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Effect of traditional and online educational interventions on nutrition knowledge acquisition and retention in pediatric residents

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Effect of traditional and online educational interventions on nutrition knowledge acquisition and retention in pediatric residents

by

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Abstract

Nutrition education for medical trainees is inadequate despite nutrition's importance in health and disease. Results showed that Canadian pediatric residency programs offered limited formal nutrition instruction. Online learning may bypass identified barriers to increasing formal nutrition instruction by allowing learning to take place on a learner's schedule, and in the absence of local expert faculty. Therefore we aimed to compare the effect of online and traditional nutrition instruction amongst pediatric residents. Participants had inadequate nutrition knowledge on baseline objective testing and subjective self-report. Following the educational intervention, both online and in-person groups demonstrated significant increases in nutrition knowledge compared to baseline that was conserved after two months. No significant difference was found between intervention groups. The results show that a focussed time-limited educational intervention can lead to significant nutrition knowledge acquisition and retention, and that online learning may provide a reasonable curricular option for postgraduate training programs.

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Dedication

I would like to dedicate this work to my wife, Andrea Gruneir. Your understanding, support and constant encouragement and good humour allowed me to see this project through to the end with a smile still on my face.

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CHAPTER 1: INTRODUCTION

Adequacy of nutrition education in pediatric residents

Nutrition plays a central role in both chronic disease and optimal health. As such, nutrition management and counselling is an essential competency of a physician's practice. Physicians are seen as an important source of credible nutrition information. They also may be involved in raising awareness of the importance of optimal nutrition in individuals and populations through advocacy and public health initiatives. The rising incidence of obesity and its impact on health outcomes emphasizes the increasing need for effective early preventive measures and nutritional intervention.

Despite the importance of nutrition and expectation for nutrition knowledge amongst practicing physicians, nutrition education at all levels of medical training largely falls short of meeting these needs. Medical students, residents and even practicing physicians report low levels of knowledge and confidence in areas of nutrition practice. Targets for minimum duration of nutrition curricula are unmet, and this problem may be worsening rather than improving. Nutrition education at the postgraduate level is likewise challenged. Barriers to overcome include busy resident schedules, lack of interested or available faculty, and a large volume of competing curricular material to cover within the tight confines of the traditional academic "half day" each week.

While this situation has direct impacts for future and practicing physicians in all areas of medicine, arguably, the importance is greatest in pediatrics. Nutrition in infants and children is crucial to optimal health and development. It also marks the optimal time for preventive interventions in order to impact individuals throughout their lives. Unfortunately children face many of the same issues as adults of increasing rates of obesity and related chronic disease. Pediatric residents have also shown low levels of knowledge in basic areas of nutrition practice such as breastfeeding or obesity counselling. Targeted educational interventions have led to demonstrated improvements in a number of reports, however a clearer understanding of the educational needs of this group, and the optimal educational interventions to achieve them, is needed.

Online learning

Technology, including computers, smart devices and the internet are pervasive tools for the creation, distribution and consumption of information. As such, they are of high interest to educational researchers looking for new and perhaps improved ways of helping students of all ages to learn. These devices provide the opportunity for the creation of multimedia and interactive learning modules. Even more importantly, they allow for learners to access these resources in an asynchronous and distributed manner. This is in stark contrast to traditional teaching that required attendance at a particular place and time. This also removes the requirement for local expert faculty.

Given these characteristics, medical trainees with their variable schedules and unique learning needs are a perfect target group for the use of distributed information and technology resources for teaching. In fact, research into this area is increasing, and there has been great interest in using these techniques in undergraduate, postgraduate and continuing medical education. If the nutrition content in postgraduate curricula is limited by lack of time, lack of expert faculty and variable learner schedules, online learning may represent the perfect educational tool to overcome these barriers.

Statement of the problem

Despite recognition of the importance of nutrition knowledge to competent medical practice, trainees at both the undergraduate and graduate levels receive inadequate training in this key area. The need to cover competing curricular topics within limited available formal teaching time and a lack of interested or qualified faculty are some of the identified barriers to increased nutrition instruction. The adoption of web-based learning modules may help circumvent these barriers by allowing trainees to access educational content outside of a restricted academic half-day schedule, and in the absence of local expert faculty. To our knowledge, no studies have directly compared these methods to traditional in-person lessons for advancing nutrition knowledge amongst pediatric trainees.

CHAPTER 2: LITERATURE REVIEW

Adequacy of nutrition education in pediatric residents

Nutrition is central to the pathogenesis and outcome of common diseases and health conditions. In fact, a recent study on the burden of disease in the United States found dietary factors to be the most significant risk factor for disability and premature death[1]. Given this impact, one may expect that physicians would be expected to be knowledgeable about nutrition, and competent in making nutritional assessment and providing relevant counselling. In fact, 61% of US adults surveyed by the American Dietetic Association felt that physicians were very credible sources of nutrition information[2]. In stark contrast, only 14% of residents in one survey felt adequately trained to provide nutrition counselling[3]. This unfortunate finding indicates that despite the importance of nutrition to health and medical practice and patient expectations, nutrition instruction remains limited at all stages of medical training.

First year medical students have been shown to have significant deficits in nutrition knowledge[4]. Unfortunately, current medical curricula may not be sufficient to correct these deficiencies. A survey of US medical schools found that fewer than 40% of responding medical schools failed to provide the minimum of 25 hours of nutrition education curricular time recommended by the National Academy of Sciences[5]. Disappointingly, a 2010 update of this review found that the situation had deteriorated, with a decrease in mean hours of nutrition education and only 27% of schools meeting

the 25 hour target[6]. Even more concerning was that a small but increasing number of medical school programs required no nutrition instruction at all. Canadian medical schools are no better in meeting the nutrition educational needs of undergraduate medical students. Most Canadian medical students in a national survey were dissatisfied with the amount of nutrition education provided in their curricula[7]. Sadly, these are not new concerns, with publications identifying deficiencies decades ago[8-10].

The available literature would suggest that the situation is not improved significantly in the postgraduate setting. Surveys in family medicine residency programs have also shown widely variable amounts of nutrition education[11]. It is unclear if an adequate knowledge base in nutrition may be obtained through informal learning through direct practical experience alone, in the absence of sufficient targeted nutrition teaching. This may be impacted by the fact that many medical programs do not have clinical rounds that allow for learners to see how nutrition can be used in practice[12]. The outcomes are clear; graduating internal medicine and family medicine residents uniformly report a lack of confidence in nutrition knowledge and skills[3].

While important in many areas of medicine, clinical nutrition is central to the care of all children in both hospital and community settings. Although this obviously involves indications such as nutrition support and assessment of failure to thrive, children and adolescents are also impacted by the rise of overweight and obesity and its health consequences. The Centers for Disease Control and Prevention reported significant

rates of overweight and obesity in US children and teens, including nearly 10% of infants and toddlers at risk for overweight[13]. Although there are no published data on formal assessments of nutrition knowledge or training amongst pediatric residents, there are indications that similar deficiencies exist in this group. Studies have documented significant deficits in recognition and assessment of obesity in pediatric patients, leading to missed opportunities for intervention[14,15]. Pediatric residents, and even pediatricians, demonstrated significant deficits with respect to breastfeeding knowledge, with correspondingly low self-reported confidence in breastfeeding management[16-18], and residency program directors reported a need for more education in this area[19]. Pediatric residents and practicing pediatricians also had low ratings of competency in managing obesity, indicating a deficiency in training[20]. Even pediatric gastroenterologists were able to identify gaps in their nutrition knowledge base that may relate to current curricula[21]. There is clearly a need to better assess the current state of nutrition knowledge of pediatric residents.

Barriers to nutrition education

A number of factors have been identified as contributing to the deficiency in nutrition education in medical training and provision of nutritional care in practice. One of the most commonly cited factors is limited available lecture time given the breadth of the curriculum[12]. A limited number of interested and knowledgeable faculty was cited as a significant barrier[11], as was a lack of faculty development[22].

Impact of educational interventions

Although currently available literature suggests that current standard educational practices may be inadequate, others have shown that interventions to improve this may lead to significant improvements. Discrete educational interventions targeting specific areas of nutrition-related patient care, such as breastfeeding[23-26] or obesity counselling[27,28] have been proven effective in improving knowledge and confidence, and effecting behaviour change amongst trainees.

More comprehensive nutritional education interventions have also been developed at some institutions. A unique student-centred, collaborative approach has been developed in Boston-area training programs to help integrate and expand involvement in nutrition across medical training[29]. Similarly integrative educational programs have been implemented at medical schools at the University of Colorado[30] and University of Nevada[31]. These programs are exceptions to the norm, and efforts to encourage broader adoption of comprehensive nutrition education have failed to achieve long-term success. Unfortunately, the National Academic Award program, a broad-based comprehensive program involving 21 US medical schools, was discontinued after losing its funding despite showing significant promise[12,32].

There continues to be room to further study different teaching strategies to target identified knowledge gaps while addressing identified barriers.

Online learning

Web-based interactive learning modules may provide several advantages over in-person teaching sessions that may be either didactic or interactive in nature. Only a finite number of in-person teaching sessions are possible within a busy training program, and trainees may be absent for a number of these during their training due to competing commitments. Web-based teaching modules may be completed whenever the trainees have time, and may stimulate further self-study. In addition to convenience, online learning may lead to improvements in measures of learning, self-efficacy and learner satisfaction compared to traditional instruction settings[33,34]. In particular, online learning modules have been proven to overcome the challenges of learners being absent for scheduled teaching sessions due to their clinical schedules[35]. These advantages have prompted significant interest in online and mobile learning platforms. A recent review identified 20 online or mobile application resources for medical education within the narrow area of chronic kidney disease alone[36].

This teaching method may encourage more active learning when compared to the passive learning that takes place in traditional didactic lectures. A significant number of studies have examined the use of common social networking sites (e.g. Facebook, Twitter) in medical education. A systematic review found positive impacts across these studies, especially in learner engagement, feedback, collaboration and professional development[37].

Medical students during their clerkship surgical rotation showed a significant improvement in surgical knowledge acquisition and retention over a three-week follow-up period using interactive computer-based learning modules compared to traditional lectures[38]. Knowledge scores were also significantly improved following exposure to online dermatology modules during clerkship[39]. Online learning has also been shown to be useful in improving test scores in fellows and staff physicians in pediatric urology[40]. Similar success has been shown in test scores and self-reported competence in practicing physicians in performing dermatologic procedures following online continuing medical education[41]. Online learning modules also may contribute directly to patient outcomes, as demonstrated by a recent study showing reduced radiation exposure during fluoroscopic procedures conducted by radiology residents who had received such training, even when compared to more experienced residents[42].

Computer-assisted and online learning modules in nutrition have been developed since the 1990s[43]. The most extensive online curriculum has been developed by the Nutrition in Medicine program, based at the University of North Carolina[44,45]. This program is committed to nutrition education for undergraduate and postgraduate medical trainees as well as practicing physicians. Modules for practicing physicians may be completed in 15 minutes or less, however medical trainee modules are designed to be completed in 30-60 minutes. To date, 29 different modules are offered, with 7 modules specifically covering pediatric nutrition topics. The organization reports that more than half of all US-based medical schools currently use the NIM program in their curricula[44].

Goals and objectives

The goals of this study were to assess current nutrition education and nutrition-related knowledge of Canadian pediatric residents and to measure the impact of a comprehensive curriculum on measures of learning in these residents. The curriculum was delivered in the form of four one-hour in-person teaching sessions to one group of pediatric residents, and as four online learning modules to another group of pediatric residents. The effect of this curriculum delivered by these two methods was compared with respect to knowledge acquisition, knowledge retention and learner satisfaction.

Research questions

A. Does nutrition education, as currently provided through pediatric residency training programs in Canada, meet the needs of Canadian pediatric residents?
B. Is nutrition knowledge amongst Canadian pediatric residents deficient, as assessed by a valid multiple-choice examination?
C. Does a nutrition education intervention in the form of a new nutrition curriculum improve nutrition knowledge acquisition and retention in Canadian pediatric residents?
D. If the nutrition curriculum intervention has an effect, is that effect greater for pediatric residents who receive this intervention through an online learning system, compared to traditional in-person instruction?

CHAPTER 3: METHODS

Needs Assessment (Research question A)

Study design

Research question A was investigated by way of an observational cross-sectional study using pediatric residency program directors from 17 pediatric residency training programs in Canada, and pediatric residents in 3 Canadian programs.

Participants

Program directors at all 17 Canadian pediatric training programs were invited to participate and complete a survey regarding the nutrition education opportunities within their residency training programs. All residents at 3 training programs were invited to participate.

Instruments

Program director survey

The Royal College of Physicians and Surgeons of Canada set out Objectives of Training in all specialty residency training programs in Canada following an extensive expert review process. This document is intended to provide an outline of the knowledge and skills expected of competent physicians in each specialty, and therefore they are expected of graduating residents as well. As such, the Objectives in Training in Pediatrics, represents an outline of the knowledge and skills expected of graduating pediatric residents by the organization responsible for certifying new

pediatricians. The principle investigator used this document as a source to identify areas of nutrition knowledge that could be reasonably expected of these trainees. These knowledge and skill items are summarized in Table 1, and were used for surveys provided to both program directors and trainees (see below).

