Received: 27 August 2021 | Accepted: 11 November 2021

DOI: 10.1111/jhn.12972

JHND Journal of Human Nutrition and Dietetics | BDA The Association of UK Dietitians

Evaluating nutrition education interventions for medical students: A rapid review

Priya Patel[1] | **Shireen Kassam**[2,3]

[1]College of Medicine and Health, St Luke's Campus, University of Exeter, Exeter, UK

[2]Department of Haematology, Kings College Hospital, Denmark Hill, London

[3]Faculty of Health and Wellbeing, University of Winchester, Winchester, Hampshire

Correspondence

Priya Patel, College of Medicine and Health, St Luke's Campus, University of Exeter, Heavitree Road, Exeter EX1 2LU, UK.
Email: Priyapatel97@hotmail.co.uk

Funding information

None

Abstract

Background: Unhealthy diets account for 20% of all deaths globally. Most medical schools do not sufficiently teach their students the clinical application of nutrition science. Evaluating the efficacy of nutrition education interventions is therefore important for their widespread implementation.

Methods: A rapid review of the literature published between 2015 and 2020 was conducted to identify nutrition education interventions delivered to undergraduate medical students. The modified Kirkpatrick hierarchy score was used to evaluate the outcome measures. Study characteristics and outcomes were charted and discussed using narrative synthesis. Included studies were appraised using the MERSQI criteria.

Results: Fifteen nutrition education interventions met the inclusion criteria. Twelve were from the USA and most were optional rather than compulsory. Interventions involved a mixture of methods including cooking sessions, lectures, and student-led programs. The content covered was variable and the median duration was 11 h (range 90 min to 75 h). The modified Kirkpatrick scores varied and the median MERSQI score was 12.8/18. No studies reported the use of national or standardised guidance to inform the learning objectives of the interventions.

Conclusions: The interventions reviewed are heterogenous in their nature and outcomes. This review highlights the advantages of utilising interprofessional learning, focusing on student's personal health behaviours and harnessing novel teaching methods such as hands-on cooking. Using national guidance to develop learning outcomes will help to standardise the content taught. Future studies may aim to use validated assessment tools and investigate the long-term impacts on delivery of care and patient outcomes.

KEYWORDS

culinary medicine, diet, medical education, nutrition education

Key points

- Increased nutrition training in medical education is needed.
- A variety of teaching approaches were identified, including novel methods such as culinary medicine and service learning.
- Future research is needed to further evaluate nutrition education interventions, including patient health outcomes.
- Development and utilisation of national guidance is needed to standardise content.

[Correction added on 24 December 2021, after first online publication: Peer review history statement has been added.]

INTRODUCTION

Globally, unhealthy diets contribute to more deaths than any other risk factor and approximately 20% of all death scan be attributed to a suboptimal diet.[1] Nutrition therefore plays a crucial role in the prevention and treatment of non-communicable diseases,[2–4] which account for 89% and 88% of all deaths in the UK and USA, respectively.[5,6] In line with this, the UK's General Medical Council states that graduates should be able to discuss the role and impact of nutrition on health.[7] In the USA, the Association of American Medical Colleges endorsed a bill in the US congress in 2019 to enhance nutrition education within medical school curricula, although this bill was not endorsed into legislation.[8,9] Nutrition is also of topical importance considering the significant role that diet plays in the development of many of the risk factors associated with severe COVID-19.[10,11]

Despite acknowledgement of the importance of nutrition, there is still a significant under-representation of nutrition education in medical school curricula,[12] which also appears to extend to postgraduate medical training.[13] The most recent systematic review on this topic found that, regardless of country, setting or year of medical education, medical students report inadequate knowledge, skills and confidence to support patients in making sustainable dietary changes.[14] Crowley et al.[14] also found that, when initiatives are incorporated into curricula, their impact is modest as a result of the heterogeneity of approaches and lack of robust tools for evaluation, thus leading to recommendations to establish competencies as a means of benchmarking nutrition knowledge and skill. Identifying effective strategies to teach medical students about nutrition is therefore essential. Teaching methods recommended by a systematic review evaluating nutrition education interventions in health professionals included interprofessional learning (IPL) and interventions that place an emphasis on learners' personal health behaviours.[15]

The present study aimed to evaluate nutrition education interventions delivered to medical students published between 2015 and 2020 to assess recent efforts in this field subsequent to publication of the prior systematic review.[15] Here, we define nutrition education as any educational experience related to the role of nutrition in health within the context of undergraduate medical education.

METHODS

Search strategy

A rapid review of the literature was conducted using Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. A search (by PP) was conducted in Medline (via OvidSp), Scopus and ERIC (via EBSCOhost) (22/10/20) for relevant papers published from October 2015 to October 2020. This timeframe was chosen as an extension of a systematic review of nutrition education interventions conducted 5 years ago.[15] The search terms used included (Medical student* or Medical school* or Medical undergraduate*) AND (Nutrition* education or Nutrition* intervention* or Nutrition* curricul* or Nutrition* training). The search terms used for each database are detailed in the Supporting information (Table S1). A forwards-citation search of the aforementioned systematic review was conducted[15] and a backwards-citation search was conducted on a recent systematic review of nutrition in medical education.[14]

Study selection

The aim of the selection process was to identify any English-language empirical studies that quantitatively evaluated nutrition education interventions delivered to medical students. The inclusion and exclusion criteria used to determine eligibility are shown in Table 1. All citations were managed using EndNote Online (https://endnote.com). Duplicates were removed by hand.

