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# An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.



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**An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.**

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## ABSTRACT

**Objectives**: Management of diet-related chronic diseases may benefit from improved nutrition education of medical students. This study aims to investigate the effects of a nutrition education course on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.

**Design:** Pre- post intervention study with a comparison group. Participants completed self-reported questionnaires on nutritional knowledge and intentions towards nutritional counselling.

**Participants:** In total, 118 undergraduate (64.4%) and graduate medical students (73.2% women) were recruited from two medical schools in the Netherlands (n=66 intervention group, n=52 comparison group).

**Intervention:** The intervention group completed a 25 hour course in nutritional counselling (the SELF course) in addition to the standard medical curriculum. The comparison group followed the standard medical curriculum.

**Outcome measures:** Self-reported nutritional knowledge and intentions towards nutritional counselling including attitude, self-efficacy and social support.

**Results:** Nutritional knowledge (B: 2.42, 95% CI: 1.81, 3.02), attitude in men (B: 0.50, 95% CI: 0.13, 0.87), and self-efficacy (B: 0.78, 95% CI: 0.62, 0.95) statistically significantly increased in the intervention group compared to the comparison group. No statistically significant differences were found for social support (B: 0.20, 95% CI: -0.02, 0.43) and attitude in women (B: 0.08, 95% CI: -0.24, 0.31) between the two groups.

**Conclusions:** The SELF course increased medical students' nutritional knowledge and stimulated their intentions towards nutritional counselling. Future research is needed to evaluate the long-term impact of nutrition education interventions on physician practice patterns and eventually at the end patient outcomes.

Word count: 240

**Strengths and limitations of this study:**

- The nutrition education course was created in co-creation with medical professionals and medical students to guarantee a broad and relevant medical nutrition education angle.
- The effects of the course were measured before and after the course in participating medical students and in the same period in medical students who did not participate.
- Randomization would have been preferable but was difficult to organize in a voluntary extracurricular course upon request of a group of students.
- Measurements were self-reported rather than assessed in performance-based clinical examinations or patient-outcomes.

## INTRODUCTION

Dietary interventions have proven to be successful in the prevention and management of important lifestyle related disease, such as diabetes type 2 and cardiovascular disease.(1,2) Nutritional counselling by physicians could help to improve diets in patients, especially since patients consider physicians to be one of the most credible sources of nutrition information.(3,4) However, the substantial body of evidence that supports the benefits of nutritional interventions has not yet been translated into medical training or practice.(5) As a consequence, physicians often lack the necessary knowledge, skills and confidence to counsel their patients effectively.(6) For example, a survey among cardiologist showed that 90% of them reported that they did not received adequate nutrition education during fellow ship, even though 95% believed that their role includes personally providing patients with at least basic nutrition information.(7)

Previous studies on the effects of medical nutrition education interventions have shown that educational interventions can improve medical students' competencies, physicians' practice behaviour, and patients' health. A study in the UK indicated that a two-day workshop for medical students could lay the foundation of nutritional knowledge and attitudes relevant to clinical practice.(8) This very short 'one-off' course showed that it is possible to provoke relevant changes in nutritional care in medical students. However, the impact on physician practice patterns and on patient outcomes was not assessed. The results of a study on nutrition education for general practitioner (GP) trainees in the Netherlands showed that a computer-based instruction improved both GP trainees' nutritional knowledge and practice behaviour on the subject of nutrition.(9) Furthermore, a study in Brazil found that wasting and stunting in children were diminished after the implementation of an educational intervention on the provision of physicians' nutrition counselling to mothers and/or caregivers.(10)

Despite the opportunities and the demand from medical students to receive nutrition education, the status of nutrition education in the medical curriculum remains largely neglected. In the US the time devoted to nutrition during medical school is limited, with an average of 19 hours divided over four years.(5) This is not different for the Netherlands, where students receive an average of 29 hours of nutrition education over six years of study.(11) To promote the need for greater nutrition education in medical schools' curricula in the Netherlands, the student-led "Student and Nutrition Foundation" (SNF) was established in 2017.(12) They developed a nutrition education course named the SELF course (Students Experienced in Lifestyle and Food) to offer medical students additional nutrition education. This provided us with the opportunity to investigate the effects of this intervention on medical students. Therefore, the aim of this study was to investigate the effects of the SELF course on nutritional knowledge and intentions towards nutritional counselling of Dutch medical students. Results of this study provide insights in the effectiveness of nutrition education in medical students which can be used to improve current medical training and long-term medical care.

## METHODS

### Design

To investigate the effects of the SELF course, a pre- post-intervention study with a comparison group was conducted. Data were collected via self-reported questionnaires using the online questionnaire service Qualtrics.(13) Data collection took place from April 2018 to June 2018. The study was conducted according to the ethical standards declared in the Helsinki declaration of 1975, as revised in 2000, and approved by the Medical Ethics Committee of the VU Medical Centre Amsterdam. Active informed consent was obtained from all participants.

**Participants and recruitment**

This study took place in the two university teaching hospitals in Amsterdam, the Netherlands: the Amsterdam Medical Center (AMC) and the VU University Medical Canter (VUmc). All medical students from the AMC and VUmc were eligible to participate in the study, however medical students who followed a newly developed nutrition course at the AMC simultaneously with the SELF Amsterdam course were excluded from the analyses.

Participants in the intervention group were recruited from 148 students who were voluntarily enrolled in the SELF Amsterdam course in April 2018. All AMC and VUmc medical students of the six-year medical curriculum could apply to this course and acceptance was based on a first-come-first-serve principle. Participants in the intervention group were asked to complete the pre- and post-questionnaires in the lecture hall prior to the start of the first SELF Amsterdam lecture and after completion of the last lecture respectively. The sampling frame for the comparison group consisted of all undergraduate and graduate medical students of the AMC and the VUmc who did not participate in the SELF Amsterdam course. Participants of the comparison group were approached before or at the end of usual lecture times at the AMC and VUmc and by soliciting volunteers in the libraries of the two medical faculties. In the pre-intervention questionnaire, the comparison group was asked for their email addresses so that they could be approached for the post-intervention measurement per e-mail.

In total, 281 participants completed the pre-intervention questionnaire (n=115 intervention group, n=166 comparison group). A total of 15 students were excluded from the study sample for declining to sign the informed consent (n=1 intervention group, n=14 comparison group) and 23 students were excluded because of other reasons (n=15 intervention group, n=8 comparison group), see Figure 1 for a flow chart with details on the reasons for exclusion. After this, 243

medical students were eligible to participate (n=99 intervention group, n=144 comparison group). Ten weeks later, a total of 126 participants completed the post-intervention questionnaire (n=74 intervention group, n=52 comparison group) of whom 8 participants were excluded because they missed pre-intervention measurement information (n=8 intervention group). So, the total study sample comprised of 118 medical students (n=66 intervention group, n=52 comparison group) who completed both the pre- and post-intervention questionnaire.

**Patient and public involvement**

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination of our research.

**Intervention**

The SELF Amsterdam course was developed based on key themes represented in the literature, several brainstorm sessions with medical students, and consultations with experts (Sept 2017 - Jan 2018).(14) The course consisted of 25 contact hours divided over ten consecutive weeks. Participants of the ten-week course had to contribute ten euro (twelve US dollar) per person to cover administrative costs. The course was designed for up to 150 undergraduate and graduate medical students. The course covered a different topic related to nutrition and lifestyle in health and disease each week, for example nutrition and diabetes, nutrition and cancer, or nutrition and cardiovascular disease. In total, 25 subject experts were selected to host a lecture, based on the criteria for SELF educators (e.g. having subject expertise and having affinity with the goals of the SNF). The experts had various backgrounds, including but not limited to nutrition, psychology, dietetics, and medicine.

**Questionnaire development**

A questionnaire to measure nutritional knowledge and intentions towards nutritional counselling was developed based on validated questionnaires, two expert meetings with health professionals and academics working in the field of nutrition, health and disease (N=12) and an online feedback session with experts (N=5).(3,15–17) The framework for the two expert meetings was based on the Attitude – Social Support – Self-Efficacy (ASE) model by De Vries, Dijkstra and Kuhlman in combination with the topic list of the SELF Amsterdam course and existing questionnaires.(18) The ASE model is a social cognition model that is commonly used in predicting and explaining health behaviour including nutrition.(19) The model postulates that there is a reliable relationship between intentions and behaviour: if intentions increase, facilitated by knowledge, behaviour should change positively.(20)

During the expert meetings experts discussed and wrote down specific scale items concerning knowledge, attitudes, social support, and self-efficacy towards nutritional counselling of essential student attainment on completion of the SELF course. Experts were asked to provide input for potential questions on testing these scale items. Results of the two expert meetings were combined and the outcomes were sent to a third group of experts to provide written feedback on accuracy and completeness. Next, three researchers (HC, JC and CD) critically revised the list of questions and created the final questionnaire. The questionnaire was pretested in a convenience sample of medical students (N=6) to assess understanding and comprehensibility. A few minor amendments were made and the responses of these participants were excluded from the final analysis. The final questionnaire consisted of 49 questions. With forced answering options,

participants were required to answer all questions before they could progress to the next page of the questionnaire.

**Outcomes**

Nutritional knowledge was assessed with thirteen multiple choice items (i.e., "What are the recommended daily amounts of fruits and vegetables for an adult woman (aged 19-50) according to the Dutch dietary recommendations?"). For all questions, one correct answer was possible and 1 point per correct answer could be obtained. The total score ranged from 0 to 13 points, with higher scores indicating higher nutritional knowledge.

Intentions (attitude, social support and self-efficacy) were assessed with rating of statements using 5-point Likert scales from "totally disagree (-2)" to "totally agree (2). A mean value score (ranging from -2 to +2) was calculated with a higher score indicating more positive intentions. Specifically, attitude was assessed with ten items (i.e., "All physicians, regardless of specialty, should counsel high-risk patients about dietary change."). The internal consistency of attitude as checked with Cronbach Alpha was α=.59 pre-intervention and α=.87 post-intervention. Social support was assessed with three items (i.e., "I know enough people in the medical faculty who I can contact in case I have questions on nutrition and lifestyle related topics.") and had a Cronbach Alpha of α=.53 pre-intervention and α=.60 post-intervention. Self-efficacy was assessed with nine items (i.e., "I am knowledgeable about nutrition education for a patient recently diagnosed with type 2 diabetes mellitus.") and had a Cronbach Alpha of α=.75 pre-intervention and α=.85 post-intervention. Questionnaire items were randomised to prevent order effects and to minimise recall bias in the post-intervention measurement.

**Co-variates**

The questionnaire contained a demographics section with questions on potential confounding factors, including gender, medical faculty, training year, prior nutrition education, rating of relevance of nutrition for future practice (5-point Likert scale) and rating of benefit of more nutrition education in the medical curriculum (5-point Likert scale).(3,15–17) The variable "Training year" was dichotomized into year 1 to year 3 (Bachelor) versus year 4 to year 6 (Master). The variable "Prior exposure to nutrition education" was dichotomized into students who indicated that they had completed either a course, practical or lecture on nutrition and lifestyle (yes) versus students who indicated that they had not received any previous nutrition education (no).

The post-intervention questionnaire consisted of questions equal to the pre-intervention questionnaire. A question on SELF lecture attendance and on the appraisal of the SELF course on a scale from 1 to 10 was added to the post-intervention questionnaire for the intervention group.

**Data analysis**

Continuous variables were presented as means and standard deviations, whereas categorical variables were presented as frequencies and percentages. Descriptive statistics, Pearson's chi-square tests of contingencies and independent t tests were used to assess potential differences in baseline characteristics of the participants who did not complete the post-intervention questionnaire and those of participants who completed both pre-intervention and post-intervention questionnaires. Paired t-tests were used to assess the changes in outcome variables occurring between pre- and post-intervention measurements in the intervention and comparison group separately. For the paired t-tests, Cohen's d was calculated as a measure of effect size. To investigate the effects of the SELF course in the intervention group compared to the comparison

group while controlling for other variables, linear regression analyses were performed on the four outcome variables separately. Intervention assignment was entered as independent variable and pre-intervention scores of the dependent variables were added to each linear regression model to adjust for pre-intervention differences.

Variables obtained from pre-intervention data were tested for effect modification and confounding respectively.(3,15–17) A statistically significant interaction term between the outcome variable and the potential effect modifier in the linear regression model was considered evidence for effect modification, resulting in further stratified analyses. A change in the estimated measure of association of 10% or more after including the potential confounding variable in the regression analysis was evidence for confounding. To adjust, confounding variables were simultaneously entered into the regression model.

All analyses were conducted using IBM SPSS software (version 24.0, SPSS Inc., Chicago, IL, 2016). The level for determining statistical significance was predefined as a *p*-value of less than 0.05 for all comparisons.

## RESULTS

Demographic characteristics of the participants who did not complete the post-intervention questionnaire were similar to those of the participants with complete post-intervention outcome information except for their rating of the statement on benefit of more nutrition education for medical students (data not shown). Participants who did not complete the post-intervention questionnaire expected to have fewer benefit of more nutrition education in the medical curriculum than participants with complete post-intervention outcome information (1.19 vs. 1.37 points; p=0.03).