Table 1: Royal College Objectives of Training Related to Nutrition

Topics
Recommended nutritional requirements
Effect of disease states on nutritional requirements
Breast feeding and infant feeding
Health implications of restricted diets, fad diets, diets determined by custom or socioeconomic situation
Indications for, physiologic basis of and complications of parenteral and enteral nutrition
Nutritional assessment
Failure to thrive
Obesity
Nutritional deficiencies and excess
Feeding disorders
Role of nutritional support in critical care
Neonatal growth, nutrition, metabolic problems, feeding problems
Skills
Prescribe and manage parenteral and enteral nutrition
Counselling for healthy active living (healthy eating and physical activity

Canadian pediatric residency training program directors received a short online survey (Appendix B). The survey was drafted by Dr. Jason Silverman, and reviewed for content and clarity by Drs. Maitreyi Raman and Sylvain Coderre. This survey contained items regarding nutrition training within their programs taking place both within their formal academic half-day curricula, as well as formal teaching at other times. The duration of this training, the providers of that training (e.g. physicians, dietitians or

other health professionals), and coverage of Royal College objectives (see Table 1) were also assessed. Program directors were asked about recent changes to academic half-day nutrition coverage and foreseen barriers to expansion of the nutrition curricula.

Pediatric resident survey

Participants in the nutrition curriculum intervention (see below) completed a short preliminary survey at the same time as their baseline examination (Appendix C). This survey asked for residents to report any formal nutrition training completed prior to, and during medical school, or during their residency training to date. They also were asked to rate their perceived knowledge and interest in the areas summarized in Table 1, by way of a Likert scale. Options ranged from 1=Strongly agree to 5=Strongly disagree.

Nutrition Curriculum Intervention

Study design

Research questions B, C and D were assessed using a prospective interventional study design.

Participants

Pediatric residents at three Canadian training centres (Dalhousie University, University of British Columbia and University of Calgary) participated in the curriculum intervention study. Research Ethics Board approval was received at all three

participating centres. Recruitment was voluntary following distribution of an invitation letter and participants completed informed consent prior to participation (Appendix A). Informed consent to participate was received from 27 residents at University of Calgary, 19 residents at UBC and 14 residents at Dalhousie University for a total of 60 out of 130 invited. Participants at University of Calgary were provided with a nutrition curriculum developed by the PI, administered as four in-person teaching sessions (see Curriculum section below). Participants at University of British Columbia received a nutrition curriculum developed by the PI and delivered via an online learning management system with the same content as the in-person curriculum (see Curriculum section below). Participants at Dalhousie University were not exposed to any specific intervention, acting as the study's control group. All three participant groups completed the same assessments (see Assessment section below).

Curriculum

Structure and schedule

The educational intervention consisted of either four in-person teaching sessions or four online learning modules. A control group was also included. Participants at the University of Calgary received four in-person teaching sessions during their regularly scheduled academic half-day. Two sessions were scheduled immediately after the pre-test (see Assessment). The remaining two sessions were scheduled two weeks later, and were immediately followed by the post-test. Sessions were developed so that they could be completed in approximately one hour to avoid learner fatigue.

Participants at University of British Columbia completed four web-based learning modules. These web-based learning modules covered the same core content (see Content) and were also developed using instructional design principles optimized for online learning (see Instructional Design). These modules were also developed so that they could be completed in approximately one hour, however as online learning is self-paced, participants could vary in the total duration of their participation. These modules were developed and deployed using a commercially available learning management system (Desire2Learn).

Lastly, a control group was included in the study to investigate the potential impact of a testing effect on self-directed study and learning. Participants at Dalhousie University received no specific intervention, but did undergo the same evaluations as at other sites (see below). These residents continued to receive their usual academic half-day curriculum as well as any other nutrition-related training that occurred through clinical experiences.

Content

The content of the nutrition curriculum was based on topic areas summarized in Table 1, based on the review of the Royal College Objectives of Training in Pediatrics completed during needs assessment. The PI developed all of the content with input from other content experts on the Thesis Committee. The subject areas to be covered in the intervention curriculum were chosen in an effort to maximize coverage of the

overall topic list while providing a reasonable number of learning sessions or modules. Topics also were selected and assigned to particular sessions or modules in a manner that maintained a logical and cohesive organizational structure. Using these aims, content in four core topic areas was developed:

1. Nutritional assessment and normal nutrition in infants and children
2. Effect of disease states on nutritional requirements and related nutritional deficiencies, including management of failure to thrive
3. Assessment and management of childhood obesity
4. Indications and considerations in enteral and parenteral nutrition support

The modules were developed following an educational blueprint designed to provide learning objectives related to each area spanning all levels of learning according to Bloom's Taxonomy[46].

Instructional design

The in-person teaching sessions were developed according to adult learning principles, optimized for an anticipated mix of learning styles amongst the participants). Some content was delivered via didactic instruction, however emphasis was placed on teaching through hands-on activities and discussion. The online learning modules were developed following instructional design principles for online learning. Activities were developed to engage participants, including formative quizzes and worksheets for later uploading and review. Content was displayed according to a hierarchical structure to

allow for easy and logical navigation. Subtopics followed the same order as in the in-person teaching sessions, however the online system allowed for users to move as they wished between topic areas.

Assessment

Examinations

Primary educational outcomes for this study included knowledge acquisition and retention. These were evaluated by multiple-choice examination. Participants had their baseline knowledge related to the curriculum content assessed by a pre-test at the beginning of the study period. Participants also completed both an immediate post-test at the end of the study period to assess knowledge acquisition, and a delayed post-test two months later to assess knowledge retention.

Each examination consisted of 32 questions, with 8 questions derived from each of the four main topic areas as reviewed in the Content section above. The pre-test and immediate post-test were developed in a parallel fashion, from the same educational blueprint, with similar examination difficulty. The delayed post-test consisted of the same questions as the pre-test, with an altered question order to mitigate the effect of pattern recognition. Control over examination difficulty was achieved using a modified Nedelsky method for determining item Minimum Performance Level (MPL), which led to a comparable total examination MPL. Three individuals, one with content expertise

(the PI), independently set the MPL for each question and these scores were averaged to derive the final MPL.

Surveys

Participants completed two surveys: a pre-curriculum survey and post-curriculum survey (the control group also completed both surveys). The pre-survey included items to assess prior nutrition education experience as well as self-assessment of knowledge and interest in content areas, as described above (Appendix C). The post-curriculum survey (Appendix D) re-assessed the same ratings of knowledge using the same Likert scale. This survey also asked about the perceived quality and usefulness of curriculum content and the mode of delivery, specific to the curriculum to which they had been exposed over the study period. The same Likert scale was used for these items. All participating residents were asked about how many hours of formal nutrition education they received over the study period, as well as self-reported time spent in relevant self-study. The PI developed both surveys with input from committee members.

Statistics

All study data including study participant characteristics, test and survey responses were entered into a data entry form created in Excel (Office 2011, Microsoft, Redmond, WA). All statistical analyses were performed using SPSS (Version 20, IBM, Armonk, NY). Descriptive statistics were used to summarize participant demographic information as well as survey responses. Paired t-tests were used to assess

differences in performance between pre-test and post-test, and between pre-test and delayed post-test. Differences between study groups were assessed through one-way analysis of variance (ANOVA). Multiple linear regression was used to identify significant predictors of test performance.

CHAPTER 4: RESULTS

The results of this study will be presented by research question.

Results for Question A:

A. Does nutrition education, as currently provided through pediatric residency training programs in Canada, meet the needs of Canadian pediatric residents?

Program Director Survey

The response rate for the program director was 71% (12/17). Selected data summarized in Table 2. Included programs were evenly split between following a two-year (n=6) or three-year (n=6) curricular cycle for their academic half days. Nutrition education was provided by a combination of physicians and dietitians in 75% of programs, with 25% of programs using dietitians exclusively. No programs reported involvement of registered nurses for the provision of nutrition education. Total time spent each year on nutrition education was 5.6 hours (range 2-12 hours) within the academic half-day, and 1.9 hours (range 0-10 hours) in formal teaching sessions outside of the academic half-day.

Table 2: Program director survey responses

Program	Hours in AHD (per year)	Hours outside AHD (per year)	Increase in past 5 years?
1	3	1	Yes
2	3	4	Yes
3	9	2	No
4	6	3	Yes
5	4	10	Yes
6	6	2	No
7	10	0	N/A
8	4	0	Yes
9	4	0	No
10	12	0	Yes
11	2	0	Yes
12	4	1	No

Most programs reported covering all of the Royal College nutrition items summarized in Table 1, although 2 programs identified some topics not covered at all. These included the implications of restricted diets, nutrient deficiencies and excess, nutritional assessment and nutrition support in critical care. Programs differed as to which topics were covered within formal teaching sessions versus through clinical exposure (limited results presented in Table 3). No program reported providing coverage of all topic areas within formal teaching sessions.

Table 3: Coverage of nutrition-related Royal College objectives

Covered in AHD	Covered through clinical exposure
Recommended nutrient requirements	Nutritional assessment
Breastfeeding/infant feeding	Health implications of diet
Parenteral/enteral nutrition	Managing parenteral/enteral nutrition
Failure to thrive	Counselling for healthy active living
Obesity	

58% of programs (n=7) reported increasing time spent in nutrition education within the past 5 years. The most commonly reported reason for this change was resident requests. The most commonly reported barrier to increasing nutrition education, or increasing it further, was insufficient time within the academic half day curriculum. Other barriers identified included viewing nutrition as a lower priority area given competing demands, and a lack of interested faculty.

Resident Survey

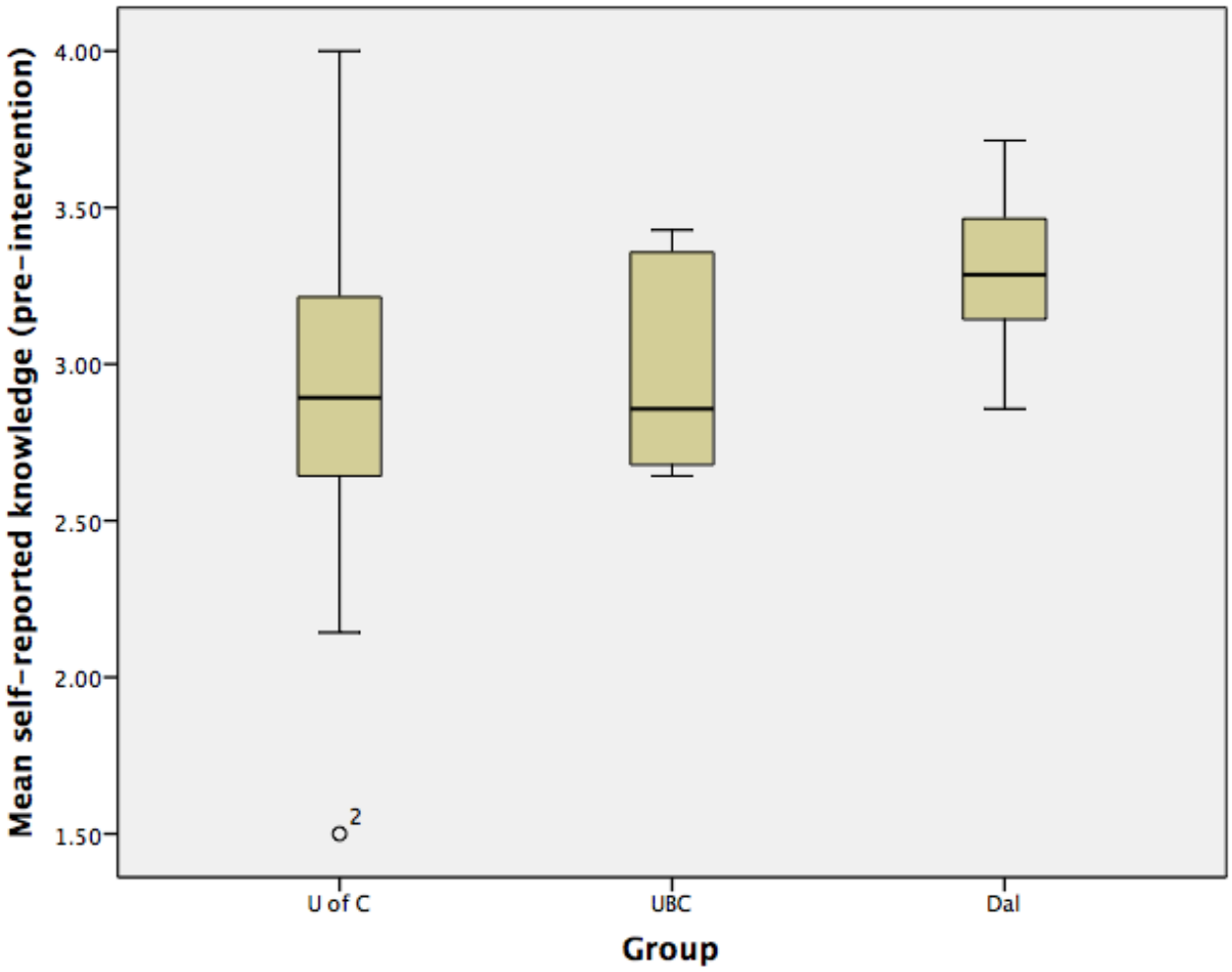
Out of 130 invited residents, a total of 51 residents (26 at University of Calgary, 12 at UBC and 13 at Dalhousie University) entered into the curriculum study and completed the pre-intervention survey. Basic demographic information and self-reported knowledge and interest regarding nutrition topics are summarized in Table 4. The UBC group had an increased proportion of first year residents compared to the other two groups. Only 2 residents in each group reported having prior formal nutrition training prior to medical school. Participants reported relatively low satisfaction with their level of knowledge in identified areas of nutrition, as indicated by neutral to negative ratings on the 5-point Likert scale (where 5 would indicate a very high level of knowledge and 1 a very low level). In contrast, residents generally reported being interested in nutrition topics (with 5 indicating a very high level of interest, and 1 indicating a very low level of interest).

