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Effectiveness of physical activity counselling and exercise prescription education among medical students: a systematic review

Efficacité du counseling en matière d'activité physique et de formation à la prescription d'exercices physiques chez les étudiants en médecine : une revue systématique

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Abstract

Background: Providing physical activity counselling and prescribing exercise increases patients' activity and cardiorespiratory fitness, but healthcare providers experience challenges in promoting activity to patients. Implementing educational intervention during medical training may be an effective strategy to promote physical activity and exercise counselling/prescriptions. The purpose of this review was to evaluate the impact of educational interventions on medical students' physical activity counselling and exercise prescription perceptions and practices.

Methods: Systematic review procedures were registered in PROSPERO (ID# CRD42022331755) prior to conducting the study. Studies were included if they conducted an educational intervention to medical students or residents aimed at improving activity practices. Sources were searched in May of 2022 and included Scopus, EMBASE, MEDLINE, CINAHL, and Academic Search Premier (*n* = 3412 citations without duplicates). The National Institutes of Health quality assessment tools were used.

Results: Fifteen interventions were included. The average quality of the included controlled trials (*n* = 6) and pre-post studies with no control group (*n* = 9) were 5.0±1.5/12 and 6.2±1.3/14, respectively. Most studies (*n* = 4/6) that reported the total number of medical students providing activity counselling to patients before and after receiving intervention observed improvements in exercise counselling behaviours. Eleven of twelve, and ten of eleven studies reported increases in confidence and perceptions toward various features of exercise counselling and physical activity promotion, respectively.

Conclusion: Despite the heterogeneous nature of intervention designs, this review supports that relatively brief interventions using a structured lecture format incorporated into curriculum promote acute improvements in medical students' perceptions and confidence in providing exercise counselling, albeit based on low-moderate study quality.

Résumé

Contexte : Les conseils en matière d'activité physique et la prescription d'exercices augmentent l'activité et la condition cardiorespiratoire des patients, mais les prestataires de soins de santé éprouvent des difficultés à promouvoir l'activité auprès des ceux-ci. La mise en œuvre d'une intervention éducative au cours de la formation médicale peut être une stratégie efficace pour promouvoir l'activité physique auprès des patients et le conseil/prescription d'exercices. L'objectif de cette étude était d'évaluer l'impact des interventions éducatives sur les perceptions et les pratiques des étudiants en médecine en matière de conseils concernant l'activité physique et la prescription d'exercices.

Méthodes : La procédure de revue systématique a été enregistrée dans PROSPERO (ID# CRD42022331755) avant la réalisation de l'étude. Les études ont été incluses si elles menaient une intervention éducative auprès d'étudiants en médecine ou de résidents en vue d'améliorer la pratique d'activités. Les moteurs de recherche bibliographique ont été explorés en mai 2022 et comprenaient Scopus, EMBASE, MEDLINE, CINAHL et Academic Search Premier (n = 3412 citations sans doublons). Les outils d'évaluation de la qualité du National Institutes of Health ont été utilisés.

Résultats : Au total, 15 interventions ont été incluses. La qualité moyenne des essais contrôlés inclus (n = 6) et des études pré-post sans groupe de contrôle (n = 9) était respectivement de 5,0±1,5/12 et de 6,2±1,3/14. La plupart des études (n = 4/6) qui ont rapporté le nombre total d'étudiants en médecine fournissant des conseils d'activité aux patients avant et après l'intervention ont observé des améliorations dans les comportements en matière de conseils d'exercice physique. Onze études sur douze et dix études sur onze ont fait état d'une augmentation de la confiance et des perceptions à l'égard de diverses caractéristiques du conseil en matière d'exercice et de la promotion de l'activité physique, respectivement.

Conclusion : Malgré la nature hétérogène des modèles d'intervention, cette revue systématique soutient que des interventions relativement brèves utilisant un format de cours structurés incorporé dans le programme d'études favorisent de nettes améliorations des perceptions et de la confiance des étudiants en médecine dans la prestation de conseils en matière d'exercice physique, bien que la qualité de l'étude soit faible à modérée.

Introduction

Regular physical activity and exercise is associated with better physical and mental health.[1] Despite this, the majority of people in the western world are insufficiently active,[2] predisposing them to an increased chronic disease risk and the development of multi-morbidity.[3] Physicians who provide their patients with written exercise prescriptions or referrals to qualified exercise professionals observe increases in their patients' physical activity[4] and cardiorespiratory fitness.[5] However, we[6,7] and others[8,9] have demonstrated that physicians discuss physical activity in few patient appointments, have low self-confidence in their ability to provide physical activity counselling, and rarely prescribe exercise. We need a better understanding of strategies that may promote prescribing exercise to more patients as a regular part of primary care.

Primary care physicians undergo extensive formation, education, and training to deliver services that improve patient health. An effective time to establish or alter future physician behaviours is during their medical training. While healthcare providers are generally open to physical activity promotion,[10] little time is spent learning about physical activity and exercise counselling/prescriptions within medical training. Specifically, a recent review on the topic reported that a median of three-hours (average of 13.7-hours) of primary lecture-based material is spent on lifestyle counselling across an entire medical student's degree, which was comprised of both nutrition (78% of studies) and exercise (59%).[11] Undergraduate medical students[12] and family medicine residents[13] report low self-confidence in their ability to prescribe exercise, but they cite a high motivation to do this with their patients. Few residents (approximately 15%) cited their educational training in exercise prescription as 'adequate'.[13] There is currently a disconnect, whereby medical trainees (i.e., medical students and residents) are interested in conducting lifestyle counselling, but believe that their training is insufficient. Certainly, medical training programs cover a lot of content and therefore, time-efficient, educational training that results in the largest improvements in medical trainee knowledge and competencies is desirable. While individual studies have assessed the impact of educational training on medical trainees' physical activity-related practices (e.g.,[14]), no study has amalgamated this literature or appraised the quality of evidence as in a systematic review that we conducted.

Medical programs that aim to educate their students on exercise prescription practices to address the growing challenge of patient physical inactivity may be interested in implementing evidence-based educational training. However, not all educational training interventions are the same, as lectures are known to be less effective than case studies or practical (i.e., hands-on experience with patients) skills training.[15] Understanding the impact of varying educational interventions on medical trainees' physical activity counselling and exercise prescription practices could help guide the implementation of future training endeavors. Therefore, the purpose of this review was to evaluate educational interventions on medical trainees' physical activity counselling and exercise prescription practices (i.e., activity counselling, frequency prescription/referrals), perceptions, confidence, perceived barriers, and knowledge of physical activity guidelines.

Methods

Search strategy

The search strategy and systematic review procedures were registered in PROSPERO (ID# CRD42022331755) prior to conducting the study. Literature searches were conducted using Scopus, EMBASE, MEDLINE, CINAHL, and Academic Search Premier databases up to May 9th, 2022. Our search strategy framework is presented in Supplemental Table 1. Although physician terms are included, to answer our specific research question, only citations that included undergraduate or resident medical students were included. The focus of this review was on trainees' perceptions/practices. However, the impact of including exercise content in patient appointments on *patients'* activity or outcomes (e.g., blood pressure) was beyond the scope of this review. This review followed the preferred reporting for items for systematic reviews and meta-analyses (PRISMA) 2020 statement.[16] Article citations were downloaded to an online research management system (Mendeley, Elsevier, Amsterdam, Netherlands) and duplicates were removed. Remaining references were exported to systematic review software for screening (Covidence, Melbourne, Australia).

