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CHOP-International: an open access nutrition education tool for physicians, resident doctors, and medical and public health students

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Abstract Dietary diseases drive some of this century's most pressing and costly global public health challenges, ranging from malnutrition-related infectious diseases such as HIV infection to overfeeding and linked chronic diseases such as type 2 diabetes mellitus and coronary heart disease. We seek to create clinically meaningful and cost-effective education tools to help treat such conditions in a manner that is both population specific and evidence based. Tulane University School of Medicine's Goldring Center for Culinary Medicine (GCCM), a medical school-based teaching kitchen and research laboratory, utilized its novel collaboration of clinicians, registered dietitians, chefs, and culinary and medical students to create an open source international nutrition education resource comprised of region-specific recipes based upon the World Health Organization's Nutrient Intake Goals. Using staple ingredients from three sample Millennium Development Goals regions, GCCM has developed sample recipes from three continents for proof-of-principle testing. The recipes

include nutrition facts, interchangeable and optional ingredients, and salient nutrition education discussion points for students and medical professionals to use with a variety of patient conditions. Community-based participatory testing of the efficacy of this tool will allow for the refinement of the complete tool in the United States, followed by global expansion in coordination with physicians and students from Tulane University School of Public Health and Tropical Medicine in Kenya, Indonesia, and Colombia.

Keywords Sustainable nutrition development · Physician Registered Dietitian collaboration · Nutrition systems · International dietary intervention

Introduction

Over two billion people worldwide are at risk for micronutrient deficiencies and protein energy malnutrition, with the prevalence being especially high in Southeast Asia and sub-Saharan Africa [1]. Those most vulnerable to such malnutrition are pregnant mothers and children, who are at risk of restricted intrauterine growth, stunting, and wasting [2]. Child and maternal malnutrition generates significant health and economic costs related to reproductive potential, economic productivity, intellectual abilities, and susceptibility to metabolic and cardiovascular disease [3]. Two dominant micronutrient deficits linked to increased morbidity and mortality include iron and vitamin A [4]. Iron deficiency is the most widespread micronutrient deficit, with over 30 % of the world's population being affected, particularly in developing nations with prevalent infectious disease [5]. Vitamin A deficiency not only causes preventable blindness in children, but also increases the risk of

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maternal mortality and severe illness from such common infections as diarrheal disease and measles [6].

Inadequate micronutrient intake is associated with and can be worsened by undernutrition, which affects 12 % of the world's population [7]. This subgroup consuming calorie-deficient diets primarily obtains their energy from starchy staple foods such as maize, rice, potatoes, cassava, and wheat [7]. Nutritious foods including fish, dairy products, oils, legumes, fruits, and vegetables are lacking from diets characterized by undernutrition. These foods can supply healthy fats, protein, and needed micronutrients, as well as energy [7]. Such suboptimal nutrition patterns cause populations to be more susceptible to infectious diseases, particularly in developing countries, ranging from HIV to tuberculosis [8, 9]. HIV infection in the context of undernutrition poses a double nutrition insult, as greater infection-related energy demands can be coupled with low energy intake to accelerate weight loss and wasting [9].

Overnutrition diseases are more widespread than undernutrition, with nearly 1.5 billion adults being overweight or obese [10]. This number is expected to double by 2030 [10]. This rapid increase in overnutrition can be partly attributed to changing dietary habits in developing countries, shifting from high-fiber, low-fat, and low-calorie foods toward calorie-dense, nutrient-poor foods [11]. Overnutrition diseases, unlike infectious disease, are associated with non-communicable diseases (NCD) and currently represent the leading cause of mortality, leading to 1 in 3 deaths in developed countries [12]. Most of these diseases are obesity associated and attributable to type 2 diabetes mellitus and coronary heart disease [11]. With 60 % of the rising global burden in NCDs anticipated to occur in developing countries [11], novel solutions are needed to improve dietary nutrition and stem the epidemic of diet-related disease.

Methods

To address such nutrition challenges at the global and local health system levels, Tulane University School of Medicine created The Goldring Center for Culinary Medicine (GCCM). The Center's three-point mission includes accelerating future physician nutrition education through integrated basic nutrition science and cooking skills, sharpening current physician education through continuing medical education (CME) units, and strengthening patient knowledge and competencies through medical student-led community nutrition and cooking classes [13–15].