**Table 1.** Characteristics of medical students included in the study in total and for intervention and comparison group separately.

| | Total (N = 118) | Intervention (N = 66) | Comparison (N = 52) |
|---|---|---|---|
| | N (%), Mean, ± | N (%), Mean, ± | N (%), Mean, ± |
| Gender | | | |
| Man | 31 (26.3%) | 15 (22.7%) | 16 (30.8%) |
| Woman | 87 (73.2%) | 51 (77.3%) | 36 (69.2%) |
| Medical faculty | | | |
| AMC | 59 (50.0%) | 34 (51.5%) | 25 (48.1%) |
| VUmc | 59 (50.0%) | 32 (48.5%) | 27 (51.9%) |
| Study year | | | |
| BSc | 76 (64.4%) | 32 (48.5%) | 44 (84.6%) |
| MSc | 42 (35.6%) | 34 (51.5%) | 8 (15.4%) |
| Previous nutrition education | | | |
| No | 41 (34.7%) | 29 (43.9%) | 12 (23.1%) |
| Yes | 77 (65.3%) | 37 (56.1%) | 40 (76.9%) |
| Relevance nutrition education future practice (-2 to +2) | 1.42 ± 0.60 | 1.62 ± 0.49 | 1.15 ± 0.64 |
| Benefit more nutrition education (-2 to +2) | 1.37 ± 0.64 | 1.61 ± 0.49 | 1.08 ± 0.68 |

N number, ± standard deviation

Among the included participants three quarters were women (73,2%) and two-thirds of the students had received previous nutrition education (65,3%) as can be seen in Table 1. Most students agreed with the statements that nutrition education was relevant for future practice (mean 1.42, SD: 0.60) and that more nutrition education would benefit the student (mean 1.37, SD: 0.64).

Students in the comparison group were statistically significantly more likely to indicate that they had received previous nutrition education compared to students in the intervention group.

Table 2 shows the results of the paired t-tests on pre- and post-intervention measurements for change in nutritional knowledge scores and attitude scores, social support scores, and self-efficacy scores towards nutrition counselling for intervention and comparison group separately There was a statistically significant increase in the intervention group's scores from pre- to post-intervention in the parameters knowledge [M: 1.70, 95% CI: 1.19, 2.21], social support [M: 0.20, 95% CI: 0.05, 0.34], and self-efficacy [M: 0.84, 95% CI: 0.71, 0.98]. Attitude scores did not change statistically significantly from pre- to post-intervention for the intervention group, nor did any of the outcome variables in the comparison group.

Table 3 shows the results of the linear regression analyses for the association between nutritional knowledge (0-13), social support (-2 to +2), and self-efficacy (-2 to +2) towards nutrition counselling and the SELF course. Nutritional knowledge scores statistically significantly increased with 2.42 points in the intervention group as compared to the comparison group (95% CI: 1.81, 3.02). There was no statistically significant difference in social support scores in the intervention group as compared to the comparison group. Self-efficacy scores statistically significantly increased in the intervention group as compared to the comparison group with 0.78 points (95% CI: 0.62, 0.95).

Table 4 shows the results of the linear regression analyses for the association between attitude towards nutrition counselling and the SELF course for the group of students in total and stratified for men and women. Men's attitude scores statistically significantly increased in the intervention group as compared to the comparison group with 0.50 points (95% CI: 0.13, 0.87).

There was no statistically significant difference in women's attitude scores between the intervention and the comparison group.

**Table 2.** Paired t-tests on pre- and post-intervention measurements for change in nutritional knowledge scores and attitude scores, social support scores, and self-efficacy scores towards nutrition counselling for intervention and comparison group separately.

| | Intervention group (n=66) | | | | Comparison group (n=52) | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | Post-intervention | Difference score | Effect size | Pre-intervention | Post-intervention | Difference score | Effect size |
| | Mean, ± | Mean, ± | Mean, ± | Cohen's d | Mean, ± | Mean, ± | Mean, ± | Cohen's d |
| Knowledge (0 to 13) | 4.65 ± 1.77 | 6.35 ± 1.57 | + 1.70* ± 2.07 | 1.02 | 3.69 ± 1.88 | 3.60 ± 1.86 | - 0.10 ± 1.86 | 0.05 |
| Attitude (-2 to +2) | 1.09 ± 0.34 | 1.17 ± 0.66 | + 0.07 ± 0.67 | 0.15 | 0.86 ± 0.32 | 0.86 ± 0.39 | <0.01 ± 0.37 | <0.01 |
| Social support (-2 to +2) | -0.68 ± 0.57 | -0.48 ± 0.64 | + 0.20* ± 0.59 | 0.33 | -0.43 ± 0.55 | -0.53 ± 0.64 | - 0.10 ± 0.66 | 0.17 |
| Self-efficacy (-2 to +2) | -0.13 ± 0.52 | 0.71 ± 0.48 | + 0.84* ± 0.56 | 1.68 | 0.15 ± 0.45 | 0.06 ± 0.51 | - 0.09 ± 0.44 | 0.19 |

*p < 0.05

N number, ± standard deviation

**Table 3.** Linear regression analyses for the association between nutritional knowledge (0-13), social support (-2 to +2), and self-efficacy (-2 to +2) towards nutrition counselling and the SELF course of Dutch medical students (N=118).

| | Knowledge | | | Social Support | | | | | | Self-efficacy | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 1 | | | Model 2 | | | Model 1 | | |
| | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI |
| Constant | 2.31 | 0.37 | 1.58, 3.05 | -0.30 | 0.09 | -0.47, -0.12 | -0.29 | 0.09 | -0.46, -0.11 | -0.01 | 0.06 | -0.14, 0.11 |
| Intervention | 2.42 | 0.31 | 1.81, 3.02 | 0.18 | 0.11 | -0.04, 0.39 | 0.20 | 0.12 | -0.02, 0.43 | 0.78 | 0.09 | 0.62, 0.95 |

Model 1: adjusted for pre-intervention scores of the dependent variable

Model 2: additionally adjusted for study year

N number, B beta, SE standard error, 95% CI 95% confidence interval

**Table 4.** Linear regression analyses for the association between attitude (-2 to +2) towards nutrition counselling and the SELF course of Dutch medical students for the group in total (N=118) and stratified for men and women.

| | Total (N=118) | | | Men (N=31) | | | | | | Women (N=87) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 1 | | | Model 2* | | | Model 1 | | | Model 2** | | |
| | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI |
| Constant | 0.44 | 0.15 | 0.15, 0.74 | 0.32 | 0.21 | -0.12, 0.76 | 0.15 | 0.29 | -0.44, 0.74 | 0.54 | 0.19 | 0.16, 0.93 | 0.19 | 0.24 | -0.28, 0.66 |
| Intervention | 0.19 | 0.11 | -0.02, 0.40 | 0.53 | 0.18 | 0.17, 0.89 | 0.50 | 0.18 | 0.13, 0.87 | 0.08 | 0.13 | -0.18, 0.33 | 0.04 | 0.14 | -0.24, 0.31 |

Model 1: adjusted for pre-intervention scores of the dependent variable

Model 2*: additionally adjusted for study year and previous nutrition education

Model 2**: additionally adjusted for medical faculty and study year

N number, B beta, SE standard error, 95% CI 95% confidence interval

## DISCUSSION

This study showed that a nutrition education course of 25 contact hours distributed over 10 weeks improved the nutritional knowledge, attitudes in men and self-efficacy towards nutritional counselling in Dutch medical students. To the best of our knowledge, this is the first study on the effects of nutrition education in Dutch medical students. Results of this study are largely in line with those of international studies. Increases in nutritional knowledge after completion of a medical nutrition education intervention were also reported in a study of Maiburg and colleagues.(9) Others have shown similar improvements in self-efficacy towards nutrition and lifestyle counselling.(4,21) However, most studies found no gender differences in outcomes whereas this study observed only improvements in attitudes in the male students.(15,17) Comparison of the findings on social support towards nutrition and lifestyle counselling with similar intervention studies involving medical students is problematic because those studies did not include social support as an outcome variable.

Although nutritional knowledge in the intervention group increased, it still remained low on average. A medical nutrition education study of Sjarif and colleagues found a stronger increase in nutritional knowledge in medical students than our study.(22) Their intervention on infant feeding practice used clinical teaching by a skill tutorial or simulation and topics were addressed in-depth in dedicated lecture sessions. A combination of interactive practical sessions and lectures as opposed to merely lecture-based classes could have improved the gains in nutritional knowledge in participants of the SELF course. Furthermore, our findings confirm the results of others who showed that nutritional knowledge of medical students is poor and supports the need to include meaningful nutrition education into all phases of medical training.(3,8,9,23,24) Social support was also still perceived to be poor upon completion of the SELF course. The lack of significant effect

of the SELF course on social support likely signifies that in total, too few medical students participated in the course to benefit social networks. To improve social support, committed participants of the medical nutrition education intervention could have received a training to disseminate key nutrition-related messages to their social networks.(8) In contrast, most participants already had positive attitudes at pre-intervention. Similar findings of positive attitudes towards nutrition counselling in medical students have been previously observed.(3,17,25) The positive attitudes of medical students are an important finding, given that students' attitudes and behaviours are determinants of dietary counselling practices as physicians.(4,26) Self-efficacy scores in the intervention group significantly improved and changed from negative to positive. The importance of self-efficacy was noted in a previous study of nutrition counselling behaviour in which self-efficacy was associated with greater incidence of addressing nutrition.(21)

The results of this study should be considered in the context of its strengths and weaknesses. A strength of this study was the inclusion of a comparison group. Also, the SELF course was developed in co-creation sessions with medical students, health professionals and nutrition academics to assess potential participants' needs and interests to guarantee a broad and relevant medical nutrition education angle.(27) A potential weakness is the lack of randomization, which was difficult to organize in a voluntary extracurricular course upon request of a group of students. Intrinsically motivated students may benefit more from a course than those students who are less interested. Otherwise, motivated students may start with a relatively high level of knowledge and skills and therefore may actually benefit less than students with fewer knowledge and skills. Another weakness refers to socially desirable answers in the questionnaires, which may not reflect real impact of the course in future clinical management.(4,27) Clinical examinations or patient outcomes would have been preferable, but these methods can be costly in both time and

resources.(16) Since we compared the results with a comparison group, we suppose that it is improbable that the effects that we observed can be attributed to social desirability bias.

This study adds to earlier work by illustrating important areas of focus for implementation and evaluation of a nutrition education intervention for medical students. It supports the feasibility of implementing a brief, low-intensity nutrition education course as a method to improve medical students' nutritional knowledge and stimulated their intentions towards nutrition counselling. The SELF course was developed merely as a first step to offer additional nutrition education to Dutch medical students and can provide a guide for future improvement of the standard medical curriculum. Further research is needed to evaluate the long-term impact of nutrition education curricula on medical students' real-time and/or simulated dietary counselling performance, physician practice patterns and at the end patient outcomes.

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**Author Contributions**

HC contributed to and coordinated the design of the study, was responsible for the execution of the experiment, collected and carried out the data analysis and wrote the manuscript. CD and JS developed the design of the study. CD and JS reviewed and critiqued the manuscript. All authors approved the final version of the manuscript.

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**Competing interests**

None.

**Patient consent**

Not required.

**Ethics approval**

Medical Ethics Committee of the VU Medical Centre (2018.345).

**Provenance and peer review**

Not commissioned; externally peer reviewed.

**Data sharing statement**

Data analyzed in this study are available from the corresponding author in response to requests that comply with ethical principles of good research.

