Evaluation of a novel nutrition education intervention for medical students from across England

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Title

Evaluation of a novel nutrition education intervention for medical students from across England.

Authors

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ABSTRACT

Objectives: Problems such as hospital malnutrition (~40% prevalence in UK) may be managed better by improving the nutrition education of 'tomorrow's doctors'. The Need for Nutrition Education Programme (NNEdPro) aimed to measure the effectiveness and acceptability of an educational intervention on nutrition for medical students in the clinical phase of their training.

Design: An educational needs analysis was followed by a consultative process to gain consensus on a suitable educational intervention. An intervention group of 100 clinical medical students from 15 medical schools across England were recruited to attend one of two identical intensive weekend workshops. The two-day training incorporated six key learning outcomes. Knowledge, Attitudes and Practice (KAP) scores in clinical nutrition were assessed before and after intervention, and after three months, using a randomised questionnaire. A student-reported evaluation of the educational intervention was also conducted.

Results: Statistically significant changes in KAP scores were seen immediately after the intervention and this was sustained for three months. Mean differences and 95% Confidence Intervals after intervention were; Knowledge 0.86 (0.43, 1.28); Attitude 1.68 (1.47, 1.89); Practice 1.76 (1.11, 2.40); KAP 4.28 (3.49, 5.06). Ninety-seven per cent of the participants rated the overall intervention and its delivery as "very good to excellent", reporting that they would recommend this educational intervention to colleagues.

Conclusion: NNEdPro has highlighted the need for curricular innovation in the area of clinical health nutrition in medical schools. This project also demonstrates the effectiveness and acceptability of such a curriculum intervention for 'tomorrow's doctors'. Doctors, dietitians and nutritionists worked well in an effective interdisciplinary partnership when teaching medical students, providing a good model for further work in a healthcare setting.

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Article Summary

Article Focus

- Hospital malnutrition has been a challenge for decades in the United Kingdom due to its cost and impact on patient care.
- The focus was to examine whether a novel two day course could make a significant improvement in the understanding of clinical nutrition, among senior medical students.

Key messages

- This study summarised the need for improved training in clinical nutrition amongst medical students in England, a need noted in other countries too.
- Statistically significant changes in KAP scores were seen immediately after the intervention among the 98 students and this was sustained for three months.
- Ninety-seven per cent of the participants rated the overall intervention and its delivery as “very good to excellent”, reporting that they would recommend this educational intervention to colleagues.

Strengths and limitations

- The learning outcomes seemed appropriate and the teaching intervention appeared effective.
- A multi-disciplinary teaching team helped emphasize the roles of various team members, in dealing with nutrition related problems in a healthcare setting.
- Comparing change to a parallel student control group would have been preferable to monitoring within-group change.

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INTRODUCTION

The prevalence of malnutrition in UK hospitals has been reported to be as high as 40% (higher than the EU average) for almost two decades, with ~£13 billion of associated healthcare costs which are potentially avoidable through early secondary prevention. [1-3] Early recognition and appropriate management in healthcare settings is essential, as is follow-up in the community. [4]

Doctors can play a crucial role in the recognition, prevention and treatment of malnutrition. However, previous surveys of health professionals regarding the assessment and management of under-nutrition concluded that their knowledge was poor, and provided a strong argument for further educational initiatives. [5, 6] The same lack of knowledge of clinical nutrition and its application has also been noted among medical students by researchers in Canada and the USA.[7-12] Over recent decades, nutrition training in UK medical curricula has been displaced by a number of other disciplines. Integrated educational initiatives have now been recommended, including the diagnosis and management of both under- and over-nutrition to reflect the 'double burden' of nutritional problems.[13-15] However, there have been no further studies to assess current levels of nutrition knowledge or skills in the British medical workforce.

In 2009, the national guidance on medical education published by the General Medical Council highlighted nutrition as a doctor's responsibility,[16] and the recent white paper on NHS reforms by the UK government assigned the highest priority to improving healthcare outcome.[17] Doctors need to understand the role played by diet and nutrition in health promotion and disease prevention/management, and need to take active roles in partnership with other health professions, as well as patients and their families.[18] Thus, NNEdPro was developed to highlight the need for nutrition education in medical schools, and to evaluate the effectiveness of a nutrition education intervention in a cohort of 'tomorrow's doctors' using Knowledge Attitude and Practice (KAP) scores related to clinical nutrition.[19]

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METHODS

Development of the intervention

Harden's ten question system for planning a course was used to formulate, monitor and evaluate the course methodology (Table 1). [20]

Table 1. Evaluation of Teaching and Learning Methods: Harden's Ten Objectives

- To assess needs relative to the product of the institution.
- To define aims and objectives of the course.
- To determine course content.
- To decide on course organisation.
- To outline educational strategies.
- To select teaching methods.
- To delineate course assessment.
- To communicate curriculum details.
- To agree on the educational environment.
- To devise a process management mechanism.

Use of this system was followed by an educational needs analysis, consisting of an online survey of a national sample of medical students about clinical nutrition. We analysed the results with a panel of experts to gain consensus on curriculum content, learning outcomes, the educational intervention and questionnaire used to evaluate KAP. This panel became the teaching team. A comprehensive overview of current national nutritional policy and recommendations, as well as their clinical application, was also provided to students.

Learning outcomes were based on the new recommendations for nutrition-related learning outcomes proposed for UK undergraduate medical curricula by the Inter-Collegiate Group on Nutrition (ICGN), as shown below (Table 2). [21]

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Table 2: Learning outcomes recommended by IGCN

- recognition that nutrition forms an important part of a doctor's responsibilities;
- understanding core principles of 'Food, Fluid and Nutritional Care' in hospital related to 'Recognition, Prevention and Management of Malnutrition';
- awareness of nationally agreed standards for nutritional care;
- ability to conduct 'MUST' ('Malnutrition Universal Screening Tool') scoring, recording this in medical notes and care plans, as well as mentioning this in discharge documents [22, 23];
- ability to use the results of the 'MUST' screening to contribute to the formulation of care plans; [24]
- promotion of protected patient mealtimes .

The Intervention

Each two-day workshop consisted of a combination of lectures, demonstrations, simulations and interactive practical sessions (small group work), and incorporated concepts of problem-based-learning (mini-PBL). This provided students with a comprehensive overview of clinical and public health aspects of nutrition, as well as an understanding of how these can be applied and implemented in practice. The role of the doctor and broader multidisciplinary healthcare team in delivering nutritional care was explored and students were given the opportunity to apply knowledge of the nutritional needs of specific populations in practical care planning sessions. Although encompassing both under- and over-nutrition as well as systems-based teaching/learning, a core component of the programme consisted of the prevention, identification and management of under-nutrition. Students were given the opportunity to participate in practical sessions using validated nutritional screening methods, including the use of the 'MUST', and to review the role of different management strategies. A spiral learning approach revisited topics on day two to build upon consolidated basic concepts. The approach was novel as it was a short intervention but included quantitative and qualitative outcomes.