Since there are little published data from international global health studies to indicate best practices for nutrition education at the population-specific level [16, 17]. GCCM utilized its culinary, medical, and nutritional expertise to

create a first-of-its-kind open source nutrition education tool and recipe database, the Cooking for Health Optimization-International (CHOP-International), comprised of region-specific recipes addressing the World Health Organization's (WHO's) Nutrient Intake Goals [18]. CHOP-International was developed in response to previous research demonstrating that a high-quality nutritious diet can be achieved by increasing the variety, nutrition content, and nutrient bioavailability of foods consumed during meals [19] and that nearly half of physicians fail to provide patients adequate nutrition education due to inadequate physician knowledge and skills [20]. CHOP-International is a two-phase open access online resource structured according to Millennium Development Goal (MDG) regions that allow local medical professionals to print and distribute one-page nutrition education tools for their patients or to direct patients to online resources. It is also designed to be a learning tool for rising medical and public health students to enhance their knowledge of dietary nutrition and to aid them when they lead GCCM community cooking classes. Recipes were created by culinary students and a professional chef with medical students and registered dietitians guiding the nutrition content. CHOP-International utilizes staple ingredients readily available to patients in specific regions of the world in a way that addresses certain health profiles to help them meet the WHO's Nutrient Intake Goals within the context of their medical professionals supporting them through ongoing nutrition education within clinical or community health visits. Resident doctors and CME physicians will test CHOP-International in clinical practice, and patient health improvement will be tracked and compared to patients cared for by GCCM trained doctors who do not use CHOP-International, as well as patients of non-GCCM trained physicians. Using patient records, health improvement will be measured longitudinally using patient HbA1c, BMI, waist-to-hip ratio, systolic blood pressure, and LDL cholesterol levels.

Results

CHOP-International Part 1: nutrition education

CHOP-International recipes are prefaced by instructor guides for medical professionals and tailored to the nutrition education needs of each MDG region's instructors and their patient populations. For example, one-page (or 30-s discussion starting points) instructor guides may target a community health worker who is educating local opinion leaders about promoting health awareness, by giving suggestions to promote iron-containing dishes for pregnant mothers. Or an instructor guide may be created for

dietitians advising rural clinic patients on nutrition strategies such as using a low-sugar diet for patients with diabetes. Another example would be of an instructor guide for physicians developing a treatment plan with hospital patients, providing a description of a low-salt diet as adjunct treatment in addition to patient medications for hypertension. Each guide utilizes key messages to assist instructors in tailoring the associated recipes for specific diseases, such as using half the amount of a meal's high-carbohydrate ingredient for patients with diabetes, for instance. In addition to these points, instructor guides outline a region's most prevalent diseases and micronutrient deficiencies, foods that can target micronutrient deficiencies, common staples in the region, and ingredients that can be substituted during preparation of the meal to allow medical professionals additional details according to their assessment of their patients' needs.

CHOP-International Part II: recipes

Three sample recipes were developed for proof-of-principle testing in representative cohorts from the respective international regions in preparation for the full CHOP-International resource that includes 36 recipes, four from each of the nine MDG regions (Caucasus and Central Asia, Northern Africa, Sub-Saharan Africa, Latin America and the Caribbean, Eastern Asia, Southern Asia, Western Asia, and Oceania). The initial three recipes to be tested with Tulane School of Public Health & Tropical Medicine global public health professionals in Africa, South America, and Asia include (1) Sub-Saharan African Goat and Root Vegetable Stew with Injera [Appendix 1], (2) Latin American and Caribbean Braised Pork Shoulder or Bean Cakes with Vegetable Rice [Appendix 2], and (3) Eastern Asian Brown Rice Stir Fry with Bok Choy, Mushroom, Eggplant, and Tofu [Appendix 3]. Each recipe contains information on ingredients, preparation notes, and related nutrition facts. Nutrition facts document the serving sizes, calories, fat, cholesterol, sodium, carbohydrates, fiber, sugar, protein, Vitamin A and C, calcium, and iron. The nutritional value of individual ingredients is listed with each recipe to enhance the educational potential of the recipes and allow experimentation with different ingredients in other recipes. Nutrient interaction was taken into account during the development of the recipes to increase bioavailability of certain nutrients. For instance, in the Bean Cakes with Vegetable Rice recipe, tomatoes and squash were included in the meal with the black beans as the vitamin C from the tomatoes and squash can increase the bioavailability of the non-heme iron from the black beans when eaten together [21]. The recipes are designed to be simplistic in terms of number of ingredients and preparation methods, as well as scalable so dishes can be made for