TABLE 1 Inclusion/exclusion criteria

Inclusion	Exclusion
Empirical study presenting quantitative data	Not published in English
Published within the past 5 years (October 2015–2020)	Unable to isolate the outcomes of medical students from cohort
Intervention delivered to undergraduate medical students	Unable to isolate the outcomes of nutrition education intervention from a general lifestyle medicine intervention
	Delivers non-generalisable nutrition education of specific patient groups
	Unable to view full text
	Assessment alone was not considered as a nutrition education intervention

Data extraction

Key information was extracted (by PP) from the included studies, identifying study design, intervention methods and modified Kirkpatrick's hierarchy score.[16] Evaluating the effectiveness of nutrition education interventions is key in recognising their impact and shaping the development of future interventions. The Kirkpatrick model is a recognised method for 'classifying the effectiveness of an intervention according to different educational outcomes'.[16] The data extraction and descriptive statistics used were adapted from the previous systematic review on nutrition education interventions.[15]

Quality appraisal

The Medical Education Research Study Quality Instrument (MERSQI) was used to appraise the included studies.[17] There was no MERSQI score cut-off for inclusion within the review. The total score was calculated as a percentage of points adjusting for non-applicable responses, giving a maximum score of 18.

RESULTS

In total, 178 papers were identified through the initial database search and 17 from citation chasing (Figure 1). After removing 69 duplicates, the remaining 126 papers were screened for eligibility based on the inclusion and exclusion criteria (Table 1) by assessing the title and/or abstract. Of these, 101 papers did not meet the inclusion criteria and were excluded. The full text of the remaining 25 papers was reviewed (by PP), of which 10 did not meet the inclusion criteria and were removed. The remaining 15 papers are evaluated in this review. A summary of the intervention descriptions,

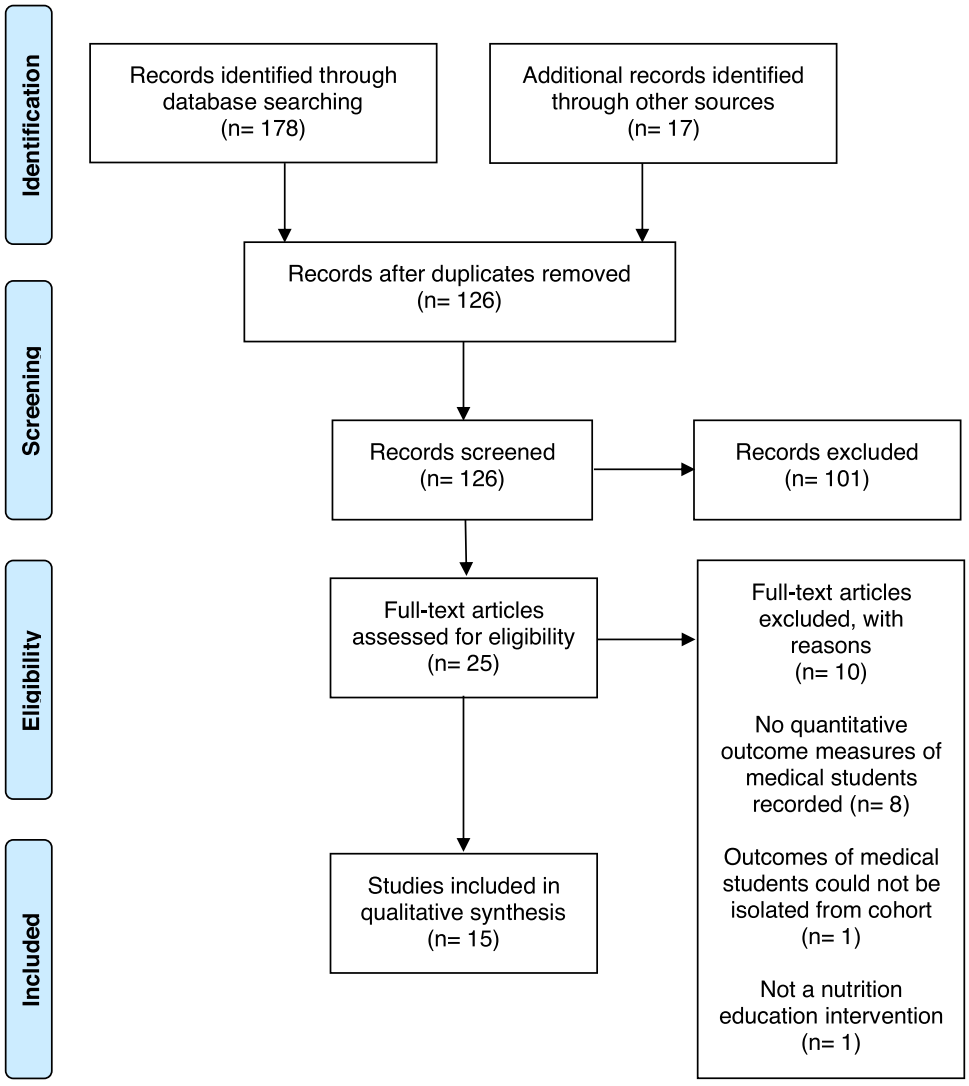

FIGURE 1 Preferred Reporting Items for Systematic reviews and Meta-Analyses diagram

reported findings and MERSQI scores of the included papers is provided in Table 2.