Table 4: Study participant baseline characteristics

	Dalhousie	UBC	UC
Number of participants	13	12	26
Year of training			
1	2	5	6
2	5	5	10
3	5	2	3
4	1	0	7
Prior nutrition training, n (%)	2 (15.38)	2 (16.67)	2 (7.69)
Nutrition knowledge, mean* (SD)	3.29 (.27)	3.00 (.36)	2.91 (.58)
Nutrition interest, mean* (SD)	4.18 (.52)	4.13 (.57)	3.92 (.95)

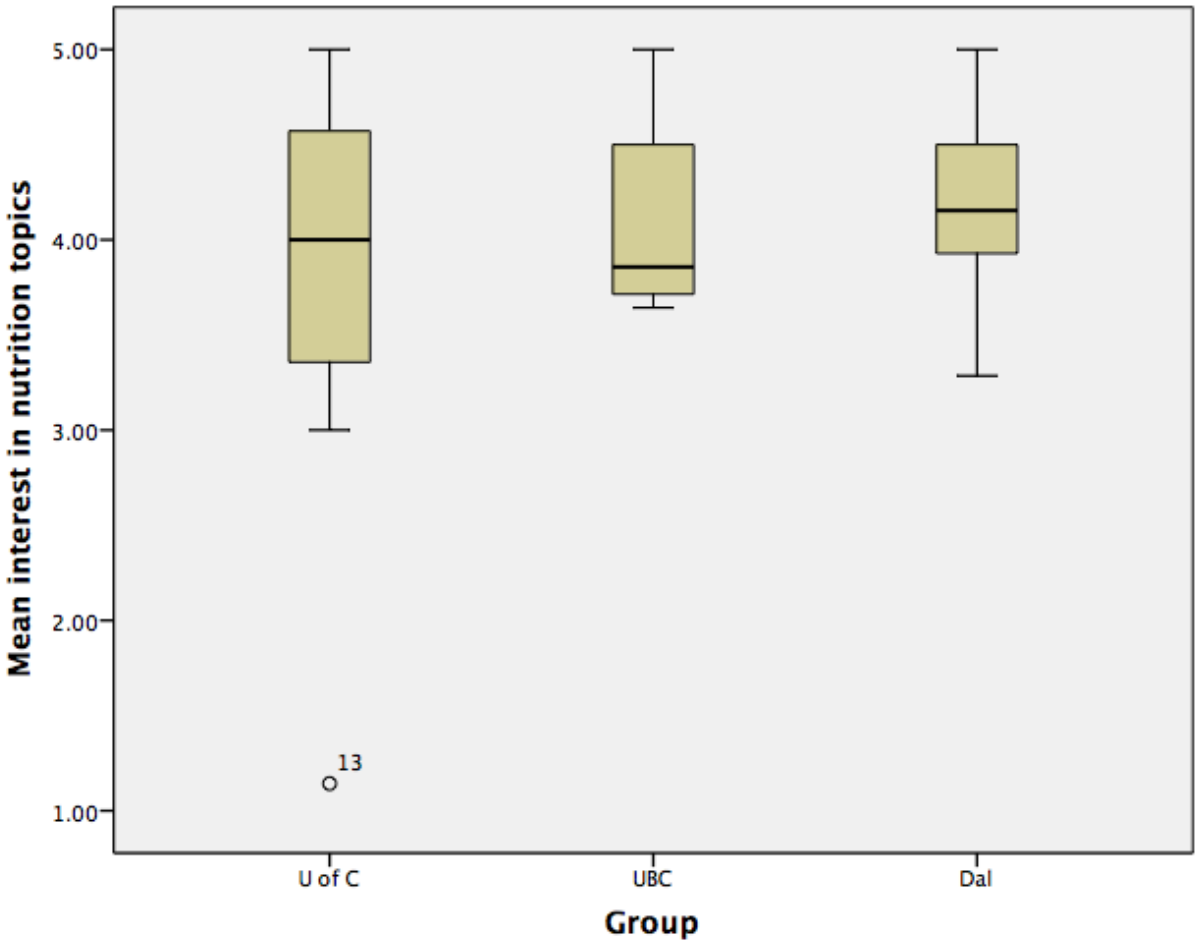
No significant differences existed across groups in terms of their baseline self-reported knowledge in nutrition, or in their interest in nutrition topics assessed by one-way ANOVA. The mean self-reported knowledge levels and interest levels are represented in Figures 1 and 2 respectively.

Figure 1: Mean self-reported baseline nutrition knowledge



Note: Outlier markers are accompanied by participant ID numbers of outliers

Figure 2: Mean self-reported interest in nutrition topics



Note: Outlier markers are accompanied by participant ID numbers of outliers

Results for Question B:

B. Is nutrition knowledge amongst Canadian pediatric residents deficient, as assessed by a valid multiple-choice examination?

Resident performance on the baseline pre-intervention 32-question multiple choice pre-test was very similar in both intervention groups. Mean test scores (±SD) were 65.1% ± 8.5% for UBC participants and 64.3% ± 8.4% for University of Calgary participants (no significant difference). Unfortunately, due to a procedural error the Dalhousie participants completed an earlier version of the pre-test. As the exams differed substantially, it did not represent a reasonable comparison, and therefore these data were excluded from analysis.

Results for Questions C and D:

C. Does a nutrition education intervention in the form of a new nutrition curriculum improve nutrition knowledge acquisition and retention in Canadian pediatric residents?

D. If the nutrition curriculum intervention has an effect, is that effect greater for pediatric residents who receive this intervention through an online learning system, compared to traditional in-person instruction?

Participants in both intervention groups scored significantly higher on the immediate post-test (a measure of knowledge acquisition) when compared to the pre-test. This also held true for performance on the delayed post-test (a measure of knowledge retention). Test results are summarized in Table 5, and represented graphically in Figure 3.

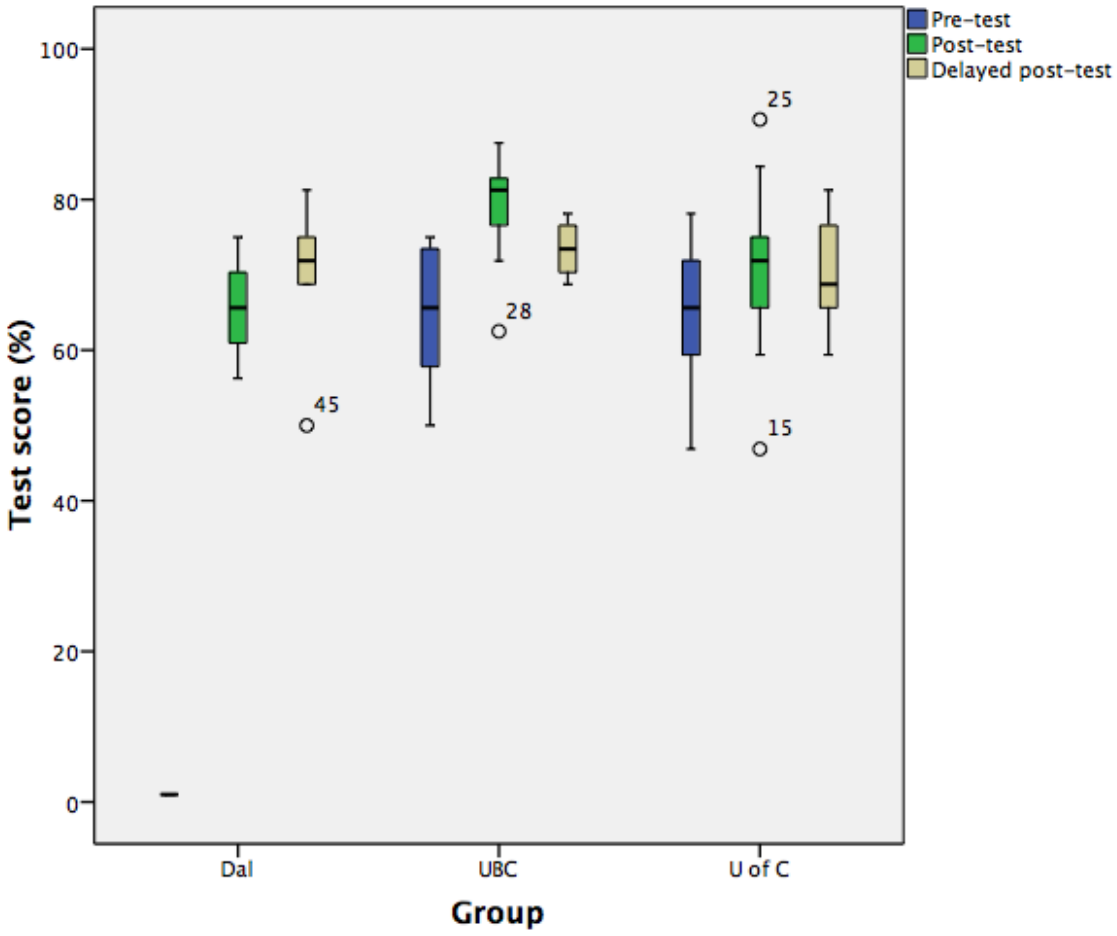
UBC participants scored 78.5% ± 8.5% and University of Calgary participants scored 71.4% ± 9.5% in the post-test. Both of these scores were significantly higher ($p < .05$ for both groups), compared with pre-test scores. Cohen's d was used to estimate the effect size of this intervention. The effect size was 1.33 for UBC, and 0.94 for the University of Calgary group. In comparison, the Dalhousie group scored 66.8% ± 7.2% on the immediate post-test. The Dalhousie group's post-test score was not significantly different from the pre-test scores of both intervention groups. In a comparison of post-test scores across all three groups, post-test scores of the Dalhousie group were significantly different from the post-test scores of both intervention groups by one-way ANOVA ($p<.05$). On post hoc analysis, only the difference between Dalhousie and UBC groups was significant, however ($p<.05$). An independent t test between intervention groups did not show a significant difference in post-test scores, however a potential trend towards an increased score in the UBC group was demonstrated ($p=.07$).

In the delayed post-test, UBC participants scored 73.4% ± 4.0% and University of Calgary participants scored 70.6% ± 6.7%, while the Dalhousie group scored 69.8% ± 10.6%. Both intervention groups continued to score significantly higher in paired t tests compared to pre-test scores ($p < .05$ for each comparison). There were no statistically significant differences between the three groups at this time point. There were also no significant differences between post-test and delayed post-test scores within each group.

Table 5: Participant test scores

	Dalhousie	**UBC**	**U of C**	**Comparison**
Pre-test score (% ± SD)	N/A	65.1 ± 8.5 (n = 12)	64.3 ± 8.4 (n = 26)	*p*=NS
Post-test score (% ± SD)	66.8 ± 7.2 (n = 9)	78.5 ± 8.5 (n = 7)	71.4 ± 9.5 (n = 20)	*p*<.05
Delayed post-test score (% ± SD)	69.8 ± 10.6 (n = 6)	73.4 ± 4.0 (n = 4)	70.6 ± 6.7 (n = 20)	*p*=NS

Figure 3: Participant test results



Note: Outlier markers are accompanied by participant ID numbers of outliers

The impact of year of training and prior nutrition training on test scores was assessed for the University of Calgary group using linear regression. This analysis was not possible for the other groups due to the small number of participants in those groups completing all tests. There was no significant impact on any test score by year of training, prior nutrition training, or an interaction between the two factors. A trend

towards higher post-test scores in those participants with prior nutrition training was seen (p=.08), however this was not sustained in the delayed post-test.

In addition to the objective post-test, participants were again asked to rate their knowledge in nutrition using the same Likert scale as in the baseline survey. Participants at Dalhousie gave a mean rating of knowledge as 2.71 (vs. 2.70 at baseline), UBC participants gave a mean rating of 2.18 (vs. 3.10 at baseline) and University of Calgary participants gave a mean rating of 2.83 (vs. 2.95 at baseline). None of the comparisons across or within groups were significant by one-way ANOVA.

CHAPTER 5: DISCUSSION

Summary of findings

In this study, we found that nutrition coverage is quite limited in Canadian pediatric residency programs on average, with just 7.5 hours per year spent on formal nutrition education. Nutrition knowledge amongst pediatric residents is deficient as measured by an objective MCQ examination, and by subjective self-report. A focussed, time-limited educational intervention resulted in improved nutrition-related knowledge acquisition and retention as measured on repeat MCQ testing. This effect was similar whether the intervention was provided through in-person instruction, or through online learning modules, although there was a trend towards increased knowledge acquisition in the online group.