individuals, families, or large groups. Recipes additionally allow optional ingredients for patients who may not have access to or cannot afford certain foods, since the main ingredients are chosen based on the most widely available and affordable staple foods in a given geographic area.

Discussion

The Goldring Center for Culinary Medicine at Tulane University School of Medicine has created the first-of-its-kind open source international nutrition education tool based on WHO nutrition guidelines. CHOP-International will help to enhance the patient-physician relationship by providing physicians dietary discussion starting points to ensure there is a sufficient conversation with the patient on dietary habits and instructor guides that ensure salient dietary information is passed from the physician to the patient. As well, CHOP-International provides recipes that allow patients to apply the knowledge they have learned from their physician at home.

The initial community-based participatory testing phase of CHOP-International will be tested in the local community of New Orleans by physicians and resident doctors at partner hospitals who will target underserved minority groups from representative MDG regions (Sub-Saharan Africa, Eastern Asia, and Latin America and the Caribbean). Local medical professionals will provide key community feedback from patient cohorts for CHOP-International and the remaining 33 recipes. Biometric data (including BMI, waist and hip circumference, blood pressure, and current medications) as well as instructor usability will be monitored as part of a global database for ongoing biometric, competency, and attitude monitoring of patient populations with this nutrition intervention.

After measuring CHOP-International efficacy in the local community, testing will be expanded globally to include students and physicians working abroad in Kenya, Indonesia, and Columbia as part of the Tulane University School of Public Health and Tropical Medicine. Sustainability will be achieved through a social entrepreneurial model in which global public health students and professionals will send their participant data back for GCCM CHOP-International developers and will encourage local food industry representatives to upload their own recipes to the CHOP-International database for GCCM researchers to optimize the nutrition quality through an open source online platform. CHOP-International will serve as a nutrition education tool for patients and a marketing tool for local food industry personnel who can use their selected recipes as advertisement for their own restaurants or food-distributing entities. Multi-center, international randomized trials are needed to test the efficacy and cost effectiveness

of this tool to improve patient population's health, nutrition competencies, attitudes, and dietary habits. The development of this cost-efficient nutrition tool may serve not only as a powerful source of health improvement in resource-poor regions throughout the globe, but also as a bridge between public health, nutrition, and medical professionals to address some of the twenty-first century's most urgent global health challenges.

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1: Sub-Saharan Africa: Goat & Root Vegetable Stew with Injera (4 Servings based on WHO nutrition guidelines)

Ingredients

For the stew:

22 mL	Palm oil
227 gm	Goat meat, medium cubes (optional)
2 each	Tomato, large, chopped
1 large	Yam, sweet potato, taro root, squash, or pumpkin, chopped
178 gm	Black-eyed peas (increase to 357 gm if omitting goat)
1 L	Water or stock (vegetable, chicken, beef, or other meat)
1 bunch	Taro, baobab, pumpkin, or rosella leaves, or collard greens, rough chop or hand-torn (approx. 340 gm)

For the Injera:

*Begin at least 1 day early

22 mL	Palm oil
187 gm	Teff, flour (ground)
½ L	Water
36 gm	Salt

Preparation

1. One day ahead, mix teff flour with water in a large bowl; cover with a damp towel and let stand at room temperature at least overnight (up to 3 days ahead for a stronger flavor).
2. Heat a large pot with palm oil over high heat. Add goat cubes and brown on all sides (skip this step if no goat meat).
3. Remove meat from pot.
4. In same pot over medium heat, briefly brown tomato, yam, and peas

5. Add water to pot.
6. Add beef into pot.
7. Cook over low heat for about 30 min.
8. Add in taro leaves, and continue to cook for another 30 min, or until beef and vegetables are tender and sauce is thickened.
9. Stir salt into injera batter before cooking.
10. Heat a large pan with palm oil over medium-high heat. Pour in enough batter to cover bottom and move around until the bottom is evenly coated.
11. Remove flatbread when small holes appear in the top and edges lift away from pan.
12. Serve stew on top of injera.