Most ($n = 12$) of the studies were conducted in the USA, with the remaining from the UK,[20] the Netherlands[22] and Portugal.[26] Four of the interventions were required,[21,24,26,28] whereas the rest were elective (optional). Five of these interventions were described as pilot studies.[18,20,29,31,32] The median number of participants was 51, ranging from 15[20] to 3248.[25] Interventions either allowed students of all year groups to participate[22,25,32] or were specific to year[19,20,24,27,28,31] and clinical groups.[18,21,23,26,29,30] The median duration of all the interventions was 11 h, ranging from 90 min[19] to 75 h.[26] However, three studies did not report the length of the student-led component of the course.[29–31]

Content areas and teaching methods

Nine of the interventions addressed specific patient populations. For example, Coppoolse et al.[22] implemented a 10-week elective course involving 25 experts hosting lectures covering a different topic related to nutrition and disease over 25 h. Lectures included 'nutrition and diabetes', 'nutrition and cancer' and 'nutrition and cardiovascular disease'. Nine interventions included basic nutrition science; for example, Mota et al.[26] delivered a nutrition and metabolism required curricula unit for first year students. Contents included metabolic pathways, micro- and macronutrients, and regulation of food intake. Culinary medicine was utilised in seven studies.[23–25,27,29,31,32] Dietary counselling was covered in six of the identified interventions.[19–21,24,28,29] Most of the studies incorporated a combination of content areas. For example, Jacob et al.[24] delivered a single day culinary laboratory where students had to identify certain micro- and macronutrients that would benefit a patient case study and consider the metabolic pathways and food sources for these nutrients before cooking a tailored recipe. No studies reported the use of national or standardised guidance to inform the learning objectives of the interventions.

A range of teaching methods were used. Five studies incorporated a student-led component where medical students taught each other,[18] school children[18,25,26] or families[30] about nutrition. One study used a student-led evidence-based nutrition lecture series involving a total of five peer taught lectures.[18] A survey found that 93% ($n = 14$) of students agreed with the statement: 'I like the peer teaching aspect of this lecture series and think it is an effective way to learn'. Ronecker et al.[30] developed a didactic curriculum with a 6-8-week student-led family coaching program. This involved a 7-h coaching and nutrition training course followed by weekly meetings with at-risk children and their families. Similarly, Ring et al.[29] involved both a teaching and service component, where medical students taught school children about healthy eating after a nutrition training course involving a combination of didactics and culinary medicine. Students reported increased confidence in nutrition and obesity counselling after the course ($p < 0.001$).

Four interventions were explicit in harnessing IPL as part of the teaching methods.[19,21,24,27] One study developed an interprofessional nutrition workshop that was jointly facilitated by registered dietitians who 'provided experience and critical content' for the session.[21] Additionally, student dietitians participated in the planning and facilitation of the experiential culinary laboratory of Jacob et al.[24] The results of a questionnaire used to evaluate medical student's attitudes towards the culinary laboratory found that the participants rated the knowledge of the student dietitians highly and above their own ($p < 0.001$).[24] Other teaching methods used include cooking sessions,[23–25,27,29,31,32] lectures[18–20,22,27,29,30,32] and case-based discussions.[24,26–28,31]

Instructors varied and with some involving a combination of professions, including dietitians,[19–22,24,26,27,30,31] physicians,[20,21,27,31,32] chefs,[27,29,32] and psychologists.[20,22] Pang et al.[27] delivered a 6-week hands-on culinary and nutrition course, with each session delivered jointly by a physician, dietitian and chef. The multidisciplinary approach allowed the course to cover content including disease pathophysiology, dietary management and meal preparation on a limited budget as a result of the wide range of faculty expertise.

Evaluation design and learning outcomes

Two studies used a single group post-test only design.[18,24] The remaining studies used a single group pre- and post-test design, with three of these also including a non-randomised control group.[21,22,25] Learning outcomes were measured using the Best Evidence in Medical Education (BEME) adapted Kirkpatrick's hierarchy.[16] Learning outcomes achieved include changes in behaviour (Level 3),[21,23,25,26] knowledge (Level 2b),[20,22,27,30] attitudes (Level 2a)[28,29,31,32] and satisfaction (Level 1).[22,24] No studies reported an impact on delivery of care (level 4a) or patient outcomes (Level 4b).