Study inclusion and exclusion criteria

Studies not published in a peer reviewed journal, or published as an editorial, opinion, review, or conference abstract were excluded. Grey literature was excluded. No language or timeline restrictions were implemented into the search strategy. All studies included human participants. To answer our research question, studies must have included undergraduate medical students (i.e.,

enrolled in a medical school) or residents (i.e., those graduated from medical school but are still completing their training towards independent practice). The type of educational training on exercise and/or physical activity was expected to be variable. Only interventional designs were included (pre-post studies with or without control groups). To be included, the intervention must have consisted of education (e.g., workshop, seminar, course) or provided a training tool (e.g., exercise prescription pad with training on usage) with the aim to improving physical activity counselling or exercise prescription practices and/or perceptions. Studies that provided simple tools without intervention or training (e.g., providing a pamphlet) were excluded. However, all other interventions were included regardless of their methods. Specifically, both active and passive educational interventions were included. Active learning is an educational approach which promotes student-centered learning during the teaching process and encourages student engagement, whereas passive learning, such as the ubiquitous lecture, merely provides information with little or no opportunity for students to work with the material and internalize it themselves.[17] No time limit was placed on the duration of the intervention or follow-up measurement period. A measure of trainee physical activity or exercise prescription and/or counselling practices (e.g., written exercise prescription frequency), perceptions (e.g., importance of exercise counselling), or confidence (e.g., writing exercise prescriptions) was required.

Study screening process and data extraction

The titles and abstracts of citations were screened independently by two reviewers (JLP, LP, or MES) who identified potential articles for inclusion. The full text of apparently relevant articles was obtained and screened by the same reviewers. If a consensus could not be reached, a third reviewer acted as the arbiter. The reference list of included articles was back searched for other potentially relevant articles. We extracted how often a referral to an outside physical activity source (e.g., kinesiologist, exercise specialist, physiotherapist, gym/program, etc.) was provided, students' confidence and perceptions on physical activity counselling or exercise prescriptions, and the adherence/dropout rates of the intervention. In addition, we extracted citation information, participant characteristics (sample size, level of training, specialty, age, sex, country of practice), theoretical basis for intervention, intervention and/or measurement tool used and description, length of intervention, length of follow-up period, main outcomes (inclusion of physical activity counselling, frequency of prescription/referrals, confidence, perceptions, knowledge of physical activity guidelines), reach of intervention, and intervention comparisons. For the purposes of this review, medical trainee practices were defined as the act of conducting physical activity counselling and/or exercise prescription, confidence was defined as medical trainee's feeling of self-assuredness in their ability to conduct components of physical activity counselling and/or exercise prescription, and perceptions were defined as the medical trainees' personal regards towards physical activity counselling and/or exercise prescription.

Study quality assessment

The National Institutes of Health quality assessment tools for controlled intervention studies or pre-post studies with no control group were used to assess the study quality/bias depending on the study design (i.e., whether a control group was included). The specific tool checklist and information on how to score each tool is presented on the National Institutes of Health website.[18] A higher value indicates a higher study quality (Yes = 1; No, cannot determine, or not applicable = 0).

Similar to the article screening process, quality assessment for each article was independently completed by two reviewers (JLP, LP, or MES). A third reviewer was consulted to make a final decision in each instance of disagreement between reviewers (JLP, LP, or MES).

Results

Study Characteristics. Our search yielded 4422 articles, across Scopus (*n* = 2347), MEDLINE (*n* = 1152), EMBASE (*n* = 557), CINAHL (*n* = 188), and Academic Search Premier (*n* = 178). After duplicates (*n* = 1010) were removed, 3412 articles were screened. As presented in Figure 1, 15 articles met our inclusion criteria after full-text screening.

The average quality of the included controlled trials (*n* = 6) and pre-post studies with no control group (*n* = 9) were 5.0±1.5/12 and 6.2±1.3/14 [range: 4-8], respectively (Table 1). In general, interventions did not have (or it was not reported whether) a sufficient sample size provided confidence or had at least 80% power (*n* = 15/15). Similarly, 15/15 interventions were not (or it was unclear whether) the people assessing the outcomes were blinded. Specific to pre-post studies with no control group, 5/9 studies had >20% attrition rate, and 8/9 studies did not have outcome measures of interest taken a multiple timepoints.

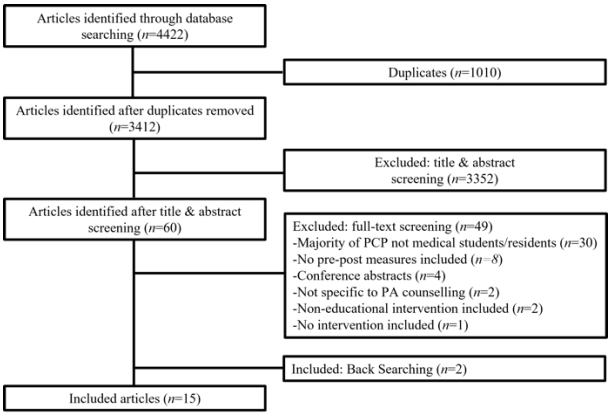

Figure 1. Flow chart indicating the number of articles included or excluded at each part of the screening process

Furthermore, specific to the controlled trials, 5/6 studies either did not include randomization or their randomization was conducted inadequately. In addition, we were unable to determine if other interventions were avoided or were similar between the group (*n* = 6/6).

Study characteristics and intervention details are presented in Table 2. Of the 15 included studies the characteristics include average intervention length of 32±62 weeks (range: 1 day - 4 years), follow-up of 13±29 weeks (range: immediate - 2 years), number of participants of 105±71 participants (range: 25-224 participants, total participants: *n*=1581; 617 reported females), age of participants of 26.8±6.8 years (range: 23-45 years), and success rate (i.e., trainees who completed the intervention in entirety) of 75.5±27.4% (range: 25.5-100%). Studies included medical students in 1st (*n* = 4), 2nd (*n* = 2), 1st and 2nd (*n* = 1), 3rd (*n* = 1), and 5th (*n* = 3) year of study, medical students studying intercalated degrees (*n* = 1), and medical residents (*n* = 3) (Table 2). The nature of the educational content included in each intervention was heterogenous but included curriculum integrated into medical students' pre-existing courses,[19,20] new workshops,[14,21–24] additional lectures,[20,23–29] and modules[30,31] (Table 2) that focused on concepts such as motivational interviewing strategies,[22,25,27,30] preventative medicine,[19] health promotion,[14,23,28] exercise prescription,[14,26,31,32] and more (Supplemental Table 2). Some interventions implemented supplemental physical activity counselling tools including a sports and exercise medicine prescription booklet,[32] an exercise is medicine guide,[26] healthy aging rounds physical activity prescription form,[31] and patient handout materials.[30] Seven studies conducted passive educational interventions,[14,19,27–29,31,32] seven conducted a combination of active and passive interventions,[20–26] and only one implemented an totally active intervention.[30]

Medical trainee practices

Six studies reported the total number of medical students and/or residents providing activity counselling to patients before and after educational intervention (Table 3).[20–22,27,29,30] Four studies observed increases in medical student or resident practices (i.e., exercise counselling, referrals, or advising) following intervention.[20,21,27,30] Two studies were randomized control trials[21,30] and the others were experimental without a control group.[20,27] These studies had an average sample size of 104±81 (range: 48-224 medical students/residents), intervention length of 54±103 weeks (range: 1 day – 4 years), and follow-up of 13±18 weeks (range: immediate – 12 months). Two of these studies[21,27] focused on promoting exercise counselling in targeted populations (i.e., those with chronic condition or geriatric populations) while the other two took a more general population perspective.[20,30] Three studies, including one randomized control trial,[21] observed no changes in medical students and/or residents' practices (i.e., exercise prescription, physical activity counselling and referrals).[21,22,29] These studies had an average sample size of 40±13 (range: 25-48 medical students/residents), intervention length of 9±8 weeks (range: 1 day-3 months), and follow-up of 8±4 weeks (range: 1-3 months). In general, those studies that did not see changes in exercise counselling practices had smaller sample sizes and shorter intervention durations (Table 2).

