Case Studies: Impact of Nutrition on Physiology

Written by Sydella Blatch

This case study is about the impact of nutrition on physiology. The role of nutrition in body functions is seldom discussed in disciplines such as biology and physiology, other than obesity, diabetes and so on. Therefore, these case studies are designed to reveal some of the diverse and dramatic ways that nutrition affects physiology.

Overview

You are given information about a person's health, diet and exercise. You are asked to propose how their diet and exercise habits may be affecting their health. The information you are given about your patient is:

(1) information about their diet, eating habits, and activity levels
(2) summary of their symptoms or any issues
(3) basic health information
(4) certain clinical data

Resources

You must use the formulas for the first question. The remaining are reliable resources to help get you started.

Formulas

- BMI = weight (kg) / height (m^2)
- TDE (in kcal, commonly called calories) = Basal energy expenditure (BEE) x Activity Factor (AF)
    - BEE for men = 66 + (13.7 x weight in kg) + (5 x height in cm) – (6.8 x age in yr)
    - BEE for women = 665 + (9.6 x weight in kg) + (1.8 x height in cm) – (4.7 x age in yr)
    - AF, Use table below

AF	Daily Activities
1.2 – 1.3	Hospital patient with limited physical mobility
1.4 - 1.65	Little (if any) physical activity at work or in leisure time, e.g. typical US office worker - male or female
1.6	Moderate physical activity at work or leisure – female
1.7	Moderate physical activity at work or leisure – male
1.7 - 2.0	Moderate physical activity at work, e.g. in construction, or some jobs in agriculture or the leisure industry. Alternatively, office workers who work-out e.g. in gym for an hour *per day*.
2.0 - 2.4	Considerable physical activity at work, e.g. some military or outdoor occupations or energetic jobs in the leisure industry - such as fitness trainers who run alongside clients. Alternatively, office workers who take at least moderate exercise for two or more hours/day.
> 2.4	Professional athlete or sports person e.g. football player

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Information about Food

http://www.eatright.org/Public/
http://www.calorieking.com
http://caloriecount.about.com/

Information about Clinical Tests

http://www.nhlbi.nih.gov/health/health-topics/topics/bdt/show.html
http://www.nlm.nih.gov/medlineplus/ency/article/003468.htm

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PATIENT: Olly V. Oyle

Olly is a 23 year-old female. She is a busy college student that is majoring in kinesiology, works part-time at a fitness center, and plays intramural basketball four days a week. Because of her hectic schedule, and lack of interest in cooking, she mostly eats outside of the home, and usually eats a meal twice per day (around 10am and 9pm, after practice ends). Olly considers herself health conscious, so her meals are generally healthy (few fried foods, whole grains, and fruits and vegetables. She seldom finishes the entire portion she is served, because she knows most restaurants serve excessively-sized portions.

Consider a typical day's diet for Olly to be:

- 11am: Panera Bread's Napa Almond Chicken Salad on Sesame Semolina Miche Sandwich
- 8pm: McDonald's Grilled Chicken Classic Sandwich with Small French Fries. Olly eats all the french fries, but about ¾ of the sandwiches for lunch and dinner.

Olly has no intention of losing weight, but she is finding that she has lost 10 pounds over the past few months. She has become dizzy frequently during basketball practice. She frequently cannot stay focused during class, which was not the case prior to when she noticed weight loss. Olly went to the doctor, concerned about these unusual symptoms. Her primary care physician ordered Complete Blood Count (CBC) and a Comprehensive Metabolic Panel (CMP). She was referred to a cardiologist whose technician performed a Stress Test. Some results of those with her basic medical information are below.

Olly V. Oyle

Height	5 ft. 5 in.
Weight	107 lbs (currently)
Blood Pressure	134/77
Resting Pulse	43 bpm
Stress Test	Normal

Selected CBC Results: Olly V. Oyle

Test Name	Value	Units
RBC	4.96	10^6 cells/ µL
Hgb	13.8	g/dL
WBC	4.2	10^3 cells/ µL
HCT	41.5	%

Selected CMP Results: Olly V. Oyle

Test Name	Value	Units
Sodium	176	mM/L or mEq/L
Calcium	6.3	mg/dL
Glucose	53	mg/dL
Chloride	87	mM/L
CO_2	27.4	mmol/L
Total Protein	6.0	g/dL

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Questions: Olly V. Oyle

1. Calculate the Body Mass Index (BMI) using the given formula. Describe the meaning of Olly's BMI.
2. Discuss the blood pressure, pulse and stress test for Olly. Could any of these relate to her symptoms?
3. Calculate Olly's total daily energy expenditure (TDE) using the given information. What does TDE describe? Is Olly meeting her TDE? Explain potential consequences.
4. Analyze the CBC and CMP results. If any values are abnormal, explain potential consequences.
5. How does Olly's diet and lifestyle explain her symptoms? What changes should she make?