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Evaluation of the Intervention

Before and after the intervention, KAP scores were assessed using a questionnaire based instrument which was construct-validated against key clinical learning outcomes. Questionnaire items were randomised differently at baseline and post-intervention, to minimise recall bias. The study design also incorporated longitudinal follow-up using identical outcome measures after three months.

Recruitment

The sampling frame consisted of all 23 medical schools in England. A total of 461 senior/clinical students responded. Non-probability quota sampling was employed to recruit an intervention group of 100 students (Figure 1).

Data Analysis

Considering the normal distribution of the data, the paired t-test was used to both evaluate the change in parameters of interest from baseline scores (post-intervention scores minus pre-intervention scores) and to check test-retest reliability using pre- and post-intervention information (I) scores. In theory the 'I' scores should be the same for each participant in the pre/post questionnaire. Since several measurements taken on the same individuals tend to be correlated, repeated measures of analysis of variance (ANOVA) were conducted to compare mean scores over the whole follow up period, including three-month follow up. To see if the sample was representative, we compared baseline scores of the intervention group with an educationally matched control group (medical students who had not received the nutrition education intervention) using a median test that performs a nonparametric K-sample test on the equality of medians.

A likelihood-based (random intercept) model was used to examine predictors of the Practice score. The dependent variable "Practice" was defined as a multi-item proxy scale designed to assess potential practices. The observation level covariates (i.e. ones that varied at repeated observations) included Attitude and Knowledge scores. Data analysis was performed using STATA software, version 9.[25] All statistical tests were two-sided and statistical significance level Alpha was set at 0.05 for all analyses. Workshop evaluation was analysed using SPSS 14. [26]

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Figure 1. Study overview

SAMPLING AND RECRUITMENT

- All 23 medical schools in England contacted
- 461 respondents from 15 medical schools
- 100 places offered to 3rd and 4th year medical students
- 98 medical students attended teaching intervention workshops

INTERVENTION PACKAGE

- Cambridge-based intensive two-day learning intervention workshops delivered to 98 medical students from England over two weekends:
  - 5-6 September 2009 (n= 47)
  - 19-20 September 2009 (n= 51)
- Study tools included:
  - Pre-intervention questionnaire given before the start of a workshop
  - Post-intervention questionnaire used immediately after workshops and again three months later (identical to pre-intervention questionnaire with questions randomised in a different order)

FOLLOW UP

- Post-intervention evaluation after 3 months using an online research tool Survey Monkey via e-mailed link to all NNEdPro participants [27]
- Over 300 educationally matched controls identified via British Medical Association Medical Students Committee Listserver to compare baseline KAP with that of the intervention group [28]

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RESULTS

All 98 participants completed the questionnaire before and after the intervention. Baseline mean scores and mean difference scores between participants at weekend one and weekend two sessions were similar, and further analysis was performed using combined scores over both weekends. There was a significant post-intervention change in parameters of interest from baseline (Table 3).

Table 3. Change from baseline in Knowledge, Attitude, Practice and KAP after Intervention

	Mean differences and 95% CI* comparing post-intervention scores to baseline N=98
Knowledge	0.86 (0.43, 1.28)
Attitude	1.68 (1.47, 1.89)
Practice	1.76 (1.11, 2.40)
KAP	4.28 (3.49, 5.06)

*P-values ≤0.0001

There were 80 responses at the three-month follow-up, of which 68 were evaluable (seven people did not provide any identification information, there was one double entry and four incomplete questionnaires). ANOVA demonstrated a statistically significant difference in scores over the follow-up time (Table 4). Mean scores were higher at the post–intervention assessment and then decreased at the three-month assessment, but remained higher compared to baseline (Table 4).

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Table 4. Mean KAP scores at baseline, post-intervention and three-month follow-up

	Baseline* N=98	Post-intervention* N=98	After Three Months* N= 68	P-value†
Knowledge	4.10 ± 2.08	4.96 ± 1.75	4.15 ± 2.22	0.0004
Attitude	9.15 ± 0.92	10.84 ± 0.71	9.91 ± 0.91	0.0000
Practice	15.2 ± 2.57	16.97 ± 2.02	16.10 ± 2.38	0.0000
KAP	28.5 ± 3.50	32.77 ± 2.79	30.16 ± 3.46	0.0000

*Values are presented as mean ± SD.

†P-value is from a repeated measures analysis of variance (ANOVA)

The mean "I" scores showed statistically significant differences between pre-intervention, post-intervention and three-month follow up scores. Median tests comparing baseline scores of the intervention group with the control group demonstrated differences that were not statistically significant, implying that the sample population was representative (Table 5).

Table 5. Median KAP scores (inter-quartile range) for the intervention group at baseline and for educationally matched controls

	Information	Knowledge	Attitude	Practice	KAP
Control	4 (3-5)	4 (2-4)	9 (8-10)	14 (11-16)	26 (22-30)
Intervention	3.5 (3-4)	4 (2-6)	9 (9-10)	16 (14-17)	29 (26-31)

Regression analysis was based on a total of 264 observations from 98 participants, with each contributing two or three data points, depending upon the frequency of their participation in follow-up assessment. The overall mean Practice score (across subjects) was estimated (in the null model) as 16.09 (95% CI: 15.79 to 16.40). According to the results, five percent of the variance in Practice score can be attributed to differences between subjects. In the model, Attitude was a significant predictor of Practice score, whereas Knowledge was not. The estimated increase in mean Practice score for a one-unit increase in Attitude score was equal to 0.55 units (95% CI: 0.29 to 0.80, p<0.001). The effect of Knowledge was not significant, with the coefficient equal to 0.03 (95% CI: -0.11, 0.18).

The educational workshops were very well received by the 98 participants from across 15 medical schools. Ninety-seven per cent of participants rated the overall intervention and its delivery as "very good to excellent", reporting that they would recommend this educational intervention to colleagues. Ninety-four per cent rated the

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level of teaching as appropriate, and 99 percent demonstrated recall of one or more of these six key take-home messages;

- ✓ Use of 'MUST' screening or similar
- ✓ Malnutrition and it's management [29]
- ✓ Risk of refeeding syndrome
- ✓ Value of protected mealtimes
- ✓ Multi-disciplinary team working in nutrition [30]
- ✓ Food is / as medicine

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DISCUSSION

Implications of study

NNEdPro assessed the impact of an intensive package of nutrition education designed to lay the foundations of nutritional knowledge and attitudes relevant to clinical practice, in particular raising awareness of the recognition, prevention and management of malnutrition in hospital and highlighting the principles of 'Nutrition, a doctor's responsibility'.

The project established normative, expressed and comparative need for undergraduate nutrition education in medical schools and also defined six key areas for curricular change/innovation.

There were both statistically and educationally significant post-intervention increments in Knowledge, Attitudes and Practice scores, with an overall increase being sustained after three months. There were no significant baseline differences between the two intervention groups suggesting that the educational intervention can be delivered in a consistent and reliable manner. Regression modelling demonstrated that Attitude scores were a positive predictor of Practice scores. This finding is of potential importance as the course placed particular emphasis on changing attitudes towards nutritional care.

