Physical activity implementation in the curricula of healthcare professions: a systematic review

Patel, R.[1], Brown, S.[1], Dinas, P.[2], Lahart, I.M.[1], and Metsios, G.S.[1,2]

Affiliations:

[1] University of Wolverhampton, Faculty of health, education, and wellbeing, Walsall Campus, Gorway Road, Walsall, WS1 3BD.

[2] Department of Nutrition and Dietetics, School of Physical Education, Sport Science and Dietetics, University of Thessaly, 42130 Trikala, Greece.

Corresponding author: Metsios, G.S. g.metsios@uth.gr

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Abstract

Aim: The aim of the current systematic review was to investigate the impact of PA teaching and learning approaches in healthcare professionals (HCPs) education on PA-related knowledge, confidence, and behaviour.

Design: Systematic review.

Data sources: Six databases (Cochrane Central Register of Controlled Trials, CINAHL, Embase, ERIC, Medline, and SPORTDiscus) were searched from inception to October 2022.

Eligibility criteria for selecting studies: Experimental studies investigating the effect of interventions that incorporate PA in to the undergraduate and postgraduate education, and continuous professional development of any HCP (medical doctors, nurses, physiotherapists, etc.) on PA-related outcomes including knowledge, perceptions, and confidence to prescribe PA.

Results: Of 1,542 records, a total of 32 studies comprising 3,256 participants fulfilled the eligibility criteria. Most studies included either medical students or doctors (n=12 and 8, respectively). The most frequently employed learning approach in eligible studies was training workshops (n=13), followed by experiential learning (n=4). Half of the studies included knowledge as an outcome (n=16) and 10 studies each included a measure of confidence and changes in behaviour/practice. Based on few RCTs (n=7), didactic input, training workshops, and flipped classroom approaches did not improve any measure of knowledge, confidence, or behaviour. However, two RCTs reported beneficial effects of experiential learning on confidence and perceived behavioural control albeit from within-group pre-post analyses. In non-randomised studies, training workshops and didactic input with and without simulated e-learning led to statistical improvements in knowledge, confidence, perceived competence, and attitudes.

Conclusion: We found support in the literature for using a blended approach to teaching and learning supported with experiential or simulated experiences to improve the knowledge, perceived competence, and confidence to prescribe PA. Future robust RCTs are needed to test the effectiveness of learning approaches to incorporating PA education in HCPs curricula.

Keywords: physical activity, healthcare professionals, education, learning and teaching approaches

INTRODUCTION

Physical inactivity is a risk factor for the development of non-communicable diseases (NCDs) [1], and is the fourth leading cause of premature mortality (7.2% of all early deaths) [2] on a global scale [3]. Furthermore, physical inactivity is responsible for 15.74 million disability-adjusted life years (DALYs) globally, which constitutes a significant burden on national health care systems [4]. Summing across five major NCDs (heart disease, stroke type 2 diabetes, and breast and colon cancer), the estimated the global health-care costs of physical inactivity was $53.8 billion in 2013 [5]. In the UK, physical inactivity is associated with one in six deaths, and is estimated to cost the UK £7.4 billion annually [6]. On the other hand, regular physical activity (PA) can both help prevent and treat symptoms of several NCDs, such as heart disease, stroke, diabetes, and breast and colon cancers, and improve mental health[7]. Despite the widely reported benefits of PA, only 66% of men and 58% of women meet the current PA recommendations [8]. According to the World Health Organization (WHO), those who are physically inactive have a 20% to 30% increased risk of all-cause mortality in comparison with those who participate in at least 30 minutes per day of moderate intensity PA [9].

To meet the WHO target for a 15% relative reduction in the global prevalence of physical inactivity in adults and in adolescents by 2030, there is a call to strengthen current workforce capabilities regarding promoting and prescribing PA. With a global shift in preventative medicine, it is increasingly important to ensure that the requisite knowledge, skills, and attitudes are embedded within healthcare curriculum. For instance, there is a reported lack of PA promotion in medical schools [10], with one study reporting that only 56% of medical schools in the UK teach the Chief Medical Officer's guidance for PA to future doctors [11]. This may also be the case for other healthcare professionals (HCPs).

Indeed, there is currently, no standardised approach to deliver PA promotion in the training of HCPs. Lectures on PA promotion along with independent learning activities and the use of self-directed educational tools may be effective in improving the exercise prescription skills of undergraduate medical students [8]. Previous research has also suggested that PA counselling skills could be improved by curricular features, such as personal PA behaviour, a strong conceptual base, practice experience, and integration of PA training into existing curriculum [12]. Studies on the key determinants of the effectiveness and long-term sustainability of PA interventions from the perspective of HCPs are required and highlights the need for a systematic assessment and synthesis of current research on this topic. Such a review can help identify gaps in the literature and give direction for future research.

Considering these objectives and the need to explicitly appraise and synthesize current evidence on the key determinants of effective PA promotion, a systematic review was deemed the most suitable approach for reviewing the literature. Therefore, the aim of the current systematic review is to investigate PA teaching and learning approaches in HCPs education and the impact it can have on their knowledge, confidence, and behaviour with regards to PA interventions in their practice. The systematic review was designed to take a whole educational system approach, including the upstream integration in undergraduate education as well as the downstream capability development with qualified healthcare practitioners.

METHODS

Search methods and eligibility criteria

We conducted a unregistered systematic review in line with the Centre for Reviews and Dissemination recommendations for undertaking systematic reviews [13] and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement [14]. Inclusion criteria were determined utilising the PICOS (Population, Interventions, Comparison, Outcomes, Study design) format (Table 1).

Table 1: Inclusion criteria.

Population	Any HCPs (medical doctors, nurses, physiotherapists, etc.), universities or educational institutions
Intervention	Education intervention: • Any intervention that incorporates PA education into existing/new curricula in HCPs education, • Any educational mode of delivery (e.g., online, taught, group or individual), • Interventions published in English, • Undergraduate, postgraduate, and continuous professional development.
Comparison	A control group that did not follow the PA educational intervention or a group that followed a similar intervention, which however, did not include PA education. Single arm design studies that include as control values the baseline values
Outcomes	Potential outcomes would include: • Curriculum change: any new additions would be reflected in the new curriculum of HCPs • Knowledge • Perceptions • Confidence (ability of prescribing PA)
Study design	A *priori* will be given to randomized controlled trials, but controlled trials, quasi-randomized controlled trials and pre-post longitudinal studies will also be considered for inclusion in this systematic review

Key: HCPs: Healthcare professionals; PA: Physical activity

The systematic review was limited to the publications written in the English language. We excluded studies based solely on PA interventions without an educational component. Interventions that combined PA with other health behaviours (e.g., healthy eating) were also excluded if outcomes were not available for PA knowledge, behaviour, and confidence.

PICOS inclusion informed the selected search terms. Searches were performed by a specialist librarian of the following databases: Cochrane Central Register of Controlled Trials (Issue 9 of 12, September 2020), CINAHL (1982-present), Embase (1974-2020), ERIC (1966-2020), Medline (1946-2020) and SPORTDiscus. Examples of search terms (abstract, keyword's, MeSH term, subject heading, title) were 'students', 'education', 'curriculum', 'exercise', 'physical activity', 'professional', 'medical' 'nursing' or 'allied health', 'lifestyle', 'systematic review' and 'randomised controlled trial'. Reference lists of included articles returned from the database search were scanned for relevant publications. No time limit was specified, original search was completed in 2020 and an updated search was conducted in Oct 2022. The search algorithm can be found in Appendix 1.

