychological science has explored this topic extensively, proposing numerous team theories and developing a rich body of knowledge. Some researchers have argued that to ensure that effective team functioning is improved and sustained, organisations must implement team development interventions and assess the associated outcomes through robust diagnostic measures [49]. The present study adopted a curriculum-based experimental intervention to validate two research hypotheses, demonstrating that the CIE curriculum model was effective at improving medical students' teamwork skills and revealed that sports can improve students' teamwork skills and that teamwork skills are positively correlated with team performance.

The benefits of the CIE programme model over the traditional physical education programme are as follows: 1. This approach improves the learning ability of students and the teaching quality of teachers. Compared with traditional physical education courses, team-centred courses can greatly promote students' role identity, interpersonal communication, solidarity and team adaptation [50]. In cheerleading competitions, individual performance is related to the interests of the team, more judges are involved in the evaluation, more spectators watch the competitions, and students and teachers are motivated by the rules of the competitions as well as by public opinion. 2 The purpose of IPE should be achieved without increasing students' academic burden. Compared with a separate teamwork course, embedding teamwork competency development based on existing compulsory courses can reduce students' academic pressure. This curriculum model is similar to the physical education teaching models developed in the United States, New Zealand and

Australia [51]. There are similarities, but it was created based on the Chinese Ministry of Education's Physical Education Curriculum Reform and is an exploration of a physical education curriculum teaching model with Chinese characteristics, which goes beyond the traditional curriculum model and focuses on physical fitness. The CIE curriculum model aims to provide a new approach to interprofessional teamwork in medicine by developing students' teamwork competencies through skills, rules, communication, interactive learning, and affective acquisition.

Interpersonal characteristics

The interpersonal domain is a component of an individual's knowledge, skills, and ability to work effectively in a team and involves collaboration, communication, and conflict resolution skills [52]. Previous research has demonstrated the relationship between interpersonal traits and teamwork contributions [53], with the personality traits of extroversion, responsibility, and agreeableness beneficial to teamwork and collaborative task performance [54]. Extraversion is a predictor of positive interpersonal interactions, and extroverted individuals are suited to work situations that require interpersonal interactions [55], which may be due to their good interpersonal skills [56]. Responsibility is a predictor of job performance in teamwork and is positively related to collaborative task performance, with dedicated members committing to the team task. Desirability is closely related to teamwork, especially in situations involving interpersonal conflict [57].

Interpersonal relationships are personal traits that are the focus of medical education and emphasise working with team members to promote smooth working relationships and influence group or team performance [58]. Research on teamwork in medicine focuses more on interpersonal behaviours. In our study, the CIE program model improved the interpersonal skills of medical students, which may have benefited from students becoming more reliable and self-disciplined ($P=0.012$), being willing to try new things ($P=0.029$), and being emotionally calm and stable ($P<0.001$). It is well known that there is a 'shortboard effect' in team play, whereby improvements in teamwork are translated into improved interpersonal skills and that being responsible is the most suitable personality trait for teamwork [59, 60]. Research supports the idea that physical activity can develop personal social responsibility in adolescents [61], a view that was also validated in our experiment. According to the common view, studies advocate the integration of responsibility modelling into club curricula to develop adolescents' sense of responsibility [62]. However, there is a distinct lack of academic evidence of students' willingness to try

new things and whether emotional stability is related to teamwork skills. Specifically, in the clinical setting, caring for and treating patients as a team based on shared goals, tasks, and competencies is a core clinical task that is similar to the shared team goals of sports. Routine clinical meetings, room visits, referrals, and discussions involving patient clinical information and treatment strategies may involve specific knowledge, skills, and experience from different professions, and interactions between healthcare professionals and between doctors and patients require students to have the ability to establish and maintain effective relationships. Although the CIE curriculum model does not demonstrate that individual characteristics are correlated with team performance, research confirms that high-achieving teams are more organisationally disciplined; this is because a sports team can be seen as an organisation where member discipline has a significant impact on team performance [63], ensuring team productivity and efficiency, which facilitates the achievement and completion of organisational goals [64]. This approach is similar to the clinical service standards and guidelines that clinical teams must follow to ensure patient safety, improve service quality, and reduce medical errors.

Teamwork

The education of healthcare professionals has been emphasised in academic research as IPE, as has lifelong education and training. Among professional organisations, four basic principles have been proposed for IPE: values and ethics, roles and responsibilities, interprofessional communication, and teamwork and team-based care. The ability of medical graduates to collaborate with others is considered essential for meeting the healthcare needs of patients and promoting the health of the population. This ability has translated into increased clinical efficiency, reduced clinical error rates, and savings in healthcare expenditures. However, achieving the vision of "interprofessional communication and teamwork and team-based care" requires effective educational reform programmes and curricular practices. It is difficult to imagine that this competency can be achieved using words, so the concept of 'virtual interprofessional education (VIPE)' has been proposed as a possible solution to collaboration silos [65]. Teamwork is always practical and requires physical sensibility to gain embodied experience, empowering students with the skills and attitudes that strengthen their long-term personality traits [66]. Therefore, curriculum teaching for medical students must reflect these values and identity evolution.

Because physical education is mandatory for students in some countries and has gained political recognition in the form of legislation in China creates [67] a unique

opportunity for IPE for medical students to enhance their "interprofessional communication and teamwork and team-based care". Teamwork is regarded as an important principle of sports participation and an effective way to develop teamwork among students. An excessive academic load and more years of education have become major causes of stress, depression and dropout among medical students [68]. Therefore, embedding IPE for medical students into an existing curriculum is a higher-performing strategy than VIPE, which adds to medical students' coursework load.