NNEdPro workshops incorporated innovative teaching methods including clinical simulation, mini-PBL and spiral learning. Spiral learning is usually employed in a vertical teaching strand over a protracted period of time. Similarly, PBL usually requires a time interval such as a week during which students facilitate peer led learning, adjourning to reach consensus on learning outcomes. This educational intervention utilised these concepts as far as possible, within the confines of a very short 'one-off' course. Based on both quantitative and qualitative findings, these methods appear to have contributed positively to the outcomes of the intervention. As part of the educational research component of NNEdPro, quasi-experimental methods were combined with traditional qualitative approaches in medical education. Finally in terms of teaching NNEdPro demonstrated that doctors, dietitians and scientists can work in an effective interdisciplinary partnership when teaching medical students and health professionals.

NNEdPro findings are relevant to curriculum planners, policy makers and all stakeholders seeking to improve the management of nutritional problems. From a broader medical education angle, this project also has the potential to act as a model for curricular innovation and change. There is a need to translate the educational impact of the NNEdPro intervention into clinical settings. Committed participants from the NNEdPro cohort could receive a leadership training package and take on the role of regional champions. These 'satisfied adopters' would then disseminate key nutrition related messages to health professionals in their local NHS

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using 'change management' principles.[31] The impact of this could be evaluated against sustainable change in clinical practices and clinical outcomes relating to hospital malnutrition.

Increasing the productivity and quality of the nutritional care workforce, including doctors, nurses and other healthcare professionals, is an essential component of efforts to mitigate the burden of hospital malnutrition in the UK. NNEdPro demonstrates that bringing about such changes is possible in a study population of 'tomorrow's doctors' and sets the stage for further applied and action research in healthcare settings.

Constraints

Firstly, the relatively small sample of students (98) was chosen from a self-selected group of medical students. Such a bias might mean that they were more interested and motivated than average medical students in England, with respect to nutrition, though our control group noted no significant difference in knowledge. The final participants were chosen using non-probability quota sampling, creating the possibility that this group was not fully representative of the 461 individuals who applied. We must also consider the extent to which the change in KAP noted was a result of the teaching intervention syllabus or whether it might be attributed to any other confounding factor. For example, a two-day intensive teaching package at a national centre led by a motivated team may have produced results that could be hard to replicate with more conventional teaching. Finally, comparing change to a parallel student control group may have been preferable to monitoring within-group change.

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Competing interests None

Contributors SR conceptualised the research, sought the funding and refined the design proposal for the research. SR, MRR, PD, RW, and JG were involved in the planning, adjustment and implementation of the design. SR, PD and JG handled liaison with the British Dietetic Association who hosted the administration of the research. KML and BT oversaw participant recruitment. SR, MRR, BT, KML, PS, RB, SS, RW, SG, and JG were involved in the organisation or teaching of the two weekend courses. SR, BT and RU managed the evaluation, statistical analysis and interpretation. SR, RU, MRR, KML, PD, PS, SS, SG, RW, MVDE, IF, and JG drafted or critiqued or rewrote part or all of the manuscript. SR is the guarantor. SJ is acknowledged as she critiqued the final draft. SS checked the final document for accuracy.

Ethics Approval This study was exempted from the need for ethics approval at a discussion with the Tayside Ethics Committee, where the project was conceived.

Provenance and Peer Review Not commissioned. Externally peer reviewed.

Data sharing statement Data may be shared as long as anonymity and confidentiality are preserved.

Appendix KAP questionnaire used in NNEdPro

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APPENDIX: NNEdPro Clinical Nutrition 'KAP' Questionnaire

Please circle or highlight the correct answers

1. How soon after admission should you screen for malnutrition?

   a. 24 hours
   b. 48 hours
   c. 72 hours
   d. 1 week

2. You need to organise a routine Chest X-ray for a patient. Which slot would be most appropriate?

   a. 6.30-7.00 am
   b. 10.30-11.00 am
   c. 12.30-1.00 pm
   d. 4.30-5.00 pm

3. A patient on your ward has had a stroke and he is unable to swallow. Which method of feeding would you recommend?

   a. Sip feeds
   b. Nasogastric feeding
   c. PEG feeding
   d. Total parenteral nutrition

4. How many litres of 5% Dextrose are needed to maintain an energy intake of 2000kcal/day?

   a. 2 litres
   b. 5 litres
   c. 10 litres
   d. 15 litres

5. When considering nutritional support for an obese patient (BMI 50 kg/m^2) what would be the energy requirement?

   a. As per patient's weight
   b. 500 kcal less
   c. 1000 extra kcal
   d. 1000 less kcal

6. Which bloods would you request for a stroke patient who has just been started on PEG feeding after 10 days of being nil by mouth?

   a. Magnesium, Phosphate, Potassium
   b. Liver function test
   c. Urea, Creatinine
   d. Glucose

7. How important is diet in management of renal disease?

   a. Not important
   b. Slightly important
   c. Very important
   d. Vital

8. A 35 year old gentleman with history of alcohol excess is admitted in confused state. Which nutritional supplement must be given?

   a. Thiamine
   b. Amino acid mix
   c. Oral nutrition supplements
   d. Multivitamin

9. What is normal weight gain in pregnancy for a healthy woman of average weight?

   a. 5 kg
   b. 7 kg
   c. 11 kg
   d. 15 kg

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10. A patient on your ward has a MUST score of 2 and the dietitian cannot see him until tomorrow. What can you do in the interim?

a. Initiate nasogastric tube feeding
b. Prescribe oral nutrition supplements
c. Wait until tomorrow
d. Start IV 5% dextrose

11. What are the odds that patient you are clerking is malnourished?

a. 1 in 2
b. 1 in 3
c. 1 in 5
d. 1 in 7

12. What is the calorie requirement for a patient with cystic fibrosis?

a. As per patient's weight
b. 120-150% of normal
c. 160-180% of normal
d. 200% of normal

13. Is there good evidence to suggest that fish oil consumption (omega-3 fatty acids) is helpful in the management of the following conditions?

a. Respiratory disease
b. Cardiovascular disease
c. Renal disease
d. Liver disease

14. How well do you think nutritional problems are managed in a hospital setting based on your experience so far?

a. Badly
b. Inadequately
c. Adequately
d. Very well

15. How much nutritional teaching have you received from your medical school to date?

a. Very little
b. Inadequate amount
c. Adequate amount
d. Substantial amount

16. Which vitamin status should be regularly monitored in patients with ileal Crohns disease?

a. Folic acid
b. Thaimine
c. Vitamin B_{12}
d. Iron

17. Which micronutrient deficiency should you be aware of in people of South East Asian origin?

a. Vitamin A
b. Iodine
c. Vitamin D
d. Zinc

18. As one of tomorrow's doctors, would you feel equipped to give general nutritional advice to patients where appropriate or required?

a. Not at all equipped
b. Inadequately equipped
c. Adequately equipped
d. Very well equipped

19. Do you think patients would value general nutritional advice from a Doctor?

a. Not at all
b. Not much
c. Somewhat
d. Very much

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20. Do you think that from a public health perspective, nutrition is important in reducing the global burden of disease?
    a. Not at all
    b. Not much
    c. Somewhat
    d. Very much

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Research Checklist

21 Sept 2011.

For an article submitted to BMJ Open;

Title; Evaluation of a novel nutrition education intervention for medical students from across England

Our study has no research protocol or checklist. It is a “before and after” study focussing on medical education and clinical nutrition.