Study collection and data extraction

All records generated by the searches were imported onto Rayyan [15] and duplicate records were removed. Two reviewers (RP and IML) independently screened the titles and abstracts from the literature search according to the eligibility criteria (Table 1). Full texts of articles which were consistent with study eligibility, were obtained and assessed independently by three reviewers (RP, IML and SB). Full-text articles that met the eligibility criteria were included in the review. Disagreement on selection of articles was solved by discussion until consensus was reached, another author (GM) was available to arbitrate if needed. Reasons for exclusion of non-eligibility studies were recorded, see Appendix 2.

After full-text screening, RP and SB extracted data using the 2016 Guideline for Reporting Evidence-based practice Educational interventions and Teaching (GREET) [16]. The GREET checklist includes items recommended for reporting educational interventions for facilitating foundation knowledge and skills in evidence-based practice. Specifically, questions are asked to address the why, what, who, how, where and the how well of the educational intervention. For each eligible study, information on the characteristics of studies, study population, PA educational intervention and outcomes were extracted. Characteristics of studies included study design, country of origin and year of publication. Characteristics of study population included sample size, pre-registration/post-registration, and professional background. Characteristics of PA intervention included content, mode of delivery and duration. Data was also extracted on outcomes assessed, statistical analysis and effect of intervention on outcomes. The data extracted from the eligible studies are in line with the PRISMA guidelines, summarised in the characteristics of eligible studies Table 2.

Risk of bias assessment

The purpose of the risk of bias assessment was to assess the methodological quality of the eligible studies and to determine the extent to which they have addressed the possibility of bias in its design, conduct and analysis. Two authors (SB and RP) independently assessed risk of bias using Joanna Briggs Institute critical appraisal tools [17]. Any disagreements were resolved through discussion, with a third reviewer (IML) acting as an arbitrator when necessary.

Data Synthesis

Meta-analysis was not possible due to the variation in quantitative study designs and the widely varying methods of measurement and analysis employed by the analytical studies, and/or insufficient data reported. Consequently, a narrative synthesis was undertaken because it can be used in systematic reviews focusing on a range of questions, not only those relating to the effectiveness of a particular intervention [18]. To assess the overall effectiveness of the reviewed educational interventions, we first evaluated each study's design and then we assessed the strength of evidence of measured outcomes: knowledge, perceptions, confidence, attitudes, beliefs, and changes in behaviour/practice (where available).

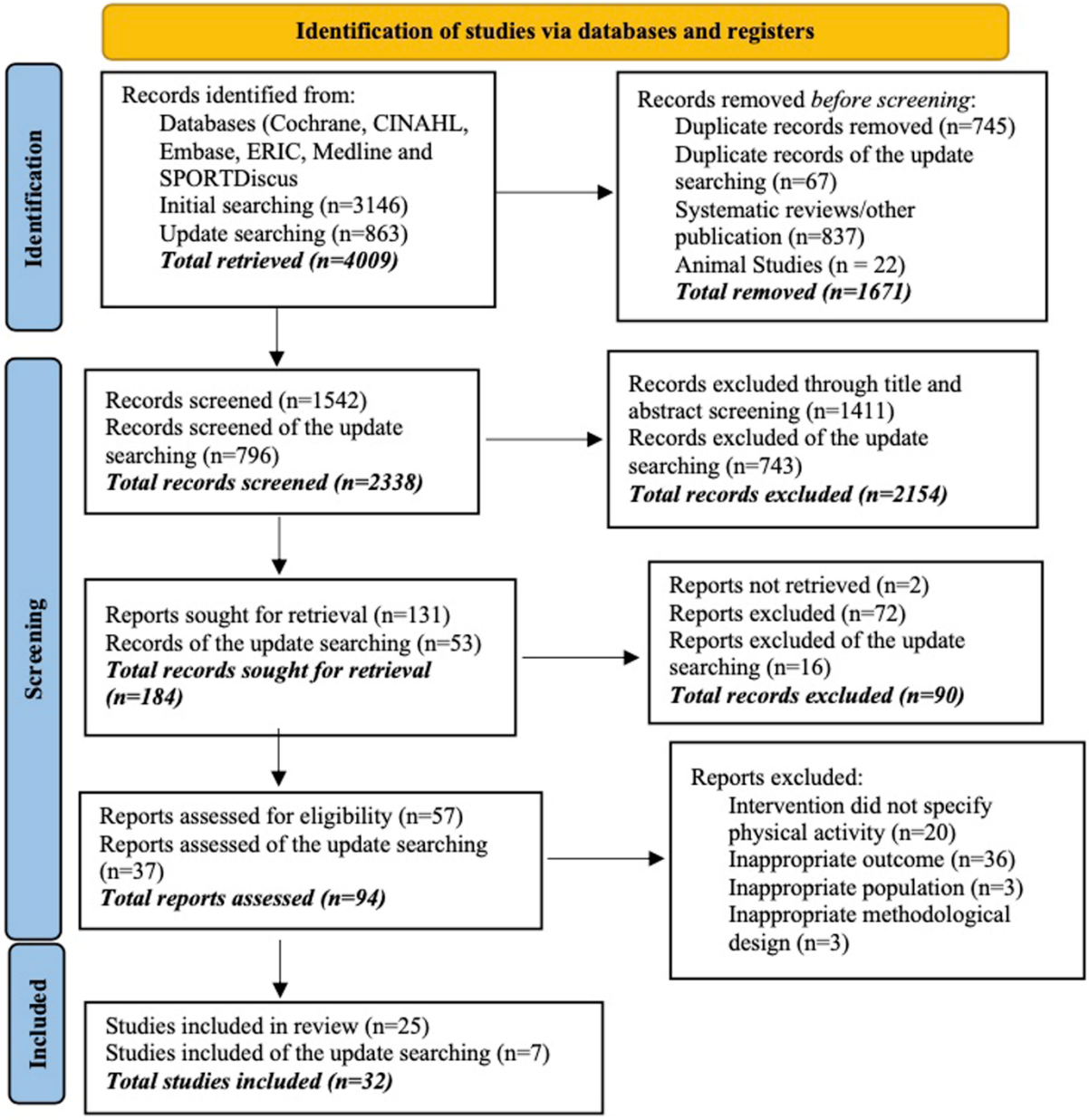
RESULTS

Search outcome

In total 1,542 articles were identified and screened. Following title and abstract screening, 1,411 articles were excluded. After full-text screening of 57 articles, 25 studies were included in the systematic review. An updated search was undertaken in Oct 2022, a total of 863 articles were retrieved across various databases; 67 duplicates were removed, 796 were abstract screened, 743 were excluded which left 53 articles for full-text screening. Of the 53, seven

additional articles were eligible for inclusion. Therefore, the total eligible number of studies was 32. The screening process and reasons for exclusion of full text articles are shown in Figure 1 using the PRISMA 2020 flow diagram for new systematic reviews. Reference to excluded studies and reasons can be found in Appendix 2.

Figure 1. PRISMA 2020 flow diagram



Characteristics of eligible studies

The characteristics of the included studies are reported in Table 2. The eligible studies included the following populations: medical students (n=12), medical doctors (n=8), pharmacy students (n=2), physiotherapy students (n=1), physician assistant students (n=1), nursing students (n=1), nurses (n=1), and a mixed cohort (n=6). The sample size by profession included, medical students (n=1801), medical doctors (n=452), pharmacy students (n=160), physiotherapy students (n=32), PA students (n=40), nursing students (n=50), nurses (n=117), and mixed cohorts (n=717).