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PATIENT: Lanz Sarmstrong

Lanz is a 27 year-old male that works full-time as a physical therapist. Lanz considers himself a fitness buff. He does two 20-minute sessions of high-intensity cardio per day, and a total of 1.5 hours of weight lifting and muscle conditioning per day. To support such a demand, he eats five times a day, and his diet is largely lean proteins (poultry, egg whites, etc.), vegetables with low a glycemic index, and small amounts of whole grains. To help maximize the results from his workout regime, Lanz takes a supplement (below). Lanz does not have any symptoms or feelings of concern.

Consider a typical day's diet for Lanz to be:

- 5am - one serving of GNC Pro Performance AMP Amplified Wheybolic Extreme 60 with ½ banana and one cup of milk
- 8am - 5 egg whites, 1 cup of spinach, ½ cup mushrooms
- 11am – 7 oz grilled chicken breast, 1 cup steamed broccoli, ½ cup brown rice
- 2pm – apple
- 4pm - one serving of GNC Pro Performance AMP Amplified Wheybolic Extreme 60 with ½ banana and one cup of milk
- 7pm – 7 oz roasted turkey (white meat), 2 cups mixed greens, ¼ cup carrots, ¼ cup tomatoes, and ½ cup brown rice
- one serving herbal supplement Swole KREATE (available from the retailer GNC).
- Total water intake per day: ½ gallon

Lanz Sarmstrong

Height	5 ft. 11 in.
Weight	190 lbs
Blood Pressure	156/93
Resting Pulse	71 bpm
Percent Body Fat	12

Selected CMP Results: Lanz Sarmstrong

Test Name	Value	Units
Glucose	70	mg/dL
Albumin	6.8	g/dL
Potassium	4.6	mmol/L
Creatinine	2.9	mg/dL

Selected Urinalysis Results: Lanz Sarmstrong

Test Name	Value	Units
pH	4.8	-
Ketone	35	mg/dL
Glucose	0	mg/dL

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Questions for Lanz Sarmstrong:

1. Calculate the Body Mass Index (BMI) using the given formula. Describe the meaning of Lanz's BMI.
2. Consider Lanz's percent body fat. Discuss what this means for Lanz. How does fit in with his BMI? What does this say about his body composition in general?
3. Calculate Lanz's total daily energy expenditure (TDE) using the given information. What does TDE describe? Is Lanz meeting his TDE? Explain potential consequences.
4. Analyze the CMP and Urinalysis results. If any values are abnormal, explain potential consequences.
5. How wise are Lanz's overall diet and lifestyle choices? Is he as healthy as he is intending? Explain. What changes should he make, if any?

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PATIENT: Bob Evans

Bob is a 37 year-old male that had a Roux-en-Y operation 6 months ago, when he weighed 328 lb. Although he has since lost a large amount of weight, 112 lb, he often does not feel well. During his normal exercise, brisk walks 3-4 times weekly, he is now more winded than he was 2 months after his operation. His legs hurt when he walks and his feet and ankles appear swollen. He also feels he maybe more infection prone than before, having episodes of diarrhea several times per week. He also has noticed a large decline in his overall energy levels. All of these symptoms are despite the fact that Bob adheres to his doctor-prescribed diet almost perfectly. He also takes two multivitamins per day.

Consider a typical day's diet for Bob to be:
7:00am - ¼ cup Light Yogurt, ¼ cup banana slices, 8oz water
9:30am - 2oz low-fat cheese, 3 small whole grain crackers, 8oz crystal light
12:00pm - 2 oz chicken breast, 2oz cooked broccoli, 8oz crystal light
2:30pm - ¼ cup cottage cheese
3:30pm - 8oz Skim Milk
5:00pm- 8oz Crystal Light
6:30pm - ½ cup mild Chili soup, 1 oz low-fat cheese
7:30pm - 8oz water

Bob Evans

Height	6 ft.
Weight	216 lbs
Blood Pressure	131/75
Resting Pulse	89bpm

Selected CBC Results: Bob Evans

Test Name	Value	Units
RBC	3.37	10^6 cells/ µL
Hgb	10.4	g/dL
WBC	5.4	10^3 cells/ µL

Selected CMP Results: Bob Evans

Test Name	Value	Units
Calcium	6.2	mg/dL
Albumin	2.9	g/dL
Potassium	4.2	mmol/L
Sodium	141	mmol/L

Questions for Bob Evans:

1. Calculate the Body Mass Index (BMI) using the given formula. Describe the meaning of Bob's BMI.

2. Calculate Bob's total daily energy expenditure (TDE) using the given information. What does TDE describe? Is he meeting his TDE? Explain potential consequences.
3. Analyze the CBC and CMP results. If any values are abnormal, explain potential consequences.
4. Consider Bob's symptoms. Are they normal for a post-operative Roux-en-Y patient? Explain why or why not. Will these symptoms persist over time, or can he do something differently to change them?
5. Are there any potential nutrient deficiencies that Bob may be facing that are not shown in the above CBC and CMP tests?