Additional notes

- Use animal fat for vegetable oil, if easier.
- Stew may also be done in a kettle over an open fire, or in a pot on top of a grill, without changing method of preparation.
- Spices, if available, should be used. Turmeric, cumin, cinnamon, chili pepper, and curry are good ideas; they will add lots of flavor and some body to the final product.
- Tomato juice or paste will help flavor the water or stock and help thicken the stew.
- Using taro or cassava instead of yam will lower the vitamin A levels a lot.

Nutrition facts for meal with goat:

Serving Size	453 g (16Oz)
Servings	4
Calories	600
Calories from fat	130
Total Fat	14 g
Saturated Fat	6 g
Trans Fat	0 g
Monounsaturated Fat	4.5 g
Cholesterol	45 mg
Sodium	200 mg
Total Carbohydrates	89 g
Dietary Fiber	13 g
Sugars	6 g
Protein	32 g
Vitamin A	50 %
Calcium	6 %
Vitamin C	80 %
Iron	20 %

Nutrition facts for meal without goat (extra peas):

Serving size	453 g (16Oz)
Servings	4

Calories	540
Calories from Fat	110
Total Fat	12 g
Saturated Fat	5 g
Trans Fat	0 g
Monounsaturated Fat	4 g
Cholesterol	0 mg
Sodium	270 mg
Total carbohydrates	95 g
Dietary fiber	15 g
Sugars	8 g
Protein	18 g
Vitamin A	50 %
Calcium	6 %
Vitamin C	80 %
Iron	8 %

Nutritional value of individual ingredients:

Palm oil	High in fats, increases uptake of vitamins D, E, A, K
Goat meat	High in protein, iron, and vitamin B12
Tomatoes	High in vitamin A and vitamin C
Yams	High in dietary fiber, vitamin C, and vitamin B6
Black-eyed peas	High in folate, protein
Taro	High in vitamin A and vitamin B6

Appendix 2: Latin America and the Caribbean: Braised Pork Shoulder or bean cakes with vegetable rice (4 servings based on WHO nutrition guidelines)

Ingredients

For the pork shoulder:

30 mL	Vegetable oil (preferably canola)
1 kg	Lean pork roast
1 L	Stock, vegetable or other (chicken, beef, fish, etc.)

OR

For the bean cakes:

453 gm	Cooked black beans
1 each	Egg
51 gm	Masa harina or cornmeal
6 gm	Salt
30 mL	Vegetable oil

For the rice:

30 mL	Vegetable oil
4 ea.	Corn or maize, on cob, fresh
1 large	Squash or sweet potato (<i>calabza</i> or similar), small cubes
½ ea.	Onion, chopped small
2 large	Tomatoes or tomatillos, chopped
391 gm	Rice
1 L	Water or stock

Preparation

For the Pork:

1. Preheat oven to 350 °F.
2. Heat oil in a large pot over high heat.
3. Brown pork on all sides; add in stock.
4. Place pot in oven and slowly boil for about 2 h, or until meat is tender and easily pulls away from bone.

OR

For the bean cakes:

1. In a bowl, mix together beans, egg, masa or cornmeal, and salt, taking care to break up the beans, until mixture holds together well.
2. Form bean mix into four patties of equal size, and set aside.
3. Heat oil in a pan over medium–high heat.
4. Cook each patty in the pan, about 5 min a side.

*These cakes may also be baked for 15 min in a medium-heat oven.

For the rice:

1. Brush corn with ½ ounce of oil; roast over open flame or on grill until corn is a little brown.
2. With a knife, remove corn kernels and set aside. Throw away cob.
3. In a pot, heat oil in a large saucepot over medium heat.
4. Add onions and cook until soft.
5. Add squash and cook for about 3 min.
6. Add rice and tomatoes and cook for 2 min, until tomatoes begin to soften.
7. Add water or stock; bring to a boil, then turn down heat until almost boiling. Let cook, slowly, until water is absorbed and rice is tender.
8. In pot, stir corn into finished rice.