Laura Feetham at BMJ advised us to save a document in Word titled “Research Checklist” and attach it to fulfil any ScholarOne website requirement for an attachment.

This exert, shown on page 2 here, may provide information similar to a research checklist.

Thanks for your help.

Regards

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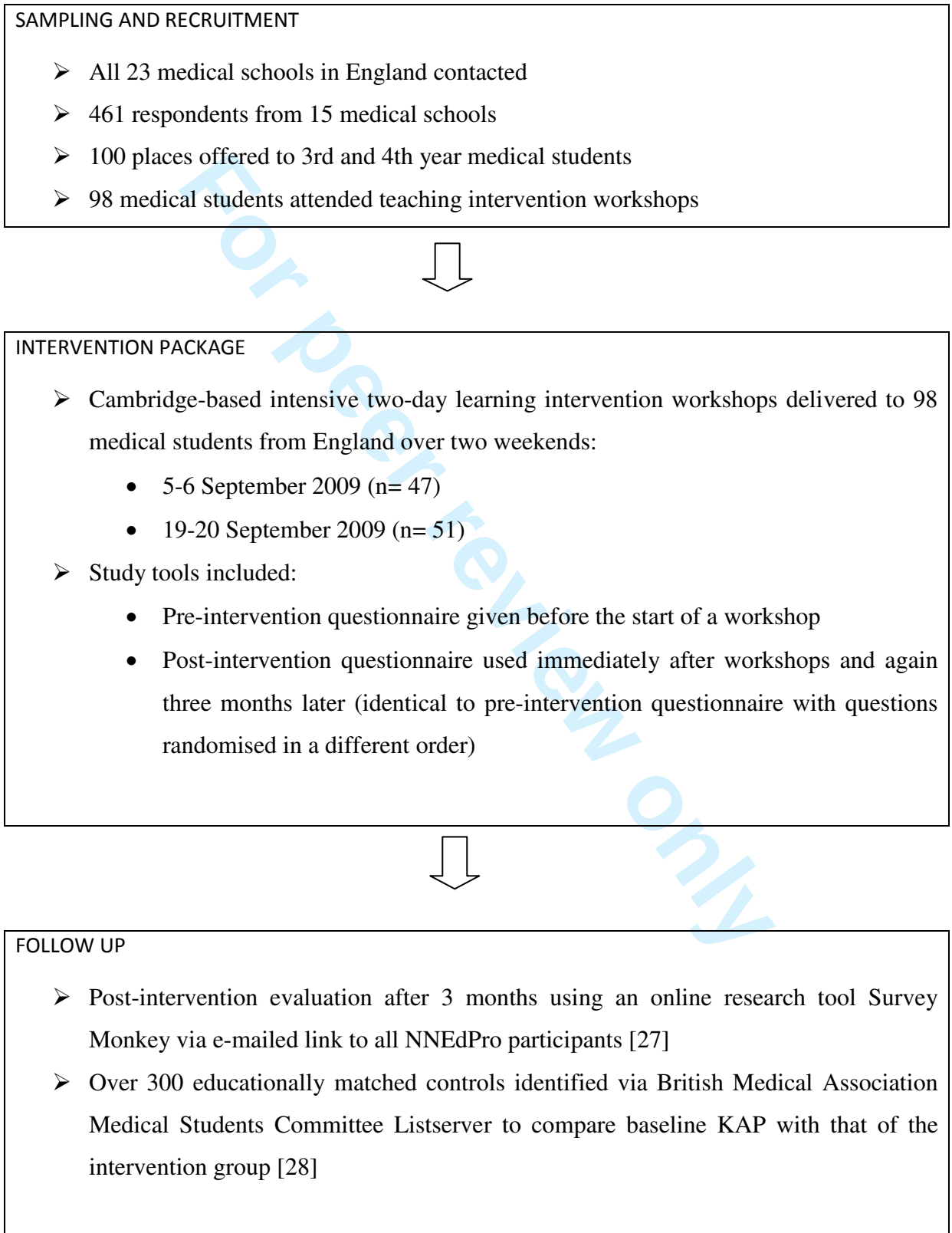
Figure 1. Study overview



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Evaluation of a novel nutrition education intervention for medical students from across England

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Title

Evaluation of a novel nutrition education intervention for medical students from across England.

Authors

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List of tables and figures

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ABSTRACT

Objectives: Problems such as hospital malnutrition (~40% prevalence in UK) may be managed better by improving the nutrition education of 'tomorrow's doctors'. The Need for Nutrition Education Programme (NNEdPro) aimed to measure the effectiveness and acceptability of an educational intervention on nutrition for medical students in the clinical phase of their training.

Design: An educational needs analysis was followed by a consultative process to gain consensus on a suitable educational intervention. This was followed by two identical two-day educational interventions with before and after analyses of knowledge, attitudes and practices (KAP). The two-day training incorporated six key learning outcomes.

Setting: Two constituent colleges of Cambridge University utilized to deliver the above educational interventions.

Participants: An intervention group of 100 clinical medical students from 15 medical schools across England were recruited to attend one of two identical intensive weekend workshops.

Primary and Secondary Outcome Measures: The primary outcome measure consisted of change in KAP scores following intervention using a clinical nutrition questionnaire. Secondary outcome measures included change in KAP scores 3 months after the intervention as well as a student-led semi-qualitative evaluation of the educational intervention.

Results: Statistically significant changes in KAP scores were seen immediately after the intervention and this was sustained for three months. Mean differences and 95% Confidence Intervals after intervention were; Knowledge 0.86 (0.43, 1.28); Attitude 1.68 (1.47, 1.89); Practice 1.76 (1.11, 2.40); KAP 4.28 (3.49, 5.06). Ninety-seven per cent of the participants rated the overall intervention and its delivery as "very good to excellent", reporting that they would recommend this educational intervention to colleagues.

Conclusion: NNEdPro has highlighted the need for curricular innovation in the area of clinical health nutrition in medical schools. This project also demonstrates the effectiveness and acceptability of such a curriculum intervention for 'tomorrow's doctors'. Doctors, dietitians and nutritionists worked well in an effective interdisciplinary partnership when teaching medical students, providing a good model for further work in a healthcare setting.