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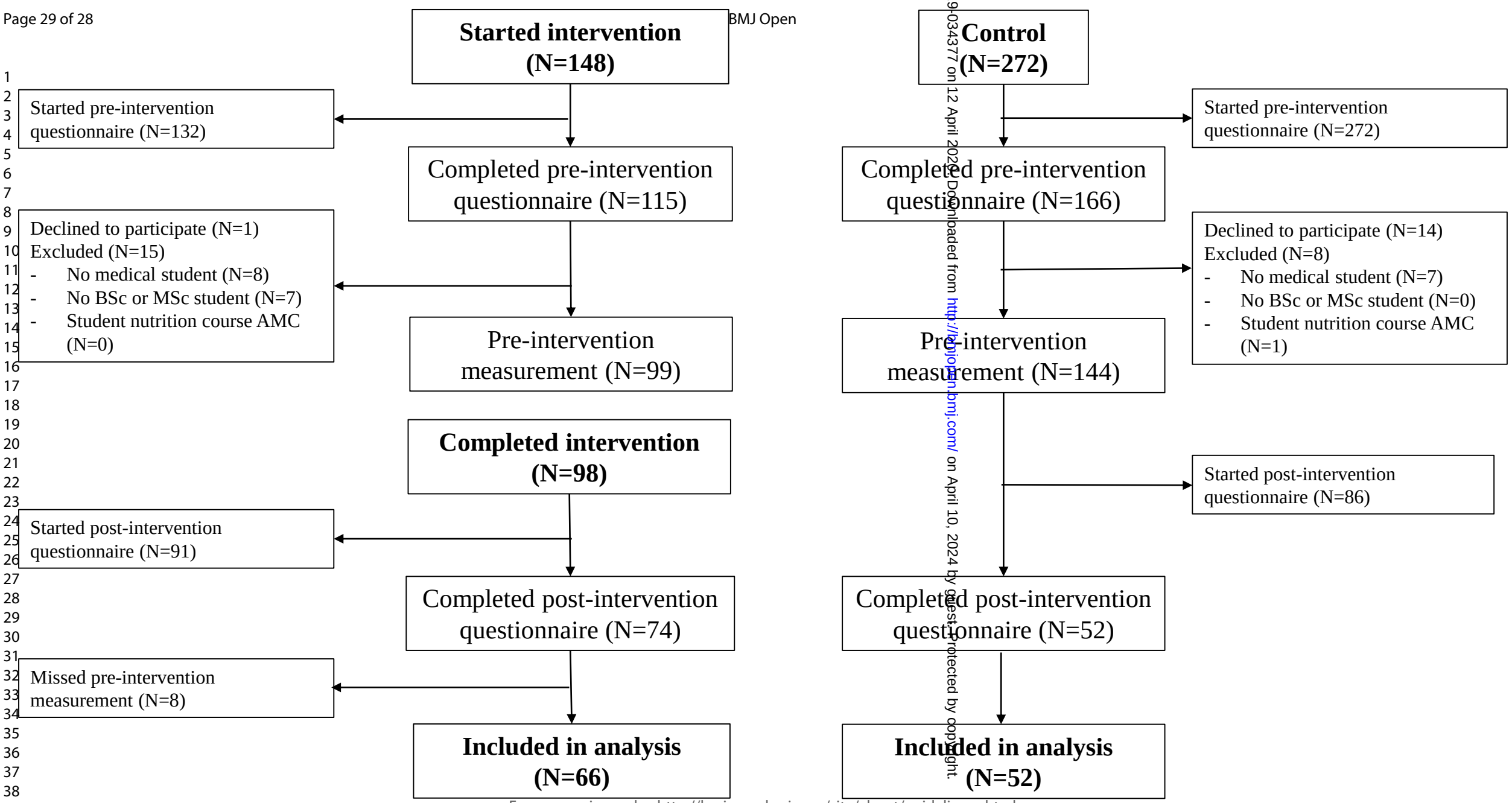

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# An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.



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**An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.**

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## ABSTRACT

**Objectives**: Management of diet-related chronic diseases may benefit from improved nutrition education of medical students. This study aims to investigate the effects of a nutrition education course on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.

**Design:** Pre- post intervention study with a comparison group. Participants completed self-reported questionnaires on nutritional knowledge and intentions towards nutritional counselling.

**Participants:** In total, 118 undergraduate (64.4%) and graduate medical students (73.2% women) were recruited from two medical schools in the Netherlands (n=66 intervention group, n=52 comparison group).

**Intervention:** The intervention group completed a 25 hour course in nutritional counselling (the SELF course) in addition to the standard medical curriculum. The comparison group followed the standard medical curriculum.

**Outcome measures:** Self-reported nutritional knowledge and intentions towards nutritional counselling including attitude, self-efficacy and social support.

**Results:** Nutritional knowledge (B: 2.42, 95% CI: 1.81, 3.02), attitude in men (B: 0.50, 95% CI: 0.13, 0.87), and self-efficacy (B: 0.78, 95% CI: 0.62, 0.95) significantly increased in the intervention group compared to the comparison group. No significant differences were found for social support (B: 0.20, 95% CI: -0.02, 0.43) and attitude in women (B: 0.08, 95% CI: -0.24, 0.31) between the two groups.

**Conclusions:** The SELF course increased medical students' nutritional knowledge and stimulated their intentions towards nutritional counselling. Future research is needed to evaluate the long-term impact of nutrition education interventions on physician practice patterns and eventually at the end patient outcomes.

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**Strengths and limitations of this study:**

- The nutrition education course was created in co-creation with medical professionals and medical students to guarantee a broad and relevant medical nutrition education angle.
- The effects of the course were measured before and after the course in participating medical students and in the same period in medical students who did not participate.
- Randomization would have been preferable but was difficult to organize in a voluntary extracurricular course upon request of a group of students.
- Measurements were self-reported rather than assessed in performance-based clinical examinations or patient-outcomes.

## INTRODUCTION

Dietary interventions have proven to be successful in the prevention and management of important lifestyle related disease, such as diabetes type 2 and cardiovascular disease.(1,2) Nutritional counselling by physicians could help to improve diets in patients, especially since patients consider physicians to be one of the most credible sources of nutrition information.(3,4) However, the substantial body of evidence that supports the benefits of nutritional interventions has not yet been translated into medical training or practice.(5) As a consequence, physicians often lack the necessary knowledge, skills and confidence to counsel their patients effectively.(6) For example, a survey among cardiologist showed that 90% of them reported that they did not received adequate nutrition education during fellow ship, even though 95% believed that their role includes personally providing patients with at least basic nutrition information.(7)

Previous studies on the effects of medical nutrition education interventions have shown that educational interventions can improve medical students' competencies, physicians' practice behaviour, and patients' health. A study in the UK indicated that a two-day workshop for medical students could lay the foundation of nutritional knowledge and attitudes relevant to clinical practice.(8) This very short 'one-off' course showed that it is possible to provoke relevant changes in nutritional care in medical students. However, the impact on physician practice patterns and on patient outcomes was not assessed. The results of a study on nutrition education for general practitioner (GP) trainees in the Netherlands showed that a computer-based instruction improved both GP trainees' nutritional knowledge and practice behaviour on the subject of nutrition.(9) Furthermore, a study in Brazil found that wasting and stunting in children were diminished after the implementation of an educational intervention on the provision of physicians' nutrition counselling to mothers and/or caregivers.(10)

Despite the opportunities and the demand from medical students to receive nutrition education, the status of nutrition education in the medical curriculum remains largely neglected. In the US, the time devoted to nutrition during medical school is limited, with an average of 19 hours divided over four years.(5) This is not different for the Netherlands, where students receive an average of 29 hours of nutrition education over six years of study.(11) To promote the need for greater nutrition education in medical schools' curricula in the Netherlands, the student-led "Student and Nutrition Foundation" (SNF) was established in 2017.(12) They developed a nutrition education course named the SELF course (Students Experienced in Lifestyle and Food) to offer medical students additional nutrition education. This provided us with the opportunity to investigate the effects of this intervention on medical students. Therefore, the aim of this study was to investigate the effects of the SELF course on nutritional knowledge and intentions towards nutritional counselling of Dutch medical students. Results of this study provide insights in the effectiveness of nutrition education in medical students which can be used to improve current medical training and long-term medical care.

## METHODS

### Design

To investigate the effects of the SELF course, a pre- post-intervention study with a comparison group was conducted. Data were collected via self-reported questionnaires using the online questionnaire service Qualtrics.(13) Data collection took place from April 2018 to June 2018. The study was conducted according to the ethical standards declared in the Helsinki declaration of 1975, as revised in 2000, and approved by the Medical Ethics Committee of the Vrije Universiteit (VU) Medical Centre Amsterdam. Active informed consent was obtained from all participants.

**Participants and recruitment**

This study took place in the two university teaching hospitals in Amsterdam, the Netherlands: the Amsterdam Medical Center (AMC) and the VU University Medical Canter (VUmc). All medical students from the AMC and VUmc were eligible to participate in the study, however medical students who followed a newly developed nutrition course at the AMC simultaneously with the SELF Amsterdam course were excluded from the analyses.

Participants in the intervention group were recruited from 148 students who were voluntarily enrolled in the SELF Amsterdam course in April 2018. All AMC and VUmc medical students of the six-year medical curriculum could apply to this course and acceptance was based on a first-come-first-serve principle. Participants in the intervention group were asked to complete the pre- and post-questionnaires in the lecture hall prior to the start of the first SELF Amsterdam lecture and after completion of the last lecture respectively. The sampling frame for the comparison group consisted of all undergraduate and graduate medical students of the AMC and the VUmc who did not participate in the SELF Amsterdam course. Participants of the comparison group were approached before or at the end of usual lecture times at the AMC and VUmc and by soliciting volunteers in the libraries of the two medical faculties. In the pre-intervention questionnaire, the comparison group was asked for their email addresses so that they could be approached for the post-intervention measurement per e-mail.

In total, 281 participants completed the pre-intervention questionnaire (n=115 intervention group, n=166 comparison group). A total of 15 students were excluded from the study sample for declining to sign the informed consent (n=1 intervention group, n=14 comparison group) and 23 students were excluded because of other reasons (n=15 intervention group, n=8 comparison

group), see Figure 1 for a flow chart with details on the reasons for exclusion. After this, 243 medical students were eligible to participate (n=99 intervention group, n=144 comparison group). Ten weeks later, a total of 126 participants completed the post-intervention questionnaire (n=74 intervention group, n=52 comparison group) of whom 8 participants were excluded because they missed pre-intervention measurement information (n=8 intervention group). The total study sample comprised of 118 medical students (n=66 intervention group, n=52 comparison group) who completed both the pre- and post-intervention questionnaire.

**Patient and public involvement**

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination of our research.

**Intervention**

The SELF Amsterdam course was developed based on key themes represented in the literature, several brainstorm sessions with medical students, and consultations with experts (Sept 2017 - Jan 2018).(14) The course consisted of 25 contact hours divided over ten consecutive weeks. Participants of the ten-week course had to contribute ten euro (twelve US dollar) per person to cover administrative costs. The course was designed for up to 150 undergraduate and graduate medical students. The course covered a different topic related to nutrition and lifestyle in health and disease each week, for example nutrition and diabetes, nutrition and cancer, or nutrition and cardiovascular disease. In total, 25 subject experts were selected to host a lecture, based on the criteria for SELF educators (e.g. having subject expertise and having affinity with the goals of the

SNF). The experts had various backgrounds, including but not limited to nutrition, psychology, dietetics, and medicine.

**Questionnaire development**

A questionnaire to measure nutritional knowledge and intentions towards nutritional counselling was developed based on validated questionnaires, two expert meetings with health professionals and academics working in the field of nutrition, health and disease (N=12) and an online feedback session with 5 experts (see supplementary files for the total questionnaire used).(3,15–17) The framework for the two expert meetings was based on the Attitude – Social Support – Self-Efficacy (ASE) model by De Vries, Dijkstra and Kuhlman in combination with the topic list of the SELF Amsterdam course and existing questionnaires.(18) The ASE model is a social cognition model that is commonly used in predicting and explaining health behaviour including nutrition.(19) The model postulates that there is a reliable relationship between intentions and behaviour: if intentions increase, facilitated by knowledge, behaviour should change positively.(20)

During the expert meetings experts discussed and wrote down specific scale items concerning knowledge, attitudes, social support, and self-efficacy towards nutritional counselling of essential student attainment on completion of the SELF course. Experts were asked to provide input for potential questions on testing these scale items. The results of the two expert meetings were combined and the outcomes were sent to a third group of experts to provide written feedback on accuracy and completeness. Next, three researchers (HC, JC and CD) critically revised the list of questions and created the final questionnaire. The questionnaire was pretested in a convenience sample of medical students (N=6) to assess understanding and comprehensibility. A few minor

amendments were made and the responses of these participants were excluded from the final analysis. The final questionnaire consisted of 49 questions. With forced answering options, participants were required to answer all questions before they could progress to the next page of the questionnaire.

**Outcomes**

Nutritional knowledge was assessed with thirteen multiple choice items (i.e., "What are the recommended daily amounts of fruits and vegetables for an adult woman (aged 19-50) according to the Dutch dietary recommendations?"). For all questions, one correct answer was possible and 1 point per correct answer could be obtained. The total score ranged from 0 to 13 points, with higher scores indicating higher nutritional knowledge.

Intentions (attitude, social support and self-efficacy) were assessed with rating of statements using 5-point Likert scales from "totally disagree (-2)" to "totally agree (2). A mean value score (ranging from -2 to +2) was calculated with a higher score indicating more positive intentions. Specifically, attitude was assessed with ten items (i.e., "All physicians, regardless of specialty, should counsel high-risk patients about dietary change."). The internal consistency of attitude as checked with Cronbach Alpha was α=.59 pre-intervention and α=.87 post-intervention. Social support was assessed with three items (i.e., "I know enough people in the medical faculty who I can contact in case I have questions on nutrition and lifestyle related topics.") and had a Cronbach Alpha of α=.53 pre-intervention and α=.60 post-intervention. Self-efficacy was assessed with nine items (i.e., "I am knowledgeable about nutrition education for a patient recently diagnosed with type 2 diabetes mellitus.") and had a Cronbach Alpha of α=.75 pre-intervention

and α=.85 post-intervention. Questionnaire items were randomised to prevent order effects and to minimise recall bias in the post-intervention measurement.

**Co-variates**

The questionnaire contained a demographics section with questions on potential confounding factors, including gender, medical faculty, training year, prior nutrition education, rating of relevance of nutrition for future practice (5-point Likert scale) and rating of benefit of more nutrition education in the medical curriculum (5-point Likert scale).(3,15–17) The variable "Training year" was dichotomized into year 1 to year 3 (Bachelor) versus year 4 to year 6 (Master). The variable "Prior exposure to nutrition education" was dichotomized into students who indicated that they had completed either a course, practical or lecture on nutrition and lifestyle (yes) versus students who indicated that they had not received any previous nutrition education (no).

