The role of evidence-based medicine in the education of medical and health science students and its practical application in assessing children's dietary intake

DOCTORAL (PhD) THESIS

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I. INTRODUCTION

Approaches to evidence-based practice in childhood nutrition

Adequate nutrition is essential for children's growth and development. Inadequate intake of energy and nutrients may predispose children to a wide range health related problems, such as are obesity, dental caries or even poor academic achievement. Non-communicable diseases (like type-2 diabetes, hypertension and cardiovascular disease) have become worldwide leading health issues during the past few decades; it has been convincingly demonstrated that these chronic diseases might be linked to childhood diet. The dietary habits acquired in childhood often persist later in life; therefore, improving children's food choices at the preschool age might be crucial to influence food choices later in life. Parents are important gatekeepers in influencing and developing children's eating habits. Consequently, parents represent a major target group for communication on nutritional properties and health effects of foods. Parents need a timely, consistent and **evidence-based information** in different formats for rational decision making about food choices.

Even for modern parents, it is difficult to obtain appropriate information about healthy nutrition of their children. Many parents utilize the Internet to seek information and support regarding healthy nutrition of their children and parenting. However, it is often difficult for parents to differentiate between nonscientific opinions, anecdotes and evidence-based nutritional information. Although misinformation is present in all health disciplines, this phenomenon is even more pronounced in the area of nutrition, as everybody has first-hand experience about nutrition and food.

Decision making in nutrition should be based on available scientific evidence. Important pillars of evidence-based practice in nutrition are systematic reviews, nutrient intake recommendations and dietary guidelines, as well as clinical practice guidelines, food standards and health claims. Systematic reviews follow a predefined methodology to systematically collect, appraise and summarize body of evidence on a reserch question. They might provide evidence-based information about the effectiveness and potential harms of a nutritional intervention, or to estimate the burden of a nutrition-related disease. Nutrient intake recommendations define reference levels for nutrients, while dietary guidelines set the types and amounts of foods to be consumed to meet daily nutrient needs

and reduce the risk of developing chronic diseases. Clinical practice guidelines translate evidence to those working in the practice.

Role of health care professionals in evidence-based healthcare

Using evidence-based medicine (EBM) in daily medical and health care practice represents an essential element of developed health care systems. Ideally, in countries with evidence-based practice (EBP), the knowledge generated in clinical trials is timely incorporated into clinical guidelines and serves as a pillar of professional bedside decision making. For successful implementation of EBP, ideas of EBM should become an integral part of the thinking of health care providers at all levels; moreover, besides their adequate knowledge of EBM it is also important that health care professionals possess the willingness and ability to use the acquired knowledge in the daily practice, when making actual decisions about the therapy of patients.

Although EBM is now an accepted part of clinical practice, there are still opposing views: while supporters emphasize facilitated and improved healthcare decisions, which result in a smaller variability in quality of health care provided by different practitioners, the critics take the position that EBM is "cookbook medicine", that it is unable to account for individual patient factors and neglects personal professional experiences. Another potential problem is that health care providers are often not properly trained to implement the evidence.

A decade ago the Hungarian EBM working group (developed into Cochrane Hungary), was one of the ten partners who participated in the EU EBM TTT project funded by the European Union. Their goal was to harmonise EBM learning and teaching across the European healthcare sector and to encourage trainers to learn effective teaching methods for tutoring application of EBM in various clinical settings. Cochrane Hungary was founded in 2014 with the aim to provide postgraduate training to healthcare practitioners and to support the understanding of the aims of Cochrane and relevance of EBM among various professionals working at all levels of healthcare.

Currently in Hungary, EBM is taught to students of medicine and health sciences mostly within the framework of facultative courses. However, during the basic, preclinical and clinical modules of healthcare education there are also several courses which do not have EBM training in their main focus. Nevertheless, these courses incorporate the principles of EBM and teach many EBM-related terms.

However, the attitudes, knowledge and skills of future health care provides, i.e. students of medical and health sciences faculties towards EBM have not been investigated so far, although proper theoretical and practical knowledge about EBM is essential for the realisation of EBP in the near future in Hungary.

II. AIMS

II./1. Dietary Energy and Nutrient Intake of Healthy Pre-School Children in Hungary

The aim of this repeated cross-sectional study was to investigate food consumption, including intakes of energy and macro- and micronutrients, in children attending a kindergarten in Hungary and compare the values observed with the current evidence-based recommendations.

II./2. Self-reported attitudes, knowledge and skills of using evidence-based medicine among students of medicine and health sciences in Hungary

Primary aim of this cross-sectional dietary survey was to evaluate the attitudes, knowledge and skills of students of medicine and health sciences shortly before they finish their studies and start to work as a health care professional. In addition, it aimed to compare data to those obtained in similar students right at the beginning of their university studies.

Secondary aim of this survey was to answer the question to what extent participation in an EBM course during the studies of medicine or health sciences can improve using EBM-related knowledge and skills in the daily health care practice and can change attitudes of students of medicine and health sciences towards evidence based medicine.

III. MATERIALS AND METHODS

III./1. Dietary Energy and Nutrient Intake of Healthy Pre-School Children in Hungary

III./1./1. Study design and setting

The data were collected in 2013 and 2016 in the baseline phase of two randomized controlled trials (2013–2014: NCT03241355 and 2016–2017: NCT03457688). This way, the data correspond to a repeated cross-sectional study.