Of the included studies, 11 were held in the United States of America (USA), six in Australia four in the UK and Canada, two in Ireland and one study in each of the following countries: Brazil, Mexico, Israel, India and Spain. All studies were published in a range of academic journals between 1999-2022. Seven of the studies had a randomised controlled trial (RCT) design, eight were non-randomised controlled trials, and 17 were single group pre-post-test designs. All trials included a single publication except for Jadczak et al. 2018 [19] which included two publications. Total size of sample was 3,256 participants, pre- and post-registration learners accounted for 2370 and 844, respectively.

Table 2. Characteristics of eligible studies (n=32)

Study; country	Sample	PA Education Intervention and Control	Outcome (measurement)	Results
Randomised controlled/comparative trials, n=7				
Benjamin et al. 2007; USA	50 Childcare Health Consultants (CCHC)	**Education Intervention:** A. 3-h Nutrition and PA for childhood overweight in-person training (n=16) B. Nutrition and PA for childhood overweight web-based training over a 3-week period (n=17) **Control:** No intervention (n=17)	Self-developed 28 multiple choice knowledge test.	Web-based CCHC performed similarly to in-person trained CHCC ($p<0.0001$). Both training groups improved statistically vs. controls ($p<0.0001$)
Cooke et al. 2015; UK	136 Medical students	**Education Intervention:** Health promotion seminar (unknown duration) to discuss and demonstrate methods of influencing patients with regards to smoking, alcohol, diet, and PA. Ongoing review of step count data and individual goal setting for step counts for the week ahead (n=70) **Control:** As above but without a review of step count data (n=66)	Intentions to promote physical activity (questionnaire based on the TPB)	There were statistically significant increases in the intervention and control group in relation to perceived behavioural control ($p<0.001$ and $p=0.004$ respectively)
Maloney et al. 2011; Australia	92 Pharmacy students	**Education Intervention**: A. In-person, 1-d, 7-h seminar (n=49) B. Web-based delivery, 7-h over a 4-week period (n=43) Content for both groups included: physiological principles, exercise selection and delivery, adherence, and behaviour change in relation to falls prevention.	Kirkpatrick's Level 2 Knowledge Outcome - 1-h knowledge test. Kirkpatrick's Level 3 Change in Practice Outcome - Self-reported change in practice survey	There was no statistical difference in the knowledge and change in practice results between both groups ($p=0.61$) and ($p=0.89$) respectively.

Marques-Sule et al. 2022; Spain	32 Physiotherapy students	**Education Intervention**: Service learning with real patients, bibliographic search, face to face session with the patients, identifying patient's needs, monitoring sessions with the patient **Control:** traditional intervention without real patients	10-item MCQ PA knowledge acquisition test	Students' PA knowledge statistically improved after the education intervention ($p<0.001$) vs. the control group ($p=0.49$).
Ockene et al. 2021; USA	904 Medical students	**Education Intervention**: 4-h self-paced web course (5As), role play exercise, web-patient encounter with feedback, enhanced clerkship **Control:** Delivery of existing curriculum	- 15-item behaviour checklist during an observed structured clinical examination (OSCE) - 16-item questionnaire self-reported perceived skill for each of the 5A items	There were no statistically significant differences ($p=0.25$) in the perceived skill and OSCE items performed ($p=0.16$) between the intervention and control group
Tiedemann et al. 2021; Australia	175 health care professionals (HCP)	**Education Intervention**: 1-day face to face workshop; falls epidemiology, risk factors, evidence-based interventions, and practical demonstrations **Control:** Usual practice and received intervention at 3-month follow-up.	Self-report questionnaire: knowledge, confidence levels and change in exercise prescription behaviour	HCP's confidence and exercise prescription behaviour statistically improved after the course ($p<0.001$) vs. the control group (p value not reported).
Shields et al. 2011; Australia	20 Physiotherapy students	**Education Intervention:** 2-h training on programme content and progression, motivational and teaching strategies, and use of the gym equipment prior to 10-week, twice a week progressive resistance training programme at a local community gym. Each student	Attitudes of the students towards the barriers to exercise for adolescents with Down syndrome (18-item Exercise Barriers Scale for carers and support people)	There were statistically significant differences ($p=0.05$) in the attitudes between the intervention and control groups on 9 of the 18 items.

		completed an exercise logbook for themselves and the adolescent with Down syndrome to document the details of each exercise (n=10) **Control:** no intervention (n=10)		
Non-randomised controlled or comparative trials, n=8				
Conroy et al. 2004; USA	137 Medical students	**Education Intervention:** 14-week preventative medicine and nutrition course; 1-week on exercise, no specific detail on content (n=110) **Control:** No intervention (n=30)	Self-developed 43-item survey measuring confidence in ability to assess and help address patients' health behaviour	Students' confidence in their ability to assess and counsel about diet and exercise statistically improved after the course ($p<0.001$) vs. the control group (p value not reported).
Eckstrom et al. 1999; USA	48 Medical doctors	**Education Intervention:** 2 x 2-h workshops: stages of change behavioural model, PA counselling, practical considerations, reflection, and solutions (n=21) **Control:** No intervention (n=27)	Self-developed 7-item survey measuring PA self-efficacy and behaviour	There was no statistical improvement in the intervention group vs. controls ($p>0.0001$).
Flood et al. 2022; Canada	30 Medical doctors	**Education Intervention:** 2 x 90-min workshops covering motivational interviewing (MI), evidence base behind PA, exercise vital sign and exercise prescription **Control:** MI workshop with minimal PA related information	Questionnaire regarding social cognitions (based on TPB) and barriers related to PA	There was no statistical improvement in the intervention group vs. controls ($p>0.0001$).
Jadczak, Tam, and Visvanathan 2018; Australia	161 Medical students	**Education Intervention:** 4.5-week geriatric medicine course and intervention. Intervention: 1.5-h PA module comprising 60 mins exercise tutorial (assessment of PA levels, risk assessment, how to customise advice, prescribe PA, and refer to an exercise programme) and	Exercise and Physical Activity Competence Questionnaire	There was a statistical improvement in the students' perceived competence in six out of ten skills ($p>0.05$) and perceived competence ($p<0.0001$) vs. the control group

		30-min counselling session with older adults (n=80) **Control:** 4.5-week geriatric medicine course (n=81)		
Kotecki and Clayton. 2003; USA	68 Pharmacy students	**Education Intervention**: 7x 1-h lectures; nutrition/PA guidelines and behaviour change techniques. Followed by 3x 2-h laboratory based experiential learning opportunities (simulated 1:1 mock patient consultations) **Control Group:** Practising Pharmacists (n=522)	14-item questionnaire of nutrition and PA beliefs	Pharmacy students reported statistical improvements ($p < 0.001$) in confidence at both the immediate post-test and delayed post-test compared with current practicing pharmacists
Malta et al. 2016; Brazil	43 Doctors and Nurses	**Education Intervention**: 16-h intervention over an 8-month period, comprising a 4-h introductory workshop and 3 additional workshops. Content: guidelines, behaviour change, MI, and barriers and facilitators (n=23) **Control Group:** no intervention (n=20)	Self-report 14-item questionnaire: 9 focussed on PA knowledge	There was a statistical difference in walking knowledge score in the intervention group vs. the control group ($p<0.0001$)
Pasarica and Kay. 2020; USA	27 Medical students	**Education Intervention**: A. Students were assigned by facilitators to either face-to-face or virtual attendance (n=27) B. Students had the option to attend, either face to face or virtually (n=31). Content: An asynchronous session online self-learning module (all) followed by a 2-h synchronous	Kirkpatrick's Level 2 - Survey of clinical confidence Kirkpatrick's Level 3 - Summative, observed structured clinical examination using a standardised patient	There was no statistical difference in the perceived clinical confidence ($p>0.01$) and clinical examination performance ($p=0.49$) between both groups.