The post-intervention questionnaire consisted of questions similar to the pre-intervention questionnaire. A question on SELF lecture attendance and on the appraisal of the SELF course on a scale from 1 to 10 was added to the post-intervention questionnaire for the intervention group.

**Data analysis**

Continuous variables were presented as means and standard deviations, whereas categorical variables were presented as frequencies and percentages. Descriptive statistics, Pearson's chi-square tests of contingencies and independent t tests were used to assess potential differences in baseline characteristics of the participants who did not complete the post-intervention questionnaire and those of participants who completed both pre-intervention and post-intervention questionnaires. Paired t-tests were used to assess the changes in outcome variables

occurring between pre- and post-intervention measurements in the intervention and comparison group separately. For the paired t-tests, Cohen's d was calculated as a measure of effect size. To investigate the effects of the SELF course in the intervention group compared to the comparison group while controlling for other variables, linear regression analyses were performed on the four outcome variables separately. Intervention assignment was entered as independent variable and pre-intervention scores of the dependent variables were added to each linear regression model to adjust for pre-intervention differences.

Variables obtained from pre-intervention data were tested for effect modification and confounding respectively.(3,15–17) A statistically significant interaction term between the outcome variable and the potential effect modifier in the linear regression model was considered evidence for effect modification, resulting in further stratified analyses. A change in the estimated measure of association of 10% or more after including the potential confounding variable in the regression analysis was evidence for confounding. To adjust, confounding variables were simultaneously entered into the regression model.

All analyses were conducted using IBM SPSS software (version 24.0, SPSS Inc., Chicago, IL, 2016). The level for determining statistical significance was predefined as a *p*-value of less than 0.05 for all comparisons.

## RESULTS

Demographic characteristics of the participants who did not complete the post-intervention questionnaire were similar to those of the participants with complete post-intervention outcome information except for their rating of the statement on benefit of more nutrition education for medical students (data not shown). Participants who did not complete the post-intervention questionnaire expected to have fewer benefits of more nutrition education in the medical

curriculum than participants with complete post-intervention outcome information (1.19 vs. 1.37 points; p=0.03).

**Table 1.** Characteristics of medical students included in the study in total and for intervention and comparison group separately.

| | Total (N = 118) | Intervention (N = 66) | Comparison (N = 52) |
|---|---|---|---|
| | N (%), Mean, ± | N (%), Mean, ± | N (%), Mean, ± |
| Gender | | | |
| Male | 31 (26.3%) | 15 (22.7%) | 16 (30.8%) |
| Female | 87 (73.2%) | 51 (77.3%) | 36 (69.2%) |
| Medical faculty | | | |
| AMC | 59 (50.0%) | 34 (51.5%) | 25 (48.1%) |
| VUmc | 59 (50.0%) | 32 (48.5%) | 27 (51.9%) |
| Study year | | | |
| BSc | 76 (64.4%) | 32 (48.5%) | 44 (84.6%) |
| MSc | 42 (35.6%) | 34 (51.5%) | 8 (15.4%) |
| Previous nutrition education | | | |
| No | 41 (34.7%) | 29 (43.9%) | 12 (23.1%) |
| Yes | 77 (65.3%) | 37 (56.1%) | 40 (76.9%) |
| Relevance nutrition education future practice (-2 to +2) | 1.42 ± 0.60 | 1.62 ± 0.49 | 1.15 ± 0.64 |
| Benefit more nutrition education (-2 to +2) | 1.37 ± 0.64 | 1.61 ± 0.49 | 1.08 ± 0.68 |

N number, ± standard deviation

Among the included participants, three quarters were female (73,2%) and two-thirds of the students had received previous nutrition education (65,3%) as can be seen in Table 1. Most students agreed with the statements that nutrition education was relevant for future practice (mean 1.42, SD: 0.60) and that more nutrition education would benefit the student (mean 1.37, SD: 0.64). Students in the comparison group were statistically significantly more likely to indicate that they had received previous nutrition education compared to students in the intervention group.

Table 2 shows the results of the paired t-tests on pre- and post-intervention measurements for change in nutritional knowledge scores and attitude scores, social support scores, and self-efficacy scores towards nutrition counselling for intervention and comparison group separately There was a statistically significant increase in the intervention group's scores from pre- to post-intervention in the parameters nutritional knowledge [M: 1.70, 95% CI: 1.19, 2.21], social support [M: 0.20, 95% CI: 0.05, 0.34], and self-efficacy [M: 0.84, 95% CI: 0.71, 0.98]. Attitude scores did not change statistically significantly from pre- to post-intervention for the intervention group, nor did any of the outcome variables in the comparison group.

Table 3 shows the results of the linear regression analyses for the association between nutritional knowledge (0-13), social support (-2 to +2), and self-efficacy (-2 to +2) towards nutrition counselling and the SELF course. In the intervention group, nutritional knowledge scores statistically significantly increased with 2.42 points as compared to the comparison group (95% CI: 1.81, 3.02). There was no statistically significant difference in social support scores in the intervention group as compared to the comparison group. In the intervention group self-efficacy scores statistically significantly increased as compared to the comparison group with 0.78 points (95% CI: 0.62, 0.95).

Table 4 shows the results of the linear regression analyses for the association between attitude towards nutrition counselling and the SELF course for the group of students in total and stratified for men and women. Men's attitude scores statistically significantly increased in the intervention group as compared to the comparison group with 0.50 points (95% CI: 0.13, 0.87). There was no statistically significant difference in women's attitude scores between the intervention and the comparison group.

**Table 2.** Paired t-tests on pre- and post-intervention measurements for change in nutritional knowledge scores and attitude scores, social support scores, and self-efficacy scores towards nutrition counselling for intervention and comparison group separately.

| | Intervention group (n=66) | | | | Comparison group (n=52) | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | Post-intervention | Difference score | Effect size | Pre-intervention | Post-intervention | Difference score | Effect size |
| | Mean, ± | Mean, ± | Mean, ± | Cohen's d | Mean, ± | Mean, ± | Mean, ± | Cohen's d |
| Knowledge (0 to 13) | 4.65 ± 1.77 | 6.35 ± 1.57 | + 1.70* ± 2.07 | 1.02 | 3.69 ± 1.88 | 3.60 ± 1.86 | - 0.10 ± 1.86 | 0.05 |
| Attitude (-2 to +2) | 1.09 ± 0.34 | 1.17 ± 0.66 | + 0.07 ± 0.67 | 0.15 | 0.86 ± 0.32 | 0.86 ± 0.39 | <0.01 ± 0.37 | <0.01 |
| Social support (-2 to +2) | -0.68 ± 0.57 | -0.48 ± 0.64 | + 0.20* ± 0.59 | 0.33 | -0.43 ± 0.55 | -0.53 ± 0.64 | - 0.10 ± 0.66 | 0.17 |
| Self-efficacy (-2 to +2) | -0.13 ± 0.52 | 0.71 ± 0.48 | + 0.84* ± 0.56 | 1.68 | 0.15 ± 0.45 | 0.06 ± 0.51 | - 0.09 ± 0.44 | 0.19 |

*p < 0.05

N number, ± standard deviation

**Table 3.** Linear regression analyses for the association between nutritional knowledge (0-13), social support (-2 to +2), and self-efficacy (-2 to +2) towards nutrition counselling and the SELF course of Dutch medical students (N=118).

| | Knowledge | | | Social Support | | | | | | Self-efficacy | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 1 | | | Model 2 | | | Model 1 | | |
| | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI |
| Constant | 2.31 | 0.37 | 1.58, 3.05 | -0.30 | 0.09 | -0.47, -0.12 | -0.29 | 0.09 | -0.46, -0.11 | -0.03 | 0.06 | -0.14, 0.11 |
| Intervention | 2.42 | 0.31 | 1.81, 3.02 | 0.18 | 0.11 | -0.04, 0.39 | 0.20 | 0.12 | -0.02, 0.43 | 0.77 | 0.09 | 0.62, 0.95 |

Model 1: adjusted for pre-intervention scores of the dependent variable

Model 2: additionally adjusted for study year

N number, B beta, SE standard error, 95% CI 95% confidence interval

**Table 4.** Linear regression analyses for the association between attitude (-2 to +2) towards nutrition counselling and the SELF course of Dutch medical students for the group in total (N=118) and stratified for men and women.

| | Total (N=118) | | | Men (N=31) | | | | | | Women (N=87) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 1 | | | Model 2* | | | Model 1 | | | Model 2** | | |
| | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI |
| Constant | 0.44 | 0.15 | 0.15, 0.74 | 0.32 | 0.21 | -0.12, 0.76 | 0.15 | 0.29 | -0.44, 0.74 | 0.54 | 0.19 | 0.16, 0.93 | 0.19 | 0.24 | -0.28, 0.66 |
| Intervention | 0.19 | 0.11 | -0.02, 0.40 | 0.53 | 0.18 | 0.17, 0.89 | 0.50 | 0.18 | 0.13, 0.87 | 0.08 | 0.13 | -0.18, 0.33 | 0.04 | 0.14 | -0.24, 0.31 |

Model 1: adjusted for pre-intervention scores of the dependent variable

Model 2*: additionally adjusted for study year and previous nutrition education

Model 2**: additionally adjusted for medical faculty and study year

N number, B beta, SE standard error, 95% CI 95% confidence interval

## DISCUSSION

The aim of this study was to investigate the effects of a nutrition education course on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students. The results showed that a nutrition education course of 25 contact hours distributed over 10 weeks improved the nutritional knowledge, attitudes in men and self-efficacy towards nutritional counselling in Dutch medical students. To the best of our knowledge, the current study is the first study on the effects of nutrition education in Dutch medical students. The results of our study are largely in line with those of international studies. Increases in nutritional knowledge after completion of a medical nutrition education intervention were also reported in a study of Maiburg and colleagues.(9) Others have shown similar improvements in self-efficacy towards nutrition and lifestyle counselling.(4,21) However, most studies found no gender differences in outcomes whereas this study observed only improvements in attitudes in the male students.(15,17) Comparison of the findings on social support towards nutrition and lifestyle counselling with similar intervention studies involving medical students is problematic because those studies did not include social support as an outcome variable.

Although nutritional knowledge in the intervention group increased, on average it still remained low. A medical nutrition education study of Sjarif and colleagues found a greater increase in nutritional knowledge in medical students than our study.(22) Their intervention group received comprehensive and integrated interactive lectures with additional multidisciplinary lectures on oral–motor skill development and behavioral approaches to feeding problems. A hands-on workshop using real cases shown on recorded video and role-play sessions was also presented to the intervention group. . A combination of interactive practical sessions and lectures as opposed to merely lecture-based classes could have improved the gains in nutritional knowledge in

participants of the SELF course. The importance of experimental in teaching is also confirmed by others who concluded that progression from a student to a health professional relies on experiential learning and participation.(23) Furthermore, our findings confirm the results of others who showed that nutritional knowledge of medical students is poor and supports the need to include meaningful nutrition education into all phases of medical training.(3,8,9,24,25) Social support was also still perceived to be poor upon completion of the SELF course. The lack of significant effect of the SELF course on social support likely signifies that in total, too few medical students participated in the course to benefit social networks. To improve social support, committed participants of the medical nutrition education intervention could have received a training to disseminate key nutrition-related messages to their social networks.(8) In contrast, most participants already had positive attitudes at pre-intervention. Similar findings of positive attitudes towards nutrition counselling in medical students have been previously observed.(3,17,26) The positive attitudes of medical students are an important finding, given that students' attitudes and behaviours are determinants of dietary counselling practices as physicians.(4,27) Self-efficacy scores in the intervention group significantly improved and changed from negative to positive (from -0.01 to 0.78 on a scale from -2 to +2). The importance of self-efficacy was noted in a previous study of nutrition counselling behaviour in which self-efficacy was associated with greater incidence of addressing nutrition.(21)

The results of this study should be considered in the context of its strengths and weaknesses. A strength of this study was the inclusion of a comparison group. Also, the SELF course was developed in co-creation sessions with medical students, health professionals and nutrition academics to assess potential participants' needs and interests to guarantee a broad and relevant medical nutrition education angle.(28) A potential weakness is the lack of randomization,

which was difficult to organize in a voluntary extracurricular course upon request of a group of students. Intrinsically motivated students may benefit more from a course than those students who are less interested. Otherwise, motivated students may start with a relatively high level of knowledge and skills and therefore may actually benefit less than students with fewer knowledge and skills. Another weakness refers to socially desirable answers in the questionnaires, which may not reflect real impact of the course in future clinical management.(4,28) Clinical examinations or patient outcomes would have been preferable, but these methods can be costly in both time and resources.(16) Since we compared the results with a comparison group, we suppose that it is improbable that the effects that we observed can be attributed to social desirability bias.