Leadership

Leadership is acquired [69]. Good leadership is based on trust and empowerment and enables each member to contribute his or her knowledge, skills, and suggestions and to be recognised for doing so. Effective leadership in healthcare settings enables high-quality patient care and improves patient health. Leadership skills training needs to be integrated into IPE programmes for medical students and vertically throughout the careers of health professionals [70]. Future clinical leaders should include both team players and team leaders, facilitating a high-quality care environment that is positively correlated with patient outcomes [71]. The support and development of leadership in IPE for health profession students has been emphasised; however, the focus has been on how to achieve this educational goal [72].

The fact that most physical education classes are structured and organised highlights [73] the need to integrate leadership education into the medical student physical education curriculum appropriately. Compared with traditional teaching models, the CIE curriculum model provides an opportunity to explore leadership development in medical student IPE. A team-focused curriculum provides opportunities for students to express themselves freely, facilitates communication among members, achieves trust and rapport in exchanges, and creates the conditions for the emergence of opinion leaders. The team leader in the CIE curriculum model may have the role of opinion leader, but the members have the same opportunity to express their individual opinions under common goals. Thus, the curriculum model that creates teamwork scenarios provides an environment for self-governance and collaborative governance [74], replacing teacher leadership to some extent and fostering student leadership in terms of hierarchical governance. Moreover, the role of the leader plays an important role in moderating the differences in the opinions of the members, which requires the teacher to allow and support the members to work independently, despite their potential opportunities to influence others [75]. There is no doubt that the CIE programme model creates conditions for

teams to work independently, while at the same time creating opportunities for students to exercise their leadership, coordinate the different opinions of their members, and manage them.

Conflict management

The clinical environment is diverse in terms of both healthcare and patients, involving the physician in charge, charge nurse, patient, family member, pharmacist, clinical dietician, nurse practitioner, laboratory, radiology, and ultrasound personnel during a shift. Each person will have a different perspective on patient care, and the diversity and individual differences that characterise patients and healthcare teams must be respected [76]. Successful care teams, therefore, must recognise and manage conflict and shape decisions in communication. Interprofessional conflict resolution is defined as follows: interprofessional teams respond to anticipated or occurring conflict situations with appropriate and skilled interventions in a timely manner by collaborating to create a range of solutions [77]. Learning objectives for IPE include managing conflicts between clients and healthcare professionals [3]. In the clinical setting, disagreements should not be interpreted as disrespect but rather as differences of opinion, and conflict resolution is a core competency of IPE [9]. Effective teamwork requires effective identification and resolution of conflict within and between teams; effective methods of dealing with interpersonal conflict; an open mind; respect for the diversity of knowledge of nursing services provided by different professionals; and recognition of the limitations of one's own knowledge, skills and abilities. There is a need for different professionals to cooperate and work together to supplement their knowledge and relevant resources to provide quality health and healthcare services to patients.

According to the CIE course model, team members work together to create a competition piece, but members have different understandings and standards of innovation. When disagreements arise, the team captain or team members are required to provide solutions, coordinate the different opinions among members, work together to find solutions to team problems, reach a consensus, and pursue the maximisation of team benefits. Given that sports were originally part of education, while guiding students to become a better version of themselves, disagreements are inevitable in team interactions. Compared with the traditional "teaching-learning" paradigm, the curriculum model of using competition as a common goal pays more attention to how to establish better interactions between members and how to perform good conflict management in IPE. In contrast, the course model of using competition as a common goal is more concerned with how to build better interactions

among members and how to manage conflict well in IPE than is the traditional "teaching–learning" paradigm.

Conclusion

Interprofessional teamwork has been established as an important means of improving population health outcomes in the 21st century, and strategies that foster the cultivation of students' teamwork skills in medical school curricula are needed to produce healthcare professionals with the ability to work together across professional boundaries to achieve the political goals of IPE. Sports have the inherent advantage of teamwork and can provide medical students with opportunities to promote interprofessional teamwork education. However, this requires a specific course design to obtain the desired results. This study proposes a CIE curriculum reform that provides a new way to promote interprofessional cooperation skills among medical students, which can be further extended to other physical education courses to maximise the benefits of enhancing students' cooperation skills. However, whether this value is universal or has a better curriculum design to obtain the maximum benefit remains to be further investigated.

Limitations of the study and future development

1. Only students who participated in the cheerleading programme were surveyed. It did not cover more physical education courses to verify whether it was applicable to all courses. 2. They failed to track whether there was a long-term effect on students' teamwork skills after receiving the intervention of this curriculum model and whether it translated into future professionalism. 3. The early motor experiences of the students involved in the experiment may have been a confounding factor in the study. 4. There is a gap between the experimental environment of the programme and the real clinical environment as well as differences in the interprofessional groups formed compared with the clinical teams. Therefore, we recommend adding a control group for future comparisons, expanding sports pilots, validating the effectiveness of the CIE curriculum model, and tracking the continuity of the effects.

Abbreviations

CIE	Competitions instead of exams
IPE	Interprofessional education
ICU	International cheer union
TCS	Teamwork competency scale
WHO	World health organization

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Zhiling Shen and Guochun Liu led the implementation of the study, wrote and edited the paper, Xinrong Zeng, Jianyu Li, Man Zhen, Jia Guo, Yaming Yang was involved in course-specific data management and Chunmei Cao provided guidance on the design of the study protocol.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Chongqing Medical and Pharmaceutical College (KYLSC20240321042). All methods were performed in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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