III./1./2. Participants

The parents of healthy children, who were attending a kindergarten in one of five Hungarian cities (Pécs, Győr, Mohács, Szeged and Szekszárd) and volunteering for one out of two consecutive prebiotic supplementation studies coordinated by our research group, were approached. The exclusion criteria were: congenital disease or malformation influencing the gastrointestinal system, immunodeficiency, food intolerance, food allergy or metabolic disorder requiring a special diet; regular (> three times per week) consumption of products or food supplements containing prebiotics or probiotics, antibiotic or laxative treatment; and/or any infectious disease within 14 days at the time of pre-examination. We have sent for the kindergartens poster about our study. Information consent for the parents was handed out.

III./1./3. Three-day food-record diary

The parents were asked to fill in a three-day food-record diary and to record the quantitative data for all foods and beverages consumed by their children on two non-consecutive working days and on one weekend day (e.g, Sunday or Saturday). The information was collected in November to December in 2013 and in September to November in 2016.

The parents were asked not to change the eating habits of the child during the study and to record all foods and drinks consumed by the child with the precise amount of the consumed portions. In the three-day food-record diary, each day, information had to be provided on the type of foods and beverages (including water) consumed by the child on the given day (starting from the time of waking up and proceeding chronologically until the time of going to sleep). The foods were to be described in detail,

including preparation methods and brands when relevant, as well as the amounts consumed.

If necessary, a qualified, skilled dietician discussed the food item data with the parents. The nursery staff was also involved into the study in order to receive proper information about food items and portion sizes consumed during the day in the kindergarten.

III./1./4. Data analysis

The energy and nutrient intake calculations were performed with NutriComp Étrend Sport 4.0 software (NutriComp Health and Nutrition Co., Budapest, Hungary). The software was validated and effectively used already in other dietary surveys in Hungary.

The average intakes over the three days were calculated to represent the observed intake distributions. The dietary data included nutrient intake estimates from foods (both naturally present and fortified) and drinks only and excluded nutrient intake estimates contributed by any dietary supplements.

The children's height and weight were recorded with children standing barefoot in light clothing. The ratio of calculated energy intake (EI) and estimated basal metabolic rate (BMR) was used to check the subjects for misreporting. BMR was calculated according to the Hungarian recommendation. The record was excluded if the EI/BMR ratio was lower than 1.1 or higher than 2.6, according to the method of Goldberg et al.. The statistical analysis was performed by SPSS 20.0 (IBM). Each child's average daily intake was compared to the Hungarian national recommendations and to the recommendations of the European Food Safety Authority. Although both recommendations are displayed, the comparisons- since they are from the data of Hungarian children- were basically compared to the Hungarian recommendation. The EFSA recommendation only provides additional information.

Seventy percent of the Hungarian RDA was defined as the lower border (potentially inadequate), whereas 130 percent of the RDA was defined as the higher border (excessive intake) to determine the extreme level of daily nutrient intake of subjects according to the method of the Institute of Medicine in the United States of America.

The descriptive statistics were generated and presented in order to show the mean intakes of nutrients and the proportion with adequate intakes. The results in the tables

were expressed as mean, standard deviation (SD) and percentage values of the appropriate variables.

Two age groups were formed according to the categories of the Hungarian national nutrient recommendations: 2.5- to 4-year old children (including all children prior to four years of age at the time of the examination) and children aged 4 to 6 years (i.e., over four years but prior to seven years of age).

III./1./5. Ethical approval

The prebiotic supplementation trials where these cross-sectional data were obtained were approved by the Scientific and Research Ethics Committee of the Medical Research Council, Budapest, Hungary (STUDY I: 40564-3/2013/EKU and STUDY II: 34458-1/2016/EKU). Children were included in the study after their parents have provided written informed consent.

III./2. Self-reported attitudes, knowledge and skills of using evidence-based medicine among students of medicine and health sciences in Hungary

III./2./1. Study design and setting

This cross-sectional survey was conducted online between February and May 2019 at every Hungarian medical and health sciences faculties.

III./2./2. Participants

All medical students studying in one of the four medical faculties in Hungary–namely, 1) University of Pécs, Medical School, Pécs; 2) Semmelweis University, Faculty of Medicine, Budapest; 3) University of Debrecen, Faculty of Medicine, Debrecen and 4) University of Szeged, Faculty of Medicine, Szeged–were eligible to participate in this survey.

All students studying health sciences in seven institutions–namely, 1) University of Pécs, Faculty of Health Sciences, Pécs; 2) Semmelweis University, Faculty of Health Sciences, Budapest; 3) University of Debrecen, Faculty of Health, Nyíregyháza; 4) University of Szeged, Faculty of Health Sciences and Social Studies, Szeged; 5) University of Miskolc, Faculty of Health Care, Miskolc; 6) Gál Ferenc College, Faculty of Health and Social Sciences, Gyula; 7) Széchenyi István University, Petz Lajos Institute of Health and Social Studies, Győr–were also eligible to participate in this survey.

Although there are medical and health sciences programs available in English and German at these Hungarian universities, in the frame of the present survey we wanted to obtain information about attitudes, knowledge and skills of Hungarian students studying in the Hungarian programs. Therefore, questionnaires were mailed only to these students, in the Hungarian language. No further exclusions were made.

III./2./3. Questionnaire and outcomes

The questionnaire was developed by Szimonetta Lohner using ideas from similar questionnaires. The questionnaire was divided into four main parts. The first part included questions regarding the background of the participating student filling in the questionnaire, including the name of the University, the class (year of studies), information on a background with practical work in health care, participation in research activity as member of the Scientific Students' Associations or having a close family member working in health care. The question regarding the participation in a course where EBM was taught was listed among the background questions, therefore students were not aware that this question was one of the main outcomes of the study. In the second part, students had to self-evaluate their EBM skills. In the third part of the questionnaire, important terms of EBM were listed and students had to self-evaluate their knowledge on a 5-point categorical scale. In the fourth part, attitudes towards using EBM in their future work as a health care professional were evaluated.