Additional notes:

- Use animal fat for vegetable oil, if easier.
- Both pork and rice may also be done in a kettle over an open fire, or in a pot on top of a grill, without changing method of preparation.
- Spices, if available, should be used in all of the dishes. Chili powder (ancho, dark, cayenne, etc.), cumin, and cinnamon are good ideas; they will add lots of flavor and some body to the rice and final product.
- Tomato juice or paste will help flavor the pork and thicken the liquid.
- If easy to find, adding greens will help increase vitamins.

Nutrition facts for meal with pork shoulder:

Serving size	396 g (14Oz)
Servings	4
Calories	610
Calories from Fat	120
Total Fat	13 g
Saturated Fat	2 g
Trans Fat	0 g
Monounsaturated fat	6 g
Cholesterol	50 mg
Sodium	270 mg
Total carbohydrates	94 g
Dietary fiber	8 g
Sugars	5 g
Protein	31 g
Vitamin A	20 %
Calcium	6 %
Vitamin C	35 %
Iron	20 %

Nutrition facts for meal with bean cakes:

Serving size	425 g (15Oz)
Servings	4
Calories	540
Calories from Fat	90
Total fat	10 g
Saturated fat	1.5 g
Trans fat	0 g
Monounsaturated fat	4 g
Cholesterol	45 mg
Sodium	170 mg
Total carbohydrates	95 g
Dietary fiber	18 g
Sugars	5 g
Protein	23 g
Vitamin A	25 %
Calcium	8 %

Vitamin C	35 %
Iron	30 %

Nutritional value of individual ingredients:

Vegetable oil	High in fat, increases uptake of vitamins D, E, A, K
Pork	High in protein, iron, vitamin B12 and vitamin B6
Black beans	High in protein, iron, calcium, vitamin B6
Egg	High in protein, vitamin D
Masa Harina	High in protein, vitamin B6
Maize	High in protein, iron, vitamin B6
Squash	High in vitamin C
Onion	Low nutritional content
Tomatoes	High in vitamin A and vitamin C

Appendix 3: Eastern Asia: Brown Rice Stir Fry with Bok Choy, Mushrooms, Eggplant, and Tofu (4 Servings based on WHO nutrition guidelines)

Ingredients

44 mL	Sesame oil
340 gm	Tofu, extra firm, 1" dice
10 gm	Garlic, chopped small
½ head	Bok choy, chopped
100 gm	Shiitake (or other) mushrooms, cleaned
1 each	Eggplant, large, cubed
30 mL	Soy sauce
870 gm	Brown rice, cooked

Preparation

1. Gather all ingredients and equipment.
2. Heat sesame and vegetable oil in a wok or pot over high heat.
3. Add tofu to hot pan and brown on both sides.
4. Add in garlic, bok choy, mushrooms, eggplant, and soy sauce and stir constantly until vegetables are tender.
5. Stir in rice to warm, and serve.

Additional notes:

- Use animal fat for vegetable oil, if easier.
- Stir-fry may also be done in any sort of pan or kettle over an open fire or grill without changing method of preparation.
- Spices, if available, should be used, especially ginger, red pepper, and lemongrass.

- Any easy-to-find mushroom can be used instead of shiitakes.
- Noodles can be used instead of rice; Buckwheat soba or rice noodles are good alternatives.

Nutrition facts for meal:

Serving size	368 g (13Oz)
Servings	4
Calories	610
Calories from Fat	160
Total fat	18 g
Saturated fat	2 g
Trans fat	0 g
Monounsaturated fat	7 g
Cholesterol	0 mg
Sodium	530 mg
Total carbohydrates	93 g
Dietary fiber	8 g
Sugars	5 g
Protein	21 g
Vitamin A	35 %
Calcium	8 %
Vitamin C	20 %
Iron	15 %

Nutritional value of individual ingredients:

Sesame oil	High in fat, increases uptake of vitamins D, E, A, K
Tofu	High in protein, iron, and calcium
Garlic	Low nutritional content
Bok choy	High in vitamin A and vitamin C
Shiitake mushroom	Low nutritional content
Eggplant	Low nutritional content

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