		session using case-based collaborative learning		
Worobetz et al. 2022; Ireland	107 Medical students	**Education Intervention**: 8-week 'MEDWELL' programme, Weekly 2-h sessions, each involving a different type of PA (1-h). Course content (30-min);metabolic adaptation, dose response curve, practical applications, behaviour change wheel, nutrition, and exercise. **Control Group:** Mindfulness-Based Stress Reduction program, same length, and duration as above. Programme focussed on stress management, anxiety, mindfulness techniques and personal reflection	Patient-centred Assessment and Counselling for Exercise (PACE+) Self-reported confidence in prescribing exercise	There was a statistical difference in confidence to prescribe exercise in the intervention group ($p<0.0001$) vs. the control group ($p=1.000$))
Single-group pre-post-test design, n=17				
Bass iii et al. 2004; USA	115 Medical students	**Education Intervention:** 2-h didactic lecture followed by standardised patient experiences in physical activity and nutritional counselling. Background material distributed prior on behaviour change. Counselling interview template provided	Self-developed 13-item knowledge questionnaire	There was a statistical improvement in knowledge and perceived self-efficacy for exercise prescription following the intervention ($p<0.001$)
Fowles et al. 2018; Canada	46 Medical Doctors	**Education Intervention:** 6-h accredited Exercise is medicine Canada workshop: PA benefits, exercise vital signs, PA counselling, MI, and aerobic/resistance exercise	Self-reflection questionnaire; practice history, confidence, barriers, and resources.	There was a statistical improvement in confidence to counsel patients in PA following the intervention ($p<0.001$). At follow up participants reported PA prescription barriers as less impactful ($p<0.05$)

Freene et al. 2022; Australia	13 health disciplines (n=267)	**Education Intervention:** Flexible implementation of Movement for Movement resources with the support of a PA champion	Self-report questionnaire of PA promotion preparedness and PA knowledge	There was no statistical difference in PA promotion preparedness and knowledge ($p>0.01$)
Galaviz et al. 2017; Mexico	186 Medical Doctors	**Education Intervention:** 3-h training based on TPB, three learning modules: international PA guidelines, FITT principle, 5 A's model	Self-reported PA counselling practices using four items from the National Family Physician Work-force Survey of Canada - Adapted TPB questionnaire	Statistical improvements in attitudes ($p< .05$), normative beliefs ($p< .05$), perceptions of control ($p< .05$), and intentions ($p<.05$) toward PA counselling after the training were observed
Hasson et al. 2018; Israel	117 Public Health Nurses	**Education Intervention:** 35-h, 5 days over 3 months. Motivational behavioural change, nutrition, physical activity, and stress resiliency. Pedometer use	Self-report questionnaire of knowledge, attitude, and behavioural questions pertaining to nutrition and physical activity	Participant knowledge remained relatively constant, while significant positive changes in attitudes and behaviours were observed when compared to baseline data
Jadczak et al. 2017; Australia	81 Medical students	**Education Intervention:** 4.5-week geriatric medicine course. No specific tutorials focused on exercise prescription. Included compulsory visit to a community-based exercise class where students interview older people about their participation in exercise	Modified Exercise and Physical Activity Competence Questionnaire	Statistical improvements in students' perceptions of the importance of designing an exercise prescription ($P=0.038$), determining the training heart rate ($P=0.021$), determining the body mass index ($P>0.001$), referring an older person to an exercise program ($P>0.001$), and identifying age-related limitations ($P=0.029$) improved significantly after the course. Students' self-

				perceived competence in exercise counselling improved significantly across all items (P>0.001)
Jones, Wylie, and Brooks. 2013; United Kingdom	121 Medical students	**Education Intervention:** 4-h exercise medicine lectures; the benefits of PA, physiological adaptations associated with regular exercise, doctor's role in assessing and prescribing PA	6-item online questionnaire assessing beliefs regarding the importance of PA in disease prevention and management, and confidence in advising patients on PA recommendations	Statistical improvements in students' beliefs regarding the importance of PA in managing disease and their confidence in PA promotion after the teaching ($p<0.001$). More students were able to correctly identify the Chief Medical Officer recommended adult PA guidelines ($p<0.05$)
Keyes and Gardner. 2020; USA	40 Physician Assistant students	**Education Intervention**: 4 x 50-min taught modules: nutrition, PA, stress management and smoking cessation. Applied knowledge through prevention and lifestyle assessment write up with peers and mock patient	9-item survey assessing self-perceived knowledge of LM and self-perceived ability in competencies related to lifestyle medicine	Statistical improvements in self-perceived knowledge and competencies related to LM ($p < 0.001$)
Mattison and Nemec. 2014; USA	13 Medical students	**Education Intervention**: Elective course; twice weekly classes for 15-week, first class 2-h, subsequent classes 1-hr. Course content; stress, management, MI, 5K race, exercise and wellness, assessments, screenings, nutrition logs, SOAP notes, patient cases, motivational interviewing role play, group presentations, flipped classroom, health and wellness related mobile apps	8-item survey regarding knowledge of LM	The ability to recommend specific LM interventions ($p<0.05$) and the ability to create a care plan with LM as the primary intervention ($p<0.05$), did yield statistical improvements in the post survey

O'Brien and Fowles. 2017; Canada	164 Medical doctors and Allied Health Professionals (AHP)	**Education Intervention**: Exercise is medicine Canada initiative. 6-h interactive workshop, course content; PA benefits, exercise vital signs, PA counselling, MI and monitoring aerobic exercise capacity	Self-reflection questionnaire assessing PA counselling confidence	AHPs were statistically more confident to assess PA and appropriately refer ($p< 0.05$) compared with Medical Doctors.
Perrin et al. 2008; USA	Paediatricians n=67	**Education Intervention**: 1-h training session, course content; detect unhealthy weight trajectories, sensitive communication, provide counselling to improve diet and PA	Self-reflection questionnaire assessing perceived confidence of counselling behaviours	Statistical increase in the level of confidence to counsel about physical activity behaviours ($p<0.003$)
Pugh et al. 2020; UK	51 Medical students	**Education Intervention**: Students were emailed a self-directed exercise prescription booklet. Contains information on generic skills in exercise prescription such as physical activity history taking, behaviour change and condition-specific exercise advice.	17-item Exercise Prescription for Medical Students Questionnaire	Students' knowledge of PA guidelines and confidence to advise patients about PA statistically improved ($p<0.03$ and $p<0.01$, respectively)
Raj, Khan, and Nair. 2020; India	50 Nursing students	**Education Intervention:** Self-instructional module (duration unknown), course content; history of yoga, types of yoga, contraindications and misconceptions and benefits of yoga on physical and mental health	32-item questionnaire to assess student knowledge regarding the beneficial effects of yoga	There was no statistical difference between the pre- and post-test knowledge score ($p>0.05$)
Roberts, Tompkins, and Kennedy. 2021; USA	24 Primary care providers (medical doctors, nurse practitioners and physician assistants)	**Education Intervention:** 30-60-min workshop: discussion, exercise guidelines	12-item questionnaire; knowledge and confidence	Statistical increase in the frequency (<0.001) and level of confidence (<0.0001) to recommend strength training
Webb. 2017; UK	44 Nurses and Allied Health Professionals.	**Education Intervention:**	Survey on frequency of discussions on PA	Of those that responded: 19 maintained discussions at the