III./2./4. Pilot testing of the survey

A pre-test was done in a small group (n = 8) of medical students in order to make sure that the study population understood the questions. Study team members and students discussed questions in detail and questions were reformulated, if this was found to be necessary.

III./2./5. Recruitment, survey administration and data collection

Students were invited to participate in the survey via internal mailing systems of the universities. Moreover, small leaflets containing the title and the QR barcode of the questionnaire were distributed among students. In the cities of Pécs and Budapest an information day was held by the study team, where students received not only QR barcodes, but those students without smartphones were also offered the opportunity to fill in the questionnaire on paper instead of the electronic version.

Students were offered to follow a link to the questionnaire website. On the website they were asked to provide informed consent according to the EU General Data Protection Regulation. Only participants providing informed consent were allowed to fill out the questionnaire. Students of medical or health sciences faculties received different links; their questionnaire differed slightly, mainly in the introductory questions.

To encourage honest and transparent responses of the students, anonymity was ensured. Individual data were identified by assigning a unique identification number based on the time point of filling in the questionnaires.

Data were captured via a Hungarian electronic surface developed for capturing online questionnaires, storing the data obtained from students and enabling a structured export of collected data to Excel and SPSS (http://online-kerdoiv.com/).

III./2./6. Data analysis

Data were first exported to Excel, in that one line represented answers of one person. Data were analysed using SPSS version 22 (SPSS INC., Chicago, IL, USA); descriptive statistics were calculated for each item. Outcomes for EBM-trained and non-trained students were compared with Mann-Whitney test after rejecting the null hypothesis of Shapiro-Wilk test of normal distribution, in case of quantitative variables. For variables expressed as percentages, Pearson Chi-square test was used. We explored possible associations between certain baseline variables and the attitudes, knowledge and skills by logistic regression models. All results with a significance level of $p < 0.05$ were considered statistically significant.

III./2./7. Ethical approval

The study was approved by the Scientific and Research Ethics Committee of the Medical Research Council, Budapest, Hungary (60826-1/2018/EKU). Written consent was obtained from the university leaders to conduct the survey.

IV. RESULTS

IV./1. Dietary Energy and Nutrient Intake of Healthy Pre-School Children in Hungary

In 2013 the final sample (n = 186) consisted of 51 children aged 2.5 to 4 years and 135 children aged 4 to 6 years. The gender distribution was 91 girls to 95 boys. In 2016, 556 participants (300 boys and 256 girls) had valid, reliable results suitable for statistical analysis. Of these children, 148 children were 2.5 to 4 years old, and 408 children were 4 to 6 years old at the beginning of the study. All the children attended kindergarten five days per week in both studies.

IV./1.1. Energy and Macronutrient Intakes

In 2013, the total mean daily energy intakes in 2.5- to 4-year-old children were fully appropriate when compared to the Hungarian recommended values adjusted for age. Three years later, in 2016, more than one fourth of the 2.5- to 4-year-old children had excessive daily energy intakes. Among the 4- to 6-year-old children, in 2016, approximately three times more children had high daily energy intakes than in 2013, according to the Hungarian recommendations.

In both the age groups and in both the years investigated (2013 and 2016), the mean protein intakes were higher than the Hungarian recommended values. However, the high consumption of protein decreased with increasing age: in 2016, among the 2.5- to 4-year-old children, every second child and one quarter of the 4- to 6-year-old children had a high protein intake, respectively.

The fat consumption as a percentage of energy (E%) was between approximately 30–35 for both the age groups in both studies.

The cholesterol intakes were far above the Hungarian recommended values: 45 percent of the 2.5- to 4-year-old children had a high cholesterol intake in 2013 and 69 percent in 2016. In 2013, a total of 27 percent, and in 2016, a total of 47 percent of the 4- to 6-year-old children had a high cholesterol intake, respectively.

Among the 2.5- to 4-year-old children, the mean daily fluid intakes were 22 percent lower than the recommendations; moreover, 44 percent of the 2.5- to 4-year-old children (2016) had insufficient daily fluid intakes (according to both Hungarian and EFSA recommendations.)

In 2013, the sugar consumption was high by 27 percent, and in 2016, by 39 percent of the 2.5- to 4-year-old children. The result was not much better at the age of 4 to 6 years. In 2013, a total of 40 percent, and 23 percent of the children in 2016, had a high sugar intake.

IV./1.2. Macroelements

All preschool children, without exception, had higher daily sodium intakes than the Hungarian and the EFSA recommendations. The sodium intakes in 2.5- to 4-year old children in 2013 were almost five times higher than the corresponding Hungarian recommended daily sodium intakes; in 2016, the corresponding values were more than six times higher than the recommendation (500 mg/day). In 4- to 6-year-old children in 2013, the mean daily sodium intakes were 3.5 times higher than the recommended daily intakes (700 mg/day), whereas in 2016, the corresponding values were approximately five times higher than the Hungarian recommendations.

Over nine out of ten of the 2.5- to 4-year-old children achieved the recommended daily potassium intakes in both studies according to both recommendations (Hungarian and EFSA). In the 4- to 6-year-old age group, the mean daily potassium intakes in 2013 were higher than the recommendations in more than half of the children, whereas in 2016, the corresponding value was higher. In contrast, the daily calcium intakes were far below the Hungarian recommendation of 800 mg/day (for both the age groups) in both of the studies. In 2016, in the 2.5- to 4-year-old children, the mean daily calcium intakes were low for 46 percent of them, whereas in the 4- to 6-year-old children, the corresponding value was 39 percent. The intakes of phosphorus were above the recommended value (EFSA and HRDA), and with increasing age, a slight increase in those exceeding the recommended daily intake was observed. In 2016, the mean daily intakes of magnesium were higher than the recommendation by 82 percent in the 2.5- to 4-year-old children and 48 percent in the 4- to 6-year-old children.