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Article Summary

Article Focus

- Hospital malnutrition has been a challenge for decades in the United Kingdom due to its cost and impact on patient care.
- The focus was to examine whether a novel two day course could make a significant improvement in the understanding of clinical nutrition, among senior medical students.

Key messages

- This study summarised the need for improved training in clinical nutrition amongst medical students in England, a need noted in other countries too.
- Statistically significant changes in KAP scores were seen immediately after the intervention among the 98 students and this was sustained for three months.
- Ninety-seven per cent of the participants rated the overall intervention and its delivery as “very good to excellent”, reporting that they would recommend this educational intervention to colleagues.

Strengths and limitations

- The learning outcomes seemed appropriate and the teaching intervention appeared effective.
- A multi-disciplinary teaching team helped emphasize the roles of various team members, in dealing with nutrition related problems in a healthcare setting.
- Comparing change to a parallel student control group would have been preferable to monitoring within-group change.

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INTRODUCTION

The prevalence of malnutrition in UK hospitals has been reported to be as high as 40% (higher than the EU average) for almost two decades, with ~£13 billion of associated healthcare costs which are potentially avoidable through early secondary prevention. [1-3] Early recognition and appropriate management in healthcare settings is essential, as is follow-up in the community. [4]

Doctors can play a crucial role in the recognition, prevention and treatment of malnutrition. However, previous surveys of health professionals regarding the assessment and management of under-nutrition concluded that their knowledge was poor, and provided a strong argument for further educational initiatives. [5 6] The same lack of knowledge of clinical nutrition and its application has also been noted among medical students by researchers in Canada and the USA.[7-12] Over recent decades, nutrition training in UK medical curricula has been displaced by a number of other disciplines. Integrated educational initiatives have now been recommended, including the diagnosis and management of both under- and over-nutrition to reflect the 'double burden' of nutritional problems.[13-15] However, there have been no further studies to assess current levels of nutrition knowledge or skills in the British medical workforce.

In 2009, the national guidance on medical education published by the General Medical Council highlighted nutrition as a doctor's responsibility,[16] and the recent white paper on NHS reforms by the UK government assigned the highest priority to improving healthcare outcome.[17] Doctors need to understand the role played by diet and nutrition in health promotion and disease prevention/management, and need to take active roles in partnership with other health professions, as well as patients and their families.[18] Thus, NNEdPro was developed to highlight the need for nutrition education in medical schools, and to evaluate the effectiveness of a nutrition education intervention in a cohort of 'tomorrow's doctors' using Knowledge Attitude and Practice (KAP) scores related to clinical nutrition.[19]

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METHODS

Development of the intervention

Harden's ten question system for planning a course was used to formulate, monitor and evaluate the course methodology (Table 1). [20]

Table 1. Evaluation of Teaching and Learning Methods: Harden's Ten Objectives

- To assess needs relative to the product of the institution.
- To define aims and objectives of the course.
- To determine course content.
- To decide on course organisation.
- To outline educational strategies.
- To select teaching methods.
- To delineate course assessment.
- To communicate curriculum details.
- To agree on the educational environment.
- To devise a process management mechanism.

Use of this system was followed by an educational needs analysis, consisting of an online survey of a national sample of medical students about clinical nutrition. We analysed the results with a panel of experts to gain consensus on curriculum content, learning outcomes, the educational intervention and questionnaire used to evaluate KAP. This panel became the teaching team. A comprehensive overview of current national nutritional policy and recommendations, as well as their clinical application, was also provided to students.

Learning outcomes were based on the new recommendations for nutrition-related learning outcomes proposed for UK undergraduate medical curricula by the Inter-Collegiate Group on Nutrition (ICGN), as shown below (Table 2). [21]

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Table 2: Learning outcomes recommended by IGCN

- recognition that nutrition forms an important part of a doctor's responsibilities;
- understanding core principles of 'Food, Fluid and Nutritional Care' in hospital related to 'Recognition, Prevention and Management of Malnutrition';
- awareness of nationally agreed standards for nutritional care;
- ability to conduct 'MUST' ('Malnutrition Universal Screening Tool') scoring, recording this in medical notes and care plans, as well as mentioning this in discharge documents [22 23];
- ability to use the results of the 'MUST' screening to contribute to the formulation of care plans; [24]
- promotion of protected patient mealtimes .

The Intervention

Each two-day workshop consisted of a combination of lectures, demonstrations, simulations and interactive practical sessions (small group work), and incorporated concepts of problem-based-learning (mini-PBL). This provided students with a comprehensive overview of clinical and public health aspects of nutrition, as well as an understanding of how these can be applied and implemented in practice. The role of the doctor and broader multidisciplinary healthcare team in delivering nutritional care was explored and students were given the opportunity to apply knowledge of the nutritional needs of specific populations in practical care planning sessions. Although encompassing both under- and over-nutrition as well as systems-based teaching/learning, a core component of the programme consisted of the prevention, identification and management of under-nutrition. Students were given the opportunity to participate in practical sessions using validated nutritional screening methods, including the use of the 'MUST', and to review the role of different management strategies. A spiral learning approach revisited topics on day two to build upon consolidated basic concepts. The approach was novel as it was a short intervention but included quantitative and qualitative outcomes.

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Evaluation of the Intervention

Before and after the intervention, KAP scores were assessed using a questionnaire based instrument which was construct-validated against key clinical learning outcomes. Questionnaire items were randomised differently at baseline and post-intervention, to minimise recall bias. The study design also incorporated longitudinal follow-up using identical outcome measures after three months.

Approvals and Recruitment

At the time of first conceiving this study, the study team were based at the University of Dundee and sought approval from the Tayside Research Ethic Committee. It was deemed by the committee chairman that as this constituted the evaluation of an educational innovation and did not involve patients or healthcare data, it could be suitably exempt from the need for ethics approval. This exemption was confirmed in writing. Participants on the educational course provided written consent to the anonymised results of the course evaluation being used for educational evaluation/research purposes.

The sampling frame consisted of all 23 medical schools in England. The medical school secretaries were contacted by the NNEdPro recruitment co-ordinator using a dedicated email. This communication included an overview of the educational intervention and was cascaded by the secretaries to all medical students in the penultimate year/phase of their clinical training. A total of 461 medical students from 15 medical schools responded directly to the NNEdPro group. Non-probability quota sampling was employed to recruit an intervention group of 100 students.

Participants were self-selected based on degree of motivation, and several medical schools were included leading to variation in the amount of nutrition teaching received. These had the potential to introduce selection bias. However, a pragmatic view was taken whereby this recruitment approach was both practical and feasible. A proportionate distribution of participants was ensured by allocating proportional quotas based on school response rate. Details on recruitment procedures are in Figure 1.