		1-h online training session, content included: lifestyle advice, behaviour change theory, PA, brief advice for cancer patients		highest level (76 to 100% of the time), 16 improved their discussions from baseline, six maintained discussions at a lower frequency, and three reported discussing physical activity less. There was a statistical increase in the frequency of discussion on PA ($p<0.01$)
Windt et al. 2015; Canada	25 Medical Doctors	**Education Intervention:** 3-h interactive workshop, content included: assessing PA levels, MI techniques, PA prescription, guidelines and using case studies.	30-item questionnaire; confidence and knowledge, PA prescription behaviours, perceived barriers to PA barriers and knowledge of PA guidelines	There was a statistical increase in self-reported knowledge ($p<0.01$) and confidence ($p<0.01$) 1 month after the intervention. Statistical increase in the proportion of PA referrals ($p<0.01$), statistical decrease in the perceived importance of tools as a barrier to PA prescription ($p<0.05$)
Worobetz et al. 2020; Ireland	69 Medical students	**Education Intervention:** 6-week 'MEDWELL' programme, Weekly 1-h sessions, each involving a different type of PA (45-min). Course content; prescribing PA for chronic diseases, PA dose response, overcoming barriers, stages of change model, motivation, and behaviour change.	Questionnaire: perceived importance of PA for common chronic conditions	Perception of the importance of exercise as a treatment modality for common chronic conditions but these did not reach statistical significance

Key: PA = Physical Activity; MI = Motivational Interviewing; BC = Behaviour Change; CHC=Childcare Health Consultants; TPB=Theory of Planned Behaviour; FITT =Frequency, Intensity, Time, Type principle; 5 A's = Ask, Advise, Assess, Assist, Arrange; LM=Lifestyle Medicine; SOAP=Subjective, Objective, Assessment and Plan

Characteristics of learning approaches included in eligible studies

Duration of the PA education interventions varied and ranged from a two-hour lecture to a 16-hour intervention over an eight-month period. Overview of commonly used learning pedagogical approaches are presented in Table 3.

Table 3. Teaching and learning approaches implemented for PA education

Learning approach	Studies, n (%)	Activities
Didactic input	3 (9)	• Case studies • Pre-reading material • Lecture-based teaching
Training workshops	13 (41)	• Theory and practical content • Interactive teaching
Self-directed e-learning	3 (9)	• Interactive quizzes • Web-based discussions • Asynchronous self- learning module • Web course
Didactic with Simulation-based learning	3 (9)	• Simulated patients • Lab based simulation • Web patient encounter • Lifestyle assessment write up
Didactic with experiential learning	1 (0)	• Theory and practical content • Pedometer use
Experiential learning	4 (13)	• Clinical practice • Pedometer use • Physical activity engagement
Flipped classroom	3 (9)	• E-learning (asynchronous) • In-person activities
Other	1 (0)	• Flexible implementation of resources

Where a control group existed, no intervention, traditional intervention (i.e. delivery of existing curriculum), or usual practice were the most common types. In most cases they were from the same population as the study sample except for Kotecki and Calyton (2003) [20], who compared pharmacy students with practising pharmacists.

The eligible studies used a variety of outcome measures. The most reported educational outcomes were knowledge (n=16), perceptions (n=3), confidence (n=10), attitudes (n=3), beliefs (n=1), and changes in behaviour/practice (n=10). Most of the outcome measures were self-developed, some were based on theoretical models such as Theory of Planned behaviour, and the only validated measure used was Kirkpatrick's model of training evaluation. Two of

the studies used structured clinical examination using a standardised patient to assess changes in practice [21,22].

Risk of bias assessment outcomes

Reporting of the studies was generally good with all studies clearly stating their research aims and appropriately describing methodology. Recruitment and data collection were described by all studies, convenience sampling was the most used sampling technique, and 11 studies adequately described loss to follow up.

None of the studies described a relationship between the participants and the researchers, making it impossible to establish what relationship, if any, existed. Eight of the studies lacked detail on who delivered the educational intervention making it difficult to establish if there may be a risk of bias introduced through professional association. Most of the outcome measures were self-developed and therefore, a key limitation of the studies, appropriate statistical tests were applied for all the studies.

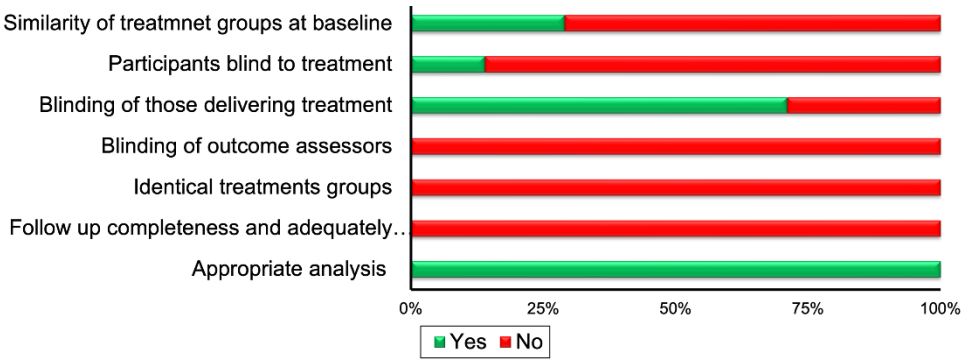
For most of the eligible studies, PA specific content was adequately described, and frequency and duration of sessions were often well described, what was less clear was the scheduling of sessions and time in between them.

For the seven eligible RCTs, only two [23,24] reported "true randomization", while only one [23] reported "concealment" of the allocation to groups. Two RCTs [21,25] reported no "similarity of treatment groups at baseline", while all RCTs reported: a) blinding of participants to the treatment assignment, b) blinding of those delivering the treatment assignment, and c) blinding of outcomes assessors to the treatment assignment. Also, all RCTs reported that treatment groups treated identically other than the intervention of interest and that participants analysed in the groups to which they were randomized. Finally, three RCTs [23,26,27] reported complete follow-up or adequately described the differences between groups adequately, while the latter information was missing from the remaining four RCTs. The outcomes of the risk of bias assessment of the eligible RCTs can be found in Table 4, while a summary of them can be found in figure 2.

Table 4: Risk of bias assessment outcomes of randomised controlled trials

	Was true randomization used for assignment of participants to treatment groups?	Was allocation to treatment groups concealed?	Were treatment groups similar at the baseline?	Were participants blind to treatment assignment?	Were those delivering treatment blind to treatment assignment?	Were outcomes assessors blind to treatment assignment?	Were treatment groups treated identically other than the intervention of interest?	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and	Were participants analyzed in the groups to which they were randomized?
Benjamin et al (2007)	N	N	N	N	N	N	Y	N	Y
Cooke et al. (2015)	Y	Y	Y	N	N	N	Y	Y	Y
Maloney et al (2011)	N	N	N	N	N	N	Y	N	Y
Marques-Sule et al (2022)	N	N	Y	N	N	N	Y	N	Y
Ockene et al (2021)	N	N	Y	N	N	N	Y	Y	Y
Tiedmann et al (2021)	Y	N	Y	N	N	N	Y	N	Y
Sheilds et al (2010)	N	N	Y	N	N	N	Y	Y	Y

Figure 2: Summary of risk of bias assessment outcomes of randomized controlled trials



Only two [22,28] out of the 25 eligible quasi-experimental and single-arm design studies did not report the "cause" and the "effect" of interest in their research question. Six studies reported similar participant characteristics in comparison groups [29-34], one study [28] reported differences in participants across groups, and in three studies [22,35,36] this information was unclear. In the remaining 15 single group studies this risk of bias component was not applicable.