This study adds to earlier work by illustrating important areas of focus for implementation and evaluation of a nutrition education intervention for medical students. It supports the feasibility of implementing a brief, low-intensity nutrition education course as a method to improve medical students' nutritional knowledge and stimulated their intentions towards nutrition counselling. The SELF course was developed merely as a first step to offer additional nutrition education to Dutch medical students and can provide a guide for future improvement of the standard medical curriculum. The current SELF course consist of 25 contact hours and is offered as an a voluntary extracurricular course of 10 consecutive weeks. If medical schools decide to focus more on nutrition in their curriculum, we would recommend them to integrate the nutrition topics into existing classes or topics during a longer period of time. For example, when teaching classes about diabetes, they could also pay attention to the nutritional aspects of diabetes or as part of the courses on cardiovascular or gastro-intestinal health, they could devote some of the time to nutritional aspects. This will prevent repetition of basic topics, thereby limiting an extra time burden, while at the same time working to create an awareness among future doctors that nutrition is in important

factor in many diseases. Furthermore, when spreading out the nutrition topics over a longer period of time provides the opportunity to reinforce, apply and practice counseling skills along the curriculum. It will also be necessary to give medical students opportunities for internships and residencies where they can reinforce, apply and practice their knowledge and skills in nutrition. This will prevent the extinguishing of nutrition knowledge and skills over time. In addition, in response to the demand of students, some medical schools in The Netherlands have recently introduced elective courses in nutrition in the second year of medical training. Further research is needed to evaluate the long-term impact of nutrition education curricula on medical students' real-time and/or simulated dietary counselling performance, physician practice patterns and at the end patient outcomes.

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HC contributed to and coordinated the design of the study, was responsible for the execution of the experiment, collected and carried out the data analysis and wrote the manuscript. CD and JS developed the design of the study. CD and JS reviewed and critiqued the manuscript. All authors approved the final version of the manuscript.

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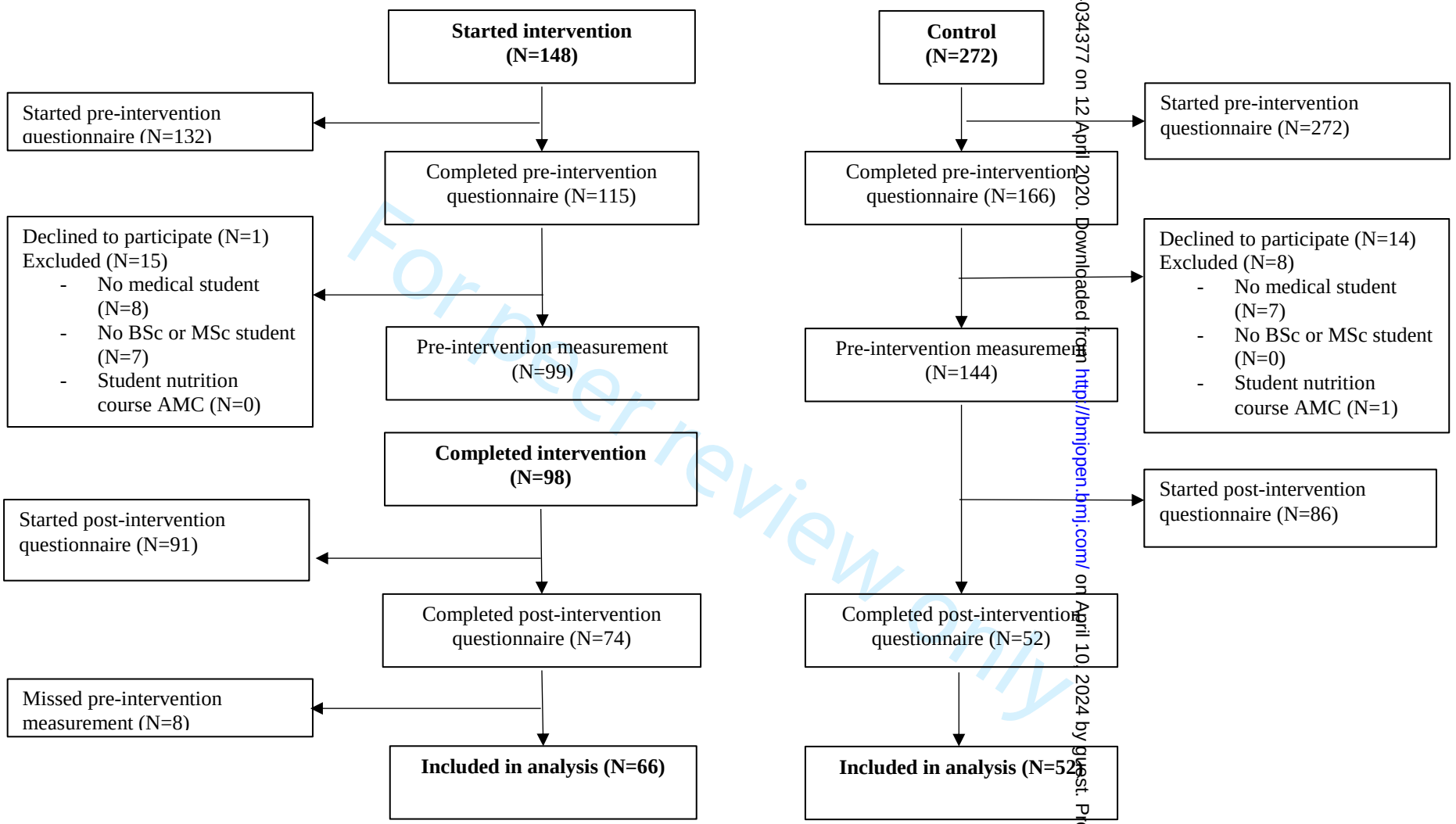


Figure 1. Flowchart of the study population

**English translation of the Dutch questionnaire used in the article "An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students".**

By participating in this study you provide insights into the need and importance of nutrition and lifestyle education for medical students. Filling out this questionnaire will take about 15 minutes. The questionnaire consists of the following components:

1. Questions about background characteristics;
2. Knowledge questions about nutrition and lifestyle;
3. Assessment of statements about nutrition and lifestyle.

**Which medical faculty do you study at?**

- ○ AMC
- ○ VUmc
- ○ Another medical faculty
- ○ I don't study at a medical faculty

**Do you currently take the nutrition elective Diometer Keuzetraject Voeding developed by the AMC?**

- ○ No
- ○ Yes

**Do you currently take the SELF course developed by Stichting Student en Voeding?**

- ○ No
- ○ Yes

**What is your gender?**

- ○ Male
- ○ Female
- ○ Other

**What is your year of study?**

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ Otherwise, namely: _____

**Do you already know your preferred medical specialization?**

- ○ No
- ○ Yes

**Of yes, what is your preferred medical specialization?**

- ○ Physician for mentally disabled
- ○ Occupational physician
- ○ General practitioner
- ○ Public health physician
- ○ Medical specialist
- ○ Geriatric physician
- ○ Insurance physician

**Do you remember having any nutrition or lifestyle education during medical school in the past? Either (a):**

| | No | Yes | I don't know |
|---|---|---|---|
| Separate nutrition / lifestyle course | ○ | ○ | ○ |
| Lectures on nutrition / lifestyle concepts | ○ | ○ | ○ |
| Practical's on nutrition / lifestyle concepts | ○ | ○ | ○ |
| Otherwise, namely: | ○ | ○ | ○ |

**How relevant do you find the topic nutrition and lifestyle for future medical practice?**

- ○ Highly irrelevant
- ○ Irrelevant
- ○ Neutral
- ○ Relevant
- ○ Highly relevant

**How much do you think you will benefit from additional nutrition education in the medical curriculum?**

- ○ Highly irrelevant
- ○ Irrelevant
- ○ Neutral
- ○ Relevant
- ○ Highly relevant

The following questions are focused on specific knowledge about nutrition and lifestyle. Choose that answer that best fits the question. If you don't know the answer please choice the "I don't know" option. It is not allowed to use any external help in answering the questions, for example the internet.

**Periodical restriction of protein in mice:**

- ○ Activates growth factors and stimulates apoptosis of healthy cells
- ○ Diminishes growth factors and stimulates growth of healthy cells
- ○ Activates growth factors and stimulates apoptosis of cancer cells
- ○ Diminishes growth factors and stimulates apoptosis of cancer cells
- ○ I don't know

**Breastmilk has benefits for both mother and child. Beneficial effects include:**

- ○ Mother: decreased risk of lung cancer, child: decreased risk of infection in the first year
- ○ Mother: decreased risk of lung cancer, child: decreased risk of celiac disease
- ○ Mother: decreased risk of ovarian cancer, child: decreased risk of infection in the first year
- ○ Mother: decreased risk of ovarian cancer, child: decreased risk of celiac disease
- ○ I don't know

**The current recommended daily amount of fruit and vegetables for adults according to the Dutch Schijf van Vijf are, in respective order:**

- ○ 200 grams of vegetables and 2 portions of fruit
- ○ 250 grams of vegetables and 2 portions of fruit
- ○ 200 grams of vegetables and 3 portions of fruit
- ○ 250 gram of vegetables and 3 portions of fruit
- ○ I don't know

**What percentage of the Dutch hospital population is malnourished?**

- ○ Approximately 5%
- ○ Approximately 10%
- ○ Approximately 15%
- ○ Approximately 20%
- ○ I don't know

**Which patient characteristics should a physician assess to screen for malnutrition?**

- ○ Chewing and swallowing problems
- ○ Malabsorption and maldigestion
- ○ Weight loss and appetite
- ○ Fatigue and functioning
- ○ I don't know

**The low-FODMAP diet is mainly used in patients with irritable bowel syndrome (IBS). For patients with inflammatory bowel disease (IBD) the low-FODMAP diet can also reduce symptoms. Which symptoms are improved especially?**

- ○ Obstipation
- ○ Abdominal pains
- ○ Bloating
- ○ Fatigue
- ○ I don't know

**Which substrate causes the cascade of training effects after a sprint interval training?**

- ○ Glycogen from the liver
- ○ Glycogen from the muscle
- ○ Lactate from muscle
- ○ Low blood glucose levels
- ○ I don't know

**Which psychiatric disorder has the strongest evidence for a relationship with diet?**

- ○ Anxiety disorders
- ○ Mood disorders
- ○ Psychotic disorders
- ○ Developmental disorders
- ○ I don't know

**During a volleyball training a hypoglycaemia occurs in a patient with type 2 diabetes. His blood sugar is 2,5 mm/L. He drinks a bottle of AA high energy drink with 46 grams of carbohydrates/sugars. How long will it take before he can start training again?**

- ○ 2 minutes
- ○ 5 minutes
- ○ 15 minutes
- ○ It is better to stop the training with a blood sugar below 3 mmol/L
- ○ I don't know

**For an optimal metabolic response, a patient who requires 100 grams of protein per day should:**

- ○ Consume preferably plant-based proteins and spread the consumption of 100 grams protein throughout the day
- ○ Consume preferably animal-based proteins and spread the consumption of 100 grams protein throughout the day
- ○ Consume preferably plant-based proteins and spread the consumption of 100 grams protein in four portions of 25 grams
- ○ Consume preferably animal-based proteins and spread the consumption of 100 grams protein in four portions of 25 grams
- ○ I don't know

**What is the current general advice on the use of dietary supplements to prevent cancer?**

- ○ Supplements do not decrease the risk of cancer
- ○ Take supplements if you can't follow current healthy eating guidelines on fruit and vegetables
- ○ Take vitamin D supplements to decrease the risk of colon and breast cancer
- ○ Take beta-carotene supplements to decrease the risk of lung cancer
- ○ I don't know

**The World Health Organization (WHO) classified processed meats as carcinogenic to humans, in the same category as tobacco smoking and asbestos. What does this mean?**

- ○ Processed meat consumers have the same relative risk to develop cancer as tobacco smokers
- ○ Processed meat consumers have the same absolute risk to develop cancer as tobacco smokers
- ○ The strength of scientific evidence about processed meats being a cause of cancer is similar to the strength of scientific evidence about tobacco smoking being a cause of cancer
- ○ Processed meats and cigarettes contain the same concentration carcinogenics
- ○ I don't know

To what extent do you agree with the following statements? Choose the answer that best fits you.

**All physicians, regardless of their specialisation, should counsel high-risk patients about relevant dietary and lifestyle changes**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Physicians can have an effect on a patient's dietary and lifestyle behaviour if they take the time to discuss this with patients**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**As a physician, it is essential to regularly ask about the progress of previously agreed dietary and lifestyle changes to maintain and improve the results achieved by patients**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**A physician should pay attention to the nutritional status of the patient**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**It is important that a physician recommends dietary and lifestyle changes before initiating drug therapy if relevant for the patient's disease**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**It is important that a physician refers patients with diet-related problems to registered dietitians or other qualified nutritional staff**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Most obese patients are not motivated to lose weight**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Attention of a physician for nutrition and lifestyle is important in every phase in the lifecycle**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Physicians should tailor their dietary and lifestyle advice towards the patient's socioeconomic and ethnic backgrounds.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Fellow medical students stimulate me to address nutritional and lifestyle topics systematically in future medical practice**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Medical academic staff stimulate me to address nutritional and lifestyle topics systematically in future medical practice**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have enough contacts within my medical training to consult experts if I want to know more about nutrition and lifestyle.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to provide general recommendation to patients about healthy nutrition and a healthy lifestyle.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to explain the health consequences of overweight of obesity to my patients. provide general recommendation to patients about healthy nutrition and a healthy lifestyle.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to stimulate patients to change their dietary and lifestyle patterns.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge about the role of a dietician to refer patients when necessary.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to differentiate nutritional facts from fiction.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to discuss maternal and infant benefits and challenges anticipated with breast-feeding with patients.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to provide a general nutrition and lifestyle advice to patients with diabetes type 2.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to provide a general nutrition and lifestyle advice to patients recently diagnosed with cancer**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to explain the consequences of a vitamin deficiency to older patients.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

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# An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.