Four studies demonstrated significant improvements in the learner's self-reported health behaviours,[23,25,26,29] three of which involved a culinary medicine component. For example, Monlezun et al.[25] evaluated a multisite cohort trial on hands-on cooking and nutrition education of 3248 medical students from over 45 institutions in the USA. This study found significantly higher self-reported adherence to a Mediterranean diet in the culinary medicine program cohort compared with the traditional curricula cohort (odds ratio = 1.40, 95% confidence interval = 1.07–1.84, $p = 0.015$). Additionally, Mota et al.[26] found improved self-reported health behaviours, including avoidance of foods high in fat and/or sugar ($p < 0.001$), after a classroom-based nutrition and metabolism compulsory curricula unit. One study

TABLE 2 Summarising of the 15 included studies

Study Author (year) Country	Intervention description	Compulsory or elective	Study design and participants	Type of instructor	Setting	Method of intervention	Duration	Content areas covered	Improved outcomes (Kirkpatrick hierarchy[a])	MERSQI Score/18
Baute et al. (2017) USA[18]	Pilot intervention of a student-led evidence-based lecture series	Elective	Single group post-test only. Clinical medical students ($n = 65$)	Medical student	Classroom	Lecture Student-led peer-assisted learning	5 h	Not reported	Satisfaction[1]	7.2
Berz et al. (2020) USA[19]	Interprofessional nutrition session	Elective	Single group pre-test and post-test Fourth year medical students ($n = 42$)	Dietitian Physician	Classroom	Lecture Interprofessional Workshop	90-min	Basic science nutrition Dietary counselling Diet history taking	Attitudes Knowledge Clinical skills (2b)	12.6
Broad et al. (2018) UK[20]	Pilot intervention of a 6-week nutrition course with a student-led school-based teaching component	Elective	Single group pre-test and post-test Final-year medical students ($n = 15$)	Dietitian Manager Pharmacist Physician Psychologist	Classroom School	Lecture Student-led service learning[b] Workshop	11 h	MDietary counselling Specific patient population	Knowledge (2b)	12
Cavuoto Petrizzo (2020) USA[21]	Interprofessional nutrition workshop integrated within the pre-clinical curricula	Required	Single group pre-test and post-test Pre-clinical medical students ($n = 63$)	Dietitian Physician	Classroom	Interprofessional Workshop	2 h	Basic nutrition science Dietary counselling Diet history taking	Satisfaction Attitudes (2a)	12.6
			Nonrandomized, 2 group Pre-clinical medical students ($n = 197$)						Behaviour (3)	15
Coppoolse (2020) The Nether-lands[22]	10-week lifestyle and nutrition course	Elective	Single group pre-test and post-test Non-randomized, 2 group Medical students (all years) ($n = 118$)	Dietitian Nutritionist Psychologist	Classroom	Lecture	25 h	Specific patient population	Knowledge (2b)	13.2
Flynn et al. (2019) USA[23]	4-week plant-based cooking program	Elective	Single group pre-test and post-test First and second year medical students ($n = 43$)	Not reported	Kitchen	Cooking session	2 h	Dietary patterns Learner's health behaviour	Knowledge Learner's health behaviour (3)	13.2

(Continues)

TABLE 2 (Continued)

Study Author (year) Country	Intervention description	Compulsory or elective	Study design and participants	Type of instructor	Setting	Method of intervention	Duration	Content areas covered	Improved outcomes (Kirkpatrick hierarchy[a])	MERSQI Score/18
Jacob et al. (2016) USA[24]	Pilot intervention of a 1-day culinary cooking laboratory for first-year medical students	Compulsory	Single group post-test only First year medical students ($n = 90$)	Student dietitian	Kitchen	Case-based discussion Cooking session Interprofessional	6 h	Basic nutrition science Culinary medicine Dietary counselling	Satisfaction (1)	9.6
Monlezun et al. (2018) USA[25]	Multisite cohort study of students from 20 medical schools over 5 years	Elective	Single group pre-test and post-test Non-randomised, 2 group Medical students (all years) ($n = 3248$)	Not reported	Classroom Kitchen Online	Cooking session Problem based learning	28 h	Basic nutrition science Culinary medicine Specific patient population	Knowledge Learner's health behaviour (3)	13.8
Mota et al. (2020) Portugal[26]	Nutrition and metabolism curricula unit for first year medical students	Compulsory	Single group pre-test and post-test Pre-clinical medical students ($n = 310$)	Dietitian	Classroom	Case-based discussion Problem based learning	75 h	Basic nutrition science Population health Specific patient populations	Attitudes Knowledge Learner's health behaviour (3)	13.2
Pang et al. (2019) USA[27]	6-week culinary medicine course for second year medical students	Elective	Single group pre-test and post-test Second year medical students ($n = 15$)	Chef Dietitian Physician	Kitchen	Case-based discussion Lecture Cooking session Interprofessional	15 h	Culinary medicine Specific patient populations	Attitudes Knowledge (2b)	13.8
Ramsetty et al. (2020) USA[28]	Pilot intervention of case-based nutrition education session via video conferencing	Compulsory	Single group pre-test and post-test Third year medical students ($n = 58$)	Not reported	Online	Case-based discussion	2 h	Dietary counselling Specific patient populations	Attitudes (2a)	8.4

TABLE 2 (Continued)