IV./1.3. Microelements

In 2016, the intakes of iron in over three quarters of the children in both age groups achieved the national recommendations. In 2016, the mean daily copper intakes of 76 percent of the 2.5- to 4-year-old children were higher than the Hungarian recommended intakes (0.4 mg/day). In over 29 percent of 4- to 6-year-old children, the intakes of copper were higher than the HRDA (0.6 mg/day). The results for 2013 were very similar to those

seen in 2016. The mean daily zinc intake values were satisfactory at above 67 percent in each group in both studies compared to the Hungarian recommendations.

IV./1.4. Fat Soluble Vitamins

The recommendation for vitamin A (retinol) is formulated as the retinol equivalent (recently, the retinol activity unit): 1 RAU is equal to 1 μg retinol or 12 μg β-carotene. In 2016, the mean daily intakes for both 2.5- to 4-year-old and 4- to 6-year-old children met the recommendations; however, the individual daily intakes were low in 2016 for approximately 21 percent and were high for approximately 23 percent of the 2.5- to 4-year old children (Table 3) compared to the Hungarian recommendations. The corresponding values were 32 percent (low) and 16 percent (high) in the 4- to 6-year-old children (Table 4).

In 2013, we observed similar results. The mean daily intakes of calciferols were low for nearly the entity of the 2.5- to 4-year-old children and 100% of the 4–6-year-old children according to the Hungarian recommendations (Tables 3 and 4). In 2016, higher than the Hungarian recommended intakes of vitamin E (-tocopherol) were observed in 58 percent of the 2.5- to 4-year-old children. In 2013, approximately 78 percent of the 2.5- to 4-year-old children and 56 percent of the 4- to 6-year-old children had high intakes of vitamin E (Tables 3 and 4).

IV./1.5. Water Soluble Vitamins

While the mean intakes of the water soluble vitamins thiamine, riboflavin, pyridoxine, and cobalamin considerably exceeded the recommendation, the ascorbic acid intakes were around the recommended levels in each age group in both studies according to both recommendations.

IV./2. Self-reported attitudes, knowledge and skills of using evidence-based medicine among students of medicine and health sciences in Hungary

IV./2.1. Participant characteristics

A total of 1080 Hungarian students of medicine and 911 Hungarian students of health sciences participated in the survey, which means approximately 17% of Hungarian medical students and 11% of health sciences students currently studying in Hungary.

Medical students. About one fourth of the medical students filling in the questionnaire have already participated in an EBM teaching course, most of them during the clinical half of medical training (12.7% of the first-year, 13.6% of the second year, 22.2% of the third year, 37.0% of the fourth year, 34.7% of the fifth year and 31.1% of the sixth year respondents).

Only 4.92% of medical students who received training in EBM found the training course inadequate, while all other students were satisfied with its content. Of the 821 medical students who did not participate in an EBM teaching course yet, 94.4% gave the answer that participation in such a course would be helpful for their later practical work as a medical doctor. As to the place of the course in the curriculum, 10.38% of medical students thought that an EBM course would be effective in the first two years of medical education, 50.93% would like to have such a course during the third or fourth year of medical studies, while 38.69% of the respondents answered that they would find a training in EBM effective during the fifth or sixth year of education.

Students of health sciences. Most of the students of health sciences filling in the survey questionnaire were participating in BSc education, with diverse specialisations. BSc specialisations representing at least 1 percent of participants were as follows: physiotherapists (27.97%), nurses (16.31%), dieticians (10.76%), paramedic officers (9.51%), health visitors (8.15%), medical diagnostic assistants (4.30%), midwifes (4.08%), health tourism managers (3.51%), public health supervisors (3.28%), radiographers (2.38%), recreation and health promotion managers (1.13%). Master specialisations representing at least 1% of participating students of health sciences were: nurses (1.59%), physiotherapists (1.25%), teacher of health sciences and health cares (1.13%) and nutritionists (1.02%).

Out of the 911 students of health sciences filling in the online questionnaire, 274 already participated in an EBM teaching course: 19.4% during the first-year, 26.7% during the second year, 34.7% during the third year and 38.7% during the fourth year among BSc students as well as 58.9% of the MSc students. The large majority of these students, i.e. 94.62% found the course useful for their later work as a health care professional. The vast majority of non-participants (95.06%) would find a training in EBM helpful for their later professional work (36.79% with preference during the 1st or 2nd year of education, while 63.24% with preference during the third or fourth year).

Among participating health sciences faculty students, 46.10% answered reading scientific literature both in the Hungarian and English language, while 45.44% answered reading scientific literature only in the Hungarian language. A small minority (7.35%) of students of health sciences reported reading medical resources also in other foreign languages, while only a very small minority (1.1%) preferred scientific literature in English.

IV./2.2. Questionnaire characteristics

Of the 1991 questionnaires only 7.8% were filled out by the students on paper; the study team members converted these questionnaires into electronicversion.

The consistency testing demonstrated good internal consistency for both the skills questions (Cronbach's alpha = 0.85) and the knowledge-evaluating part (Cronbach's alpha = 0.89), and acceptable internal consistency for the attitude-evaluating part (Cronbach's alpha = 0.71).

IV./2.3. Self-reported skills in EBM

The majority of medical students rated the following skills as average: finding medical literature, searching in online databases, critical appraisal of papers on clinical research and identifying patient-relevant clinical questions. Majority of medical students reported limited experience in critical appraisal of available scientific literature, while ability to identify knowledge gaps were reported to be poor. Only a minority (under 10% of medical students for all the investigated categories) reported having advanced EBM-related skills.