Data Analysis

Considering the normal distribution of the data, the paired t-test was used to both evaluate the change in parameters of interest from baseline scores (post-intervention scores minus pre-intervention scores) and to check test-retest reliability using pre- and post-intervention information (I) scores. In theory the 'I' scores should be the same for each participant in the pre/post questionnaire. Since several measurements taken on the same individuals tend to be correlated, repeated measures of analysis of variance (ANOVA) were conducted to compare mean scores over the whole follow up period, including three-month follow up. To see if the sample was representative, we compared baseline scores of the intervention group with an educationally matched

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control group (medical students who had not received the nutrition education intervention) using a median test that performs a nonparametric K-sample test on the equality of medians.

A likelihood-based (random intercept) model was used to examine predictors of the Practice score. The dependent variable "Practice" was defined as a multi-item proxy scale designed to assess potential practices. The observation level covariates (i.e. ones that varied at repeated observations) included Attitude and Knowledge scores. Data analysis was performed using STATA software, version 9.[25] All statistical tests were two-sided and statistical significance level Alpha was set at 0.05 for all analyses. Workshop evaluation was analysed using SPSS 14. [26]

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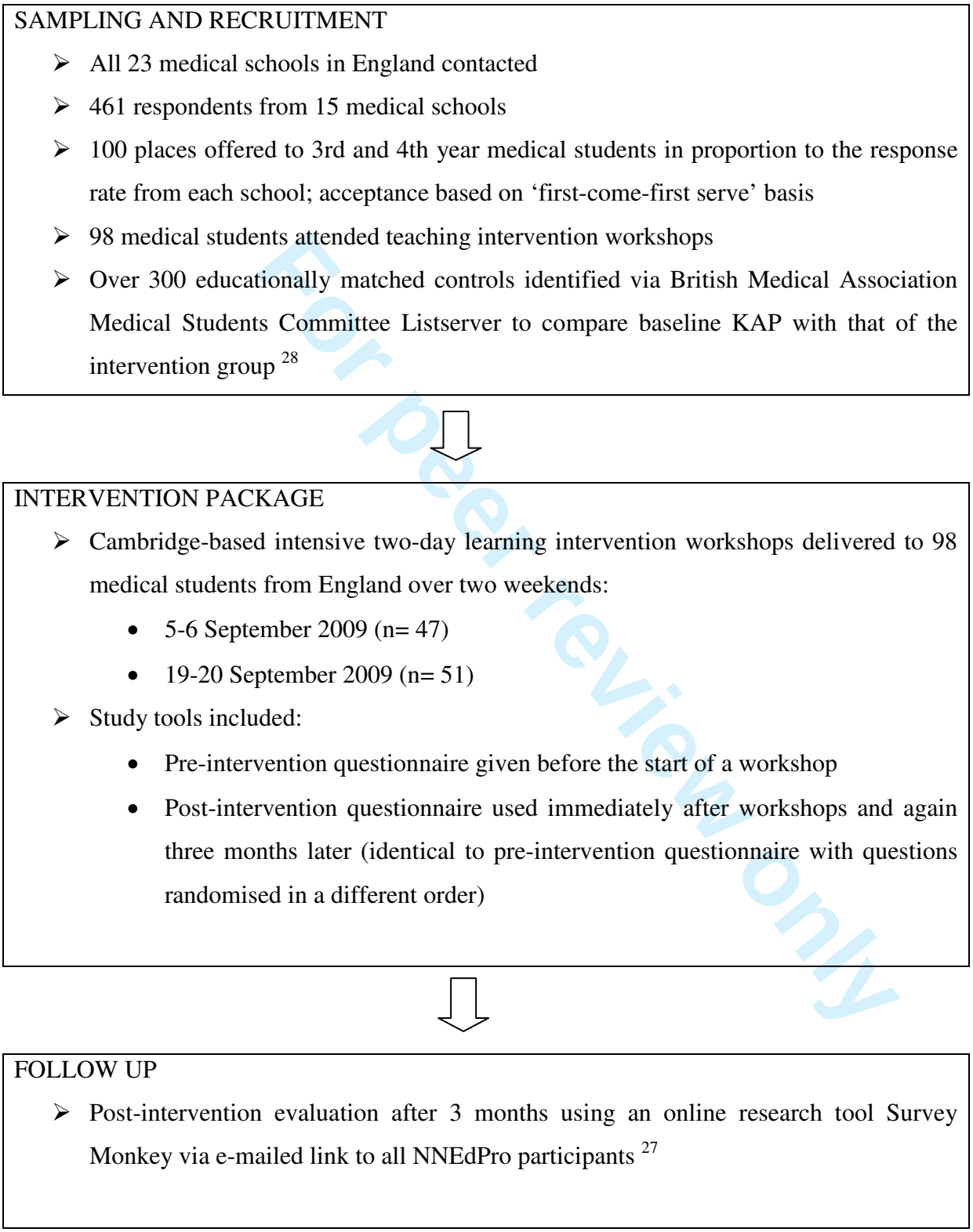
Figure 1. Study overview



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RESULTS

All 98 participants completed the questionnaire before and after the intervention. Baseline mean scores and mean difference scores between participants at weekend one and weekend two sessions were similar, and further analysis was performed using combined scores over both weekends. There was a significant post-intervention change in parameters of interest from baseline (Table 3).

Table 3. Change from baseline in Knowledge, Attitude, Practice and KAP after Intervention

	Mean differences and 95% CI* comparing post-intervention scores to baseline N=98
Knowledge	0.86 (0.43, 1.28)
Attitude	1.68 (1.47, 1.89)
Practice	1.76 (1.11, 2.40)
KAP	4.28 (3.49, 5.06)

*P-values ≤0.0001

There were 80 responses at the three-month follow-up, of which 68 were evaluable (seven people did not provide any identification information, there was one double entry and four incomplete questionnaires). ANOVA demonstrated a statistically significant difference in scores over the follow-up time (Table 4). Mean scores were higher at the post–intervention assessment and then decreased at the three-month assessment, but remained higher compared to baseline (Table 4).

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Table 4. Mean KAP scores at baseline, post-intervention and three-month follow-up

	Baseline* N=98	Post-intervention* N=98	After Three Months* N= 68	P-value†
Knowledge	4.10 ± 2.08	4.96 ± 1.75	4.15 ± 2.22	0.0004
Attitude	9.15 ± 0.92	10.84 ± 0.71	9.91 ± 0.91	0.0000
Practice	15.2 ± 2.57	16.97 ± 2.02	16.10 ± 2.38	0.0000
KAP	28.5 ± 3.50	32.77 ± 2.79	30.16 ± 3.46	0.0000

*Values are presented as mean ± SD.

†P-value is from a repeated measures analysis of variance (ANOVA)

The mean "I" scores showed statistically significant differences between pre-intervention, post-intervention and three-month follow up scores. Median tests comparing baseline scores of the intervention group with the control group demonstrated differences that were not statistically significant, implying that the sample population was representative (Table 5).