Study Author (year) Country	Intervention description	Compulsory or elective	Study design and participants	Type of instructor	Setting	Method of intervention	Duration	Content areas covered	Improved outcomes (Kirkpatrick hierarchy[a])	MERSQI Score/18
Ring et al. (2018) USA[29]	Pilot intervention combining didactics, culinary sessions with a student-led school-based teaching component	Elective	Single group pre-test and post-test First and second year medical students ($n = 21$)	Chef	Classroom Kitchen School	Lecture Cooking session Student-led service learning	15 h plus student-led component (not reported)	Basic nutrition science Culinary medicine Dietary counselling Population health Specific patient populations	Attitudes Learner's health behaviour (3)	11.4
Ronecker et al. USA (2019)[30]	Didactic curriculum with a 6-8-week student-led family coaching program	Elective	Single group pre-test and post-test First and second year medical students ($n = 25$)	Dietitian Physician	Classroom Community[c]	Lecture Student-led service learning	7 h plus student-led component (not reported)	Specific patient populations Population health	Attitudes Knowledge (2b)	12.6
Rothman et al. (2020) USA[31]	Pilot intervention culinary sessions with disease specific case-based discussions with a student-led school-based teaching component	Elective	Single group pre-test and post-test Fourth year medical students ($n = 30$)	Dietitian Physician	Classroom Kitchen School	Cooking session Case-based discussion Patient experience Student-led service learning	16 h plus student-led component (not reported	Basic nutrition science Culinary medicine Specific patient populations	Attitudes (2a)	8.4
Shafto et al. (2016) USA[32]	Pilot intervention combining didactic and culinary sessions	Elective	Single group pre-test and post-test Medical students (all years) ($n = 17$)	Chef Physician	Kitchen	Cooking session Lecture	18 h	Basic nutrition science Dietary patterns Culinary medicine	Attitudes (2a)	10.2

[a]Modified Kirkpatrick levels based on Best Evidence in Medical Education: (1) learners' views on the intervention, (2a) learners' attitudes toward the intervention, (2b) learners' improved knowledge or skills, (3) learners' behaviour change, (4a) delivery of care or (4b) patient outcomes.

[b]Service-learning: Students teaching members of the community.

[c]Community: Outside of the institution or school setting.

assessed for behaviour change by comparing the student's Objective Structured Clinical Exam (OSCE) scores with a historical control group.[21]

Study quality

The median MERSQI score was12.6/18, ranging from 8.4[18] to 15.[21] All studies used surveys sent to the participants as one way to evaluate the intervention. Four studies either used a previously validated survey[25,26] or took steps to validate their own.[21,22] The validity of instrument domain of the MERSQI was excluded for most studies because the data collected were not considered applicable except for one study, which included an objective skills assessment.[21] The study with the highest MERSQI score was one of two included studies involving students from multiple institutions and used OSCE scores to evaluate the impact of the intervention.[21] As a result, all participant data were available for analysis and student behaviour was assessed using objective, rather than self-assessed, measures. This study involved a single classroom-based interprofessional nutrition workshop integrated within the pre-clinical curricula. Features of studies achieving low quality rating scores included evaluation methods that were self-assessed, achieved learning outcomes regarding student satisfaction and attitudes only, and had a low or unreported response rate. Item-specific scores are detailed in the Supporting information (Table S2).

DISCUSSION

The present study aimed to evaluate nutrition education interventions delivered to medical students published between 2015 and 2020 and assess recent efforts in this field subsequent to publication of the prior systematic review on the topic.[15] To the best of the author's knowledge, this is the only review of undergraduate medical nutrition education interventions and their outcomes published[15] within this timeframe.

Similar to the previous review, the majority of studies were conducted in the USA and the remainder in European countries, which may mean that the interventions reviewed are not culturally applicable to other countries. The under-representation of other nations in the peer-review literature may limit the development of culturally diverse interventions and result in less appropriate approaches to nutrition education. Therefore, the recent literature base would benefit from wider global representation.

The majority of the interventions in this review were elective (optional), despite the growing consensus that nutrition education for medical students should be required in undergraduate training.[14] The study by Mota et al.[26] was the only one in this review to integrate and evaluate a required curricula unit, consisting of 75 h of nutrition education for first year medical students.[26] Medical students participating in optional interventions may represent either a more motivated or more nutritionally aware cohort, which may over- or underestimate results. Despite the centrality of nutrition to health,[14] efforts to introduce compulsory nutrition education may be hindered by an already crowded curriculum. Strategies to navigate this include establishing nutrition as an integrated theme throughout the curriculum and using the existing content to discuss the role of nutrition in health.[33] Using themes allows educators to meaningfully link different disciplines for students to appreciate the relevance of learning to their future practice.[34] However, this requires commitment from curriculum designers to support their staff and organise its delivery and evaluation.[34] Progress has been made by some UK medical schools including University College London Medical School, which has included a culinary medicine course within its core curriculum involving culinary skills training, case-based discussions and motivational interviewing role play.[35]

Most interventions included non-medical professionals as instructors ($n = 11$); however, only four were explicit in utilising IPL.[19,21,24,27] The latest BEME report on the effects of IPL found that it improves the effectiveness of educational interventions.[36] The benefits of IPL include improved interprofessional attitudes and perceptions and increased collaborative knowledge and skills.[36] In addition, the multidisciplinary nature of nutrition care and patient education is well suited to IPL. This may address concerns that faculty are not equipped to develop and deliver nutrition training when preparing students for the reality of collaborative practice.[37] This is highlighted in one of the included studies where dietitians were described as being crucial for the development and facilitation of a nutrition workshop.[21] There is also the potential to incorporate IPL with nutrition competencies to prepare students for practice in delivering high quality care and advice.[37] For an intervention to be considered as IPL, there must be an active exchange between different professionals with the aim of improving care.[36] This should be made explicit when designing and describing a multidisciplinary intervention, as highlighted by the latest systematic review of nutrition education interventions.[15]