Table 1. Study quality assessment by the National Institutes of Health quality assessment tools

Pre-Post Studies with No Control Group												
	Was the study question/ objective clearly stated?	Were eligibility criteria for population clearly described?	Were participants representative?	Were all eligible participants enrolled?	Was the sample size sufficient to provide confidence?	Was the intervention clearly described/ delivered consistently ?	Were outcome measures prespecified , defined, valid, reliable, and assessed consistently ?	Were the people assessing the outcomes blinded?	Was loss to follow-up after baseline ≤20%?	Did statistical methods examine Δ in outcome measures from before-after intervention ?	Were outcome measures of interest taken multiple times?	Did statistical analysis take into account the use of individual-level data to determine effects at the group level?
Brennan et al.[14]	Yes	Yes	Yes	Yes	No	Yes	No	NA	No	Yes	No	NA
Frank et al.[20]	Yes	Yes	Yes	Yes	CND	Yes	Yes	CND	No	Yes	No	Yes
Jadczak et al.[27]	Yes	Yes	Yes	Yes	CND	Yes	No	No	Yes	Yes	No	No
Jones et al.[28]	Yes	Yes	Yes	No	CND	Yes	No	NA	No	Yes	No	NA
Malatskey et al.[23]	Yes	Yes	Yes	No	CND	Yes	Yes	CND	Yes	Yes	No	No
Mandic et al.[24]	Yes	No	Yes	No	CND	No	Yes	CND	Yes	Yes	No	CND
Mohler et al.[31]	Yes	Yes	Yes	CND	CND	Yes	No	NA	NA	No	No	NA
Pugh et al.[32]	Yes	Yes	Yes	Yes	No	CND	Yes	CND	No	Yes	No	NA
Rogers et al.[29]	Yes	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No

Control Trials														
	Randomized trial?	Randomization adequate?	Treatment allocation concealed ?	Participants/providers blinded to treatment group assignment?	People assessing outcomes blinded?	Similar groups?	Drop-out rate ≤20% of the number allocated to treatment ?	Differential drop-out rate at endpoint ≤15%?	High adherence to the intervention protocols for each treatment group?	Other interventions avoided or similar in the groups?	Outcomes assessed using valid and reliable measures ?	Sample size was sufficiently large with at least 80% power?	Outcomes reported or subgroups analyzed prespecified?	Used an intention-to-treat analysis?
Conroy et al.[19]	No	NA	No	Yes	Yes	Yes	Yes	No	Yes	CND	No	No	No	NA
Eckstrom et al.[21]	Yes	Yes	NA	Yes	NA	Yes	Yes	Yes	Yes	CND	No	No	Yes	No
Flood et al.[22]	No	No	No	CND	CND	No	Yes	Yes	CND	CND	Yes	No	NA	Yes

Jadczak et al.[26]	No	No	No	CND	CND	CND	Yes	Yes	Yes	CND	Yes	CND	NA	Yes
Jadczak et al.[25]	No	No	No	CND	CND	Yes	No	Yes	CND	CND	Yes	CND	NA	Yes
Katz et al.[30]	Yes	No	Yes	CND	CND	CND	CND	CND	CND	CND	CND	No	Yes	Yes

CND, can not determine; NA, not applicable; Yes=1; No/CND/NA=0.

Table 2. Included studies and intervention characteristics

Author (year); Country	Study Design	Intervention Description	Passive or Active Learning Techniques	Outcome Measures	Intervention Length; Follow-up Length	Population of Interest	# Participants (# Females)	Age (years)	Reach; Success Rate
Brennan et al.[14]; Canada	Experimental without control group	Various workshops providing practical information about PA in primary care were conducted at a mandatory event for medical students. Students cycled through 7 stations in total. Questionnaires were completed before and after the exposition.	Passive	PA prescription Confidence Knowledge of PA Guidelines	1 day; immediate	2nd year medical students	54(29)	25.1±2.8	54/100 students; 100%
Conroy et al.[19]; United States	Non-randomized experimental with control	Integrated course which included problem-based learning tutorials, counselling skills, debates, and self-assessment 14 weekly 45-minute small groups sessions. Questionnaire completed at baseline and follow-up.	Passive	Student exercise patterns Confidence	14 weeks; immediate	2nd year medical students	164 (NR)	25.7 ± 2.1	130/137 students; 95%
Eckstrom et al.[21]; United States	Randomized control trial	Two 2-hour workshops 3-months apart First workshop focused on PA counselling skills, particularly in patients with chronic conditions Second workshop allowed residents to receive feedback on their PA counselling attempts Residents were provided with educational handout	Passive and Active	PA counselling behaviours Confidence Self-reported patient PA PA prescription	2-hours; 3-months	Internal medicine residents	48 (NR)	NR	NR; 100%
Flood et al.[22]; Canada	Non-randomized experimental	Theory of Planned Behaviour guided introduction to motivational interviewing and	Passive and Active	Social cognitions for PA counselling behaviours Barriers to PA counselling behaviour	14 weeks; 1 month	1st year family medicine residents	25(18)	26.2±2.0	25/53 students; 60%

	without control group	PA counseling educational material 2 x 90-minute workshops. Questionnaires were completed one month before and after intervention.							
Frank et al.[20]; United States	Non-randomized experimental with control group	Intervention included educational curricular and extracurricular components regarding importance of diet, exercise, tobacco, and alcohol on health Student were recorded and assessed during 4 standardized patient examinations administered during control and intervention groups' senior year internal medicine rotation. Questionnaires were completed during freshman orientation and at the end of senior year internship	Passive and Active	PA counselling behaviours Perceptions of PA counselling Self-reported PA levels	4 years; immediate	1st year medical students	Intervention: 114 (52) Control: 110 (42)	23.2 (range: 21-35)	NR
Jadczak et al.[27]; Australia	Experimental without control	4.5-week geriatric medicine course was created to teach students the importance of PA counselling in older populations 1-hour exercise lecture-style tutorial on general geriatric medicine. Questionnaire was completed before and after the course.	Passive	Perceptions of PA counselling Barriers PA counselling behaviour	5 weeks; immediate	5th year medical students	81(43)	23.4±1.5	NR; 96.3%
Jadczak et al.[26]; Australia	Non-randomized experimental with control group	A pre-existing 4.5- week course integrated the importance of PA counselling in geriatric populations 1-hour exercise lecture-style tutorial on Exercise is Medicine combined with a 30-minute practical counselling session with patients. Questionnaire was completed before and after the course.	Passive and Active	Exercise prescription Confidence PA referrals/prescriptions	5 weeks; immediate	5th year medical students	Intervention: 80 (39) Control: 81 (38)	Intervention: 23.4±1.4 Control: 23.4±1.5	161/161 students; NR
Jadczak et al.[25]; Australia	Non-randomized Experimental with control group	4.5-week geriatric medicine course included the importance of PA counselling in older populations	Passive and Active	Perceptions Exercise Prescriptions	5 weeks; 2 years	5th year geriatric medicine interns	Intervention: 18 (9) Control: 23 (8)	Intervention: 24.8±1.0 Control: 24.9±1.2	NR; 22.5% IG 28.4% CG