Table 5. Median KAP scores (inter-quartile range) for the intervention group at baseline and for educationally matched controls

	Information	Knowledge	Attitude	Practice	KAP
Control	4 (3-5)	4 (2-4)	9 (8-10)	14 (11-16)	26 (22-30)
Intervention	3.5 (3-4)	4 (2-6)	9 (9-10)	16 (14-17)	29 (26-31)

Regression analysis was based on a total of 264 observations from 98 participants, with each contributing two or three data points, depending upon the frequency of their participation in follow-up assessment. The overall mean Practice score (across subjects) was estimated (in the null model) as 16.09 (95% CI: 15.79 to 16.40). According to the results, five percent of the variance in Practice score can be attributed to differences between subjects. In the model, Attitude was a significant predictor of Practice score, whereas Knowledge was not. The estimated increase in mean Practice score for a one-unit increase in Attitude score was equal to 0.55 units (95% CI: 0.29 to 0.80, p<0.001). The effect of Knowledge was not significant, with the coefficient equal to 0.03 (95% CI: -0.11, 0.18).

The educational workshops were very well received by the 98 participants from across 15 medical schools. Ninety-seven per cent of participants rated the overall intervention and its delivery as "very good to excellent", reporting that they would recommend this educational intervention to colleagues. Ninety-four per cent rated the

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level of teaching as appropriate, and 99 percent demonstrated recall of one or more of these six key take-home messages;

- ✓ Use of 'MUST' screening or similar
- ✓ Malnutrition and it's management [29]
- ✓ Risk of refeeding syndrome
- ✓ Value of protected mealtimes
- ✓ Multi-disciplinary team working in nutrition [30]
- ✓ Food is / as medicine

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DISCUSSION

Implications of study

NNEdPro assessed the impact of an intensive package of nutrition education designed to lay the foundations of nutritional knowledge and attitudes relevant to clinical practice, in particular raising awareness of the recognition, prevention and management of malnutrition in hospital and highlighting the principles of 'Nutrition, a doctor's responsibility'.

The project established normative, expressed and comparative need for undergraduate nutrition education in medical schools and also defined six key areas for curricular change/innovation.

There were both statistically and educationally significant post-intervention increments in Knowledge, Attitudes and Practice scores, with an overall increase being sustained after three months. There were no significant baseline differences between the two intervention groups suggesting that the educational intervention can be delivered in a consistent and reliable manner. Regression modelling demonstrated that Attitude scores were a positive predictor of Practice scores. This finding is of potential importance as the course placed particular emphasis on changing attitudes towards nutritional care.

NNEdPro workshops incorporated innovative teaching methods including clinical simulation, mini-PBL and spiral learning. Spiral learning is usually employed in a vertical teaching strand over a protracted period of time. Similarly, PBL usually requires a time interval such as a week during which students facilitate peer led learning, adjourning to reach consensus on learning outcomes. This educational intervention utilised these concepts as far as possible, within the confines of a very short 'one-off' course. Based on both quantitative and qualitative findings, these methods appear to have contributed positively to the outcomes of the intervention. As part of the educational research component of NNEdPro, quasi-experimental methods were combined with traditional qualitative approaches in medical education. Finally in terms of teaching NNEdPro demonstrated that doctors, dietitians and scientists can work in an effective interdisciplinary partnership when teaching medical students and health professionals.

NNEdPro findings are relevant to curriculum planners, policy makers and all stakeholders seeking to improve the management of nutritional problems. From a broader medical education angle, this project also has the potential to act as a model for curricular innovation and change. There is a need to translate the educational impact of the NNEdPro intervention into clinical settings. Committed participants from the NNEdPro cohort could receive a leadership training package and take on the role of regional champions. These 'satisfied adopters' would then disseminate key nutrition related messages to health professionals in their local NHS

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using 'change management' principles.[31] The impact of this could be evaluated against sustainable change in clinical practices and clinical outcomes relating to hospital malnutrition.

Increasing the productivity and quality of the nutritional care workforce, including doctors, nurses and other healthcare professionals, is an essential component of efforts to mitigate the burden of hospital malnutrition in the UK. NNEdPro demonstrates that bringing about such changes is possible in a study population of 'tomorrow's doctors' and sets the stage for further applied and action research in healthcare settings.

Constraints

Firstly, the relatively small sample of students (98) was chosen from a self-selected group of medical students. Such a bias might mean that they were more interested and motivated than average medical students in England, with respect to nutrition, though our control group noted no significant difference in knowledge. The final participants were chosen using non-probability quota sampling, creating the possibility that this group was not fully representative of the 461 individuals who applied. We must also consider the extent to which the change in KAP noted was a result of the teaching intervention syllabus or whether it might be attributed to any other confounding factor. For instance, the 15 different medical schools from which the participants were recruited had varying degrees of nutrition education in their respective curricula. In addition, a two-day intensive teaching package at a national centre led by a motivated team may have produced results that could be hard to replicate with more conventional teaching. Finally, comparing change to a parallel student control group may have been preferable to monitoring within-group change.

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Competing interests None

Contributors SR conceptualised the research, sought the funding and refined the design proposal for the research. SR, MRR, PD, RW, and JG were involved in the planning, adjustment and implementation of the design. SR, PD and JG handled liaison with the British Dietetic Association who hosted the administration of the research. KML and BT oversaw participant recruitment. SR, MRR, BT, KML, PS, RB, SS, RW, SG, and JG were involved in the organisation or teaching of the two weekend courses. SR, BT and RU managed the evaluation, statistical analysis and interpretation. SR, RU, MRR, KML, PD, PS, SS, SG, RW, MVDE, IF, and JG drafted or critiqued or rewrote part or all of the manuscript. SR is the guarantor. SJ is acknowledged as she critiqued the final draft. SS checked the final document for accuracy.

Ethics Approval This study was exempted from the need for ethics approval at a discussion with the Tayside Ethics Committee, where the project was conceived.

Provenance and Peer Review Not commissioned. Externally peer reviewed.

Data sharing statement Data may be shared as long as anonymity and confidentiality are preserved.

Appendix KAP questionnaire used in NNEdPro

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APPENDIX: NNEdPro Clinical Nutrition 'KAP' Questionnaire

Please circle or highlight the correct answers

1. How soon after admission should you screen for malnutrition?

   a. 24 hours
   b. 48 hours
   c. 72 hours
   d. 1 week

2. You need to organise a routine Chest X-ray for a patient. Which slot would be most appropriate?

   a. 6.30-7.00 am
   b. 10.30-11.00 am
   c. 12.30-1.00 pm
   d. 4.30-5.00 pm

3. A patient on your ward has had a stroke and he is unable to swallow. Which method of feeding would you recommend?

   a. Sip feeds
   b. Nasogastric feeding
   c. PEG feeding
   d. Total parenteral nutrition

4. How many litres of 5% Dextrose are needed to maintain an energy intake of 2000kcal/day?

   a. 2 litres
   b. 5 litres
   c. 10 litres
   d. 15 litres

5. When considering nutritional support for an obese patient (BMI 50 kg/m^2) what would be the energy requirement?

   a. As per patient's weight
   b. 500 kcal less
   c. 1000 extra kcal
   d. 1000 less kcal