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# An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.

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## ABSTRACT

**Objectives**: Management of diet-related chronic diseases may benefit from improved nutrition education of medical students. This study aims to investigate the effects of a nutrition education course on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students.

**Design:** Pre- post intervention study with a comparison group. Participants completed self-reported questionnaires on nutritional knowledge and intentions towards nutritional counselling.

**Participants:** In total, 118 undergraduate (64.4%) and graduate medical students (73.2% women) were recruited from two medical schools in the Netherlands (n=66 intervention group, n=52 comparison group).

**Intervention:** The intervention group completed a 25 hour course in nutritional counselling (the SELF course) in addition to the standard medical curriculum. The comparison group followed the standard medical curriculum.

**Outcome measures:** Self-reported nutritional knowledge and intentions towards nutritional counselling including attitude, self-efficacy and social support.

**Results:** Nutritional knowledge (B: 2.42, 95% CI: 1.81, 3.02), attitude in men (B: 0.50, 95% CI: 0.13, 0.87), and self-efficacy (B: 0.78, 95% CI: 0.62, 0.95) significantly increased in the intervention group compared to the comparison group. No significant differences were found for social support (B: 0.20, 95% CI: -0.02, 0.43) and attitude in women (B: 0.08, 95% CI: -0.24, 0.31) between the two groups.

**Conclusions:** The SELF course increased medical students' nutritional knowledge and stimulated their intentions towards nutritional counselling. Future research is needed to evaluate the long-term impact of nutrition education interventions on physician practice patterns and eventually at the end patient outcomes.

Word count: 238

**Strengths and limitations of this study:**

- The nutrition education course was created in co-creation with medical professionals and medical students to guarantee a broad and relevant medical nutrition education angle.
- The effects of the course were measured before and after the course in participating medical students and in the same period in medical students who did not participate.
- Randomization would have been preferable but was difficult to organize in a group of students participating in a voluntary extracurricular course.
- Measurements were self-reported rather than assessed in performance-based clinical examinations or patient-outcomes.

## INTRODUCTION

Dietary interventions have proven to be successful in the prevention and management of important lifestyle related disease, such as diabetes type 2 and cardiovascular disease.(1,2) Nutritional counselling by physicians could help to improve diets in patients, especially since patients consider physicians to be one of the most credible sources of nutrition information.(3,4) However, the substantial body of evidence that supports the benefits of nutritional interventions has not yet been translated into medical training or practice.(5) As a consequence, physicians often lack the necessary knowledge, skills and confidence to counsel their patients effectively.(6) For example, a survey among cardiologist showed that 90% of them reported that they did not received adequate nutrition education during fellowship, even though 95% believed that their role includes personally providing patients with at least basic nutrition information.(7)

Previous studies on the effects of medical nutrition education interventions have shown that educational interventions can improve medical students' competencies, physicians' practice behaviour, and patients' health. A study in the UK indicated that a two-day workshop for medical students could lay the foundation of nutritional knowledge and attitudes relevant to clinical practice.(8) This very short 'one-off' course showed that it is possible to provoke relevant changes in nutritional care in medical students. However, the impact on physician practice patterns and on patient outcomes was not assessed. The results of a study on nutrition education for general practitioner (GP) trainees in the Netherlands showed that a computer-based instruction improved both GP trainees' nutritional knowledge and practice behaviour on the subject of nutrition.(9) Furthermore, a study in Brazil found that wasting and stunting in children were diminished after the implementation of an educational intervention on the provision of physicians' nutrition counselling to mothers and/or caregivers.(10)

Despite the opportunities and the demand from medical students to receive nutrition education, the status of nutrition education in the medical curriculum remains largely neglected. In the US, the time devoted to nutrition during medical school is limited, with an average of 19 hours divided over four years.(5) This is not different for the Netherlands, where students receive an average of 29 hours of nutrition education over six years of study.(11) To respond to the need for greater nutrition education in medical schools' curricula in the Netherlands, the student-led "Student and Nutrition Foundation" (SNF) was established in 2017.(12) They developed a nutrition education course named the SELF course (Students Experienced in Lifestyle and Food) to offer medical students additional nutrition education. This provided us with the opportunity to investigate the effects of this intervention on medical students. Therefore, the aim of this study was to investigate the effects of the SELF course on nutritional knowledge and intentions towards nutritional counselling of Dutch medical students. Results of this study provide insights in the effectiveness of nutrition education in medical students which can be used to improve current medical training and long-term medical care.

## METHODS

### Design

To investigate the effects of the SELF course, a pre- post-intervention study with a comparison group was conducted. Data were collected via self-reported questionnaires using the online questionnaire service Qualtrics.(13) Data collection took place from April 2018 to June 2018. The study was conducted according to the ethical standards declared in the Helsinki declaration of 1975, as revised in 2000, and approved by the Medical Ethics Committee of the Vrije Universiteit (VU) Medical Centre Amsterdam. Active informed consent was obtained from all participants.

**Participants and recruitment**

This study took place in the two university teaching hospitals in Amsterdam, the Netherlands: the Amsterdam Medical Center (AMC) and the VU University Medical Canter (VUmc). All medical students from the AMC and VUmc were eligible to participate in the study, however medical students who followed a newly developed nutrition course at the AMC simultaneously with the SELF Amsterdam course were excluded from the analyses.

Participants in the intervention group were recruited from 148 students who were voluntarily enrolled in the SELF Amsterdam course in April 2018. All AMC and VUmc medical students of the six-year medical curriculum could apply to this course and acceptance was based on a first-come-first-serve basis. Participants in the intervention group were asked to complete the pre- and post-questionnaires in the lecture hall prior to the start of the first SELF Amsterdam lecture and after completion of the last lecture respectively. The sampling frame for the comparison group consisted of all undergraduate and graduate medical students of the AMC and the VUmc who did not participate in the SELF Amsterdam course. Participants of the comparison group were approached before or at the end of usual lecture times at the AMC and VUmc and by soliciting volunteers in the libraries of the two medical faculties. In the pre-intervention questionnaire, the comparison group was asked for their email addresses so that they could be approached for the post-intervention measurement per e-mail.

In total, 281 participants completed the pre-intervention questionnaire (n=115 intervention group, n=166 comparison group). A total of 15 students were excluded from the study sample for declining to sign the informed consent (n=1 intervention group, n=14 comparison group) and 23 students were excluded because of other reasons (n=15 intervention group, n=8 comparison

group), see Figure 1 for a flow chart with details on the reasons for exclusion. After this, 243 medical students were eligible to participate (n=99 intervention group, n=144 comparison group). Ten weeks later, a total of 126 participants completed the post-intervention questionnaire (n=74 intervention group, n=52 comparison group) of whom 8 participants were excluded because they missed pre-intervention measurement information (n=8 intervention group). The total study sample comprised of 118 medical students (n=66 intervention group, n=52 comparison group) who completed both the pre- and post-intervention questionnaire.

**Patient and public involvement**

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination of our research.

**Intervention**

The SELF Amsterdam course was developed based on key themes represented in the literature, several brainstorm sessions with medical students, and consultations with experts (Sept 2017 - Jan 2018).(14) The course consisted of 25 contact hours divided over ten consecutive weeks. Participants of the ten-week course had to contribute ten euro (twelve US dollar) per person to cover administrative costs. The course was designed for up to 150 undergraduate and graduate medical students. The course covered a different topic related to nutrition and lifestyle in health and disease each week, for example nutrition and diabetes, nutrition and cancer, or nutrition and cardiovascular disease. In total, 25 subject experts were selected to host a lecture, based on the criteria for SELF educators (e.g. having subject expertise and having affinity with the goals of the

SNF). The experts had various backgrounds, including but not limited to nutrition, psychology, dietetics, and medicine.

**Questionnaire development**

A questionnaire to measure nutritional knowledge and intentions towards nutritional counselling was developed based on validated questionnaires, two expert meetings with health professionals and academics working in the field of nutrition, health and disease (N=12) and an online feedback session with 5 experts (see supplementary files for the complete questionnaire used).(3,15–17) The framework for the two expert meetings was based on the Attitude – Social Support – Self-Efficacy (ASE) model by De Vries, Dijkstra and Kuhlman in combination with the topic list of the SELF Amsterdam course and existing questionnaires.(18) The ASE model is a social cognition model that is commonly used in predicting and explaining health behaviour including nutrition.(19) The model postulates that there is a reliable relationship between intentions and behaviour: if intentions increase, facilitated by knowledge, behaviour should change positively.(20)

During the expert meetings experts discussed and wrote down specific scale items concerning knowledge, attitudes, social support, and self-efficacy towards nutritional counselling of essential student attainment on completion of the SELF course. Experts were asked to provide input for potential questions on testing these scale items. The results of the two expert meetings were combined and the outcomes were sent to a third group of experts to provide written feedback on accuracy and completeness. Next, three researchers (HC, JC and CD) critically revised the list of questions and created the final questionnaire. The questionnaire was pretested in a convenience sample of medical students (N=6) to assess understanding and comprehensibility. A few minor

amendments were made and the responses of these participants were excluded from the final analysis. The final questionnaire consisted of 49 questions. With forced answering options, participants were required to answer all questions before they could progress to the next page of the questionnaire.

**Outcomes**

Nutritional knowledge was assessed with thirteen multiple choice items (i.e., "What are the recommended daily amounts of fruits and vegetables for an adult woman (aged 19-50) according to the Dutch dietary recommendations?"). For all questions, one correct answer was possible and 1 point per correct answer could be obtained. The total score ranged from 0 to 13 points, with higher scores indicating higher nutritional knowledge.

Intentions (attitude, social support and self-efficacy) were assessed with rating of statements using 5-point Likert scales from "totally disagree (-2)" to "totally agree (2). A mean value score (ranging from -2 to +2) was calculated with a higher score indicating more positive intentions. Specifically, attitude was assessed with ten items (i.e., "All physicians, regardless of specialty, should counsel high-risk patients about dietary change."). The internal consistency of attitude as checked with Cronbach Alpha was α=.59 pre-intervention and α=.87 post-intervention. Social support was assessed with three items (i.e., "I know enough people in the medical faculty who I can contact in case I have questions on nutrition and lifestyle related topics.") and had a Cronbach Alpha of α=.53 pre-intervention and α=.60 post-intervention. Self-efficacy was assessed with nine items (i.e., "I am knowledgeable about nutrition education for a patient recently diagnosed with type 2 diabetes mellitus.") and had a Cronbach Alpha of α=.75 pre-intervention

and α=.85 post-intervention. Questionnaire items were randomised to prevent order effects and to minimise recall bias in the post-intervention measurement.

**Co-variates**

The questionnaire contained a demographics section with questions on potential confounding factors, including gender, medical faculty, training year, prior nutrition education, rating of relevance of nutrition for future practice (5-point Likert scale) and rating of benefit of more nutrition education in the medical curriculum (5-point Likert scale).(3,15–17) The variable "Training year" was dichotomized into year 1 to year 3 (Bachelor) versus year 4 to year 6 (Master). The variable "Prior exposure to nutrition education" was dichotomized into students who indicated that they had completed either a course, practical or lecture on nutrition and lifestyle (yes) versus students who indicated that they had not received any previous nutrition education (no).

The post-intervention questionnaire consisted of questions similar to the pre-intervention questionnaire. A question on SELF lecture attendance and on the appraisal of the SELF course on a scale from 1 to 10 was added to the post-intervention questionnaire for the intervention group.

**Data analysis**

Continuous variables were presented as means and standard deviations, whereas categorical variables were presented as frequencies and percentages. Descriptive statistics, Pearson's chi-square tests of contingencies and independent t tests were used to assess potential differences in baseline characteristics of the participants who did not complete the post-intervention questionnaire and those of participants who completed both pre-intervention and post-intervention questionnaires. Paired t-tests were used to assess the changes in outcome variables

occurring between pre- and post-intervention measurements in the intervention and comparison group separately. For the paired t-tests, Cohen's d was calculated as a measure of effect size. To investigate the effects of the SELF course in the intervention group compared to the comparison group while controlling for other variables, linear regression analyses were performed on the four outcome variables separately. Intervention assignment was entered as independent variable and pre-intervention scores of the dependent variables were added to each linear regression model to adjust for pre-intervention differences.

Variables obtained from pre-intervention data were tested for effect modification and confounding respectively.(3,15–17) A statistically significant interaction term between the outcome variable and the potential effect modifier in the linear regression model was considered evidence for effect modification, resulting in further stratified analyses. A change in the estimated measure of association of 10% or more after including the potential confounding variable in the regression analysis was evidence for confounding. To adjust, confounding variables were simultaneously entered into the regression model.