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PATIENT: Jen E. Krayg

Jen is a 21 year-old female, administrative assistant. She is aiming to lose weight. She met with her doctor to get an idea of what to eat, especially because she is not able to exercise at this time, due to an unhealed injury. Her doctor gave her a very specific diet plan. She has been following this 4 weeks, and has not lost any weight. According to her doctor, based on her age, lifestyle, etc. she should be losing weight. Since most people recommend having at least one meal per week off diet, Jen has been allowing herself this opportunity, but only once per week. This cheat meat has enabled Jen to have the willpower to stay on her diet throughout the rest of the week. She works very hard throughout the week to resist her favorite foods, avoid eating too much, which is especially hard when others around her eat as they wish. In addition, she values this as a social opportunity where she can enjoy meals out with her friends. But the entire rest of the week she follows her diet. Jen does not have any symptoms, other than frustration because she is not losing weight.

Diet Plan, per day

- Breakfast:1 slice whole-wheat bread spread with 2 Tbsp. part-skim ricotta, topped with 1 chopped dried fig and 1 tsp. honey with a banana
- Snack: Kellog's Special K Strawberry Protein Meal bar
- Lunch: Salad - 2 cups lettuce, 1 cup chopped raw vegetables, 1 hard-boiled egg, 2 Tbsp. raisins and 2 Tbsp. almonds with 2 Tbsp. low-fat balsamic dressing
- Snack: 1 small apple and 22 pistachios
- Dinner: Stir fry - 1/2 cup extra-firm tofu, 1 cup diced broccoli & carrots in 2 tsp. canola oil, 1/2 tsp. sesame oil, 2 tsp. soy sauce. With 1 cup cooked quinoa and 1 Tbsp. of peanuts

Once per week cheat meal, at T.G.I. Friday's Restaurant

- Two Margaritas
- Pan Seared Pot Stickers (individual appetizer)
- Jack Daniel's Chicken Sandwich with Sweet potato fries
- Vanilla Bean Cheesecake

Jen E. Krayg

Height	5 ft. 4 in.
Weight	175
Blood Pressure	149/86
Resting Pulse	112 bpm

Selected CBC Results: Jen E. Krayg

Test Name	Value	Units
RBC	4.5	10^6 cells/ µL
Hgb	13.8	g/dL
WBC	7.2	10^3 cells/ µL

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Selected CMP Results: Jen E. Krayg		
Test Name	Value	Units
Calcium	9.9	mg/dL
Albumin	4.6	g/dL
Potassium	5.1	mmol/L
Sodium	154	mmol/L

Questions for Jen E. Krayg:

1. Calculate the Body Mass Index (BMI) using the given formula. Describe the meaning of Jen's BMI.
2. Calculate Jen's total daily energy expenditure (TDE) for her diet plan, using the given information. What does TDE describe? If she only ate within her diet plan would she lose weight? (In other words, is this the right amount of calories she should be having to lose weight?)
3. Calculate Jen's the calories, and grams of fat, protein and carbohydrate for her weekly cheat meal. How does this compare in each of those four aspects to what a woman such as her should be consuming per day?
4. Analyze the CBC and CMP results. If any values are abnormal, could these be related to her diet?
5. Predict what would happen to Jen one year from now if she continued to eat as she is, and if she ate only as prescribed in the diet plan (still without the ability to exercise).

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References

Thompson, Janice L., Melinda M. Manore, and Linda A. Vaughan. The Science of Nutrition, 2nd Ed. Pearson, Boston, 2011.

- BMI Formula

Zeman, Frances J. Clinical Nutrition and Dietetics, 2nd Ed. MacMillan, New York, 1991.

- TDE formula
- BEE formula

Activity Factors for BEE (in TDE) modified from
http://www.ivy-rose.co.uk/HumanBiology/Nutrition/Physical-Activity-Level.php

Complete Blood Count, Normal ranges
http://www.mayoclinic.com/health/complete-blood-count/MY00476/DSECTION=results

Comprehensive Metabolic Panel
http://www.nlm.nih.gov/medlineplus/ency/article/003468.htm

Roux-n-Y Postoperative meal plan and concerns
http://www.surgicalassociatesvhc.com/Nutrition-and-Exercise-following-Gastric-Bypass-82011.pdf
http://www.westernbariatricinstitute.com/default/patient_information/WBI-RNY.pdf

Meal Plan for weight loss (1500 cal/day)
http://www.eatingwell.com/nutrition_health/weight_loss_diet_plans/diet_meal_plans/5_day_1500_calorie_diet_meal_plan?page=2