Discussion surrounding research question A

The survey of Canadian pediatric residency program directors revealed that, on average, approximately 7.5 hours of formal instruction in nutrition was provided annually. Programs were evenly split between offering a two or three year curricular cycle. Therefore a resident completing all four years of core pediatrics may receive 30 hours of nutrition instruction however only half may represent new content. Although there are no recommended standards at the postgraduate level, this duration falls well short of the 25 hours recommended within undergraduate medical curricula[5]. This relatively brief coverage of nutrition also marks an increase over previous levels, as most programs reported increasing nutrition coverage within the previous four years,

generally at the request of residents. Resident requests for more nutrition coverage are in keeping with the survey findings in the present study, where residents rated nutrition topics as quite important, but their baseline knowledge in these topics as relatively low. This is also echoed in published data reporting only 14% of resident physicians feeling that they had received adequate training for nutrition counselling[47]. Even pediatric gastroenterologists (the only pediatric subspecialty with formal nutrition training as part of their core curriculum) identified gaps in their nutrition knowledge base that may relate to deficient education during training[21].

The most commonly cited barriers to increasing nutrition coverage within the academic half day setting were limited time, competing curricular demands and lack of interested or expert faculty. These same barriers have been cited in numerous other studies[12,22,48-50]. These barriers were identified in assessing a lack of core nutrition coverage in pediatric gastroenterology, hepatology and nutrition subspecialty training programs in a similar survey of program directors[51]. The authors of that study concluded that incomplete coverage of core nutrition topics might be addressed through the creation of core curricula and learning modules.

It is clear from the combination of program director survey data, and study participant self-report, that currently provided nutrition education is not yet meeting the needs of pediatric trainees. The creation of a core nutrition curriculum, including an evaluation of

online learning modules in the present study was an attempt to address this learning gap, as highlighted elsewhere[51].

Discussion surrounding research question B

A baseline assessment of nutrition knowledge across core nutrition topics was administered to study participants (see Appendix F). Both intervention group participants scored similarly, with mean test scores of 65.1% and 64.3%. This falls well short of the score of 70-80% expected to pass a number of standardized medical examinations, including those used in the American Board of Pediatrics recertification process[52]. A prior study involving pediatric residents' knowledge regarding breastfeeding revealed a similar (although slightly higher) mean baseline score of 69%[25]. Likewise pediatric residents' baseline obesity-related knowledge was measured as 68%[27]. Therefore the present study's participants did demonstrate deficient nutrition-related knowledge on a valid multiple-choice examination, however their scores were in keeping with those seen in prior similar studies.

Discussion surrounding research questions C and D

Both intervention groups were exposed to a focussed yet comprehensive nutrition curriculum that required approximately four hours to complete. Despite the relatively limited time investment, both groups demonstrated significant new nutrition-related knowledge acquisition and retention two months later on follow-up testing. Although there are a number of reported barriers to increasing nutrition coverage in formal

postgraduate curricula, it is important to document that brief, but focussed interventions can lead to demonstrable knowledge changes. This itself is not unique to this study, as it has been shown repeatedly in brief educational interventions to increase knowledge related to breastfeeding or obesity management and counselling amongst undergraduate and postgraduate medical trainees[28,49,53-55].

While provision of information in any format may lead to acquisition of knowledge demonstrable on immediate post-testing, additional elements of instructional design are important to producing knowledge retention or long-term learning. Introducing challenging elements to the lesson, varying learning conditions or interweaving different concepts appear to impair knowledge acquisition, however they have been shown to enhance long-term learning, and are therefore known as desirable difficulties[56]. A variety of methods have been used to demonstrate this principle, including the use of visually inverted text to enhance long-term vocabulary retention[57]. In this study, both the in-person sessions and online learning modules were designed to include a variety of activities and periods of problem-solving which provided these desirable difficulties, and may have led to enhanced knowledge retention. This reinforced the importance of instructional design in developing both in-person and online learning modules.

Online learning may offer potential advantages over traditional in-person teaching sessions over and above the ability to overcome the limitations of scheduling, location

and physical presence of expert faculty. Learners may review material and proceed at their own pace[58]. They may return to portions of the material for review an unlimited number of times. Studies have shown that repeated study sessions lead to knowledge retention[59]. Providing material online allows learners to take a break to read around topics using external resources as desired, also potentially reinforcing the knowledge obtained. Learners may feel more comfortable searching for definitions or clarifications online rather than interrupting an instructor and potentially demonstrating ignorance in front of their peers. Those learners may subsequently be able to build off these basic principles with the material that follows, rather than remaining in the dark.

These factors may have led to some studies demonstrating superior learning and learner satisfaction in online, or technology-assisted learners[33]. A meta-analysis that included over 200 studies on internet-based medical education found large positive effects compared to control groups, however trials comparing online learning to traditional instruction methods had more heterogeneous outcomes suggesting equivalent effectiveness[60]. This is in keeping with the present study, which found no statistically significant advantage to online learning group, however a trend towards higher scores for the online group were noted. The voluntary nature of participation in the online group contributed to a large attrition rate, with only 4 participants completing all study components. It is possible that this introduced bias, where more intrinsically motivated learners completed later testing, which may have contributed to higher test scores in this group. Regardless, it appears reasonable to conclude that the online

curriculum was at least non-inferior to traditional instruction by interested, expert faculty.

The control group participants had immediate post-test scores that were similar to pre-test scores in the intervention groups, in keeping with their “untaught” status. At the delayed post-test, their scores increased. While the increase from immediate post-test was not statistically significant, the difference amongst study groups at this stage was no longer significant. One potential explanation is that there was again a significant attrition rate in the control group which potentially introduced bias where more intrinsically motivated learners completed all study components. The effect of testing on learning is also a potential explanation for this observation. Cycles of testing interspersed with study has been shown to be superior to repeated studying alone for producing knowledge retention[59,61]. This also has been shown to be true through the use of online quizzes[62]. Although test-enhanced learning can significantly lead to improved knowledge retention, this effect should have applied equally to all study groups, as they all completed the same examinations. The use of practice quizzes and other opportunities for attempted information retrieval is an important means for enhancing learning, however, and should be considered in the instructional design of any curriculum.

As already mentioned, in the present study a relatively high attrition rate was observed in both the online learning and control groups. The attrition rate in the in-person

instruction group was much lower. While study participation was strictly voluntary across all sites, the potential barriers to participation (extra time and effort) were reduced at the University of Calgary where tests and surveys were administered preceding or following the nutrition instruction which took place during the regular academic half day schedule. In the other locations, participants were required to either attend extra sessions to complete tests (in the control group), or to find the time to complete online learning modules, tests and surveys. In the online group, this can be seen as a true representation of how online learning is done. The flexible and self-directed nature of online learning may be seen as both an advantage and a disadvantage as it is dependent upon learner motivation for completion. It is worthwhile noting, however, that the online group in the present study had a similar attrition rate to the control group, suggesting that the attrition rate was not solely a result of the intervention to which the group was exposed.

In reviewing other studies of online learning in medicine, attrition rates are variable, but on the whole comparable to what was seen in the present study. One other factor that may play a role is study duration. In study of online continuing medical education, 34 physicians consented to participate, however only 12 participants completed the project which spanned 6 months[63]. In another study involving interns, 280 interns were enrolled in an online intervention trial, with 205 participants completing the project after approximately one month[64]. The lower attrition rate in the second study may also have been related to program expectations within an internship rotation. Future work on

developing online learning for postgraduate medical training will need to address the attrition rate seen in voluntary research trials. Instituting online learning modules as a mandatory component of the formal curriculum would be one direct way of addressing this issue. Studies conducted over shorter durations may be associated with a lower attrition rate, however this must be balanced against aims to assess knowledge retention which require longer follow up.

Study strengths and limitations

Study delimitations

The participants of this study included only pediatric residents from three training programs in Canada. The choice of programs was a convenience sampling based on the location of the principal investigator and of colleagues able to act as site investigators.

Study strengths

The nutrition curriculum was developed, and administered as in-person teaching sessions and online learning modules by the same instructor. This ensured consistency of content across intervention groups. Assessment tools were developed in a rigorous fashion, ensuring content and face validity. Minimum performance levels for all exams were set by three independent raters to remove exam difficulty as a potential confounder.

Study limitations

The primary limitation was a relatively small sample size in the UBC and Dalhousie groups. The goal had been to recruit 30 participants from each site, however this goal was not reached. There was also a significant attrition rate in both of these sites. Participation in the study was entirely voluntary and no study component was considered mandatory within the included training programs. However, scheduling factors may have influenced the variable attrition rate across groups. The lower attrition rate at the University of Calgary site likely reflected the scheduling of study teaching and testing sessions within the regular academic half day (those not participating in the study were excused during testing). This schedule made it more convenient for participants to continue with their participation. Participants at UBC and Dalhousie required more personal motivation to take part in the online learning modules and tests (for UBC) and testing outside of the academic half day (for Dalhousie). This may also have introduced an attrition bias, as more intrinsically motivated participants remained active in the study for all components. This may have had an impact on observed test scores.

Another significant limitation was introduced by a procedural error whereby the Dalhousie group completed the wrong baseline examination. This precluded assessing baseline nutrition knowledge in comparison to the other groups. The post-test scores in this group were very similar to the baseline scores in the other groups, however. As the Dalhousie group received no instruction during the intervention period, the post-

test scores may be seen as an effective pre-test, and might be expected to be similar to the other “untaught” groups.

A further potential limitation involved the timing of the delayed post-test. The choice of a two month delay was influenced by a desire to complete all study components within one academic year at all three sites. A longer delay period may have resulted in a different report of knowledge retention.

Future directions

The findings of the present study suggest that online learning modules can be effective for teaching residents in an asynchronous and distributed manner. The voluntary nature of the research study may have contributed to the significant attrition rate observed. Inclusion of online learning as a mandatory component of the postgraduate curriculum would be expected to resolve this issue. With evidence of efficacy and acceptability, program directors may choose to make such learning modules a mandatory component of the formal postgraduate curriculum. Coupled with opportunities for testing, this may produce demonstrable improvement in the nutrition knowledge of postgraduate trainees, and therefore future practitioners.

CHAPTER 6: CONCLUSIONS

Nutrition coverage in pediatric residency programs in Canada remains quite limited, despite the importance of nutrition to health and disease. This is associated with pediatric residents who have deficiencies in their nutrition-related knowledge base by both self-report and objective testing. Important barriers to increasing nutrition coverage in residency programs include time constraints, competing curricular demands and availability of expert faculty. Despite these barriers, most programs have made efforts to increase nutrition coverage based on resident requests.

A focussed time-limited nutrition curriculum was shown to be effective in improving nutrition knowledge in study participants that was maintained on delayed repeat testing. This curriculum was equally as effective when delivered through online learning modules as compared to traditional in-person instruction. As online learning modules may be completed in an asynchronous and distributed manner, it is our opinion that they represent an effective curricular tool for postgraduate program directors to improve nutrition knowledge amongst trainees while circumventing longstanding barriers. This statement can also be applied to a wide variety of critical curricular content where limitations of scheduling or available faculty may impact learning in training programs. The use of online learning modules should therefore be further developed across training programs to complement in-person teaching sessions, providing improvements in formal curricular coverage.

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APPENDIX A: CONSENT FORM

STUDY PARTICIPATION CONSENT FORM

TITLE: Effect of traditional and online educational interventions on nutrition knowledge acquisition and retention in pediatric residents.

SPONSOR: Canadian Association of Gastroenterology

INVESTIGATORS:

Principal Investigator:	Dr. Maitreyi Raman
Co-Investigators:	Dr. Jason Silverman Dr. Sylvain Coderre
Site investigators:	Dr. Linda Casey Dr. Sarah Manos
Contact information:	Phone: (403) 592-5020 Fax: (403) 592-5090 email: mkothand@ucalgary.ca

This consent form is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Take the time to read this carefully and to understand any accompanying information. You will receive a copy of this form.

BACKGROUND

Nutrition management and counselling is an essential competency of a physician's practice. Physicians play a critical role in raising awareness of the importance of optimal nutrition in individuals and populations through advocacy and public health initiatives. Despite its importance, nutrition instruction remains limited in most undergraduate medical training programs. Limited available lecture time given the breadth of other topics to cover is often pointed to as a factor leading to the deficiency in nutrition education in both undergraduate and postgraduate medical training.

It is unclear if informal learning obtained through direct practical experience is sufficient to obtain an adequate knowledge base in this vital area in the absence of sufficient targeted nutrition teaching. While important in many areas of medicine, nutrition knowledge and interventions are central to the care of all children in both hospital and community settings. Unfortunately, there is no published data on the adequacy of nutrition knowledge or training in

pediatric residents. There is clearly a need to better assess the current state of nutrition knowledge of pediatric residents, as well as to assess different teaching strategies to target identified knowledge gaps.

Web-based interactive learning modules may provide several advantages over in-person teaching sessions that may be either didactic or interactive in nature. Only a finite number of in-person teaching sessions are possible within a busy training program, and trainees may be absent for a number of these during their training. Web-based teaching modules may be completed whenever the trainees have time, and may stimulate further self-study. To our knowledge, no studies have directly compared these methods to traditional in-person lessons for advancing nutrition knowledge amongst pediatric trainees.