		1-hour exercise lecture-style tutorial on Exercise is Medicine combined with a 30-minute practical counselling session with patients. Questionnaire was completed before and after a follow-up period							
Jones et al.[28]; United Kingdom	Experimental without control group	Four 1-hour lectures related to benefits of PA, physiological adaptations, and the doctor's role in exercise promotion and prescription Students completed 6-item online questionnaire prior to and after lectures	Passive	Perceptions Confidence Knowledge of PA promotion and exercise prescription	3 years; immediate	1st and 2nd year medical student	121 (NR)	NR	15%; 100%
Katz et al.[30]; United Kingdom	Randomized control trail	Programme targeting resident's PA counselling behaviour and their patients' PA levels 5 interactive educational sessions at 1-month intervals. Questionnaire was completed before and after intervention.	Active	Patient PA levels	5 months; 6 and 12 months	1st year internal medicine residents	Intervention: 29 (NR) Control: 36 (NR)	NR	NR; NR
Malatskey et al.[23]; Israel	Experimental without control group	20-hours divided into 14 weekly sessions of a lifestyle medicine course designed to promote lifestyle behaviour counselling with a practical clinical project as final a assignment that involved accompanying and supporting a patient in the process of lifestyle health behaviour change. Questionnaire completed at baseline and follow up.	Passive and Active	Perceptions Confidence	14 weeks; NR	Medical residents in a lifestyle medicine course	91(49)	45.0±4.9	91/112 students; 81.3%
Mandic et al.[24]; New Zealand	Experimental without control group	3-tutotials and one lecture related to PA counselling and experiential learning by providing health checks to local residents. Questionnaires completed at baseline and follow-up.	Passive and Active	Knowledge of PA guidelines Perceptions	1 month; 5 months	3rd year medical students	216(115)	21.1±2.2	216/237 students; 91%
Mohler et al.[31]; United States	Experimental without control group	2-hour module on physical activity counselling, social engagement tips for counselling and prescribing PA	Passive	Perceptions	2-hours; immediate	1st year medial students	37(NR)	NR	NR; 70%

		Students completed an end-of-session evaluation form							
Pugh et al.[32]; United Kingdom	Non-randomized experimental without control	Students were sent a booklet via email and were instructed to review the chapters, case scenarios, and learning points on PA prescription. Questionnaire completed at baseline and follow up.	Passive	Confidence Perceptions Knowledge of PA guidelines	Self-paced; immediate	Medical students studying intercalated degrees	205 (132)	NR	16-45 UK medical schools; 27%
Rogers et al.[29]; United States	Experimental without control group	Based on input from internal medicine resident focus groups, 6 large group conferences focused on varying topics related to PA counselling including exercise physiology, PA benefits, stages of behaviour change, integrating PA in daily activities, and more.	Passive	PA counselling habits Confidence Perceptions	3-months; immediate & 3-months	Internal Medicine Residents	48(NR)	30.0±5.0	25/63; 60%

Footnote: Reach, ratio between number of medical students/residents asked to participate in the study to the number of those who consented to do so; success rate, ration between the number of students/residents that consented to participants to the number of those who completed the study. NR, not reported; PA, physical activity

Table 3. Confidence and perception outcomes from medical trainee exercise counselling interventions

Author (year)	Medical Trainee Practices	Confidence Outcomes	Perception Outcomes
Brennan et al.[14]	NR	↑ discussing PA with patients ↑ persuading patients to engage in PA	↑ intention to seek additional information about PA ↑ intention to seek additional information to persuade patients to engage in PA
Conroy et al.[19]	NR	↑ assessing patient exercise ↑ changing patient exercise	NR
Eckstrom et al.[21]	↑ patients advised to engage in regular PA ↔ # of patients who received written exercise prescription ↔ # patients asked about their PA habits	↔ assessing PA history ↔ assessing contradictions to PA ↑ prescribing PA ↑ persuading patients to begin PA	NR
Flood et al.[22]	↔ # patient visits containing activity counselling (18/150 vs 25/150 visits) ↔ in referrals (2% vs 3% patient visits containing referrals)	↔ discussing PA with patients	↔ discussing PA with patients will improve their PA behaviour ↑ being adequately prepared to discuss PA in practice ↔ having adequate time to provide PA counselling ↔ discussing physical activity is a priority ↔ it is not physicians' responsibility ↑ having the resources to discuss PA
Frank et al.[20]	56% greater odds of providing exercise counselling during standardized patient encounters (odds ratio: 1.56, 95% CI: 1.04, 2.34)	NR	↑ the school curriculum encourages health ↑ the school curriculum emphasizes preventive medicine
Jadczak et l.[27]	↑ students providing activity counselling (53% vs 100% of students) ↑ # of students who were able to provide exercise	↑ conducting physical examination to approve exercise engagement ↑ determining maximum heart rate ↑ calculating training heart rate ↑ designing an exercise prescription for older adults ↑ referring patients to an exercise program	↔ importance to conduct physical examination to approve exercise engagement ↔ importance to determine maximum heart rate ↑ importance to calculate training heart rate ↑ importance to design exercise prescription for older adults