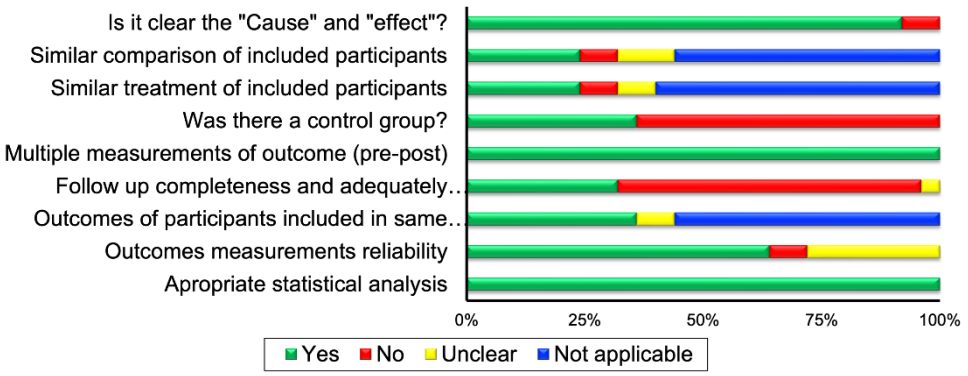
Six studies [22,29,32,34-36] reported that apart from the allocated intervention all participants received similar treatment, one study [28] reported differences in received , in two studies [30,31] this information was unclear, while in the remaining 16 this risk of bias component was not applicable.

Also, there was a control group in nine [20,28-31,33-36] out of the 25 studies, while all studies reported multiple measurements of outcome (pre-post). In follow up completeness and adequately description component, nine studies [20,22,29-32,34,37,38] reported yes, in one study [28] this information was unclear, while the remaining 10 studies reported no. Regarding the component of outcomes of participants to be included in same way, in two studies [31,35] this information was unclear, nine studies [20,22,28-30,32-34,36] reported yes, while in the remaining 14 studies this risk of bias component was not applicable. In the outcomes measurements reliability component, two studies [39,40] reported no, in seven studies [20,22,28-31,35] this information was unclear, while the remaining 16 studies reported yes. Finally, all studies reported appropriate statistical analysis. The outcomes of the risk of bias assessment of the e eligible quasi-experimental and single arm design can be found in Table 5, while a summary of them can be found in figure 3.

Table 5: Risk of bias assessment outcomes of quasi-experimental and single arm design studies

	Is it clear in the study what is the 'cause' and what is the 'effect'?	Were the participants included in any comparisons similar?	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Was there a control group?	Were there multiple measurements of the outcome both pre and post the intervention/exposure?	Was follow up complete and if Nt, were differences between groups in terms of their follow up adequately described and analyzed?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Was appropriate statistical analysis used?
Bass iii et al (2004)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Conroy (2004)	Y	unclear	Y	Y	Y	N	unclear	unclear	Y
Eckstrom et al (1999)	Y	Y	Y	Y	Y	Y	Y	unclear	Y
Flood et al. (2022)	Y	unclear	Y	Y	Y	N	Y	Y	Y
Fowles et al (2018)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Freene et al (2017)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Galvaziz et al (2017)	Y	Y	n/a	Y	Y	N	Y	Y	Y
Hasson et al (2018)	Y	n/a	n/a	N	Y	N	n/a	N	Y
Jadczak et al (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y
Jadczak, Tam and Visvanathan (2018)	Y	Y	unclear	Y	Y	Y	Y	unclear	Y
Jones, Wylie and Brooks (2013)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Key and Gardner (2020)	Y	n/a	n/a	N	Y	Y	n/a	Y	Y
Kotecki and Clayton (2003)	Y	N	N	Y	Y	Y	Y	unclear	Y
Malta et al (2016)	Y	Y	unclear	Y	Y	Y	unclear	unclear	Y
Mattison and Nemec (2014)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
O'Brien and Fowles (2017)	Y	Y	Y	N	Y	Y	Y	Y	Y
Pasarica and Kay (2020)	N	unclear	Y	N	Y	Y	Y	unclear	Y
Perrin et al (2008)	Y	n/a	n/a	N	Y	N	m/a	Y	Y
Pugh et al (2020)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Raj, Khan and Nair (2020)	Y	n/a	n/a	N	Y	N	n/a	N	Y
Roberts, Tompkims and Kennedy (2021)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Webb (2017)	Y	n/a	n/a	N	Y	Y	n/a	Y	Y
Windt et al (2015)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Worobetz et al (2020)	Y	n/a	n/a	N	Y	N	n/a	Y	Y
Worobetz et al (2022)	N	N	N	Y	Y	unclear	Y	unclear	Y

Figure 3: Summary of risk of bias assessment outcomes of quasi-experimental and single arm design studies



Data synthesis outcomes

Didactic input

Of the three studies [21,35,41] which reported a solely didactic approach to education delivery, two [35,41] reported statistical improvements in confidence and knowledge in students' ability to assess and counsel about PA as well as students' beliefs regarding the importance of PA in managing disease. Maloney et al 2011 [21], was the only RCT and reported no statistical difference in the knowledge and change in practice between the intervention and the control group.

Training workshops

Interactive training workshops were the most common method of educational delivery. Of the 13 eligible studies, four (of which one was a RCT and two were non-randomised control trials) did not reach statistically significant findings in relation to knowledge, behaviour, and perceptions. The remainder were single group pre-post-test design and statistical improvements in confidence, attitudes, beliefs, knowledge, and behaviour were observed.

Self-directed e-learning

Self -directed on-line learning was exclusively used in three of the studies, all of which were single group pre-post-test design [8,38,40]. Raj, Khan and Nair (2020) study [40] did not reach statistical significance in knowledge scores, Pugh et al (2020) did achieve statistical improvements in relation to students' knowledge and confidence and Webb et al. [38] revealed a statistical increase in the frequency of discussion on PA.

Didactic with Simulation-based learning

Didactic with simulation-based learning was used in three of the studies, of which two [20,30] were non-randomised control trials and the remaining study [42] was a single group pre-post-test design. Of the three studies, Jadczak, Tam and Visvanathan (2018) [30] reported a statistical improvement in perceived competence, Kotecki and Clayton (2003) [20] reported statistical improvements in confidence and Bass iii et al (2004) [42] noted a statistical improvement in knowledge and self-efficacy for exercise prescription.

Didactic with experiential learning

Experiential learning for Hasson et al (2018) [39] was in the form of pedometer use and whilst the intervention did not impact knowledge amongst public health nurses it did result in statistically significant positive changes in attitudes and behaviours when compared to baseline data.