Novel methods of teaching nutrition, including culinary medicine and student-led components, were observed in this review. Interactive cooking sessions were used in seven of the interventions, giving students a 'hands-on' learning experience termed culinary medicine. This differs from the previous review on nutrition education interventions, with only two of the 32 included studies involving a kitchen-based element.[15] Potential reasons for this increased interest may include a greater focus on prevention in policy[38] and the shift towards delivering engaging and applicable medical education.[39]

Part of the rationale behind this method is the evidence that doctors are more likely to counsel patients on lifestyle modifications if they themselves practice healthy habits.[40] Three of these interventions demonstrated improved student self-reported health behaviours.[23,25,29] For example, students participating in a multisite medical school-based teaching kitchen intervention significantly higher self-reported high and medium adherence to a Mediterranean diet compared with a control cohort (odds ratio = 1.40, 95% confidence interval = 1.07–1.84, $p = 0.015$).[25] The wider benefits of such schemes include the potential for medical students to teach patient groups in similar settings. A randomised controlled study demonstrated improved biometrics in patients with type 2 diabetes after student and faculty-led cooking classes.[41] Statistically significant changes include improvements in diastolic blood pressure (−4 vs. 7 mmHg, $p = 0.037$) and total cholesterol (−14 vs. 17 mg dl^{-1}, $p = 0.044$). Furthermore, a recent systematic review concluded that culinary interventions delivered to patients were associated with improved attitudes and a healthier dietary intake.[42] The increasing application of culinary medicine is highlighted by the recent formation of organisations such as Culinary Medicine[43] in the UK and the Teaching Kitchen Collaborative[44] in the USA.

Some interventions required the students themselves to teach peers,[18] schoolchildren[20,29,31] or families[30] about nutrition. Learning-by-teaching is a recognised method of learning supported by empirical evidence suggesting that teaching promotes cognitive benefits.[45] There are also many established benefits of specifically peer-assisted learning[46] and service-learning[47] that may extend beyond the individual. The benefits of service-learning in the identified studies include improved mentorship skills[30] and increased confidence in nutrition and obesity counselling.[29]

The heterogeneity between the identified interventions, including the content and methods, is mirrored from the previous review.[15] This is important to address so that future physicians are able to provide consistent and high-quality care to their patients. As echoed by Crowley et al.,[14] there is a need to standardise and integrate nutrition education across nations. Institutions such as the Association for Nutrition UK[48] and European Society for Clinical Nutrition and Metabolism[49] have developed guidance outlining the requirements of undergraduate nutrition training, although further action is needed to integrate these standardised objectives within medical curricula. Additionally, variations in the scope and detail of these guidelines may ultimately impact the nutrition care delivered within these regions.[50] Therefore, a 'joint international strategic approach to nutrition in medical education' has been suggested as a more consistent solution.[50]

Strengths and limitations

The strengths of this review include its systematised search and appraisal strategy. Although only English-language studies were included in this review, no studies were excluded on language alone after full-text review. A wider search of databases such as MedEdPORTAL and a grey literature search may have yielded further relevant studies. This study did not undergo double screening.

CONCLUSIONS AND RECOMMENDATIONS

This rapid review explores and summarises nutrition education interventions delivered to medical students published within the past 5 years. Heterogeneity in the methods, content and outcomes of the identified interventions was identified. This review highlights the benefits of teaching approaches including IPL and placing a focus on the student's personal health behaviours. Novel teaching methods such as culinary medicine and student-led initiatives may offer additional benefits, including to the wider community. This review highlights the need for institutions to publish and share their resources for wider global representation in the literature. Additionally, the use of validated surveys and objective assessments should be considered to improve the quality of their findings. Institutions may also consider a curricula-wide approach to integrating nutrition education using national guidance to improve standardisation of learning objectives and assessment. Future research may involve longitudinal studies to assess the long-term impact of integrated nutrition education on delivery of care and its impact on patients.

ACKNOWLEDGEMENTS

We thank Dr Carolina Rojido for her invaluable editing assistance. We also thank Dr Stephanie Bull, Alison Bethel and Amy McEwan for their timely and thoughtful advice with this review. Priya Patel and Shireen Kassam agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved and both authors were in agreement to be submitted for publication. There was no funding granted for this project.

CONFLICT OF INTERESTS

The authors declare that there are no conflicts of interest.

ETHICAL APPROVAL

No human subjects were involved in this study. This was a rapid review.

AUTHOR CONTRIBUTIONS

Priya Patel contributed from conception to the design and main body of the paper. Shireen Kassam contributed significantly to the main body of the paper, particularly with development of the introduction and discussion. Priya Patel and Shireen Kassam reviewed and edited several drafts of the paper.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Priya Patel http://orcid.org/0000-0002-0740-1099
Shireen Kassam https://orcid.org/0000-0002-6173-3326

PEER REVIEW

The peer review history for this article is available at https://publons.com/publon/10.1111/jhn.12972.