	referrals (9% vs 86% students) and PA prescription (6% vs 72% students)	↑ identifying age-related limitations to exercise ↔ determining body mass index ↔ determining the caloric needs of older adults ↔ explaining the benefits of exercise	↔ importance to refer patients to an exercise program ↑ importance to identify age-related limitations to exercise ↑ importance to determine body mass index ↔ importance to determine the caloric needs of older adults ↔ importance to explain the benefits of exercise
Jadczak et al.[26]	NR	↑ conducting physical examination to approve exercise engagement ↑ determining maximum heart rate ↑ calculating training heart rate ↑ designing an exercise prescription for older adults ↑ referring patients to an exercise program ↑ identifying age-related limitations to exercise ↑ determining body mass index ↑ determining the caloric needs of older adults ↑ explaining the benefits of exercise	↔ importance to conduct physical examination to approve exercise engagement ↑ importance to determine maximum heart rate ↔ importance to calculate training heart rate ↔ importance to design exercise prescription for older adults ↔ importance to refer patients to an exercise program ↔ importance to identify age-related limitations to exercise ↔ importance to determine body mass index ↔ importance to determine the caloric needs of older adults ↔ importance to explain the benefits of exercise
Jadczak et al.[25]	NR	↑ overall with a group x time interaction effect	↑ overall importance at post-intervention and follow-up in intervention and control group ↔ overall importance between groups at post-intervention ↔ overall importance between groups at follow-up
Jones et al.[28]	NR	↑ in PA advising following lectures	↑ importance of PA in preventing and treating disease ↑ advising about PA is a physician's job
Katz et al.[30]	↑ students providing PA counselling (53% vs 85% of students)	NR	NR
Malatskey et al.[23]	NR	↑ providing patients with knowledge on PA to elicit behaviour change ↔ PA counselling patients	↔ lifestyle counselling is effective
Mandic et al.[24]	NR	↑ advising on PA ↑ perceived competence	↑ exercise advising is a high priority ↑ exercise counselling impacts patient quality of life ↔ some PA is better than none ↔ additional benefits occur proportionally to the frequency/duration of PA ↑ aerobic and resistance PA are beneficial ↔ health benefits from PA occur for all ages and racial/ethnic groups ↔ benefits of PA outweigh its adverse outcomes ↑ adults with chronic conditions benefit from PA ↑ PA is safe for adults with chronic conditions ↔ older adults and those with chronic conditions should consult physicians about PA ↔ overall perceived importance
Mohler et al.[31]	NR	NR	↑ role of PA in older adults' health ↑ many older adults are active and healthy
Pugh et al.[32]	NR	↑ advising ↑ raising the issue ↑ prescribing exercise to those with osteoporosis or cancer ↔ prescribing exercise to those with weight management or hypertension	↑ importance of PA for treating disease ↔ PA importance for preventing disease ↔ PA advising is an important part of a doctor's job
Rogers et al.[29]	↔ PA counselling provided to patients	↑ counselling PA at first follow-up ↑ providing PA counselling at first follow-up ↔ counsel PA at second follow-up ↔ success providing PA counselling at second follow-up	NR

Footnote: NR, note reported; PA, physical activity; ↑, significant ($p<0.05$) increase in confidence or perception; ↓ significant ($p<0.05$) decrease in confidence or perceptions; ↔, no change in confidence or perceptions ($p>0.05$).

Medical trainees' confidence

Detailed changes in students' confidence and perceptions in activity counselling are presented in Table 3. Eleven of twelve studies reported improvements in medical students' confidence in some relation to physical activity counselling for patients.[14,19,21,23–29,32] Five of ten studies reported confidence increased during interactions such as discussing, persuading, and advising patients on physical activity following intervention.[14,19,24,26,28] All five studies had relatively large sample sizes of medical students in all years of study (i.e., no residents) (*n* = 54-216) and two of five included a control group.[14,26] The interventions included in these studies greatly varied in total length (range: 1 day-3 years), but the frequency of content delivery was at least once per week. Furthermore, six of thirteen studies reported both increases and no changes in varying unique facets of confidence between baseline and intervention follow-up timepoints[21,23,25–27,29,32] and one study reported no changes in confidence following intervention.[22] The study that found no change in confidence was conducted in 25 1st year family residents and utilized the Theory of Planned Behaviour to conduct workshops to promote activity counseling over 14 weeks with a one month follow-up.[22] Two studies did not measure changes in confidence.[20,30]

Medical trainee's perceptions

Eleven studies reported changes in perceptions as a main outcome variable.[14,20,22–28,31,32] Four studies observed improvements in perceptions following their respective interventions.[14,20,28,31] Most studies (*n* = 3/4) included 1st or 2nd year medical students,[14,20,31] whereas one of four included both 1st and 2nd year undergraduate medical students.[28] All four studies had substantial sample sizes (*n* = 37-224), but only one had a control group.[20] Two studies consisted of single day interventions[14,31] which included either multiple educational stations or a single hands-on module, while the other two lasted multiple years and integrated lectures related to activity counselling into medical students' degree programs.[20,28] None of these studies had a follow-up period with additional data collection. Seven of eleven studies reported a combination of both increases and no changes in perceptions of aspects of activity counselling.[22–27,32] Three studies included control groups[22,25,26] and two studies were conducted with residents only.[22,23] These studies had very heterogenous sample sizes (*n* = 25-216), intervention lengths (self-paced-14 structured weeks), intervention structure (e.g., tutorials and lectures related to activity counselling and experimental learning through providing health checks to local resident versus weekly sessions devoted to acquiring knowledge and skills in prescribing physical activity), and follow-up periods (immediate-2 years). Two studies did not report perceptions as an outcome measure.[19,30]

Perceived barriers

Three studies reported perceived barriers to activity counselling.[22,23,27] Flood et al. reported that their intervention diminished the perceived barriers of activity counselling and provided necessary resources from baseline to follow-up, but did not change barriers including belief, time, priority, or professional role.[22] Jadczak et al. reported that percentages of students cited the following barriers: a lack of knowledge (57%), patient compliance (39%), patient ability (33%), being the most qualified (12%), and positive perceptions of activity (8%).[27] Lastly, Malatskey et al. observed that students perceived increased barriers explaining why many physicians do not promote healthy lifestyle behaviours. These included a lack of belief in the effectiveness of counselling, compensation, relevant knowledge, responsibilities, and interest, but not a lack of time.[23]

Knowledge of activity guidelines

Four studies investigated changes in the ratings of knowledge on activity guidelines among medical trainees.[14,22,24,32] Pugh et al. concluded students were able to identify a greater percentage of activity guidelines (72% vs 90%) following their self-directed educational intervention.[32] Similarly, Mandic et al. observed increased knowledge of national and chronic disease specific guidelines.[24] Brennan et al. reported an increase in the proportion of students correctly reporting the activity guidelines (23% vs 94%), however there was no change in student awareness of the activity guidelines between the pre- and post-intervention scores (83% vs 88% of students).[14] In contrast, Flood et al. observed no statistically significant change in the percentage of 1st year family medicine residents who could correctly identify activity guidelines from baseline to follow-up (13% vs 47% of students, $p = 0.06$), likely attributed to their smaller sample size of intervention completers (*n* = 15).[22]

Discussion

The purpose of this study was to review educational interventions on medical trainees' physical activity counselling and exercise prescription practices (i.e., activity counselling, frequency prescription/referrals), perceptions, confidence, perceived barriers, and

knowledge of physical activity guidelines. Most studies implemented relatively brief interventions that typically involved only a few sessions, but most interventions increased medical trainees' physical activity counselling perceptions, confidence, and knowledge of activity guidelines. Brief education may be an expeditious means of equipping medical students or residents with the knowledge and self-efficacy to promote more physical activity in patient sessions.