Experiential learning

Of the four studies that included interventions comprising experiential learning, three were RCTs (Cooke; Marques-Sule; Shields 2010), and one was a single group pre-post-test design (Jadczak et al., 2017). Marques-Sule and colleagues (2022) found a statistical within-group improvement in Physiotherapists PA knowledge in the intervention group but no change in the control group, while Cooke et al. (2015) found improvements in UK medical students perceived behavioural control in both intervention and control groups. Another RCT found that contact with adolescents with Down syndrome during a physiotherapy clinical placement statistically improved students' attitudes towards exercise for people with Down syndrome [27]. In a single-group study, Jadczak, and colleagues (2017) observed that an intervention consisting of medical student-led interviews of older people participating in a community-based exercise class led to statistical improvements in students perceived competence in counselling older people about exercise.

Flipped classroom

Of the three eligible studies that used a flipped classroom approach, only Ockene et al (2021) [26] was a RCT, Pasarica and Kay (2020) [22] was a non-randomised control trial and Mattison and Nemec (2014) [43] was a single group pre-post-test design. In relation to perceived skill, Ockene et al.'s study revealed no statistical difference between the intervention and control group. Pasarica and Kay (2020) revealed no statistical difference in perceived confidence and Mattison and Nemec (2014) noted a statistically significant improvement in knowledge following the intervention.

Other

Freene et al. (2022) found that the use of PA champions to encourage access to a PA resource across 13 health disciplines in one Australian university, resulted in no statistical changes in PA promotion preparedness, PA knowledge, or the amount of PA content delivered, despite a statistical increase in the use of teaching resources.

DISCUSSION

This systematic review explored and synthesised physical activity teaching and learning approaches in HCPs education and the impact it can have on HCPs knowledge, confidence, and behaviour relating to PA counselling in their practice. This review has highlighted that no single educational approach used in isolation has been shown to provide effective and enduring changes among healthcare professionals. However, consistent positive outcomes were reported for education which is delivered in an interactive format (i.e., training workshops) using a mixed approach to delivery (e.g., classroom-based with simulation-based learning). These findings corroborate with the conclusions of other studies [12,44]. For example, Netherway, Smith, and Monforte [44] indicated that employing blended learning approaches was welcomed by medical students, indicated that employing blended learning approaches was welcomed by medical students, including peer mentoring activities. This was further reiterated by Dacey et al. [12] who concluded that positive outcomes were associated with programs that provide both didactic approaches and counselling practice experience.

Previous research [45] has suggested that conceptual frameworks that illuminate the complexity of behaviour change could increase the likelihood of improving PA counselling skills. Within the current review, theoretical frameworks used included Stages of Change behavioural model [29], Theory of Planned Behaviour [33], and Social Cognitive Theory [26]. In some studies behaviour change was included within the content but there was insufficient detail on underpinning theoretical frameworks. Ten studies included theoretical concepts based in behavioural science, concepts such as PA counselling, motivational interviewing, adherence [21,29,31,42,46] and the 5 'As' (Ask, Advise, Assess, Assist, and Arrange) [33,41] were commonly used. 15 of the studies included sufficient description of the educational content and eight of the studies detailed the pedagogical approach that would allow for replication.

Healthcare programmes should implement current educational theory/principles in order to maximise the development of professional expertise [47]. A limited number of studies (n=8) provided an underpinning educational theory for the teaching and learning strategy that was employed. Experiential learning featured in six [20,23,26,42,48] of the studies, and this took the form of an educational intervention (seminar or lectures) followed by use of a pedometer to review step count data [23] or a simulated patient experiences in physical activity counselling. Kotecki and Clayton [20] and Bass iii et al [42] both used simulated standardised patient opportunities (2 hours and 15 minutes respectively). Similarly, Marques-Sule et al. [48] implemented a service-learning programme for physiotherapy students with real patients (4h) with heart transplantation and acute coronary syndrome. Greater consideration needs to be given to evidence based pedagogical approaches that support learners to achieve a deeper level of learning.

Simulated and peer evaluation have both been reported as positive learning experiences for physiotherapy students [49]. Seven of the studies provided enhanced learning opportunities via experiential modes of learning. In Shields et al. study [50] physiotherapy students completed a 10 week twice weekly progressive resistance training programme with an adolescent living with Down's Syndrome. Participants in Cooke et al. [23] and Pasarica and Kay [22] studies used a pedometer and participants were required to set step count goals. Jadczak, Tam and Visvanathan [30] followed a 1.5-hour PA module with a 30-minute counselling session with an older adult. Similarly, Keyes and Gardner [37] and Kotecki and Clayton [20] also provided a simulated 1:1 mock patient consultation. These additional learning opportunities provide students with opportunities to safely apply their learning within a simulated environment. The potential benefit from using these learning approaches is that self-reflection and feedback can be used to improve performance and better prepare the learner for practice.

There is a call for embedding sports and exercise medicine into the medical curriculum [51]. In 11 of the 32 studies, PA education was taught alongside other lifestyle interventions mainly nutrition [25,35,42,52] or in combination with multiple lifestyle factors such as smoking, alcohol, and stress management [23,37]. Whereas 21 studies were exclusively related to PA educational interventions within specific modules. PA and behaviour change span patient pathways and clinical specialities, and therefore there is a call for PA to be integrated or spiralled throughout the curriculum.

Recommendations/Implications for practice and research

Although various e-learning approaches were used in the appraised studies, such as online self-learning modules, interactive exercises, and web-based discussion forums, they could have been developed further to include virtual consultations. The interventions that did compare in-

person versus web-based approaches produced similar outcomes, suggesting that from a time and cost efficiency perspective, e-learning approaches may form e a growing evidence base.

Instructors involved in the delivery of the educational interventions included research study teams, strength and conditioning specialist, medical doctors, academics, pharmacist, exercise physiologists and nurses, calling for a multi-disciplinary team approach to teaching and learning.

Strengths and Limitation

The current systematic review sheds light on the teaching and learning approaches used in delivering PA education for health care professionals. Whilst this review has captured teaching and learning approaches for pre- and post-registration provision across all health care professions, this review does have several limitations. First, this review built exclusively on published studies, whereas unpublished studies, grey literature and non-peer-reviewed literature were excluded. Although including unpublished, grey, and non-peer-reviewed literature has potential benefits in terms of comprehensiveness, it can introduce greater bias in the results of the systematic review. Unpublished studies are usually of lower methodological quality than published studies. The educational intervention studies within this review generally have design limitations which limit the ability to support replication and draw any firm conclusions.

Given the heterogeneity and reliance on self-developed, self-report survey measures, caution must be applied to the validity of the reported outcomes due to the risk of response bias[53]. Most of the studies lacked an adequate sample size, and, in many cases, there was a high loss to follow up which will result in selection bias representing a threat to the internal validity of the studies. Similar design limitations have been reported elsewhere [12].

CONCLUSION

To develop the next generation of health care professionals to deliver effective PA intervention, the literature advocates for a blended approach to teaching and learning supported with experiential/simulated experiences. Although the available evidence had limitations, there was some evidence to support simulation-based learning as it encourages learners to participate in real world problem solving while reflecting on their learning experiences. Interventions that combined theoretical concepts with practical application in an active learning environment also tended to result in more favourable outcomes.

Recommendations based on this review include the development of blended learning approaches that integrate the cognitive and behavioural domains of clinical competence. Where experiential learning does exist, to apply it through the framework of simulation-based learning pedagogy to support consolidation and transferability of learning. There was a paucity of evidence from RCTs to support each learning approaches, but for some of the approaches there was no available RCTs (e.g., self-directed e-learning and didactic with simulation-based or experiential learning). Development of a validated outcome measures would considerably enhance the methodological validity and credibility of research findings. Finally, there is a need for longitudinal studies in this area that would better represent the longer-term impact of PA education intervention. This review highlights the need for more robust research in this area to fully realise the impact that PA education intervention for HCPs can have on the health and quality of life of the populations they serve.