The present study will involve participants from pediatric residency training programs in three centres in Canada: The University of Calgary, The University of British Columbia and Dalhousie University. We hope to have approximately 30 residents participating at each centre. Participants at the University of Calgary will receive four in-person instructional sessions in nutrition. Participants at the University of British Columbia will be asked to complete four web-based learning modules covering the same material. Participants at Dalhousie University will receive no specific intervention. The aim will be to compare learning outcomes and participant self-reported confidence in nutrition knowledge and practices across study locations.

WHAT IS THE PURPOSE OF THE STUDY?

To assess and compare knowledge acquisition, retention and perceived confidence in nutrition assessment and counselling between groups of residents who receive different nutrition education interventions

WHAT WOULD I HAVE TO DO?

If you participate in the study, regardless of your location, you will complete three MCQ-based tests of your nutrition knowledge administered in parallel across study locations, at three different time points. You will also complete two short surveys (at the start, and end of the study period) covering your perceived knowledge and confidence in nutritional assessment and counselling, as well as some details about other ways in which you learned about nutrition during the study period.

If you are currently training at the University of Calgary, you will attend four instructional sessions during your regularly scheduled academic half day. If you are currently training at the University of British Columbia, you will complete four web-based learning modules covering the same nutrition content. If you are currently training at Dalhousie University, you will continue with your current training program with no alterations.

WHAT ARE THE RISKS?

There are no anticipated risks to participants.

WILL I BENEFIT IF I TAKE PART?

If you agree to participate in this study there may or may not be a direct benefit to you. As a participant, you will confidentially receive your test scores. This information, and your exposure to these test questions may provide guidance for self-study in the area of nutrition. If you receive an educational intervention, you may benefit through increased content area knowledge and/or confidence in nutrition assessment and counselling. The information we get from this study may help pediatric training programs to provide better nutrition education in the future for pediatric trainees.

DO I HAVE TO PARTICIPATE?

Participation in this study is voluntary. You may choose to participate and complete the tests and surveys as described above. You may also choose not to participate at all. If you consent to participate in the study, you may withdraw from the study at any point by contacting the principal investigator using the contact information above. This will have no effect on your residency training. Resident evaluations in your program are completely independent of this study and will not be impacted in any way by choosing either to participate or not participate in the present study.

You may be withdrawn from the study by the researchers if you are unable to complete the necessary evaluations during the study period.

WHAT ELSE DOES MY PARTICIPATION INVOLVE?

There are no other expectations for your participation in this study.

WILL I BE PAID FOR PARTICIPATING, OR DO I HAVE TO PAY FOR ANYTHING?

Participants in the study will receive a gift card valued at $40 upon completion of all study components. Participants will not incur any costs related to their participation.

WILL MY RECORDS BE KEPT PRIVATE?

Only the investigators will have access to test and survey information collected. The survey and test documents will carry only a study identification number personalized for each participant. The participant list with assigned identification numbers will be kept in an encrypted digital file. No personal information of any kind will be disclosed. Only aggregate (and therefore anonymous) data will be shared with participating program directors after study completion.

SIGNATURES

Your signature on this form indicates that you have understood to your satisfaction the information regarding your participation in the research project and agree to participate as a

participant. In no way does this waive your legal rights nor release the investigators or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time without jeopardizing your residency training. If you have further questions concerning matters related to this research, please contact:

Dr. Jason Silverman at jason.silverman@albertahealthservices.ca

If you have any questions concerning your rights as a possible participant in this research, please contact the Chair, Conjoint Health Research Ethics Board, University of Calgary at 403-220-7990.

Participant's Name	Signature and Date
Investigator/Delegate's Name	Signature and Date
Witness' Name	Signature and Date

The University of Calgary Conjoint Health Research Ethics Board has approved this research study.

A signed copy of this consent form has been given to you to keep for your records and reference.

APPENDIX B: PROGRAM DIRECTOR SURVEY

Thank you for agreeing to take the following **brief** survey regarding nutrition education within your training program. This will take only 5-10 minutes to complete.

1. Name of training program:

2. How many core pediatric residents are currently in your program?

3. Do you have a set curriculum of formal teaching sessions to cover during your structured "academic half-day" teaching times?
   - ❑ Yes
   - ❑ No
   - ❑ We do not have dedicated academic half-days

4. What is the duration of your full academic half-day curriculum?
   - ❑ We do not have a set curriculum
   - ❑ We have a set curriculum which is completed each year
   - ❑ Our curriculum is completed every two years
   - ❑ Our curriculum is completed every three years
   - ❑ Other, please specify:

5. How many hours of formal nutrition teaching (didactic or interactive) do the residents take part in during one full academic half-day curricular cycle? If you do not have a set curriculum, please provide the number of hours in one year.

6. In each year, how many hours of formal group teaching in nutrition takes place as part of the core pediatric program outside of the academic half-day curriculum?

7. Who provides formal teaching in nutrition-related topics to your residents (check all that apply)
   - ❑ We have no formal nutrition-related teaching
   - ❑ Physician(s)

- ❑ Registered dietitians
- ❑ Other health professional (please specify)

8. The following is a list of nutrition-related learning objectives as set out in the Royal College of Physicians and Surgeons Learning Objectives of Training in Pediatrics. For each, please state whether your residents cover these objectives through formal teaching sessions, through clinical exposure or not at all. Please choose all applicable answers.

Learning objective	Formal teaching	Clinical exposure	Not covered
Recommended nutritional requirements	☐	☐	☐
Effect of disease states on nutritional requirements	☐	☐	☐
Breast feeding and infant feeding	☐	☐	☐
Health implications of restricted diets, fad diets, diets determined by custom or socioeconomic situation	☐	☐	☐
Indications for, physiologic basis of and complications of parenteral and enteral nutrition	☐	☐	☐
Nutritional assessment	☐	☐	☐
Failure to thrive	☐	☐	☐
Obesity	☐	☐	☐
Nutritional deficiencies and excess	☐	☐	☐
Feeding disorders	☐	☐	☐
Role of nutritional support in critical care	☐	☐	☐
Neonatal growth, nutrition, metabolic problems, feeding problems	☐	☐	☐
Skill: Prescribe and manage parenteral and enteral nutrition	☐	☐	☐
Skill: Counselling for healthy active living (healthy eating and physical activity)	☐	☐	☐

9. Has your program made any changes to the number of hours of formal teaching covering nutrition-related topics in the past 5 years?
   - ❑ No, there have been no changes
   - ❑ Yes, the number of hours covering nutrition topics has decreased
   - ❑ Yes, the number of hours covering nutrition topics has increased

10. If you indicated that you made a change, what were your reasons?

11. What do you see as barriers to increasing the number of nutrition-related teaching hours in your program?
    - ❏ Not enough/no available time in academic half-day curriculum
    - ❏ Lower priority than other content areas
    - ❏ Lack of faculty interested in providing nutrition education
    - ❏ Lack of nutrition experts to provide teaching
    - ❏ I do not see a need to increase nutrition-related teaching in my program
    - ❏ Other, please specify

Thank you very much for taking the time to complete this survey. If you have any additional comments you would like to make, please enter them below.

APPENDIX C: PARTICIPANT PRE-INTERVENTION SURVEY

1. Participant ID number:

2. What year of training are you currently in?
   - ❑ PGY1
   - ❑ PGY2
   - ❑ PGY3
   - ❑ PGY4

3. Did you have formal nutrition education prior to medical school?
   - ❑ Yes
   - ❑ No

4. Did you have formal nutrition lectures, seminars or rotations during medical school?
   - ❑ Yes
   - ❑ No (skip to Question 6)

5. If you answered "Yes" to question 4, how many hours of nutrition education did you have?
   - ❑ <2
   - ❑ 2-3.9
   - ❑ 4-5.9
   - ❑ 6-7.9
   - ❑ ≥ 8

6. Have you received formal nutrition lectures, seminars or rotations during your residency to date?
   - ❑ Yes
   - ❑ No (skip to Question 8)

7. If you answered "Yes" to question 6, how many hours of nutrition education did you have?
   - ❑ <2
   - ❑ 2-3.9
   - ❑ 4-5.9
   - ❑ 6-7.9
   - ❑ ≥ 8

8. The following is a list of nutrition-related knowledge and skills. Please answer with your level of agreement with the following statement:

"I feel that my knowledge and/or skill in the following area is at a satisfactory level"
1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree

Nutrition area	1	2	3	4	5
Recommended nutritional requirements	☐	☐	☐	☐	☐
Effect of disease states on nutritional requirements	☐	☐	☐	☐	☐
Breast feeding and infant feeding	☐	☐	☐	☐	☐
Health implications of restricted diets, fad diets, diets determined by custom or socioeconomic situation	☐	☐	☐	☐	☐
Indications for, physiologic basis of and complications of parenteral and enteral nutrition	☐	☐	☐	☐	☐
Nutritional assessment	☐	☐	☐	☐	☐
Failure to thrive	☐	☐	☐	☐	☐
Obesity	☐	☐	☐	☐	☐
Nutritional deficiencies and excess	☐	☐	☐	☐	☐
Feeding disorders	☐	☐	☐	☐	☐
Role of nutritional support in critical care	☐	☐	☐	☐	☐
Neonatal growth, nutrition, metabolic problems, feeding problems	☐	☐	☐	☐	☐
Skill: Prescribe and manage parenteral and enteral nutrition	☐	☐	☐	☐	☐
Skill: Counselling for healthy active living (healthy eating and physical activity)	☐	☐	☐	☐	☐

9. The following is a list of nutrition-related knowledge and skills. Please answer with your level of agreement with the following statement:
"I would be interested in learning more about the following area"
1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree

Nutrition area	1	2	3	4	5
Recommended nutritional requirements	☐	☐	☐	☐	☐
Effect of disease states on nutritional requirements	☐	☐	☐	☐	☐
Breast feeding and infant feeding	☐	☐	☐	☐	☐
Health implications of restricted diets, fad diets, diets determined by custom or socioeconomic situation	☐	☐	☐	☐	☐
Indications for, physiologic basis of and complications of parenteral and enteral nutrition	☐	☐	☐	☐	☐
Nutritional assessment	☐	☐	☐	☐	☐
Failure to thrive	☐	☐	☐	☐	☐

Nutrition area	1	2	3	4	5
Obesity	☐	☐	☐	☐	☐
Nutritional deficiencies and excess	☐	☐	☐	☐	☐
Feeding disorders	☐	☐	☐	☐	☐
Role of nutritional support in critical care	☐	☐	☐	☐	☐
Neonatal growth, nutrition, metabolic problems, feeding problems	☐	☐	☐	☐	☐
Skill: Prescribe and manage parenteral and enteral nutrition	☐	☐	☐	☐	☐
Skill: Counselling for healthy active living (healthy eating and physical activity)	☐	☐	☐	☐	☐

Thank you very much for taking the time to complete this survey. If you have any additional comments you would like to make, please enter them below.

APPENDIX D: PARTICIPANT POST-INTERVENTION SURVEY

1. Participant ID number:

2. During the past month, have you received formal nutrition lectures?
   - ❑ Yes
   - ❑ No (skip to Question 5)

3. If you answered "Yes" to question 2, how many hours of nutrition education did you have?
   - ❑ <2
   - ❑ 2-3.9
   - ❑ 4-5.9
   - ❑ 6-7.9
   - ❑ ≥ 8

4. The following is a list of statements regarding the formal nutrition lectures you attended. Please answer with your level of agreement with each statement:
   1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree

Nutrition area	1	2	3	4	5
The sessions were informative	□	□	□	□	□
The sessions were useful	□	□	□	□	□
The level of detail included was adequate	□	□	□	□	□
The sessions answered questions I had about nutrition-related topics	□	□	□	□	□
The sessions prompted me to do further reading/study in nutrition	□	□	□	□	□
These sessions should be a permanent part of our curriculum	□	□	□	□	□

5. In the past month, have you participated in web-based nutrition education?
   - ❑ Yes
   - ❑ No (skip to Question 8)

6. If you answered "Yes" to question 6, how many hours did you spend on web-based nutrition education?
   - ❑ <2
   - ❑ 2-3.9
   - ❑ 4-5.9
   - ❑ 6-7.9
   - ❑ ≥ 8

7. The following is a list of statements regarding the web-based nutrition education you completed. Please answer with your level of agreement with each statement:
   1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree

Nutrition area	1	2	3	4	5
The web-based learning modules were informative	☐	☐	☐	☐	☐
The web-based learning modules were useful	☐	☐	☐	☐	☐
The level of detail included was adequate	☐	☐	☐	☐	☐
The web-based learning modules answered questions I had about nutrition-related topics	☐	☐	☐	☐	☐
The web-based learning modules prompted me to do further reading/study in nutrition	☐	☐	☐	☐	☐
These learning modules should be a permanent part of our curriculum	☐	☐	☐	☐	☐
The web-based learning system was easy to use	☐	☐	☐	☐	☐
I enjoyed learning using the web-based learning modules	☐	☐	☐	☐	☐
The web-based learning modules took a reasonable amount of time to complete	☐	☐	☐	☐	☐
I would like to have access to similar web-based learning modules for other topic areas	☐	☐	☐	☐	☐
Completing the web-based learning modules felt like “extra work”	☐	☐	☐	☐	☐
I would prefer to learn about these topics through self-directed study	☐	☐	☐	☐	☐

8. In the past month, have you spent any time in self-directed study on nutrition-related topics?
   - ❑ Yes
   - ❑ No (skip to Question 10)

9. If you answered “Yes” to question 6, how many hours did you spend on nutrition-related self-directed study?
   - ❑ <2
   - ❑ 2-3.9
   - ❑ 4-5.9
   - ❑ 6-7.9
   - ❑ ≥ 8

10. The following is a list of nutrition-related knowledge and skills. Please answer with your level of agreement with the following statement:
    “I feel that my knowledge and/or skill in the following area is at a satisfactory level”
    1 = Strongly agree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly disagree

Nutrition area	1	2	3	4	5
Recommended nutritional requirements	☐	☐	☐	☐	☐
Effect of disease states on nutritional requirements	☐	☐	☐	☐	☐
Breast feeding and infant feeding	☐	☐	☐	☐	☐
Health implications of restricted diets, fad diets, diets determined by custom or socioeconomic situation	☐	☐	☐	☐	☐
Indications for, physiologic basis of and complications of parenteral and enteral nutrition	☐	☐	☐	☐	☐
Nutritional assessment	☐	☐	☐	☐	☐
Failure to thrive	☐	☐	☐	☐	☐
Obesity	☐	☐	☐	☐	☐
Nutritional deficiencies and excess	☐	☐	☐	☐	☐
Feeding disorders	☐	☐	☐	☐	☐
Role of nutritional support in critical care	☐	☐	☐	☐	☐
Neonatal growth, nutrition, metabolic problems, feeding problems	☐	☐	☐	☐	☐
Skill: Prescribe and manage parenteral and enteral nutrition	☐	☐	☐	☐	☐
Skill: Counselling for healthy active living (healthy eating and physical activity)	☐	☐	☐	☐	☐

Thank you very much for taking the time to complete this survey. If you have any additional comments you would like to make, please enter them below.