Even though the efficacy of exercise prescriptions to improve patients' physical activity levels are well-established,[4] physicians feel ill-equipped promoting activity to their patients.[6] Medical school has been suggested as an opportune time to prepare medical students with the skills and background knowledge to perform physical activity counselling and prescribe exercise to patients over the course of their career.[6,33] Many medical students share the desire for more lifestyle education within their medical training.[12,13] Of the studies included, only two were randomized controlled trials, representing a higher level of evidence and observed that 1st year internal medicine residents increased their rates of activity counselling greater than the control group at 12-month follow-up (intervention: monthly educational sessions for five-months)[30] and that workshop-based training increased their confidence to prescribe exercise.[21] Interventions early in students' undergraduate training (*n* = 9/15 studies) may promote the frequency and comfort in providing lifestyle counselling. Interventions in postgraduate residency (*n* = 6/15 studies) may still be effective,[25,30] but residents more readily recognize factors such as 'lack of time' as major deterrents to counselling patients on physical activity and prescribing exercise.[23] Our effectiveness outcomes are primarily based on the immediate changes in perceptions and practices following the educational training, with limited evidence supporting or refuting long-term changes. Future studies with longer follow-up or external assessments of their effectiveness to provide activity counselling (e.g., reporting in medical records) would be informative. Of the interventions that examined the frequency of physical activity counselling,[20,27,30] studies that generally provided a greater volume of education observed a favorable impact of education on their inclusion of activity counselling with patients. Studies that implemented few student contacts (e.g., two, 90-min workshops[22]) were less efficacious. Certainly, avoiding one-and-done training opportunities and more frequently discussing lifestyle medicine throughout medical training will equip future physicians with a greater skillset and comfort level talking about physical activity to patients. Importantly, both passive and active (e.g., case studies that integrate practical skills[25]) learning strategies are likely an effective model of educational training and may be a simple means of addressing the initial needs of medical trainees. In contrast to previous studies that demonstrate passive learning approaches may be less effective than active learning,[15,34] motivated medical trainees may be highly receptive to physical activity education contributing to the success of both education approaches.[13]

Inherently, medical students see fewer patients than practicing physicians, and therefore studies that examine their perceptions and confidence may be as important as changes in routine practices with patients if change is maintained over time in this population. Perceived importance and confidence in performing a task are predictive of executing the task, with cross-sectional studies demonstrating a clear positive association between self-efficacy and frequency of recommending activity to patients.[12,35] Our review adds to the current literature by highlighting the aspects related to perception/confidence of medical students that were improved following educational training. Most studies included a perception-based outcome,[14,20,22–28,31,32] and generally demonstrated that students had greater confidence in their ability to perform basic practices, such as discussing activity with patients and assessing their activity. Tools and resources are available to help students begin the conversation of physical activity between providers and patients (e.g., exercise vital sign or exercise prescription pad) in a time-effective manner.[36,37] Some studies[24,26,27,32] observed that students had a higher perception/confidence following interventions in more advanced aspects of exercise prescription, such as heart rate zone exercise prescription, exercise programming, and disease-specific exercise prescriptions. In practice, physicians should be able to provide basic recommendations, but may not have the time and expertise to perform detailed, individualized exercise programming.

National[40] and international[41] guidelines have moved to a whole day approach since these interventions, but the greatest evidence base is for the ≥150 minutes of moderate-vigorous physical activity (MVPA) weekly. After three tutorials and one lecture, 3rd year medical students responded that they were more aware of activity guidelines, the American College of Sports Medicine's guidelines for chronic disease, and New Zealand's green

prescription initiative.[24] However, a greater *awareness* may not translate to *knowing* and *implementing* such guidelines. Brennan et al.[14] highlight this nuance, whereby students had a high awareness of the MVPA guidelines at baseline (83% of students) but only a sub-sample could accurately recall them (27%) prior to the intervention (single workshop), which increased post-intervention (94%). Knowing the MVPA portion of the guidelines is important, given the documented associated health benefits[42] and relevance of providing evidence-based recommendations. , but future efforts should educate on the new, whole-day guidelines.

As outlined in our pre-registered study design (PROSPERO: CRD42022331755), there was an intention of conducting a meta-analysis if data were sufficiently homogenous. However, the heterogeneous nature of the interventions implemented, measurement timepoints, and outcomes assessed prevented the amalgamations of studies for a meta-analysis. If future interventions implemented similar educational program structure and standardized assessment tools, future meta-analysis would be possible. Ideally, this structured model would follow the length of traditional medical courses. As with any review, our conclusions are limited to the studies included, which were limited to generally low-moderate quality studies, albeit specific to intervention studies, and not cross-sectional studies. Notably, this review only includes two randomized control trials which were published >10-years ago[21,30] and a number of studies with missing information (e.g., age, number of females, etc.). This emphasizes the need for more recent randomized control trials to explore the impact of education intervention on medical students and resident physical activity counselling practices, perceptions, and confidence. In addition, future controlled studies should conduct their interventions using adequate methods to improve study quality such that the researcher is blinded to group allocations. It is difficult to determine which type of educational training is “best” for medical programs considering implementing more lifestyle education, with the needs of the individual students varying. Rather than argue which type of training is best, our data indicate that almost any brief training produces favourable immediate effects and that ‘some’ is greater than ‘none.’ Nevertheless, the outcomes of this review provide direction for further study and highlight interventions for possible inclusion into medical school programs.

Conclusion

In conclusion, educational interventions promote improvements in medical trainees’ perceptions and confidence towards exercise counselling, and knowledge of activity guidelines. Whether this translates to changes in practice as students’ progress through their medical career is unclear. Sustained implementation of learning experiences within medical education are likely needed for long term behavioural change. These encouraging findings support the benefits of including educational intervention on medical trainees’ physical activity and exercise counselling perceptions, in addition to perceived competency in discussing physical activity with patients.

Conflicts of Interest: None

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References

1. McKinney J, Lithwick D, Morrison B, et al. The health benefits of physical activity and cardiorespiratory fitness. *BCMJ*. 2016;58(3):131-137.
2. Kohl HW, Craig CL, Lambert EV, et al. The pandemic of physical inactivity: global action for public health. *Lancet*. 2012;380(9838):294-305. https://doi.org/10.1016/S0140-6736(12)60898-8
3. Chudasama Y V., Khunti KK, Zaccardi F, et al. Physical activity, multimorbidity, and life expectancy: a UK Biobank longitudinal study. *BMC Med*. 2019;17(1):108. https://doi.org/10.1186/s12916-019-1339-0
4. Thornton JS, Frémont P, Khan K, et al. Physical activity prescription: a critical opportunity to address a modifiable risk factor for the prevention and management of chronic disease: a position statement by the Canadian Academy of Sport and Exercise Medicine. *Br J Sports Med*. 2016;50(18):1109-1114. https://doi.org/10.1136/bjsports-2016-096291
5. O’Brien MW, Bray NW, Kivell MJ, Fowles JR. A scoping review of exercise referral schemes involving qualified exercise professionals in primary health care. *Appl Physiol Nutr Metab*. Published online April 2021:apnm-2020-1070. https://doi.org/10.1139/apnm-2020-1070
6. O’Brien MW, Shields C, Crowell S, Theou O, McGrath P, Fowles J. The effects of previous educational training on physical activity counselling and exercise prescription practices among physicians across Nova Scotia: a cross-sectional study. *Can Med Educ J*. 2018;9(4):e35-45. https://doi.org/10.36834/cmej.43098