REFERENCES

1. GBD 2017 Diet collaborators. Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019;393:1958–72.
2. Clinton SK, Giovannucci EL, Hursting SD. The World Cancer Research Fund/American Institute for Cancer Research third expert report on diet, nutrition, physical activity, and cancer: impact and future directions. J Nutr. 2020;150:663–71.
3. Estruch R, Ros E, Salas-Salvadó J, Covas MI, Corella D, Arós F, et al. Primary prevention of cardiovascular disease with a Mediterranean diet. N Eng J of Med. 2013;368:1279–90.
4. Kahleova H, Levin S, Barnard N. Cardio-metabolic benefits of plant-based diets. Nutrients. 2017;9:848.
5. World Health Organisation Noncommunicable diseases country profiles: United Kingdom. 2018. [cited 2018 Sep]. Available from: https://www.who.int/nmh/countries/gbr_en.pdf
6. World Health Organisation Noncommunicable diseases country profiles: United States of America. 2018. [cited 2018 Sep]. Available from: https://www.who.int/nmh/countries/usa_en.pdf
7. General Medical Council & Outcomes for graduates 2020. [cited 2020 Feb 25]. Available from: https://www.gmc-uk.org/education/standards-guidance-and-curricula/standards-and-outcomes/outcomes-for-graduates/outcomes-for-graduates
8. GovTrack.us H.R. 1888 — 116th Congress: ENRICH Act. 2021. [cited 2019 Mar 26]. Available from: https://www.govtrack.us/congress/bills/116/hr1888
9. AAMC Endorses Bill to Enhance Medical School Curricula in Nutrition 2019. [cited 2019 Dec 5]. Available from: https://www.aamc.org/advocacy-policy/washington-s/aamc-endorses-bill-enhance-medical-school-curricula-nutrition
10. O'hearn M, Liu J, Cudhea F, Micha R, Mozaffarian D. Coronavirus disease 2019 hospitalizations attributable to cardiometabolic conditions in the United States: a comparative risk assessment analysis. J Am Heart Assoc. 2021;10:e019259.
11. Williamson EJ, Walker AJ, Bhaskaran K, Bacon S, Bates C, Morton CE, et al. Factors associated with COVID-19-related death using OpenSAFELY. Nature. 2020;584:430–6.
12. Macaninch E, Buckner L, Amin P, Broadley I, Crocombe D, Herath D, et al. Time for nutrition in medical education. BMJ Nutr Prev Health. 2020;3:40.
13. Ganis L, Christides T. Are we neglecting nutrition in UK medical training? A quantitative analysis of nutrition-related education in postgraduate medical training curriculums. Nutrients. 2021;13(3):957.
14. Crowley J, Ball L, Hiddink GJ. Nutrition in medical education: a systematic review. Lancet Planet Health. 2019;3:e379–89.
15. Dang TM, Maggio LA. Supporting the call to action: a review of nutrition educational interventions in the health professions literature and MedEdPORTAL. Acad Med. 2017;92:403–16.
16. Hammick M, Dornan T, Steinert Y. Conducting a best evidence systematic review. Part 1: from idea to data coding. BEME Guide No. 13. Med Teach. 2010;32:3–15.
17. Reed DA, Cook DA, Beckman TJ, Levine RB, Kern DE, Wright SM. Association between funding and quality of published medical education research. JAMA. 2007;298:1002–9.
18. Baute V, Carr AD, Blackwell JN, Carstensen ER, Chhabra P, Porter LC, et al. Incorporating formal nutrition education into a medical school curriculum: a student-initiated lecture series. Am J Med. 2017;130:623–5.
19. Berz J, Donovan K, Eyllon M. An interprofessional nutrition education session for senior medical students on evidence-based diet patterns and practical nutrition tips. MedEdPORTAL. 2020;16:10876.
20. Broad J, Wallace M. Nutrition and public health in medical education in the UK: reflections and next steps. Public Health Nutr. 2018;21:2523–5.
21. Cavuoto Petrizzo M, Block L, Olvet DM, Sheridan EM, Dougherty R, Whitson M, et al. Implementation of an interprofessional nutrition workshop to integrate nutrition education into a preclinical medical school curriculum. J Am Coll Nutr. 2020;40(2):111–8.
22. Coppoolse HL, Seidell JC, Dijkstra SC. Impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students: an intervention study. BMJ Open. 2020;10:034377.
23. Flynn MM, George P, Schiffman FJ. Food is medicine: using a 4-week cooking program of plant-based, olive oil recipes to improve diet and nutrition knowledge in medical students. Med Sci Educ. 2019;29:61–6.
24. Jacob M, Stewart P, Medina-Walpole A, Fong CT. A culinary laboratory for nutrition education. Clin Teach. 2016;13:197–201.
25. Monlezun DJ, Dart L, Vanbeber A, Smith-Barbaro P, Costilla V, Samuel C, et al. Machine learning-augmented propensity score-adjusted multilevel mixed effects panel analysis of hands-on cooking and nutrition education versus traditional curriculum for medical students as preventive cardiology: multisite cohort study of 3,248 trainees over 5 years. BioMed Res Int. 2018;2018:5051289.
26. Mota IB, Castelo I, Morais J, Anjos M, Costa JP, Dias M, et al. Nutrition education in Portuguese medical students: impact on the attitudes and knowledge. Acta Med Port. 2020;33:246–51.
27. Pang B, Memel Z, Diamant C, Clarke E, Chou S, Gregory H. Culinary medicine and community partnership: hands-on culinary skills training to empower medical students to provide patient-centered nutrition education. Medl Educ Online. 2019;24:1630238.
28. Ramsetty A, Adams C, Berini C, Watson KH. Medical student attitudes on nutrition counseling after implementation of a novel curricular activity. J Am Coll Nutr. 2020;39:333–7.
29. Ring M, Cheung E, Mahadevan R, Folkens S, Edens N. Cooking up health: a novel culinary medicine and service learning elective for health professional students. J Altern Complement Med. 2019;25:61–72.
30. Ronecker J, Liu J, VanGarsse A, Newman R. Coaching, health, and movement program (Champs) taught by medical students: a didactic curriculum and program analysis. Osteopath Fam Physician. 2019;11:12–7.
31. Rothman JM, Bilici N, Mergler B, Schumacher R, Mataraza-Desmond T, Booth M, et al. A culinary medicine elective for