APPENDIX E: PRE-TEST

Nutrition pre-test

Participant ID:

For each question below, please select the one BEST answer.

1. A Canadian-born 3 year old boy of Nigerian descent, Tyler, presents for an annual check up. Three months ago, the entire family had a brief illness including vomiting and diarrhea. All recovered spontaneously, however following this, Tyler continued to have episodes of diarrhea despite remaining well. Because of this, his mother has attempted an elimination diet removing dairy, wheat and soy from Tyler's diet with subsequent resolution of his diarrhea. Tyler continues on this diet. Before this illness, Tyler had been entirely well.

   Which of the following conditions is most likely to occur?

   A. Rickets
   B. Low serum vitamin D
   C. Hypocalcemia
   D. Hypoalbuminemia
   E. Low serum carotene

2. You are seeing a 14-year-old boy for a periodic health exam, who is healthy, but has started a vegan diet. When taking a diet history you are concerned that intake the following nutritional component may be inadequate:

   A. Fibre
   B. Folic acid
   C. Vitamin A
   D. Vitamin B12
   E. Vitamin C

3. You are seeing a 2-year old female for a routine check-up. Her mother tells you that her daughter was 3.5 kg at birth, and gained 6 kg over her first year of life. In the past year, however, she has only gained 3 kg. What is the most appropriate management plan at this point? (A blank growth chart is provided below for your use)

    A. Refer to a gastroenterologist for evaluation.
    B. **Reassure the mother that this is normal growth.**
    C. Refer to a dietitian for assessment.
    D. Monitor the child with weekly weights.
    E. Ask mom to provide nutritional supplementation.

WHO GROWTH CHARTS FOR CANADA

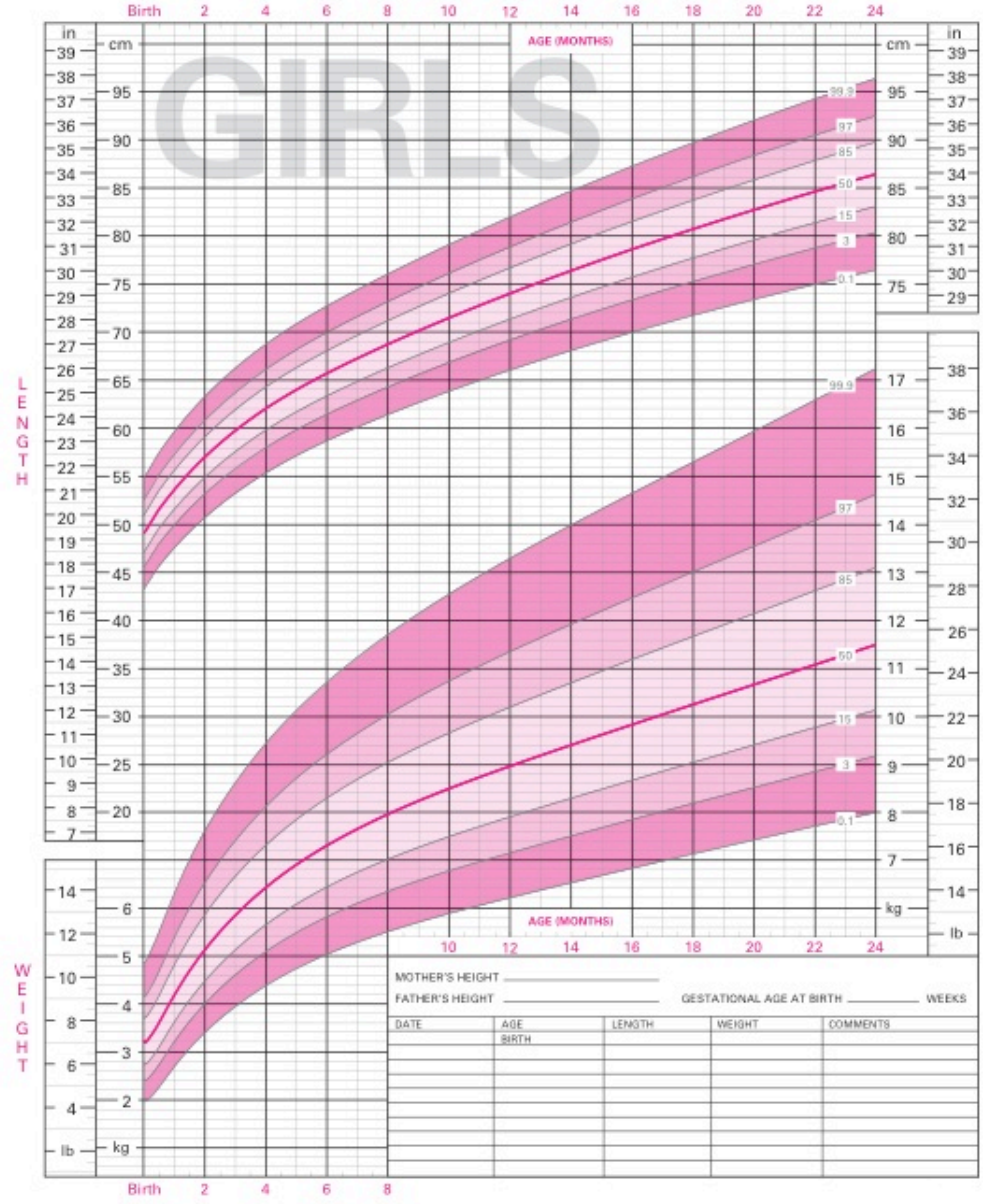
GIRLS

BIRTH TO 24 MONTHS: GIRLS

Length-for-age and Weight-for-age percentiles

NAME: _____

DOB: _____ RECORD # _____



SOURCE: Based on the World Health Organization (WHO) Child Growth Standards (2006) and adapted for Canada by Dietitians of Canada, Canadian Paediatric Society, the College of Family Physicians of Canada and Community Health Nurses of Canada.

www.dietitians.ca/growthcharts

4. You are seeing a 6-month-old infant for a routine follow-up visit. You have calculated the infant's average weight gain over the past two months. Which of the following average weight gain amounts would fall within the expected (normal) range?

    A. 60 grams per week
    B. 75 grams per week
    C. 90 grams per week
    D. 120 grams per week
    E. 150 grams per week

5. Which of the following isolated findings would suggest that a child is at risk for failure to thrive?

    A. Weight crossing one percentile line on growth chart
    B. Weight less than 25th percentile for age
    C. BMI less than 3rd percentile for age
    D. Weight for length less than 10th percentile for age
    E. Head circumference less than 5th percentile for age

6. The most common cause of growth failure in children is

    A. Malabsorption due to an underlying intestinal or pancreatic disorder.
    B. Anorexia due to chronic disease.
    C. Chronic or recurrent infections.
    D. Inadequate intake in an otherwise healthy child.
    E. Increased losses due to vomiting or gastroesophageal reflux.

7. You have been following Billy, age 3, closely for poor growth and weight gain for the past 3 months. Physical exam is normal apart from his thin appearance and low growth parameters. His weight is below the 3rd percentile; height is at the 10th percentile. Baseline investigations including CBC, electrolytes, creatinine, total protein and albumin, ESR, CRP, liver enzymes, immunoglobulins, TSH, urinalysis and a celiac screen have all been normal. Billy and his mother have met with a dietitian, and his mother reports adding extra fat to his foods and a daily nutritional supplement as suggested. Despite this, he has failed to gain any weight during your follow-up. Which of the following measures will be most likely to provide an explanation for Billy's growth pattern?

    A. Morning cortisol level
    B. Referral to a pediatric gastroenterologist for endoscopic evaluation
    C. Abdominal ultrasound
    D. Admission to hospital for feeding and weight observation
    E. MRI brain

8. Historically (on CDC growth charts), when has it been considered acceptable for a child to cross downward more than one major percentile in height? Choose the best answer:

    A. Only during the first 1 year of life
    B. Only from 2 to 3 years of age
    C. It is never acceptable to cross downward more than one percentile
    D. Anytime before the onset of puberty
    E. Only after the pubertal growth spurt

9. A mother and father ask to speak with you about their 5-year-old son. They tell you that his school's public health nurse informed them that their son was overweight. Which of the following factors most strongly increases the risk of obese children becoming obese adults?

    A. Caucasian race
    B. Overweight before age 2
    C. Parental obesity
    D. Parental smoking
    E. Female sex

10. A medical student is working in your office and sees a 2-year-old male patient. She has taken several measurements and wonders whether the child may be obese. You tell her the best measurement of obesity in children 2 years of age is:

    A. Body mass index ≥ 30 kg/m^2
    B. Weight for height ≥ 95% for age and sex
    C. Body mass index ≥ 99.9% for age and sex
    D. Weight ≥ 95% for age and sex
    E. Waist to hip ratio ≥ 95% for age and sex

11. You are seeing a 9-year-old girl in your office. She was previously of normal weight and played on a recreational soccer team. One year ago, she broke her tibia and did not return to soccer. She has gained 10 kg in the last year. In counselling this patient and her parents, you would advise:

    A. A decrease in screen time.
    B. Aiming for a 2 kg weight loss target per month over the next 2 months.
    C. A high-intensity interval training program 5 days per week
    D. A 1200 kcal/day diet plan until normal weight achieved
    E. Increased fruit consumption through addition of fruit juices.

12. A 17-year-old male presents to your office for the first time. On history, he states that he has always struggled with his weight and has weighed around 100 kg for the last 3 years. Both of his parents are obese, and his mother was recently diagnosed with type 2 diabetes mellitus. His review of symptoms is unremarkable. The only finding on physical exam was darkened, thick skin in his right axilla. You decide to perform lab investigations. Which of the additional following results are you most likely to find?

    A. Normal urinalysis, elevated glycated hemoglobin, elevated fasting plasma glucose
    B. Elevated thyroid stimulating hormone, normal free T4, normal T3
    C. Elevated HDL cholesterol, normal LDL cholesterol, normal triglycerides
    D. Glucose on urinalysis, normal glycated hemoglobin, normal oral glucose tolerance test
    E. Low HDL cholesterol, normal LDL cholesterol, elevated triglycerides

13. You are seeing an obese 10-year-old female for a periodic health exam. She has been otherwise well and takes no medications. Her mother has no specific concerns. Family history reveals that her mother is overweight but otherwise well, and her father is of normal weight and is well. Her physical exam reveals abdominal obesity with striae present on her lower back and abdomen but is otherwise unremarkable. What is the next best investigation in this child's evaluation?

    A. Measure morning plasma cortisol and adrenocorticotropic hormone level
    B. Alanine aminotransferase and lipid panel
    C. Ultrasound of the abdomen including small intestine and gall bladder
    D. Fasting blood glucose and oral glucose tolerance test
    E. No investigations are necessary at this time

14. You are seeing an 11-year-old male patient for a minor viral illness and note that he meets criteria for obesity. You ask him to return for further assessment when he is feeling better. Several weeks later, the boy and his father see you in clinic, and you suggest several weight management strategies. They miss their next follow-up appointment, and you do not see them again until the patient's 12-year-old routine check up. At that time, the patient states that he has been following your advice, but you note on physical exam that he has gained 5 kg since your last appointment. What is the next best step in his management?

    A. Investigate for hormonal causes of weight gain.
    B. Reassure the patient that this is normal pubertal weight gain.
    C. Give him a handout outlining an exercise plan.
    D. Ask if the family is interested in meeting your dietitian.
    E. Discharge the patient from your practice for non-compliance.