7. O'Brien M, Shields CA, Oh PI, Fowles JR. Health care provider confidence and exercise prescription practices of Exercise is Medicine Canada workshop attendees. *Appl Physiol Nutr Metab*. 2017;42(4):384-390. https://doi.org/10.1139/apnm-2016-0413
8. Petrella R, Lattanzio C, Overend T. Physical activity counseling and prescription among Canadian primary care physicians. *Arch Intern Med*. 2007;167(16):1774-1781. https://doi.org/10.1001/archinte.167.16.1774
9. Windt J, Windt A, Davis J, Petrella R, Khan K. Can a 3-hour educational workshop and the provision of practical tools encourage family physicians to prescribe physical activity as medicine? A pre–post study. *BMJ Open*. 2015;5(7):e007920. https://doi.org/10.1136/bmjopen-2015-007920
10. Albert FA, Crowe MJ, Malau-Aduli AEO, Malau-Aduli BS. Physical Activity Promotion: A Systematic Review of The Perceptions of Healthcare Professionals. *Int J Environ Res Public Health*. 2020;17(12):4358. https://doi.org/10.3390/ijerph17124358
11. Pasarica M, Boring M, Lessans S. Current practices in the instruction of lifestyle medicine in medical curricula. *Patient Educ Couns*. 2022;105(2):339-345. https://doi.org/10.1016/j.pec.2021.05.042
12. McFadden T, Fortier M, Sweet SN, Tomasone JR, McGinn R, Levac BM. Canadian medical students' perceived motivation, confidence and frequency recommending physical activity. *Prev Med Reports*. 2019;15:100898. https://doi.org/10.1016/j.pmedr.2019.100898
13. Solmundson K, Koehle M, McKenzie D. Are we adequately preparing the next generation of physicians to prescribe exercise as prevention and treatment? Residents express the desire for more training in exercise prescription. *Can Med Educ J*. 2016;7(2):e79-e96. https://doi.org/10.36834/cmej.36702
14. Brennan AM, D'Urzo KA, Fenuta AM, Houlden RL, Tomasone JR. Integrating exercise counseling into the medical school curriculum: A workshop-based approach using behavior change techniques. *Am J Lifestyle Med*. 2021;15(1):84-107. https://doi.org/10.1177/1559827617722754
15. Erickson M, Marks D, Karcher E. Characterizing student engagement with hands-on, problem-based, and lecture activities in an introductory college course. *Teach Learn Inq*. 2020;8(1):138-153. https://doi.org/10.20343/teachlearninqu.8.1.10
16. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. Published online March 2021:n71. https://doi.org/10.1136/bmj.n71
17. Armellini A, Padilla Rodriguez BC. Active blended learning: definition, literature review, and a framework for implementation. *Cases on Active Blended Learning in Higher Education.* 2021:1-22. https://doi.org/10.4018/978-1-7998-7856-8.ch001
18. National Heart Lung and Blood Insitute. Study Quality Assessment Tools. Published 2021. https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools
19. Conroy MB, Delichatsios HK, Hafler JP, Rigotti NA. Impact of a preventive medicine and nutrition curriculum for medical students. *Am J Prev Med*. 2004;27(1):77-80. https://doi.org/10.1016/j.amepre.2004.03.009
20. Frank E, Elon L, Hertzberg V. A quantitative assessment of a 4-year old intervention that improved patient counseling through improving medical student health. *MedGenMed Medscape Gen Med*. 2007;9(2):58. http://www.ncbi.nlm.nih.gov/pubmed/17955112
21. Eckstrom E, Hickam DH, Lessler DS, Buchner DM. Changing physician practice of physical activity counseling. *J Gen Intern Med*. 1999;14(6):376-378. https://doi.org/10.1046/j.1525-1497.1999.00356.x
22. Flood SM, D'Urzo KA, Shallow S, Dobrowolski S, Howse K, Tomasone JR. Determining the impact of an educational intervention on family medicine residents' social cognitions and behavior for discussing physical activity. *Teach Learn Med*. 2022;34(1):89-104. https://doi.org/10.1080/10401334.2021.1891542
23. Malatskey L, Bar Zeev Y, Tzuk-Onn A, Polak R. Lifestyle medicine course for family medicine residents: preliminary assessment of the impact on knowledge, attitudes, self-efficacy and personal health. *Postgrad Med J*. 2017;93(1103):549-554. https://doi.org/10.1136/postgradmedj-2016-134726
24. Mandic S, Wilson H, Clark-Grill M, O'Neill D. A physical activity learning module improves medical students' skills and confidence for advising patients about physical activity. *Montenegrin J Sport Sci Med*. 2018;7(1):31-38. https://doi.org/10.26773/mjssm.180304
25. Jadczak AD, Visvanathan R. The sustained impact of a medical school-based physical activity module on interns' perceived competence in advising older adults about exercise. *J Frailty Aging*. 2020;9(3):155-157. https://doi.org/10.14283/jfa.2019.39
26. Jadczak AD, Tam KL, Visvanathan R. Educating medical students in counselling older adults about exercise: The impact of a physical activity module. *J Frailty Aging*. 2018;7(2):113-119. https://doi.org/10.14283/jfa.2017.44
27. Jadczak AD, Tam KL, Yu S, Visvanathan R. Medical students' perceptions of the importance of exercise and their perceived competence in prescribing exercise to older people. *Australas J Ageing*. 2017;36(3):E7-E13. https://doi.org/10.1111/ajag.12412
28. Jones PR, Brooks JHM, Wylie A. Realising the potential for an Olympic legacy; teaching medical students about sport and exercise medicine and exercise prescribing. *Br J Sports Med*. 2013;47(17):1090-1094. https://doi.org/10.1136/bjsports-2013-092386
29. Rogers LQ, Gutin B, Humphries MC, et al. A physician fitness program: Enhancing the physician as an "exercise" role model for patients. *Teach Learn Med*. 2005;17(1):27-35. https://doi.org/10.1207/s15328015tlm1701_6
30. Katz DL, Shuval K, Comerford BP, Faridi Z, Njike VY. Impact of an educational intervention on internal medicine residents' physical activity counselling: the Pressure System Model. *J Eval Clin Pract*. 2008;14(2):294-299. https://doi.org/10.1111/j.1365-2753.2007.00853.x
31. Mohler MJ, D'Huyvetter K, Tomasa L, O'Neill L, Fain MJ. Healthy aging rounds: Using healthy-aging mentors to teach medical students about physical activity and social support assessment, interviewing, and prescription. *J Am Geriatr Soc*. 2010;58(12):2407-2411. https://doi.org/10.1111/j.1532-5415.2010.03125.x
32. Pugh G, O'Halloran P, Blakey L, Leaver H, Angioi M. Integrating physical activity promotion into UK medical school curricula: Testing the feasibility of an educational tool developed by the Faculty of Sports and Exercise Medicine. *BMJ Open Sport Exerc Med*. 2020;6(1):e000679. https://doi.org/10.1136/bmjsem-2019-000679
33. Weiler R, Chew S, Coombs N, Hamer M, Stamatakis E. Physical activity education in the undergraduate curricula of all UK medical schools. Are tomorrow's doctors equipped to follow clinical guidelines? *Br J Sports Med*. 2012;46(14):1024-1026. https://doi.org/10.1136/bjsports-2012-091380
34. Minhas PS, Ghosh A, Swanzy L. The effects of passive and active learning on student preference and performance in an

undergraduate basic science course. *Anat Sci Educ*. 2012;5(4):200-207. https://doi.org/10.1002/ase.1274