Medical students who participated in an EBM course rated all the six items of their skills in searching and evaluating medical literature significantly better than students who did not receive training in EBM. However, this difference was not as marked in the subgroup Evidence-based medicine in medical and health sciences education of Hungary of first and second year medical students, where such students participating in an EBM course rated only their skills in critical appraisal of the content of a scientific publications ($p = 0.007$) and in identifying knowledge gaps ($p = 0.025$) significantly better as compared to student who have not yet participated in such a course. Among third and fourth year medical students, all the six investigated skills were evaluated as significantly better in the subgroup of EBM course participants as compared to non-participants. The same was also true for the subgroup of fifth and sixth year medical students.

The distribution of answers to certain questions was similar among students of health sciences to that seen in the case of medical students, with the majority of students

of health sciences rating their skills as average in locating professional literature, searching in online databases, in critical appraisal of papers on clinical research and in identifying patient-relevant clinical questions. Students had limited experience in critical appraisal of available scientific literature and rated their skills in identifying knowledge gaps as poor. With the exception of searching in online databases, students of health sciences with EBM training had significantly higher ratings than had EBM non-trained students.

IV./2.4. Sources and methods of healthcare information retrieval

Medical students not yet trained in EBM were significantly more likely to choose printed books as the main source of healthcare information retrieval, while medical students who already participated in an EBM course choose online journals and professional guidelines to a significantly higher extent compared to those who did not participate in EBM course.

Among students of the faculty of health sciences who were trained in EBM choose printed books to a significantly lower extent (28.8% vs 37.8%; $p = 0.01$) and professional guidelines to significantly higher extent (10.2% vs 3.6%; $p < 0.001$) than those students who did not participate in EBM course. No other significant difference was seen between the two groups.

Google was the most popular search engine, followed by Wikipedia and Pubmed/Medline.

Medscape and especially the Cochrane Library were used by only a minority of students for the retrieval of scientific literature.

When conducting a subgroup analysis comparing EBM trained and non-trained medical students, we found that Pubmed/Medline (84.0% vs. 57.9%, [EBM trained vs. EBM nontrained], $p<0.001$), Medscape (36.2.0% vs. 18.2%, $p<0.001$), and the Cochrane Library (12.3% vs. 2.8%, $p<0.001$) were used to a significantly higher extent for healthcare information retrieval by EBM trained than non-trained medical students. There were no significant differences in the use of Google (92.6% vs. 94.6%, $p = 0.35$), Google Scholar (30.7% vs. 26.0%, $p = 0.27$) and Wikipedia (73.8% vs. 68.1%, $p = 0.16$) between the EBM trained and non-trained medical students.

Although the use of Pubmed, Medscape and Cochrane Library were generally lower among students of health sciences than among medical faculty students, subgroup analysis comparing EBM trained and non-trained health sciences students had comparable results to those seen in the case of medical students: Pubmed/Medline (62.7%

vs. 43.6%, [EBM trained vs. EBM nontrained], p<0.001), Medscape (25.3.0% vs. 14.0%, p<0.001), and Google scholar (26.6% vs. 17.9%, p = 0.01) were used to a significantly higher extent by EBM trained than non-trained health sciences faculty students, while there were no significant differences in the use of Google (90.6% vs. 90.7%, p = 1.00) and Wikipedia (51.9% vs. 52.9%, p = 0.81). Among students of the faculty of health sciences, the use of the Cochrane Library did not significantly differ between EBM trained and non-trained students (6.4% vs. 3.9%, p = 0.14).

IV./2.5. Knowledge of EBM-related terms

There were large differences in the understanding of different EBM-related terms (Table 8). The most known term among medical students was ’sample size’; about two third of medical students answered that they could explain meaning of the term to others. In contrast, only 7% of medical students thought that they could explain the meaning of the term ’intention-totreat analysis’. When evaluating answers as if they were scores on a 5-point-scale and comparing the range of scores between EBM-trained and non-trained medical students, we found that those participating in an EBM course rated their knowledge regarding EBM-related terms to be significantly better than students who did not receive a training in EBM yet (with p<0.001 for all investigated terms).

We also calculated a mean score based on the 13 scores (listed in Table 4) evaluating knowledge of individual students and conducted a multifactorial logistic regression analysis to reveal factors having an influence on better or worse scores (i.e. a mean score higher or lower than 2.0). Healthcare work experience (OR = 1.59; 95% CI = 1.01–2.52, p = 0.048), conducting student research as member of the Scientific Students’ Associations (OR = 2.02; 95% CI = 1.45– 2.82, p<0.001), upper year university students (OR = 1.65; 95% CI = 1.37–1.98, p<0.001) and participation in an EBM teaching course (OR = 3.32; 95% CI = 2.32–4.76, p<0.001) proved to have a significant positive influence on the knowledge of EBM related terms among medical students, while gender (OR = 1.22; 95% CI = 0.93–1.61, p = 0.15) and having a close family member working in healthcare (OR = 0.96; 95% CI = 0.73–1.26, p = 0.75) had no significant effect.

Among students of health sciences, the most known term was ’case study’, while the least known was ’confidence interval’. Also health sciences faculty students with EBM training rated their knowledge on most of the EBM-related terms significantly better than students without EBM training, although there was no significant difference in the knowledge of trained and non-trained students in case of the terms ’lost to follow-

up' ($p = 0.15$) and 'number needed to treat' ($p = 0.05$). Upper year university students (OR = 1.47; 95% CI = 1.05–2.05, $p < 0.05$) and participation in an EBM teaching course (OR = 1.69; 95% CI = 1.47–1.93, $p < 0.001$) were factors that significantly influenced EBM-related knowledge.