6. Which bloods would you request for a stroke patient who has just been started on PEG feeding after 10 days of being nil by mouth?

   a. Magnesium, Phosphate, Potassium
   b. Liver function test
   c. Urea, Creatinine
   d. Glucose

7. How important is diet in management of renal disease?

   a. Not important
   b. Slightly important
   c. Very important
   d. Vital

8. A 35 year old gentleman with history of alcohol excess is admitted in confused state. Which nutritional supplement must be given?

   a. Thiamine
   b. Amino acid mix
   c. Oral nutrition supplements
   d. Multivitamin

9. What is normal weight gain in pregnancy for a healthy woman of average weight?

   a. 5 kg
   b. 7 kg
   c. 11 kg
   d. 15 kg

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10. A patient on your ward has a MUST score of 2 and the dietitian cannot see him until tomorrow. What can you do in the interim?

a. Initiate nasogastric tube feeding
b. Prescribe oral nutrition supplements
c. Wait until tomorrow
d. Start IV 5% dextrose

11. What are the odds that patient you are clerking is malnourished?

a. 1 in 2
b. 1 in 3
c. 1 in 5
d. 1 in 7

12. What is the calorie requirement for a patient with cystic fibrosis?

a. As per patient's weight
b. 120-150% of normal
c. 160-180% of normal
d. 200% of normal

13. Is there good evidence to suggest that fish oil consumption (omega-3 fatty acids) is helpful in the management of the following conditions?

a. Respiratory disease
b. Cardiovascular disease
c. Renal disease
d. Liver disease

14. How well do you think nutritional problems are managed in a hospital setting based on your experience so far?

a. Badly
b. Inadequately
c. Adequately
d. Very well

15. How much nutritional teaching have you received from your medical school to date?

a. Very little
b. Inadequate amount
c. Adequate amount
d. Substantial amount

16. Which vitamin status should be regularly monitored in patients with ileal Crohns disease?

a. Folic acid
b. Thaimine
c. Vitamin B_{12}
d. Iron

17. Which micronutrient deficiency should you be aware of in people of South East Asian origin?

a. Vitamin A
b. Iodine
c. Vitamin D
d. Zinc

18. As one of tomorrow's doctors, would you feel equipped to give general nutritional advice to patients where appropriate or required?

a. Not at all equipped
b. Inadequately equipped
c. Adequately equipped
d. Very well equipped

19. Do you think patients would value general nutritional advice from a Doctor?

a. Not at all
b. Not much
c. Somewhat
d. Very much

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20. Do you think that from a public health perspective, nutrition is important in reducing the global burden of disease?
    a. Not at all
    b. Not much
    c. Somewhat
    d. Very much

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Research Checklist

21 Sept 2011.

For an article submitted to BMJ Open;

Title; Evaluation of a novel nutrition education intervention for medical students from across England

Our study has no research protocol or checklist. It is a “before and after” study focussing on medical education and clinical nutrition.

Laura Feetham at BMJ advised us to save a document in Word titled “Research Checklist” and attach it to fulfil any ScholarOne website requirement for an attachment.

This exert, shown on page 2 here, may provide information similar to a research checklist.

Thanks for your help.

Regards

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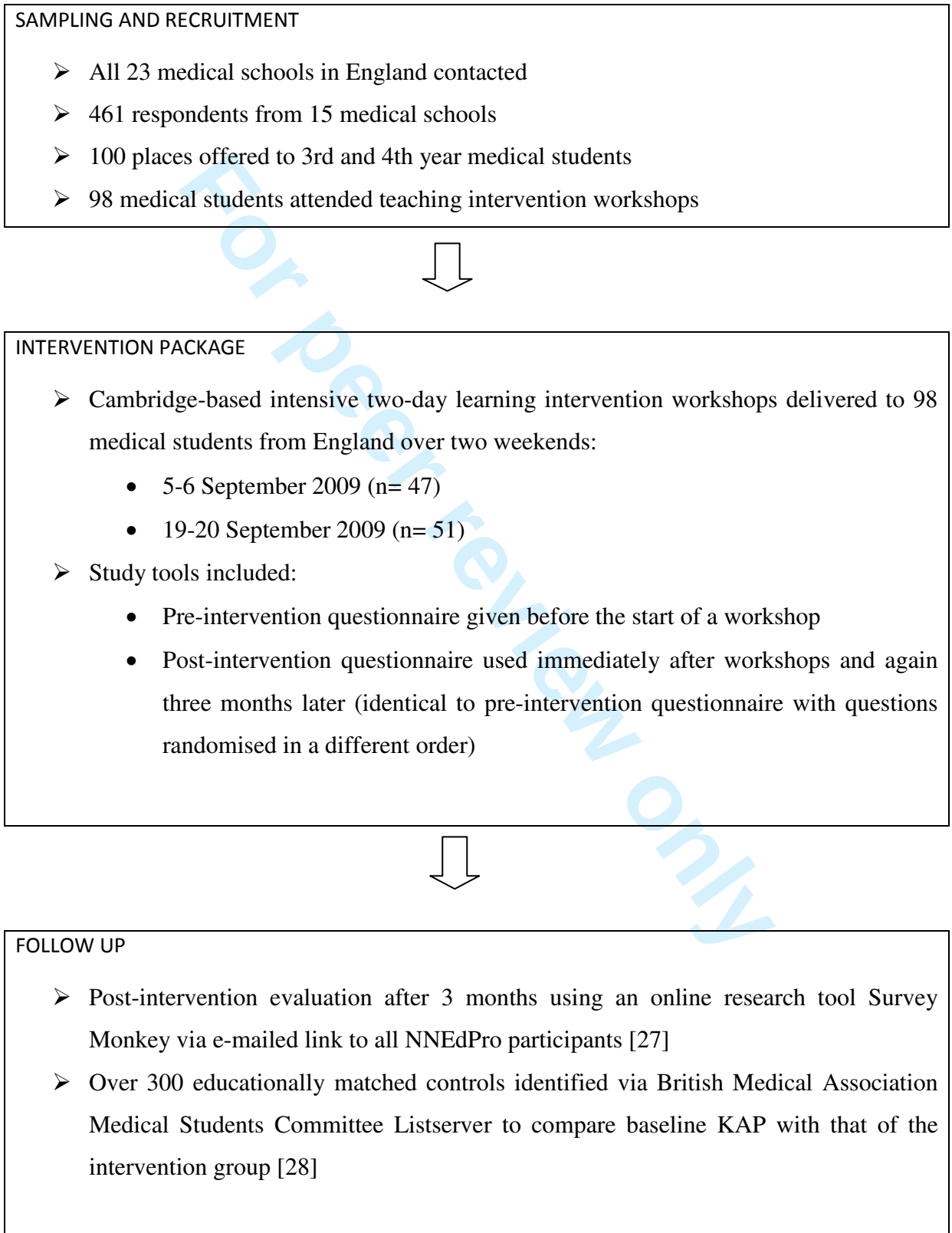
Figure 1. Study overview



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