35. O'Brien MW, Shields C, Solmundson K, Fowles J. Exercise is medicine Canada workshop training improves physical activity practices of physicians across Canada, independent of initial confidence level. *Can Med Educ J*. 2020;11(5):e5-e15. https://doi.org/10.36834/cmej.68376
36. Bowen P, Mankowski R, Harper S, Buford T. Exercise Is Medicine as a Vital Sign: Challenges and Opportunities. *Transl J ACSM*. 2019;4(1):1-7. https://doi.org/10.1249/TJX.0000000000000076
37. Frémont P, Fortier M, Frankovich RJ. Exercise prescription and referral tool to facilitate brief advice to adults in primary care. *Can Fam Physician*. 2014;60(12):1120-1122, e591-2.
38. Orrow G, Kinmonth A-L, Sanderson S, Sutton S. Effectiveness of physical activity promotion based in primary care: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2012;344:e1389. https://doi.org/10.1136/BMJ.E1389
39. Rowley N, Mann S, Steele J, Horton E, Jimenez A. The effects of exercise referral schemes in the United Kingdom in those with cardiovascular, mental health, and musculoskeletal disorders: a preliminary systematic review. *BMC Public Health*. 2018;18(1):949. https://doi.org/10.1186/s12889-018-5868-9
40. Ross R, Chaput J-P, Giangregorio LM, et al. Canadian 24-Hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years or older: an integration of physical activity, sedentary behaviour, and sleep. *Appl Physiol Nutr Metab*. 2020;45(10 (Suppl. 2)):S57-S102. https://doi.org/10.1139/apnm-2020-0467
41. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*. 2020;54(24):1451-1462. https://doi.org/10.1136/bjsports-2020-102955
42. Tremblay MS, Warburton DE, Janssen I, et al. New Canadian physical activity guidelines. *Appl Physiol Nutr Metab*. 2011;36(1):36-46. https://doi.org/10.1139/H11-009
43. Dogra S, Copeland JL, Altenburg TM, Heyland DK, Owen N, Dunstan DW. Start with reducing sedentary behavior: A stepwise approach to physical activity counseling in clinical practice. *Patient Educ Couns*. 2022;105(6):1353-1361. https://doi.org/10.1016/j.pec.2021.09.019

Appendix A. Supplemental Tables

Supplemental Table 1. Search strategy framework.

Main Concepts	Search Terms
Educational Intervention	Workshop OR Seminar OR Course OR Interview OR Tool OR Training OR Counselling OR Learning OR Intervention OR University OR Education OR Webinar
Medical Provider	Physician OR Family Physician OR Medical Student OR Family Medicine OR General Practitioner OR Primary Health Care OR Routine Consultation OR Doctor OR Practitioner OR Resident
Practice Outcome	Prescription OR Counselling OR Motivation OR Confidence OR Perceptions OR Behaviours OR Barriers
Movement	Physical Activity OR Exercise
	NOT "Review"

Supplemental Table 2. Educational content involved in each intervention

Author (year)	Intervention Curriculum
Brennan et al.[14]	Seven distinct stations prompted the following: Five major steps to intervention (exercise counseling) Exercise Prescription and Goal Setting Simple Strategies for Aerobic Activity Considerations for Rural and Remote Settings Strategies for PA Promotion Introduction to the Canadian PA Guidelines Strategies for Resistance Exercise Training.
Conroy et al.[19]	4-weeks clinical preventative medicine, 8-weeks of clinical nutrition, and 1-week exercise counselling using problem-based learning tutorials, stimulated scenarios, and student-led debates
Eckstrom et al.[21]	Workshop 1 focused on PA counselling skills in patients with chronic conditions including obstructive pulmonary disease, congestive heart failure, and diabetes. Workshop 2 focused on alternative action for problems that may arise during PA counselling Physicians were provided educational handout summarizing the content of the workshop and a list of community resources to give to patients interested in beginning a PA program
Flood et al.[22]	Workshop 1 include motivational interview strategies Workshop 2 included presenting evidence behind the importance of PA for prevention and treatment, practical steps for discussing PA, using the PA Vital Sign appropriately, how to provide PA prescription, referral and follow-up, and applying these learned skills in various populations
Frank et al.[20]	Focused on diet, exercise, alcohol, and tobacco habits Specific lectures on exercise focused on patient counselling with materials from national leader in the field
Jadczak et al.[27]	No specific tutorials focused on exercise prescription, but students were exposed to therapy programs and required to conduct community-based exercise classes where students interviewed older adults about exercise Leaning the PA guidelines specific to older adults
Jadczak et al.[26]	How to assess PA levels in older adults, conduct safety screening, identify risk factors, motivate an older population, determine readiness to change, write exercise prescriptions, and provide medical clearance for exercise programs
Jadczak et al.[25]	No specific tutorials focused on exercise prescription, but students were exposed to therapy programs and required to conduct community-based exercise classes where students interviewed older adults about exercise Leaning the PA guidelines specific to older adults
Jones et al.[28]	Lectures incorporated promoting wellness through PA and preventing injury through safe exercise practice Lecture content guided by the General Medical Council's 'Tomorrow's Doctors'.
Katz et al.[30]	Apply the Pressure System Model, conduct motivational interviewing, and create decision balance tables (pro/con lists) with patients about exercise Review case studies and strategies to address barriers to PA counselling
Malatskey et al.[23]	Convery the importance of lifestyle medicine to patient health Acquire knowledge and skills in prescribing physical activity for situations of health and common illnesses; will know how to evaluate patients prior to physical activity and how to motivate them to action.

	Adopt a positive attitude toward lifestyle intervention and will promote the application of this field
Mandic et al.[24]	Conducting health checks including assessing PA habits and providing PA advice
Mohler et al.[31]	10-minute introduction of aging, inclusive of sociodemographic, use and health status 15-minutes about PA, guidelines and tips, and counselling tops Couples with reference articles provided before session A recording of PA regimen plans was provided to students 20-minutes one-on-one PA interview and counselling session with student-health mentor 10-minute wrap-up session
Pugh et al.[32]	Generic skills in exercise prescription including PA history taking, behaviour change, and chronic condition specific exercise advice
Rogers et al.[29]	Conference 1: Physiology of cardiorespiratory fitness, endurance, and performance Conference 2: Physical activity benefits, physical activity recommendations, calculating target heart rate, local exercise facilities/opportunities, and safety issues. Conference 3: Stages of change, resident physician determination of personal stage of change, components of an exercise prescription, administration/discussion of physician-based assessment and counseling for exercise materials Conference 4: Muscular strength training/endurance, joint mobility Conference 5&6: Stages of change reviewed, behavioral management of the physical activity process

PA, physical activity

Supplemental Table 3. PRIMSA 2020 checklist

Section and Topic	Item #	Checklist item	Location where item is reported (page #)
TITLE			
Title	1	Identify the report as a systematic review	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstract checklist	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	3-4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4
METHODS			
Eligibility Criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses	5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4-5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used	5-6
Selection Process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	5-6
Data Collection Process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process	5-6
Data items	10	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5-6
	11	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	6
Study risk of bias	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	6

Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results	NA
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	7-8
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	8-9
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses	NA
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	5-6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression)	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	6
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome	NA
RESULTS			
Study Selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram	6-7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	NA
Study characteristics	17	Cite each included study and present its characteristics.	Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study	NA
Results of individuals studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots	7-11
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	NA
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7-11
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	7-11
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	7-11
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	7-11
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence	14
	23b	Discuss any limitations of the evidence included in the review.	18
	23c	Discuss any limitations of the review processes used.	18-19
	23d	Discuss implications of the results for practice, policy, and future research.	18-19
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	11
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	4
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the revie	17-18
Competing interests	26	Declare any competing interests of review authors	18
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	NA