IV./2.6 Attitudes towards using EBM in health care practice

All medical students agreed that EBM is important for the practical work of physicians and wished to improve their skills in applying EBM.

The degrees of agreement with the statements that "EBM is important for patients to receive the optimal treatment" and that "EBM facilitates decisions about individual patient's care" were also significantly higher in the EBM-trained medical student group than in those without EBM training. Life-long learning was seen as very important in both groups, but scores representing the strength of agreement were significantly higher among EBM trained medical students. Among students of health sciences there were 6 out of 11 statements with significant difference between the opinion of EBM-trained and non-trained students.

V. DISCUSSION

V./1. Dietary Energy and Nutrient Intake of Healthy Pre-School Children in Hungary

Our study showed that in Hungarian preschool children, sugar, protein, fat, cholesterol, sodium, potassium and phosphorus intakes were, in general, high, whereas intakes of calcium, vitamin D, pantothenic acid and folic acid were low. Water consumption was not satisfying in either of the age groups. Moreover, among the 2.5- to 4-year-old children, every third child had an excessive intake of energy according to the recommendations of either HRDA or EFSA.

The importance of dietary intervention programs for preschool children to influence theirs food choice at an early age in order to prevent several childhood and adulthood health problems is evident. In Hungary, kindergartens provide pre-school education and full day care for children aged 2.5 to 6 years as part of the public education system. Kindergarten education and care is free in all public institutions; moreover, at the time of this survey, approximately one third of the Hungarian 3- to 6-year-old children received meals in kindergarten for free (parents only have to pay for the meals if their

income is above a certain level). Children consumed not only one hot meal (lunch) in the childcare institution but also two other cold meals (one in the morning hours and one in the afternoon). This means that the foods and beverages consumed in the kindergarten are core parts of the children's diets.

All the kindergartens included into the present study were maintained within the Hungarian public education system, i.e., privately-owned kindergartens offering various special services for an extra fee were not included. Since in public kindergartens, both the admission criteria of the children and the fees to be covered by the families are regulated on a nation-wide basis, it can be assumed with good reason that the socio-economical backgrounds of the families in the present study were evenly distributed and representative for the 2.5- to 6-year-old urban pediatric population in Hungary.

The energy intake data seen in our dietary survey indicate that a positive energy balance is already present in a considerable percentage of kindergarten-aged children in Hungary. Worldwide, over 200 million children (one in three children under five) are either undernourished or overweight. The proportion of overweight children (5 to 19 years old) rose from one in ten to almost one in five in roughly one generation's time between 2000 and 2016. This also underlines the importance of the early start of dietary intervention programs to prevent obesity. In Hungary, the public kindergarten system may offer an excellent place for carrying out obesity prevention programs.

Adequate protein and essential amino acid intakes are important for normal child growth and development; however, a high protein intake has no known benefit but carries an additional possible risk of obesity development. The background of this phenomenon might be explained by the "Early Protein Hypothesis": excessive intakes of protein stimulates the secretion of insulin and insulin-like growth factor I (IGF-1) and increases the plasma concentration of insulin-releasing amino acids. The high protein intakes observed in the present study may contribute to susceptibility for overweight and obesity.

Long periods of adequate Ca intake in childhood increase bone mineral density (BMD) and reduce osteopenia risk. Both in the present Hungarian dietary questionnaire study and in a similar study among 6-year-old Polish children, intakes of calcium did not reach the recommended level, and inadequate intakes of vitamin D and potassium with excessive intakes of sodium were observed. The observation that a dietary pattern characterized by a relatively high consumption of dairy products and whole grains with cheese and eggs is positively associated with childhood higher bone mineral density might offer the possibility of dietary intervention.

Studies indicated that the early introduction to starchy table foods resulted in an increased affinity for the taste of salt at the preschool age. Sugar-sweetened beverage consumption was described to be positively associated with salt intake; each additional 1 g/day salt intake was associated with 17 g/day sugar-sweetened beverage consumption in a study. Consequently, reducing the salt intake might have a preventive role in both later hypertension and childhood obesity.

Although in our investigation, the energy percentage derived from protein, fat and carbohydrates were in their normal ranges, the energy percentage of added sugar was one to two percent higher than recommended. A high intake of sugar-added beverages is associated with an increased risk of overweight and obesity. Furthermore, it might result in higher diastolic blood pressure and elevated triglycerides levels and elevated cardiovascular risks later in life.

Excessive salt intake causes extracellular volume increase, resulting in an elevation of blood pressure.

The uppermost recommended daily intake of sodium is 0.5 g for 1- to 3-year-old children and 0.7 g for 4- to 6-year-old children (according to HRDA). The current intakes of sodium in the present study were three to five times higher than the Hungarian recommended daily sodium intake for preschool children. The Public Catering Act-EMMI (Ministry of Human Capacities) Decree 37/2014. (IV.30) maximized the quantity of added salt and decreased it to 2.5 times lower than before. This regulation ("Canteen reform") has been mandatory for kindergartens, primary and secondary schools, in-patient care and any other public catering in Hungary since September 2015. During implementation, it is important to keep in mind that most of the sodium originates from processed foodstuffs, not mainly from table salting.

Excessive refined sugar and sodium intake and suboptimal calcium were described not only in other Hungarian cross-sectional surveys involving children from other age groups but also in other countries involving children from the age groups investigated in our study. This also underlines the extent of the problem and strengthens the importance of the early healthy-eating interventions among the kindergarten and preschool children.

Dietary fiber has vital role in providing optimal growth conditions for a healthy gut microbiota. Diets high in fibre- specifically from cereal or vegetable sources and rich in insoluble type fibre- are significantly associated with lower risk of coronary heart disease and cardiovascular disease and reflect recommendations to increase intake.