15. You are seeing a 17-year-old female and her mother in your office to discuss the teenager's weight. The girl states that when she entered her physical parameters on an internet health website calculator, the result stated that she had severe obesity. When you address the subject, the girl begins to cry. She says she does not want to go to the gym because she's embarrassed by her appearance. She wants to lose weight, but she has not found a diet that works. She states that she is desperate and wants your help. Which of the following represents the best initial step to institute in her management over the next two weeks?

    A. Prescribe weight loss medication.
    B. Refer the patient for bariatric surgery assessment.
    C. Counsel the family to go on a diet together.
    D. Counsel the patient to start exercising for 60 minutes daily.
    E. Counsel the patient to fill half her dinner plate with vegetables.

16. Which of the following options represents historical features of the Subjective Global Nutrition Assessment?

    A. Changes in weight or appetite
    B. Sibling heights and weights
    C. Family history of eating disorder
    D. Medication use
    E. Allergy history

17. When compared to parenteral nutrition, enteral nutrition:

    A. Has a lower risk of electrolyte abnormalities
    B. Has a higher risk of refeeding syndrome
    C. Has a higher risk of liver disease
    D. Leads to worse glycemic control
    E. Is more likely to impair gut barrier function

18. Which of the following is a consequence of refeeding syndrome?

    A. Hypophosphatemia
    B. Hypermagnesemia
    C. Severe dehydration
    D. Hyperkalemia
    E. Hypercalcemia

19. A 14-year-old girl has decreased her intake of animal protein and increased her intake of foods such as whole grain breads, cereals and salads over the past 12 months. Which of the following micronutrient deficiencies is she at risk for?

    A. Chromium
    B. Selenium
    C. Folate
    D. Zinc
    E. Magnesium

20. Which of the following statements regarding macronutrient energy value is TRUE?

    A. Carbohydrates provide 9 kcal/g consumed
    B. Protein provides 2 kcal/g consumed
    C. Fat provides 7 kcal/g consumed
    D. Protein provides 4 kcal/g consumed
    E. Fat provides 12 kcal/g consumed

21. Which of the following components of energy expenditure generally accounts for the largest proportion of the 24-hour energy expenditure total?

    A. Thermic effect of food
    B. Resting energy expenditure
    C. Activity-related energy expenditure
    D. Energy of fidgeting
    E. Energy of catabolism

22. Which of the following is a clinical manifestation of thiamine (vitamin B1) deficiency?

    A. Peripheral neuropathy
    B. Alopecia
    C. Skin rash
    D. Ascites
    E. Hyperglycemia

23. In comparing the nutritional composition of human milk to standard cow milk-based formula, which of the following statements is correct?

    A. Human milk has higher lactose content, lower protein content and similar kcal/mL compared to standard formula
    B. Human milk has lower lactose content, higher protein content and lower kcal/mL compared to standard formula
    C. Human milk has lower lactose content, lower protein content and lower kcal/mL compared to standard formula
    D. Human milk is lactose-free, but has similar protein content and kcal/mL compared to standard formula
    E. Human milk has higher lactose content, lower protein content and higher kcal/mL compared to standard formula

24. Sally is a healthy 4-month-old infant. She has been exclusively breastfed since birth and has been gaining weight well. Her mother has decided to switch to formula feeding as she is returning to work early. She wants to know how much formula Sally will need to meet her requirements and continue her good growth. Assuming that Sally's mother will be using standard strength formula, you tell her:

    A. 100mL/kg/day which will provide 150kcal/kg/day
    B. 150mL/kg/day which will provide 100kcal/kg/day
    C. 100mL/kg/day which will provide 100kcal/kg/day
    D. 200mL/kg/day which will provide 130kcal/kg/day
    E. 150mL/kg/day which will provide 150kcal/kg/day

25. In which of the following scenarios would you select enteral nutrition support without parenteral nutrition?

    A. 16 year old girl with Crohn's disease-related intra-abdominal abscess due to colonic fistula
    B. 7 month old male with short bowel syndrome (25cm small bowel remaining)
    C. 12 year old female with anorexia nervosa admitted for refeeding
    D. 10 day old ex 33-week gestation male with necrotizing enterocolitis
    E. 6 year old girl with severe mucositis following bone marrow transplantation

26. Central venous access is generally preferred over peripheral lines for the administration of parenteral nutrition because:
    A. IV lipids cannot be run through a peripheral IV
    B. Maximal infusion rates can be higher in central lines
    C. Central lines are associated with a lower rate of infectious complications
    D. Osmolality of IV solutions must be limited in peripheral lines, limiting calories and protein
    E. Intravenous multivitamins cannot be run through a peripheral IV

27. Which of the following statements is true regarding the introduction of solids in infants?
    A. Introduction of solids should be delayed until 6 months to avoid the development of food allergies
    B. First foods should be iron-rich, including meats and fortified cereals
    C. Fish should be avoided for the first year of life
    D. New foods should be introduced daily to provide variety
    E. Infants with poor head control should still start solids at 6 months

28. Which of the following statements is true regarding the Healthy Active Living Guidelines for children:
    A. No specific recommendations are made for children under 5 years
    B. Children 5 years and older should do at least 1 hour of moderate to vigorous intensity activity 5 days/week
    C. Children less than 2 years should be limited to 2 hours of screen time per day
    D. Children 1-4 years of age should do 30 minutes of vigorous exercise per day
    E. Screen time for school-age children should be limited to 4 hours per day

29. Which of the following statements is true regarding enteral nutrition formulas:
    A. For most children, oligomeric formulas are preferred due to improved absorption
    B. Lactose is the primary carbohydrate source in elemental formulas
    C. Standard strength formulas are 0.67kcal/mL for infants and 1.0kcal/mL for older children
    D. Formula osmolality is fairly consistent between formulas, varying only with formula concentration
    E. At normal feeding volumes, additional micronutrients are added to standard formulas to achieve daily reference intakes

30. A premature infant female is born with gastroschisis and associated intestinal atresias. She has undergone surgical resection of a significant amount of her small bowel. You have discussed the implications of her anatomy, and specifically discuss the need for parenteral nutrition support. Her mother asks you about the potential complications. You should tell her:
    A. Catheter occlusion due to thrombosis is an extremely rare line-related complication
    B. Infection is the most common significant line-related complication
    C. Liver dysfunction is a significant concern with short-term parenteral nutrition
    D. Hypoglycemia can be prevented by cycling parenteral nutrition
    E. Excessive protein administration can lead to a metabolic alkalosis

31. After initiating parenteral nutrition, early (first days) laboratory monitoring should include:
    A. Electrolytes, creatinine and total cholesterol
    B. CBC, total protein and zinc
    C. Electrolytes, triglycerides and BUN
    D. Glucose, vitamin D and copper
    E. ALT, GGT and selenium

32. Which of the following statements about modes of enteral nutrition delivery is true?
    A. Nasojejunal tubes allow for short term post-pyloric bolus feeds
    B. Laparoscopic placement is the preferred method of gastrostomy tube placement for long-term enteral support
    C. Gastrostomy tubes are less likely to become occluded due to their larger calibre
    D. Home enteral nutrition requires the availability of a portable infusion pump
    E. Nasogastric feeding tubes should only be used for <2 weeks to avoid erosive nasal complications

END OF TEST

APPENDIX F: POST-TEST

Nutrition post-test

Participant ID:

For each question below, please select the one BEST answer.

1. Tyler presents for an annual check up. Three months ago, the entire family had a brief illness including vomiting and diarrhea. All recovered spontaneously, except Tyler who continued to have daily diarrhea despite remaining otherwise well. Before this illness, Tyler had been entirely well.

   Which of the following nutrient deficiencies may be associated with Tyler's chronic diarrhea?

   A. Calcium
   B. Iron
   C. Zinc
   D. Vitamin C
   E. Thiamine

2. You are seeing a 12-year-old girl for a periodic health exam, who is healthy, but has started a vegan diet. When taking a diet history you are concerned that intake of the following item may be inadequate:

   A. Folic acid
   B. Vitamin C
   C. Vitamin E
   D. Magnesium
   E. Vitamin D

3. You are seeing a 2-year old female for a routine check-up. Her mother tells you that her daughter was 3.5 kg at birth, and gained 6 kg over her first year of life. In the past year, however, she has only gained 2 kg. What is the most appropriate management plan at this point? (A blank growth chart is provided below for your use)

    A. Refer to a gastroenterologist for evaluation.
    B. Reassure the mother that this is normal growth.
    C. Refer to a dietitian for assessment.
    D. Monitor the child with weekly weights.
    E. Ask mom to provide nutritional supplementation.

WHO GROWTH CHARTS FOR CANADA

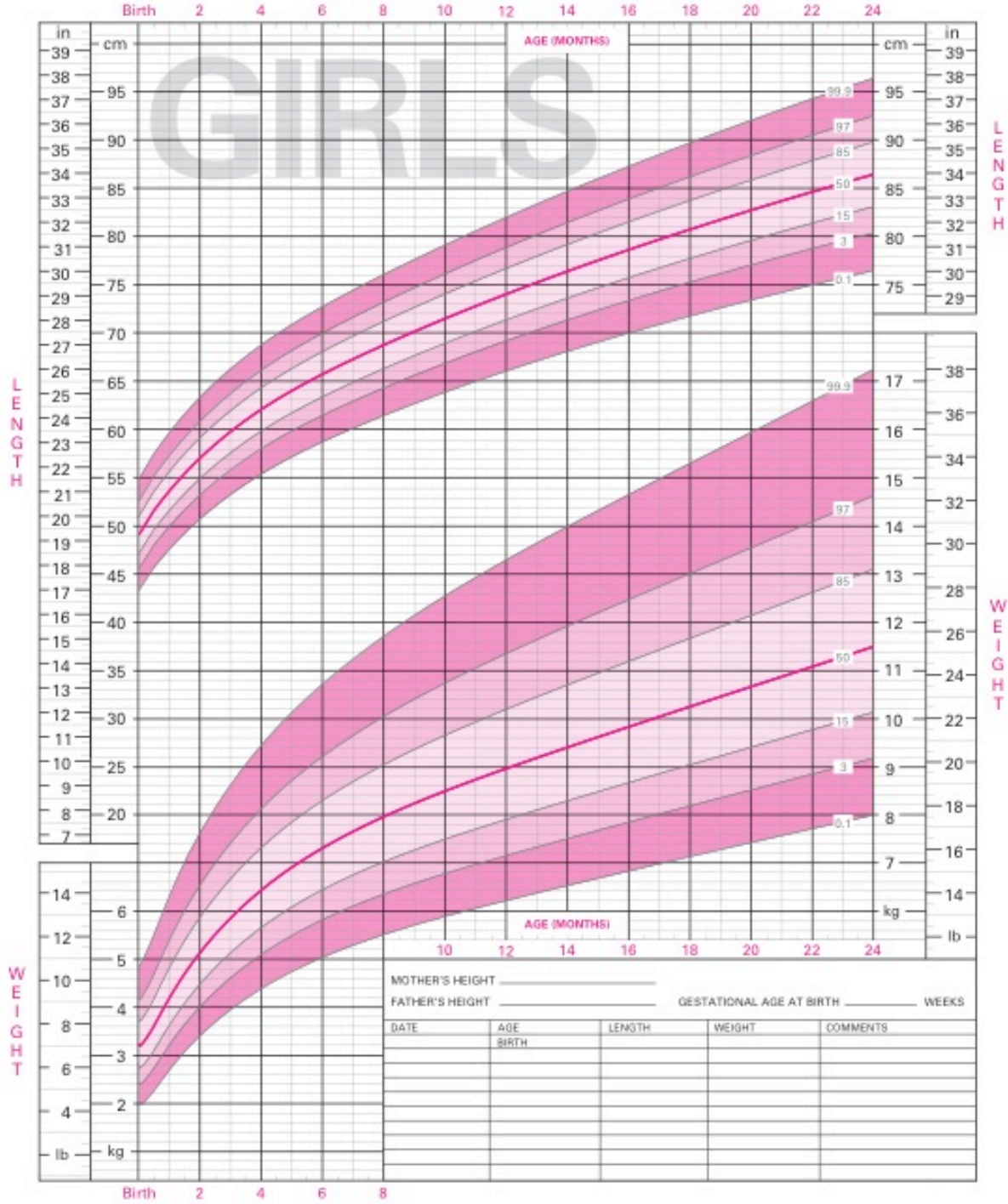
GIRLS

BIRTH TO 24 MONTHS: GIRLS

Length-for-age and Weight-for-age percentiles

NAME: _____

DOB: _____ RECORD # _____



SOURCE: Based on the World Health Organization (WHO) Child Growth Standards (2006) and adapted for Canada by Dietitians of Canada, Canadian Paediatric Society, the College of Family Physicians of Canada and Community Health Nurses of Canada.

www.dietitians.ca/growthcharts

4. You are seeing a 14-month-old child for a routine follow-up visit. You have calculated the infant's average weight gain over the past two months. Which of the following average weight gain amounts would fall within the expected (normal) range?