All analyses were conducted using IBM SPSS software (version 24.0, SPSS Inc., Chicago, IL, 2016). The level for determining statistical significance was predefined as a *p*-value of less than 0.05 for all comparisons.

## RESULTS

Demographic characteristics of the participants who did not complete the post-intervention questionnaire were similar to those of the participants with complete post-intervention outcome information except for their rating of the statement on benefit of more nutrition education for medical students (data not shown). Participants who did not complete the post-intervention questionnaire expected to have fewer benefits of more nutrition education in the medical

curriculum than participants with complete post-intervention outcome information (1.19 vs. 1.37 points; p=0.03).

**Table 1.** Characteristics of medical students included in the study in total and for intervention and comparison group separately.

| | Total (N = 118) | Intervention (N = 66) | Comparison (N = 52) |
|---|---|---|---|
| | N (%), Mean, ± | N (%), Mean, ± | N (%), Mean, ± |
| Gender | | | |
| Male | 31 (26.3%) | 15 (22.7%) | 16 (30.8%) |
| Female | 87 (73.2%) | 51 (77.3%) | 36 (69.2%) |
| Medical faculty | | | |
| AMC | 59 (50.0%) | 34 (51.5%) | 25 (48.1%) |
| VUmc | 59 (50.0%) | 32 (48.5%) | 27 (51.9%) |
| Study year | | | |
| BSc | 76 (64.4%) | 32 (48.5%) | 44 (84.6%) |
| MSc | 42 (35.6%) | 34 (51.5%) | 8 (15.4%) |
| Previous nutrition education | | | |
| No | 41 (34.7%) | 29 (43.9%) | 12 (23.1%) |
| Yes | 77 (65.3%) | 37 (56.1%) | 40 (76.9%) |
| Relevance nutrition education future practice (-2 to +2) | 1.42 ± 0.60 | 1.62 ± 0.49 | 1.15 ± 0.64 |
| Benefit more nutrition education (-2 to +2) | 1.37 ± 0.64 | 1.61 ± 0.49 | 1.08 ± 0.68 |

N number, ± standard deviation

Among the included participants, three quarters were female (73,2%) and two-thirds of the students had received previous nutrition education (65,3%) as can be seen in Table 1. The number of participating MSc students in the comparison group (15,4%) was lower than in the intervention group (51,5%). Most students agreed with the statements that nutrition education was relevant for future practice (mean 1.42, SD: 0.60) and that more nutrition education would benefit the student (mean 1.37, SD: 0.64). Students in the comparison group were statistically significantly more likely to indicate that they had received previous nutrition education compared to students in the intervention group.

Table 2 shows the results of the paired t-tests on pre- and post-intervention measurements for change in nutritional knowledge scores and attitude scores, social support scores, and self-efficacy scores towards nutrition counselling for intervention and comparison group separately There was a statistically significant increase in the intervention group's scores from pre- to post-intervention in the parameters nutritional knowledge [M: 1.70, 95% CI: 1.19, 2.21], social support [M: 0.20, 95% CI: 0.05, 0.34], and self-efficacy [M: 0.84, 95% CI: 0.71, 0.98]. Attitude scores did not change statistically significantly from pre- to post-intervention for the intervention group, nor did any of the outcome variables in the comparison group.

Table 3 shows the results of the linear regression analyses for the association between nutritional knowledge (0-13), social support (-2 to +2), and self-efficacy (-2 to +2) towards nutrition counselling and the SELF course. In the intervention group, nutritional knowledge scores statistically significantly increased with 2.42 points as compared to the comparison group (95% CI: 1.81, 3.02). There was no statistically significant difference in social support scores in the intervention group as compared to the comparison group. In the intervention group self-efficacy

scores statistically significantly increased as compared to the comparison group with 0.78 points (95% CI: 0.62, 0.95).

Table 4 shows the results of the linear regression analyses for the association between attitude towards nutrition counselling and the SELF course for the group of students in total and stratified for men and women. Men's attitude scores statistically significantly increased in the intervention group as compared to the comparison group with 0.50 points (95% CI: 0.13, 0.87). There was no statistically significant difference in women's attitude scores between the intervention and the comparison group.

**Table 2.** Paired t-tests on pre- and post-intervention measurements for change in nutritional knowledge scores and attitude scores, social support scores, and self-efficacy scores towards nutrition counselling for intervention and comparison group separately.

| | Intervention group (n=66) | | | | Comparison group (n=52) | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | Post-intervention | Difference score | Effect size | Pre-intervention | Post-intervention | Difference score | Effect size |
| | Mean, ± | Mean, ± | Mean, ± | Cohen's d | Mean, ± | Mean, ± | Mean, ± | Cohen's d |
| Knowledge (0 to 13) | 4.65 ± 1.77 | 6.35 ± 1.57 | + 1.70* ± 2.07 | 1.02 | 3.69 ± 1.88 | 3.60 ± 1.86 | - 0.10 ± 1.86 | 0.05 |
| Attitude (-2 to +2) | 1.09 ± 0.34 | 1.17 ± 0.66 | + 0.07 ± 0.67 | 0.15 | 0.86 ± 0.32 | 0.86 ± 0.39 | <0.01 ± 0.37 | <0.01 |
| Social support (-2 to +2) | -0.68 ± 0.57 | -0.48 ± 0.64 | + 0.20* ± 0.59 | 0.33 | -0.43 ± 0.55 | -0.53 ± 0.64 | - 0.10 ± 0.66 | 0.17 |
| Self-efficacy (-2 to +2) | -0.13 ± 0.52 | 0.71 ± 0.48 | + 0.84* ± 0.56 | 1.68 | 0.15 ± 0.45 | 0.06 ± 0.51 | - 0.09 ± 0.44 | 0.19 |

*p < 0.05

N number, ± standard deviation

**Table 3.** Linear regression analyses for the association between nutritional knowledge (0-13), social support (-2 to +2), and self-efficacy (-2 to +2) towards nutrition counselling and the SELF course of Dutch medical students (N=118).

| | Knowledge | | | Social Support | | | | | | Self-efficacy | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 1 | | | Model 2 | | | Model 1 | | |
| | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI |
| Constant | 2.31 | 0.37 | 1.58, 3.05 | -0.30 | 0.09 | -0.47, -0.12 | -0.29 | 0.09 | -0.46, -0.11 | -0.03 | 0.06 | -0.14, 0.11 |
| Intervention | 2.42 | 0.31 | 1.81, 3.02 | 0.18 | 0.11 | -0.04, 0.39 | 0.20 | 0.12 | -0.02, 0.43 | 0.77 | 0.09 | 0.62, 0.95 |

Model 1: adjusted for pre-intervention scores of the dependent variable

Model 2: additionally adjusted for study year

N number, B beta, SE standard error, 95% CI 95% confidence interval

**Table 4.** Linear regression analyses for the association between attitude (-2 to +2) towards nutrition counselling and the SELF course of Dutch medical students for the group in total (N=118) and stratified for men and women.

| | Total (N=118) | | | Men (N=31) | | | | | | Women (N=87) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 1 | | | Model 2* | | | Model 1 | | | Model 2** | | |
| | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI | B | SE | 95% CI |
| Constant | 0.44 | 0.15 | 0.15, 0.74 | 0.32 | 0.21 | -0.12, 0.76 | 0.15 | 0.29 | -0.44, 0.74 | 0.54 | 0.19 | 0.16, 0.93 | 0.19 | 0.24 | -0.28, 0.66 |
| Intervention | 0.19 | 0.11 | -0.02, 0.40 | 0.53 | 0.18 | 0.17, 0.89 | 0.50 | 0.18 | 0.13, 0.87 | 0.08 | 0.13 | -0.18, 0.33 | 0.04 | 0.14 | -0.24, 0.31 |

Model 1: adjusted for pre-intervention scores of the dependent variable

Model 2*: additionally adjusted for study year and previous nutrition education

Model 2**: additionally adjusted for medical faculty and study year

N number, B beta, SE standard error, 95% CI 95% confidence interval

## DISCUSSION

The aim of this study was to investigate the effects of a nutrition education course on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students. The results showed that a nutrition education course of 25 contact hours distributed over 10 weeks improved the nutritional knowledge, attitudes in men and self-efficacy towards nutritional counselling in Dutch medical students. To the best of our knowledge, the current study is the first study on the effects of nutrition education in Dutch medical students. The results of our study are largely in line with those of international studies. Increases in nutritional knowledge after completion of a medical nutrition education intervention were also reported in a study of Maiburg and colleagues.(9) Others have shown similar improvements in self-efficacy towards nutrition and lifestyle counselling.(4,21) However, most studies found no gender differences in outcomes whereas this study observed only improvements in attitudes in the male students.(15,17) Comparison of the findings on social support towards nutrition and lifestyle counselling with similar intervention studies involving medical students is problematic because those studies did not include social support as an outcome variable.

Although nutritional knowledge in the intervention group increased, on average it still remained low. A medical nutrition education study of Sjarif and colleagues found a greater increase in nutritional knowledge in medical students than our study.(22) Their intervention group received comprehensive and integrated interactive lectures with additional multidisciplinary lectures on oral–motor skill development and behavioral approaches to feeding problems. A hands-on workshop using real cases shown on recorded video and role-play sessions was also presented to the intervention group. A combination of interactive practical sessions and lectures as opposed to merely lecture-based classes could have improved the gains in nutritional knowledge in

participants of the SELF course. The importance of experiential learning in teaching is also confirmed by others who concluded that progression from a student to a health professional relies on experiential learning and participation.(6) Furthermore, our findings confirm the results of others who showed that nutritional knowledge of medical students is poor and supports the need to include meaningful nutrition education into all phases of medical training.(3,8,9,23,24) Social support was also still perceived to be poor upon completion of the SELF course. The lack of significant effect of the SELF course on social support likely signifies that in total, too few medical students participated in the course to benefit social networks. To improve social support, committed participants of the medical nutrition education intervention could have received a training to disseminate key nutrition-related messages to their social networks.(8) In contrast, most participants already had positive attitudes at pre-intervention. Similar findings of positive attitudes towards nutrition counselling in medical students have been previously observed.(3,17,25) The positive attitudes of medical students are an important finding, given that students' attitudes and behaviours are determinants of dietary counselling practices as physicians.(4,26) Self-efficacy scores in the intervention group significantly improved and changed from negative to positive (from -0.01 to 0.78 on a scale from -2 to +2). The importance of self-efficacy was noted in a previous study of nutrition counselling behaviour in which self-efficacy was associated with greater incidence of addressing nutrition.(21)

The results of this study should be considered in the context of its strengths and weaknesses. A strength of this study was the inclusion of a comparison group. Also, the SELF course was developed in co-creation sessions with medical students, health professionals and nutrition academics to assess potential participants' needs and interests to guarantee a broad and relevant medical nutrition education angle.(27) A potential weakness is the lack of randomization,

which was difficult to organize in a group of students participating in a voluntary extracurricular course and that participating students had to pay a small fee to participate in the optional course, further emphasizing their expression of interest and commitment to nutrition education. . Intrinsically motivated students may benefit more from a course than those students who are less interested. Otherwise, motivated students may start with a relatively high level of knowledge and skills and therefore may actually benefit less than students with fewer knowledge and skills. Another weakness refers to socially desirable answers in the questionnaires, which may not reflect real impact of the course in future clinical management.(4,27) Clinical examinations or patient outcomes would have been preferable, but these methods can be costly in both time and resources.(16) Since we compared the results with a comparison group, we suppose that it is improbable that the effects that we observed can be attributed to social desirability bias.

This study adds to earlier work by illustrating important areas of focus for implementation and evaluation of a nutrition education intervention for medical students. It supports the feasibility of implementing a brief, low-intensity nutrition education course as a method to improve medical students' nutritional knowledge and stimulated their intentions towards nutrition counselling. The SELF course was developed merely as a first step to offer additional nutrition education to Dutch medical students and can provide a guide for future improvement of the standard medical curriculum. The current SELF course consist of 25 contact hours and is offered as an a voluntary extracurricular course of 10 consecutive weeks. If medical schools decide to focus more on nutrition in their curriculum, we would recommend them to integrate the nutrition topics into existing classes or topics during a longer period of time. For example, when teaching classes about diabetes, they could also pay attention to the nutritional aspects of diabetes or as part of the courses on cardiovascular or gastro-intestinal health, they could devote some of the time to nutritional

aspects. This will prevent repetition of basic topics, thereby limiting an extra time burden, while at the same time working to create an awareness among future doctors that nutrition is in important factor in many diseases. Furthermore, when spreading out the nutrition topics over a longer period of time provides the opportunity to reinforce, apply and practice counseling skills along the curriculum. It will also be necessary to give medical students opportunities for internships and residencies where they can reinforce, apply and practice their knowledge and skills in nutrition. This will prevent the extinguishing of nutrition knowledge and skills over time. In addition, in response to the demand of students, some medical schools in The Netherlands have recently introduced elective courses in nutrition in the second year of medical training. Further research is needed to evaluate the long-term impact of nutrition education curricula on medical students' real-time and/or simulated dietary counselling performance, physician practice patterns and at the end patient outcomes.