Dietary fiber has many benefits and physiological effects: reduced cardiovascular disease risk, reduced risk of colorectal and breast cancers, improved body mass index, reduced type two diabetes risk ,interfering with fat and cholesterol absorption, improved fecal bulk, reduced postprandial glucose concentrations, and altering bacteria populations in the gut microbiome. Among children, satisfaying dietary intake lowering the risk of developing diabetes, heart disease, obesity and constipation. To ensure and achieve the benefits of different dietary fibers, children should consume a variety of fibers from fruits, vegetables, legumes, seeds, nuts and cereal grains. Our study showed us, that 9% of the 2.5-4 years old and 22% of the 4-6 years old participating children had a low intake of dietary fiber in 2016. Furthermore, daily fluid intake was low for every second 2.5-4 years old and for 68% of the 4-6 years old children It is a warning sign, because low fluid and dietary fiber intake together can lead to further health problems. Our present study has some limitations. Some of the data originated from the kindergarten teachers, who completed the filling out of the questionnaires in addition to their other work duties, which could have resulted in inaccuracies in data intake and later during the evaluation. The dietary data included nutrient intake estimates from foods (both naturally present and fortified) and drinks only and excluded nutrient intake estimates contributed by eventual dietary supplements. The differences in the results of the two studies may be due to the larger sample size in 2016.

Children acquire dietary habits during early life. It should be, therefore, a high priority to provide evidence-based and parent-focused practical support for parents and emphasize the importance of healthy eating among the staff members of kindergarten kitchens. Inappropriate diets and eating habits in childhood lead to an increasing number of overweight and obese children and adolescents, although there is an increasing awareness of the adverse effects of non-communicable diseases. In Hungary, the obesity rate is high; among children, it is 40 percent, and among adolescents, it is 32 percent. Family and public catering systems (e.g., preschool, school) have a predominant place in the formation of nutritional behavior. There are several risk behaviors, e.g., elevated energy and fat intake, the overconsumption of simple carbohydrates, excess salt intake, low vegetable and fruit consumption, low calcium intake and the consumption of sugarsweetened beverages among kindergarten and school children. The objective is reducing the prevalence of obesity and non-communicable diseases, making the healthier option the easier option.

V./2. Self-reported attitudes, knowledge and skills of using evidence-based medicine among students of medicine and health sciences in Hungary

The present study attempted to provide an overall picture about the extent to which concepts of EBM are incorporated into medical and health sciences education in Hungary and to answer the question whether evidence-based education in the present form is effective enough to improve skills and knowledge and build a generally positive attitude towards EBM among students.

In the international scientific literature several studies are available that assess the attitudes, knowledge and skills of medical and healthcare professionals, and describe generally positive attitudes, however with skills of very different level in using EBM in practice. Moreover, in countries, where EBM courses are already incorporated into the curriculum, surveys have assessed the attitudes, knowledge and skills of both educators and educated students. These studies consistently reported positive attitudes toward EBM among undergraduate students participating in EBM education.

The uniqueness of our study is that it compares attitudes, knowledge and skills of students who participated in an EBM training course and those who are not EBM course attendees studying in the same institutions and faculties. Therefore we think, that our findings may also be adaptable and useful to countries where, as in Hungary, only a part of students receive focused EBM education or where EBM concepts are just in progress to be introduced into curriculum.

In the present study, the attitude towards EBM was generally positive among both medical and health sciences students; however, only a small minority of students rated their EBM related skills as advanced, and there were large differences in the understanding of different EBM-related terms. General terms, like ’evidence-based medicine’ or ’sample size’ were better understood than more specific terms, like ’intention-to-treat analysis’, ’confidence interval’ or ’number needed to treat’. This difference might be related simply to the fact that general terms are more likely to appear also during the education of subjects other than EBM. These results suggests that a list of EBM-related terms which is constructed at faculty level, handed out and recommended for medical and health sciences faculty students during their studies might improve the transmission of EBM-related knowledge.

Importance of targeted EBM training is strongly underpinned in our study by the results on sources and methods used by students for scientific information retrieval. Of

course, for a large majority of university students printed books represent the most important source of information. However, EBM training seems to be an important tool to educate students of the importance of using up-to-date scientific information (e.g. those published in online journals) for supporting healthcare decisions. The significant difference in the use of PubMed/Medline and the more than fourfold difference in the use of the Cochrane Library seen in this study in medical students who participated in EBM courses as compared to those who did not highligh the importance of teaching how to use these data retrieval systems for medical decision making.

Among both medical and health sciences faculty students, upper year students and participating in research activities were important factors contributing to EBM-related knowledge. Because the percent of EBM-trained student was also increasing in parallel with the number of years of studies, this observation might underpin further the important role of incorporating EBM education into other courses besides targeted EBM training.

Students of health sciences were generally characterised by more self-confidence, especially when self-evaluating their EBM-related skills. However, differences between EBM-trained and EBM non-trained students from the faculty of health sciences were less pronounced than in the case of medical students. These slight differences between students of medicine and health sciences might not necessarily reflect the lower effectiveness of EBM training among students of health scientific, but might rather indicate that the number of non-EBM-trained students overestimating their knowledge was higher in our sample among students of the faculties of health sciences.

It is interesting that the large majority of medical students were neutral regarding the statements ’EBM considers the personal expertise of physicians’ and ’EBM considers views and preferences of patients’ with no significant differences between EBM-trained and non-trained students. This observation indicates that medical students, at least in Hungary, are unsure about the way how EBM should be implemented in the daily practice. There is considerable potential for improvements to move away from “cookbook medicine” towards a sciencebased, but individualised medicine that involve both professional expertise and individual patient factors.