clinically experienced medical students: a pilot study. J Altern Complement Med. 2020;26:636–44.
32. Shafto K, Breen J, Decker D. Reimagining nutrition education in a teaching kitchen. findings from a pilot study. Minn Med. 2016; 99:44–5.
33. Kushner RF, Van Horn L, Rock CL, Edwards MS, Bales CW, Kohlmeier M, et al. Nutrition education in medical school: a time of opportunity. Am J Clin Nutr. 2014;99:1167S–73S.
34. Malik AS, Malik RH. Twelve tips for developing an integrated curriculum. Med Teach. 2011;33:99–104.
35. Xie JY, Abramovich N, Burridge J, Jaffee A, Broadley I. Nutrition education in core medical curricula: a call to action from tomorrow's doctors. Future Healthc J. 2021;8:19–21.
36. Reeves S, Fletcher S, Barr H, Birch I, Boet S, Davies N, et al. A BEME systematic review of the effects of interprofessional education: BEME Guide No. 39. Med Teach. 2016;38:656–68.
37. DiMaria-Ghalili RA, Edwards M, Friedman G, Jaferi A, Kohlmeier M, Kris-Etherton P, et al. Capacity building in nutrition science: revisiting the curricula for medical professionals. Ann N Y Acad Sci. 2013;1306:21–40.
38. National Health Service The NHS long term plan. 2019. [cited 2019 Jan]. Available from: https://www.longtermplan.nhs.uk/
39. Buja LM. Medical education today: all that glitters is not gold. BMC Med Educ. 2019;19:110.
40. Oberg EB, Frank E. Physicians' health practices strongly influence patient health practices. J R Coll Physicians Edinb. 2009;39:290–1.
41. Monlezun DJ, Kasprowicz E, Tosh KW, Nix J, Urday P, Tice D, et al. Medical school-based teaching kitchen improves HbA1c, blood pressure, and cholesterol for patients with type 2 diabetes: results from a novel randomized controlled trial. Diabetes Res Clin Pract. 2015;109:420–6.
42. Hasan B, Thompson WG, Almasri J, Wang Z, Lakis S, Prokop LJ, et al. The effect of culinary interventions (cooking classes) on dietary intake and behavioral change: a systematic review and evidence map. BMC Nutr. 2019;5:29.
43. Culinary Medicine UK. 2021. Available from: https://culinarymedicineuk.org
44. Teaching Kitchen Collaborative. 2021. Available from: https://teachingkitchens.org
45. Duran D. Learning-by-teaching. Evidence and implications as a pedagogical mechanism. Innov Educ Teach Int. 2017;54:476–84.
46. Yu T-C, Wilson NC, Singh PP, Lemanu DP, Hawken SJ, Hill AG. Medical students-as-teachers: a systematic review of peer-assisted teaching during medical school. Adv Med Educ Pract. 2011;2:157–72.
47. Stewart T, Wubbena ZC. A systematic review of service-learning in medical education: 1998–2012. Teach Learn Med. 2015;27: 115–22.
48. Association for Nutrition UK. Undergraduate curriculum in nutrition for medical doctors. 2021. [cited 2021 Oct]. Available from: https://www.associationfornutrition.org/wp-content/uploads/2021/10/2021-UK-Undergraduate-Curriculum-in-Nutrition-for-Medical-Doctors-FINAL.pdf
49. Cuerda C, Muscaritoli M, Donini LM, Baqué P, Barazzoni R, Gaudio E, et al. Nutrition education in medical schools (NEMS). An ESPEN position paper. Clin Nutr. 2020;39: 2938–9.
50. Crowley J, Ball L, Laur C, Wall C, Arroll B, Poole P, et al. Nutrition guidelines for undergraduate medical curricula: a six-country comparison. Adv Med Educ Prac. 6:127–33.

AUTHOR BIOGRAPHIES

Priya Patel, MSc, is a final year medical student.

Dr Shireen Kassam, MBBS, FRCPath, PhD, is a Consultant Haematologist and Lifestyle Medicine Physician. Founder and Director of Plant-Based Health Professionals UK.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Patel P, Kassam S. Evaluating nutrition education interventions for medical students: A rapid review. J Hum Nutr Diet. 2022;35:861–871. https://doi.org/10.1111/jhn.12972