    A. 30 grams per week
    B. 60 grams per week
    C. 90 grams per week
    D. 120 grams per week
    E. 150 grams per week

5. Which of the following isolated findings would suggest that a child is at risk for failure to thrive?

    A. Weight crossing two percentile line on growth chart
    B. Weight less than 25th percentile for age
    C. BMI less than 25th percentile for age
    D. Weight for length less than 10th percentile for age
    E. Head circumference less than 5th percentile for age

6. The most common cause of failure to thrive in children is

    A. Pancreatic insufficiency leading to malabsorption
    B. Anorexia due to chronic kidney disease
    C. Frequent infections
    D. Poor intake in an otherwise healthy child
    E. Increased losses due to persistent emesis

7. You have been following Sarah, age 6, closely for poor growth and weight gain for the past 3 months. Physical exam is normal apart from her thin appearance and low growth parameters. Her weight is below the 3rd percentile; height is at the 10th percentile. Baseline investigations including CBC, electrolytes, creatinine, total protein and albumin, ESR, CRP, liver enzymes, immunoglobulins, TSH, urinalysis and a celiac screen have all been normal. Sarah's mother reports adding extra snacks and encouraging seconds at meals. Despite this, he has failed to gain any weight during your follow-up. Which of the following measures will be most likely to provide an explanation for Sarah's growth pattern?

    A. Fasting growth hormone level
    B. Referral to a dietitian for a diet evaluation
    C. Fecal elastase
    D. Upper endoscopy with duodenal biopsies by a gastroenterologist
    E. CT chest and abdomen

8. Historically (with CDC growth charts) when has it been acceptable for a child to cross downward more than one major percentile in height? Choose the best answer:

    A. Between 2 and 6 months of age
    B. Between 4 and 6 years of age
    C. Between 10 and 12 years of age
    D. After the pubertal growth spurt is complete
    E. It is never acceptable to cross downward more than one percentile

9. A mother and father ask to speak with you about their 6-year-old son. They tell you that his school's public health nurse informed them that their son was overweight. Which of the following factors most strongly increases the risk of obese children becoming obese adults?

    A. Caucasian race
    B. Diagnosis of obesity in adolescence
    C. Increasing activity in teenage years
    D. Female sex
    E. Breastfeeding in the first year

10. A medical student is working in your office and sees a 12-year-old male patient. She has taken several measurements and wonders whether the child may be overweight. You tell her the best measurement of overweight in children over 5 years of age is:

    A. Body mass index ≥ 30 kg/m2
    B. Weight for height ≥ 75% for age and sex
    C. Body mass index ≥ 85% for age and sex
    D. Weight ≥ 95% for age and sex
    E. Waist to hip ratio ≥ 75% for age and sex

11. You are seeing an 8-year-old girl in your office. She was previously of normal weight and played on a recreational hockey team. One year ago, she broke her femur and did not return to hockey. She has gained 12 kg in the last year. In counselling this patient and her parents, you would:

    A. Focus on increasing activity only, while maintaining current diet
    B. Set a 4 kg weight loss target per month over the next 2 months.
    C. Encourage the family to start a walking program.
    D. Avoid changing body weight and creating body image issues
    E. Maintain the current consumption of desserts and juices.

12. A 16-year-old female presents to your office for the first time. She states that she has always struggled with her weight and she has weighed around 90 kg for the last 3 years. Both of her parents are obese, and her father was recently diagnosed with type 2 diabetes mellitus. Her review of symptoms is unremarkable. The only finding on physical exam was darkened, thick skin in her axillae. You decide to perform lab investigations. Which of the additional following results are you most likely to find?

    A. Normal urinalysis, normal TSH, abnormal oral glucose tolerance test
    B. Elevated thyroid stimulating hormone, normal free T4, normal T3
    C. Elevated HDL cholesterol, normal LDL cholesterol, elevated triglycerides
    D. Glucosuria, elevated glycated hemoglobin, normal fasting glucose
    E. Low HDL cholesterol, elevated LDL cholesterol, elevated triglycerides

13. You are seeing a severely obese 14-year-old male for a periodic health exam. He has been otherwise well and takes no medications. His mother has no specific concerns. Family history reveals that his mother is obese, and has Type 2 diabetes; his father is of normal weight and is well. His physical exam reveals abdominal obesity with striae present on his lower back and abdomen but is otherwise unremarkable. What is the next best investigation in this child's evaluation?

    A. Morning plasma cortisol level
    B. Fasting lipid and glucose levels
    C. Oral glucose tolerance test
    D. Urine microalbumin/creatinine ratio
    E. No investigations are necessary at this time.

14. You are seeing a 14-year-old male patient for a minor gastrointestinal illness and note that he meets criteria for obesity. You ask him to return for further assessment when he is feeling better. Several weeks later, the boy and his mother see you in clinic, and you suggest several weight management strategies. They miss their next follow-up appointment, and you do not see them again until the patient's 15-year-old routine check up. At that time, the patient states that he has been following your advice, but you note on physical exam that he has gained 5 kg since your last appointment. What is the next best step in his management?

    A. Investigate for hormonal causes of weight gain.
    B. Reassure the patient that this is normal pubertal weight gain.
    C. Give him a handout outlining a low calorie diet
    D. Ask about his mother's concerns about his weight
    E. Discharge the patient from your practice for non-compliance.

15. You are seeing a 14-year-old boy, Steven, and his mother in your office to discuss the teenager's weight. Steven states that when he entered his physical parameters on an internet health website calculator, the result stated that he had severe obesity. When you address the subject, he becomes quite upset. He says he does not want to go to the gym because he's embarrassed by his appearance. He wants to lose weight, but he has found it difficult to change what he eats. He states that he is desperate and wants your help. Which of the following represents the best initial step to institute in his management over the next two weeks?

    A. Prescribe weight loss medication.
    B. Refer him for bariatric surgery assessment.
    C. Suggest that the family start a low-calorie diet together.
    D. Suggest that he start walking for 30 minutes 3 days per week.
    E. Suggest that Steven eliminate meat from his diet.

16. Which of the following options represents historical features of the Subjective Global Nutrition Assessment?

    A. Parental dietary preferences
    B. School attendance and sports participation
    C. Family history of celiac disease
    D. Vitamin supplement usage
    E. Siblings' BMI

17. When compared to enteral nutrition, parenteral nutrition:

    A. Has a lower risk of electrolyte abnormalities
    B. Has a lower risk of refeeding syndrome
    C. Has a lower risk of fluid overload
    D. Has higher incidence of liver disease with prolonged use
    E. Has the advantage of stimulating gut barrier function

18. Which of the following is a clinical consequence of refeeding syndrome?

    A. Hyperkalemia
    B. Hypomagnesemia
    C. Acute fulminant fatty liver
    D. Hyperphosphatemia
    E. Elevated vitamin B1 levels

19. A 16-year-old girl has decreased her intake of animal protein and increased her intake of foods such as whole grain breads, cereals and salads over the past 12 months. Which of the following micronutrient deficiencies is she at risk for?

    A. Chromium
    B. Iodine
    C. Folate
    D. Iron
    E. Vitamin C

20. Which of the following statements regarding macronutrient energy value is TRUE?

    A. Carbohydrates provide 8 kcal/g consumed
    B. Protein provides 2 kcal/g consumed
    C. Fat provides 9 kcal/g consumed
    D. Protein provides 1 kcal/g consumed
    E. Carbohydrates provide 2 kcal/g consumed

21. Which of the following components of energy expenditure generally accounts for the smallest proportion of the 24-hour energy expenditure total?

    A. Thermic effect of food
    B. Resting energy expenditure
    C. Activity-related energy expenditure
    D. Energy of fidgeting
    E. Energy of catabolism

22. Which of the following is a clinical manifestation of thiamine (vitamin B1) deficiency?

    A. Confusion
    B. Alopecia
    C. Skin rash
    D. Ascites
    E. Hyperglycemia

23. In comparing the nutritional composition of cow milk-based formula to human milk, which of the following statements is correct?

    A. Cow milk-based formulas have higher lactose content, lower protein content and similar kcal/mL compared to human milk
    B. Cow milk-based formulas have lower lactose content, higher protein content and similar kcal/mL compared to human milk
    C. Cow milk-based formulas have lower lactose content, lower protein content and lower kcal/mL compared to human milk
    D. Cow milk-based formulas are lactose-free, but has similar protein content and kcal/mL compared to human milk
    E. Cow milk-based formulas have higher lactose content, lower protein content and higher kcal/mL compared to human milk

24. Sally is a healthy 4-month-old infant. She weights 6kg. She has been exclusively breastfed since birth and has been gaining weight well. Her mother has decided to switch to formula feeding as she is returning to work early. She wants to know how much formula Sally will need to meet her requirements and continue her good growth. Assuming that Sally's mother will be using standard strength formula, you tell her:

    A. 600mL per day which will provide 900 kcal per day
    B. 900mL per day which will provide 900 kcal per day
    C. 600mL per day which will provide 600 kcal per day
    D. 1200ml per day which will provide 800 kcal per day
    E. 900mL per day which will provide 600 kcal per day

25. In which of the following scenarios would you select parenteral nutrition over enteral nutrition:

    A. 16 year old girl with Crohn's disease following an ileal resection
    B. 7 year-old male admitted for a severe flare-up of ulcerative colitis
    C. 12 year old female with anorexia nervosa admitted for refeeding
    D. 16 year-old admitted with necrotic gallstone pancreatitis
    E. 6 year old girl with severe mucositis and vomiting following bone marrow transplantation

26. Central venous access is generally preferred over peripheral lines for the administration of parenteral nutrition because:

    A. IV lipids can only be run through central lines
    B. Central lines allow for infusion rates > 100mL/hr
    C. Peripheral lines are associated with a higher rate of infectious complications
    D. Osmolality of PN solutions may be higher in central lines, providing more calories and protein in reduced volumes
    E. Intravenous multivitamins cannot be run through a peripheral IV

27. Which of the following statements is true regarding the introduction of solids in infants?

    A. There is no evidence to support delayed introduction to avoid allergies
    B. First foods should be calcium-rich, including dairy and fortified cereals
    C. Nut butters should be avoided for the first year of life
    D. Two or more new foods should be introduced simultaneously for variety
    E. Infants must be able to sit unassisted before starting solids

28. Which of the following statements is true regarding the Healthy Active Living Guidelines for children:

    A. No specific recommendations are made for children under 5 years
    B. Children 5 years and older should do at least 30 minutes of moderate to vigorous intensity activity 4 days/week
    C. Children 2-4 years should be limited to < 3 hours of screen time/day
    D. Children 1-4 years of age should do at least 180 minutes of activity/day
    E. Recreational screen time for school-age children should be limited to 4 hours/day

29. Which of the following statements is true regarding enteral nutrition formulas:

    A. For most children, polymeric formulas are well-tolerated
    B. Lactose is the primary carbohydrate source in elemental formulas
    C. Standard strength formulas are 1 kcal/mL for infants and children
    D. Elemental formulas are well-suited for oral consumption
    E. At normal feeding volumes, additional long chain fatty acids are added to standard formulas to avoid essential fatty acid deficiency

30. A premature male infant underwent a significant small bowel resection due to necrotizing enterocolitis. You have discussed the implications of her anatomy, and specifically discuss the need for parenteral nutrition support. Her mother asks you about the potential complications. You should tell her:

    A. Perforation of a major vessel is a common line-related complication.
    B. Catheter occlusion is an uncommon line-related complication
    C. Liver disease is a significant concern with long-term parenteral nutrition
    D. Hyperglycemia can be prevented by cycling parenteral nutrition
    E. Excessive protein administration can lead to hyperalbuminemia

31. After initiating parenteral nutrition, early laboratory monitoring should include:

    A. Glucose, LDL and HDL
    B. Iron studies
    C. Electrolytes, glucose and BUN
    D. Vitamin A, D and E levels
    E. Zinc, copper and manganese levels

32. Which of the following statements about modes of enteral nutrition delivery is true?

    A. Bolus feeding should be avoided via nasojejunal feeding tubes
    B. Laparoscopic placement is the preferred method of gastrostomy tube placement for long-term enteral support
    C. Gastrostomy tubes are useful for short-term enteral nutrition support
    D. Home enteral nutrition requires the availability of a portable infusion pum
    E. Nasogastric feeding tubes should only be used for <2 weeks to avoid erosive nasal complications

END OF TEST

APPENDIX G: EXAMINATION BLUEPRINT

Pre-test

Module	Diagnosis	Investigation	Treatment	Basic Science/ Screening	Total# questions
Normal nutrition/nutrition assessment	16		3	4,20,21,23,24,27	**8**
Failure to thrive/nutritional deficiencies	1,2,6,19,22	7		5,8	**8**
Management of obesity	10	12,13	11,14,15	9,28	**8**
Enteral/parenteral nutrition	18	31	26,29,30,32	17,25	**8**
Total	**8**	**3**	**5**	**10**	**32**

Post-test

Module	Diagnosis	Investigation	Treatment	Basic Science/ Screening	Total# questions
Normal nutrition/nutrition assessment	16		3	4,20,21,23,24,27	**8**
Failure to thrive/nutritional deficiencies	1,2,6,19,22	7		5,8	**8**
Management of obesity	10	12,13	11,14,15	9,28	**8**
Enteral/parenteral nutrition	18	31	26,29,30,32	17,25	**8**
Total	**8**	**3**	**5**	**10**	**32**