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**Author Contributions**

HC contributed to and coordinated the design of the study, was responsible for the execution of the experiment, collected and carried out the data analysis and wrote the manuscript. CD and JS developed the design of the study. CD and JS reviewed and critiqued the manuscript. All authors approved the final version of the manuscript.

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**Competing interests**

None.

**Patient consent**

Not required.

**Ethics approval**

Medical Ethics Committee of the VU Medical Centre (2018.345).

**Provenance and peer review**

Not commissioned; externally peer reviewed.

**Data sharing statement**

Data analyzed in this study are available from the corresponding author in response to requests that comply with ethical principles of good research.

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Figure 1. Flowchart of the study population

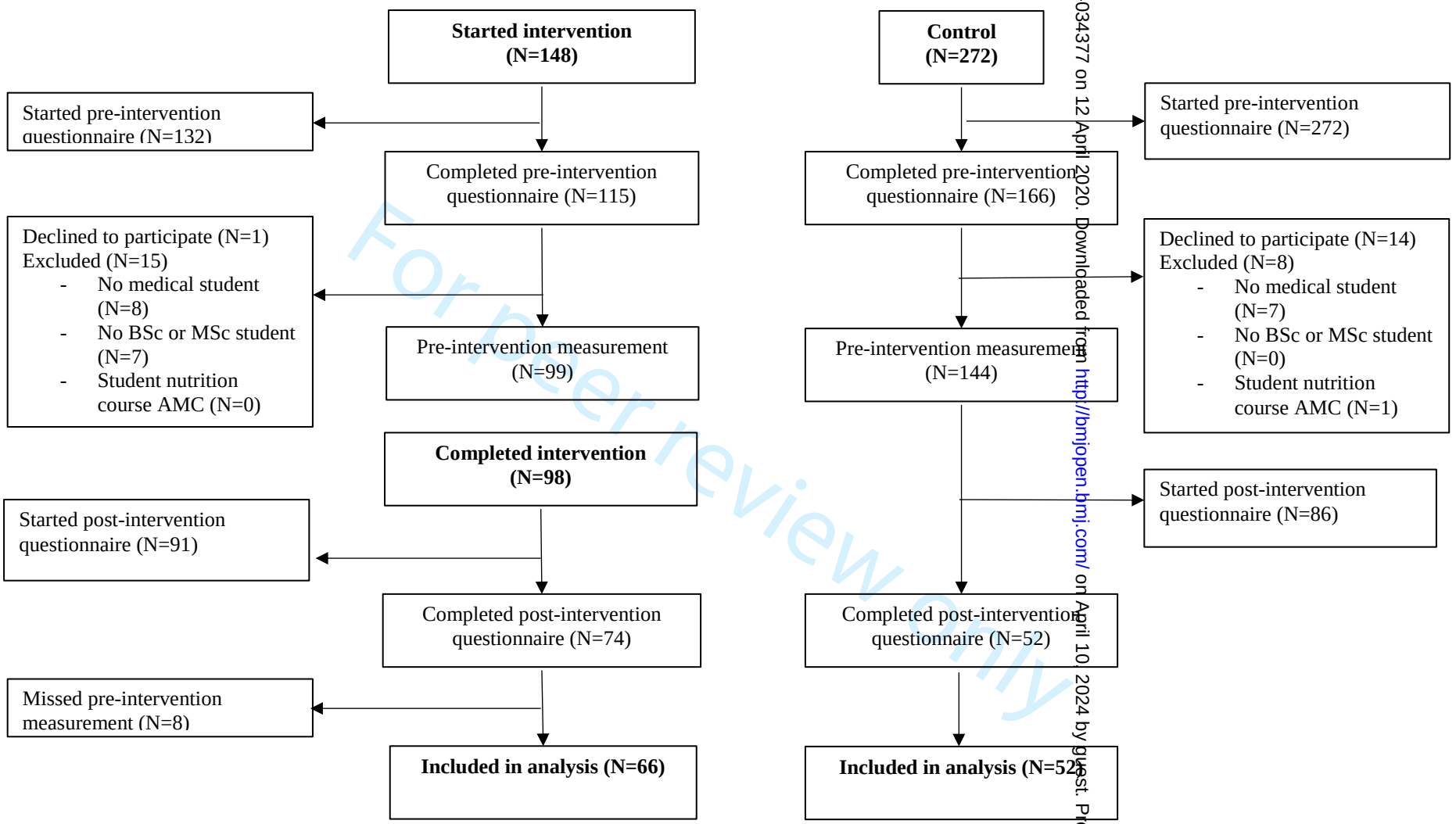


Figure 1. Flowchart of the study population

**English translation of the Dutch questionnaire used in the article "An intervention study on the impact of nutrition education on nutritional knowledge and intentions towards nutritional counselling in Dutch medical students".**

By participating in this study you provide insights into the need and importance of nutrition and lifestyle education for medical students. Filling out this questionnaire will take about 15 minutes. The questionnaire consists of the following components:

1. Questions about background characteristics;
2. Knowledge questions about nutrition and lifestyle;
3. Assessment of statements about nutrition and lifestyle.

**Which medical faculty do you study at?**

- ○ AMC
- ○ VUmc
- ○ Another medical faculty
- ○ I don't study at a medical faculty

**Do you currently take the nutrition elective Diometer Keuzetraject Voeding developed by the AMC?**

- ○ No
- ○ Yes

**Do you currently take the SELF course developed by Stichting Student en Voeding?**

- ○ No
- ○ Yes

**What is your gender?**

- ○ Male
- ○ Female
- ○ Other

**What is your year of study?**

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ Otherwise, namely: _____

**Do you already know your preferred medical specialization?**

- ○ No
- ○ Yes

**Of yes, what is your preferred medical specialization?**

- ○ Physician for mentally disabled
- ○ Occupational physician
- ○ General practitioner
- ○ Public health physician
- ○ Medical specialist
- ○ Geriatric physician
- ○ Insurance physician

**Do you remember having any nutrition or lifestyle education during medical school in the past? Either (a):**

| | No | Yes | I don't know |
|---|---|---|---|
| Separate nutrition / lifestyle course | ○ | ○ | ○ |
| Lectures on nutrition / lifestyle concepts | ○ | ○ | ○ |
| Practical's on nutrition / lifestyle concepts | ○ | ○ | ○ |
| Otherwise, namely: | ○ | ○ | ○ |

**How relevant do you find the topic nutrition and lifestyle for future medical practice?**

- ○ Highly irrelevant
- ○ Irrelevant
- ○ Neutral
- ○ Relevant
- ○ Highly relevant

**How much do you think you will benefit from additional nutrition education in the medical curriculum?**

- ○ Highly irrelevant
- ○ Irrelevant
- ○ Neutral
- ○ Relevant
- ○ Highly relevant

The following questions are focused on specific knowledge about nutrition and lifestyle. Choose that answer that best fits the question. If you don't know the answer please choice the "I don't know" option. It is not allowed to use any external help in answering the questions, for example the internet.

**Periodical restriction of protein in mice:**

- ○ Activates growth factors and stimulates apoptosis of healthy cells
- ○ Diminishes growth factors and stimulates growth of healthy cells
- ○ Activates growth factors and stimulates apoptosis of cancer cells
- ○ Diminishes growth factors and stimulates apoptosis of cancer cells
- ○ I don't know

**Breastmilk has benefits for both mother and child. Beneficial effects include:**

- ○ Mother: decreased risk of lung cancer, child: decreased risk of infection in the first year
- ○ Mother: decreased risk of lung cancer, child: decreased risk of celiac disease
- ○ Mother: decreased risk of ovarian cancer, child: decreased risk of infection in the first year
- ○ Mother: decreased risk of ovarian cancer, child: decreased risk of celiac disease
- ○ I don't know

**The current recommended daily amount of fruit and vegetables for adults according to the Dutch Schijf van Vijf are, in respective order:**

- ○ 200 grams of vegetables and 2 portions of fruit
- ○ 250 grams of vegetables and 2 portions of fruit
- ○ 200 grams of vegetables and 3 portions of fruit
- ○ 250 gram of vegetables and 3 portions of fruit
- ○ I don't know

**What percentage of the Dutch hospital population is malnourished?**

- ○ Approximately 5%
- ○ Approximately 10%
- ○ Approximately 15%
- ○ Approximately 20%
- ○ I don't know

**Which patient characteristics should a physician assess to screen for malnutrition?**

- ○ Chewing and swallowing problems
- ○ Malabsorption and maldigestion
- ○ Weight loss and appetite
- ○ Fatigue and functioning
- ○ I don't know

**The low-FODMAP diet is mainly used in patients with irritable bowel syndrome (IBS). For patients with inflammatory bowel disease (IBD) the low-FODMAP diet can also reduce symptoms. Which symptoms are improved especially?**

- ○ Obstipation
- ○ Abdominal pains
- ○ Bloating
- ○ Fatigue
- ○ I don't know

**Which substrate causes the cascade of training effects after a sprint interval training?**

- ○ Glycogen from the liver
- ○ Glycogen from the muscle
- ○ Lactate from muscle
- ○ Low blood glucose levels
- ○ I don't know

**Which psychiatric disorder has the strongest evidence for a relationship with diet?**

- ○ Anxiety disorders
- ○ Mood disorders
- ○ Psychotic disorders
- ○ Developmental disorders
- ○ I don't know

**During a volleyball training a hypoglycaemia occurs in a patient with type 2 diabetes. His blood sugar is 2,5 mm/L. He drinks a bottle of AA high energy drink with 46 grams of carbohydrates/sugars. How long will it take before he can start training again?**

- ○ 2 minutes
- ○ 5 minutes
- ○ 15 minutes
- ○ It is better to stop the training with a blood sugar below 3 mmol/L
- ○ I don't know

**For an optimal metabolic response, a patient who requires 100 grams of protein per day should:**

- ○ Consume preferably plant-based proteins and spread the consumption of 100 grams protein throughout the day
- ○ Consume preferably animal-based proteins and spread the consumption of 100 grams protein throughout the day
- ○ Consume preferably plant-based proteins and spread the consumption of 100 grams protein in four portions of 25 grams
- ○ Consume preferably animal-based proteins and spread the consumption of 100 grams protein in four portions of 25 grams
- ○ I don't know

**What is the current general advice on the use of dietary supplements to prevent cancer?**

- ○ Supplements do not decrease the risk of cancer
- ○ Take supplements if you can't follow current healthy eating guidelines on fruit and vegetables
- ○ Take vitamin D supplements to decrease the risk of colon and breast cancer
- ○ Take beta-carotene supplements to decrease the risk of lung cancer
- ○ I don't know

**The World Health Organization (WHO) classified processed meats as carcinogenic to humans, in the same category as tobacco smoking and asbestos. What does this mean?**

- ○ Processed meat consumers have the same relative risk to develop cancer as tobacco smokers
- ○ Processed meat consumers have the same absolute risk to develop cancer as tobacco smokers
- ○ The strength of scientific evidence about processed meats being a cause of cancer is similar to the strength of scientific evidence about tobacco smoking being a cause of cancer
- ○ Processed meats and cigarettes contain the same concentration carcinogenics
- ○ I don't know

To what extent do you agree with the following statements? Choose the answer that best fits you.

**All physicians, regardless of their specialisation, should counsel high-risk patients about relevant dietary and lifestyle changes**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Physicians can have an effect on a patient's dietary and lifestyle behaviour if they take the time to discuss this with patients**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**As a physician, it is essential to regularly ask about the progress of previously agreed dietary and lifestyle changes to maintain and improve the results achieved by patients**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**A physician should pay attention to the nutritional status of the patient**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**It is important that a physician recommends dietary and lifestyle changes before initiating drug therapy if relevant for the patient's disease**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**It is important that a physician refers patients with diet-related problems to registered dietitians or other qualified nutritional staff**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Most obese patients are not motivated to lose weight**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Attention of a physician for nutrition and lifestyle is important in every phase in the lifecycle**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**Physicians should tailor their dietary and lifestyle advice towards the patient's socioeconomic and ethnic backgrounds.**

- Strongly disagree
- Disagree
- Undecided
- Agree
- Strongly agree

**Fellow medical students stimulate me to address nutritional and lifestyle topics systematically in future medical practice**

- Strongly disagree
- Disagree
- Undecided
- Agree
- Strongly agree

**Medical academic staff stimulate me to address nutritional and lifestyle topics systematically in future medical practice**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have enough contacts within my medical training to consult experts if I want to know more about nutrition and lifestyle.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to provide general recommendation to patients about healthy nutrition and a healthy lifestyle.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to explain the health consequences of overweight of obesity to my patients. provide general recommendation to patients about healthy nutrition and a healthy lifestyle.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to stimulate patients to change their dietary and lifestyle patterns.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge about the role of a dietician to refer patients when necessary.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to differentiate nutritional facts from fiction.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to discuss maternal and infant benefits and challenges anticipated with breast-feeding with patients.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to provide a general nutrition and lifestyle advice to patients with diabetes type 2.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to provide a general nutrition and lifestyle advice to patients recently diagnosed with cancer**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree

**I have sufficient basic knowledge to explain the consequences of a vitamin deficiency to older patients.**

- ○ Strongly disagree
- ○ Disagree
- ○ Undecided
- ○ Agree
- ○ Strongly agree