Although attempts were made to maximize the rate of filling out the questionnaire by a representative number of students by sending out invitations and reminders to participate several times, the participation rate from different universities does not fit the proportion of the students studying there. Consequently, students with more active attitudes towards scientific or public life might be overrepresented in the sample.

Moreover, first and second year students were more eager to participate in the survey, therefore their opinion might be overrepresented against the opinion of students from upper university years. We cannot fully exclude response bias and should be cautious with self-reported information.

In the present survey we have not asked detailed information about the characteristics (e.g. hours, content) of the EBM course attended by the students. Additionally, the possible differences in EBM education among faculties and specialisations were not studied and their impact were not analysed.

During the university studies there is a unique opportunity to form attitudes of future healthcare providers and to pass over EBM-related knowledge, however in our findings, i.e. attitudes, knowledge and skills of undergraduate medical and health sciences faculty students do not necessarily reflect the real use these students will make of EBM later as a health professional.

VI. NOVEL FINDINGS AND PRACTICAL APPLICATIONS

VI./1. Dietary Energy and Nutrient Intake of Healthy Pre-School Children in Hungary

1. Sodium and refined sugar intake, which are known risk factors of obesity and hypertension, should be better controlled already in kindergarten children.
2. Increased consumption of dairy products might be advised to increase the calcium intakes.
3. The average daily intake of vitamin D proved to be insufficient for every preschool child in our present study in Hungary.
4. Phosphorus intake was high in half of the children in both age groups.
5. Pantothenic acid intake was low in every fifth 4-6 years old children.
6. Folic acid intake was low in 20% of the 2.5-4 years old children, and low in 40% of the 4-6 years old children.
7. Dietary fiber consumption was satisfying in three quarters of the children in both age groups, and was low in over 20% of the 4-6 years old children.
8. The daily fluid intake was low in 44% of the 2.5-4 years old children and low in 68% among the 4-6 years old children.

9. While the total energy and carbohydrate intakes were appropriate among 2.5- to 4-year-old preschool children, every third child had an excessive intake of energy. Morover, protein, fat and cholesterol intakes were, in general, also high.
10. Sodium intake was enormously high, while potassium intake also exceeded the recommended value in both studies. Consequently, the sodium/potassium ratio was rather unfavorable in the present study.
11. Children acquire dietary habits during early life. It should be, therefore, a high priority to provide evidence-based and parent-focused practical support for parents and emphasize the importance of healthy eating among the staff members of kindergartens.
12. Evidence-based nutritional interventions targeting Hungarian preschool children should be focused on the promotion of increased intake of fruits, vegetables and plain water. Furthermore, decrease in saturated fat and added sugar intakes are also should be recommended.

VI./2. Self-reported attitudes, knowledge and skills of using evidence-based medicine among students of medicine and health sciences in Hungary

1. The present study demonstrated that substantial proportion of students of the medical and health sciences faculties would like to acquire EBM-related knowledge and skills during their university studies.
2. Although the attitude towards EBM is generally positive, only a small minority of students rated their EBM-related skills as advanced in the present survey.
3. There were large differences in the understanding of different EBM-related terms. These results suggest that a list of EBM-related terms which is constructed at faculty level, handed out and recommended for medical and health sciences faculty students during their studies might improve the transmission of EBM-related knowledge.
4. Self-reported EBM-related knowledge and skills are higher among students who already received an EBM-training, an observation which underlines the importance of targeted EBM education in both medical and health sciences education.
5. EBM training seems to be an important tool to educate students of the importance of using up-to-date scientific information for supporting healthcare decisions.

6. Our observation indicates that medical students, at least in Hungary, are unsure about the way how EBM should be implemented in the daily practice. There is considerable potential for improvements to move away from “cookbook medicine” towards a sciencebased, but individualised medicine that involve both professional expertise and individual patient factors.
7. During the university studies there is a unique opportunity to form attitudes of future healthcare providers and to pass over EBM-related knowledge.
8. Targeted EBM training seems to be more effective following the second education year, when medical students have already acquired basic knowledge in medicine. Increased EBM-related knowledge and skills among higher year medical students highlight the importance of integrating EBM concepts also into other courses of the basic, preclinical and clinical modules.

LIST OF PUBLICATIONS

Number of publications that form the basis of this dissertation: **2**
Cumulative impact factor: **8.64**

Publications related to the thesis

Csertő, M., Mihályi, K., Mendl, E., Lőcsei, D., Daum, V., Szili, N., Decsi, T., & Lohner, S. (2023). Dietary Energy and Nutrient Intake of Healthy Pre-School Children in Hungary. **Nutrients**, *15*(13), 2989. https://doi.org/10.3390/nu15132989

Impact factor: 5.9

Csertő, M., Berényi, K., Decsi, T., & Lohner, S. (2019). Self-reported attitudes, knowledge and skills of using evidence-based medicine in daily health care practice: A national survey among students of medicine and health sciences in Hungary. **PloS one,** *14*(12), e0225641. https://doi.org/10.1371/journal.pone.0225641

Impact factor: 2.74

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Csertő M., Marosvölgyi T., Turonyi T.A., Csókási K., Pusztafalvi H. (2018) Study of disability related attitude among parents with toddler and childless adults. **NÉPEGÉSZSÉGÜGY**, 96(2), 144.
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Polyák, É., **Csertő, M.,** Gubicskóné, K.A., Bonyárné, M.K., Szekeresné, S. S., Faludy, A., Figler, M. (2011)
„Commercially available citrus species and changes in vitamin C content at different storage methods."
Kereskedelmi forgalomban kapható citrusfélék és leveik c-vitamin tartalmának változása különböző tárolási módok során. ÚJ DIÉTA, 5.

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