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Appendix 1 Review search algorithm include all of them this is Medline

1	exp Students, Health Occupations/
2	exp Education, Professional/
3	((medical or nursing or allied health or ahp? or pharmac* or dentist? or dental or physiotherap* or therapy or therapist*) adj2 (education or school?)).ti,ab,kw.
4	((medical or physician or nurs* or allied health or ahp? or health* or pharmac* or dental or physiotherap* or therap*) adj2 student?).ti,ab,kw.
5	1 or 2 or 3 or 4
6	Curriculum/
7	(teach* or curricul* or elective? or module? or rotation? or lecture? or lesson? or tutorial? or workshop? or class* or course? or training or mentor* or coach*).ti,ab,kw.
8	6 or 7
9	Exercise/ or Life Style/
10	(physical activity or PA or exercise or lifestyle or life style).ti.
11	((physical activity or pa or exercise or lifestyle or life style) adj5 (advice or counsel* or coach* or prescri* or promot* or educat*)).ti,ab,kw.
12	9 or 10 or 11
13	5 and 8 and 12
14	limit 13 to ("systematic review" or "reviews (maximizes specificity)")
15	randomized controlled trial.pt.
16	controlled clinical trial.pt.
17	randomized.ab.
18	placebo.ab.
19	drug therapy.fs.
20	randomly.ab.
21	trial.ab.
22	groups.ab.
23	prospective studies/ or controlled before-after studies/ or interrupted time series analysis/ or pilot projects/
24	clinical trial/
25	(intervention? or preintervention? or postintervention?).ti,ab.
26	((pilot or feasibility) adj2 (stud* or project*)).ti,ab.
27	(prospective adj2 (stud* or project*)).ti,ab.
28	(before adj2 after).ti,ab.
29	(time series or time point? or timepoint? or end point? or endpoint?).ti,ab.
30	15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29
31	exp animals/ not humans.sh.
32	30 not 31
33	13 and 32
34	14 or 33
35	Schools/ or School Teachers/
36	(schoolchild* or school child* or ((primary or junior or elementary or middle or high or secondary) adj school?)).ti,ab,kw.
37	35 or 36
38	34 not 37
39	limit 38 to english language

Appendix 2 Table of excluded studies and reasons			
First author, year	**Screener**	**Eligibility**	**Reason for exclusion**
Acosta et al, 2014	RP	Exclude	Intervention did not include physical activity education, outcomes not appropriate
Arakawa Martins et al, 2019	RP	Exclude	outcomes not appropriate
Avdagovska et al, 2016	RP	Exclude	wrong population
Barker, Room & Toye (2022)	RP	exclude	outcomes not appropriate
Beno et al, 2005	RP	Exclude	Intervention did not include physical activity education
Black et al, 2016	RP	Exclude	Intervention did not include physical activity education,
Bonnet et al, 2019	RP	Exclude	Intervention did not include physical activity education
Brandt, Booker, and McGrath (2013)	RP	Exclude	Intervention did not include physical activity education
Brown et al (2001)	RP	Exclude	Methodology
Burgess et al (2019)	RP	exclude	wrong population
Butler et al (2013)	RP	Exclude	outcomes not appropriate
Chevan et al (2022)	RP	exclude	outcomes not appropriate
Damayanti et al (2020)	RP	exclude	outcomes not appropriate
Drevenhorn et al (2006)	RP	Exclude	Intervention did not include physical activity education, outcomes not appropriate
Drevenhorn et al (2012)	RP	Exclude	Intervention did not include physical activity education, outcomes not appropriate

Drevenhorn, Bengston and Kjellgren (2009)	RP	Exclude	Intervention did not include physical activity education, outcomes not appropriate
D'Urzo et al (2019)	RP	exclude	outcomes not appropriate
Edwards et al (2015)	RP	Exclude	outcomes not appropriate
Eklund, Ruud and Grov (2016)	RP	Exclude	Intervention did not include physical activity education, outcomes not appropriate
Evans et al (2011)	RP	Exclude	outcomes not appropriate
Feuerstein et al (2015)	RP	Exclude	Intervention did not include physical activity education
Fiala and Brazdova (1996) - wrong population	RP	Exclude	wrong population
Grune et al 2022	RP	exclude	outcomes not appropriate
Guzzardo (2021)	RP	exclude	outcomes not appropriate
Hardy et al (2014)	SB	Exclude	outcomes not appropriate
Jones (2021)	RP	exclude	outcomes not appropriate (use of telehealth)
Kaminska 2021	RP	exclude	outcomes not appropriate
Keogh et al. (2018)	SB	Exclude	Intervention did not include physical activity education,
Khacnatry and Balalian (2013)	SB	Exclude	Intervention did not include physical activity education,
Kivela (2020)	RP	exclude	outcomes not appropriate - patient
Lakey (2020)	RP	exclude	outcomes not appropriate - patient
Lee and Teh (2020)	RP	exclude	outcomes not appropriate - empathy
Lin (2021)	RP	exclude	outcomes not appropriate - patient
Mohhamed (2021)	RP	exclude	outcomes not appropriate
Myers (2020)	RP	exclude	Intervention did not include physical activity education, outcomes not appropriate

Naumann (2020)	RP	exclude	outcomes not appropriate
Nazar (2021)	RP		methodology
Nutting (2020)	RP	exclude	outcomes not appropriate
Pendharkar (2021)	RP	exclude	no PA intervention
Pololi and Pooter (1994)	RP	Exclude	Intervention did not include physical activity education
Popp (2020)	RP	exclude	outcomes not appropriate
Qutishat (2019)	RP	DUPLICATE	
Rasmussen et al (2008)	RP	Exclude	outcomes not appropriate
Richter, Malkiewicz and Shaw (1987)	RP	Exclude	outcomes not appropriate
Romero-Collado (2020)	RP	exclude	outcomes not appropriate/descriptive study
Shani et al (2014)	RP	Exclude	outcomes not appropriate
Shearin (2020)	RP	exclude	outcomes not appropriate
Shilts (2021)	RP	exclude	outcomes not appropriate
Soundy 2021	RP	exclude	outcomes not appropriate = empathy and communication
Stark et al (2012)	RP	Exclude	Intervention did not include physical activity education
Stark, Manning-Walsh and Vliem (2005)	RP	Exclude	Intervention did not include physical activity education
Torrecilla-Abril et al (2018)	RP	Exclude	Intervention did not include physical activity education
Trujillo and Hardy (2009)	RP	Exclude	Intervention did not include physical activity education
Tucker et al (2016)	RP	Exclude	outcomes not appropriate

isensee, Anderson and Lapp (1989)	RP	Exclude	Intervention did not include physical activity education, outcomes not appropriate
Wentink et al (2019)	RP	Exclude	outcomes not appropriate
White et al (2017)/White et al (2019)	RP	Exclude	Intervention did not include physical activity education,
Williams and Denehy (2019)	RP	Exclude	outcomes not appropriate
Wills and Kelly	RP	Exclude	outcomes not appropriate
Wormley (2022)	RP	exclude	outcomes not appropriate - gaming
Wylie and Leedhan-Green (2017)	RP	Exclude	Methodology
Wylie et al (2009) No specifc PA intervention	RP	Exclude	outcomes not appropriate
Yadav (2020)	RP	Exclude	outcomes not appropriate
Yeh et al (2005) no specific PA primary intervention	RP	Exclude	outcomes not appropriate