Improving Public Health by Understanding Diversity in Metabolism, Body Weight & Calorie Requirements

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Learning Objectives:

1. Use the NIH body weight planner to accurately estimate the calorie requirements of patients who would benefit from changing their body composition

2. Use calorie requirements to make practical recommendations for patients

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The response to long-term overfeeding in identical twins.

Bouchard C[1], Tremblay A, Després JP, Nadeau A, Lupien PJ, Thériault G, Dussault J, Moorjani S, Pinault S, Fournier G.

⊕ Author information

Abstract

We undertook this study to determine whether there are differences in the responses of different persons to long-term overfeeding and to assess the possibility that genotypes are involved in such differences. After a two-week base-line period, 12 pairs of young adult male monozygotic twins were overfed by 4.2 MJ (1000 kcal) per day, 6 days a week, for a total of 84 days during a 100-day period. The total excess amount each man consumed was 353 MJ (84,000 kcal). During overfeeding, individual changes in body composition and topography of fat deposition varied considerably. The mean weight gain was 8.1 kg, but the range was 4.3 to 13.3 kg. The similarity within each pair in the response to overfeeding was significant (P less than 0.05) with respect to body weight, percentage of fat, fat mass, and estimated subcutaneous fat, with about three times more variance among pairs than within pairs (r approximately 0.5). After adjustment for the gains in fat mass, the within-pair similarity was particularly evident with respect to the changes in regional fat distribution and amount of abdominal visceral fat (P less than 0.01), with about six times as much variance among pairs as within pairs (r approximately 0.7). We conclude that the most likely explanation for the intrapair similarity in the adaptation to long-term overfeeding and for the variations in weight gain and fat distribution among the pairs of twins is that genetic factors are involved. These may govern the tendency to store energy as either fat or lean tissue and the various determinants of the resting expenditure of energy.

kg

$r^2 = 0.3$

Individual Changes

Pairs of MZ Twins

1 2 3 4 5 6 7 8 9 10 11 12
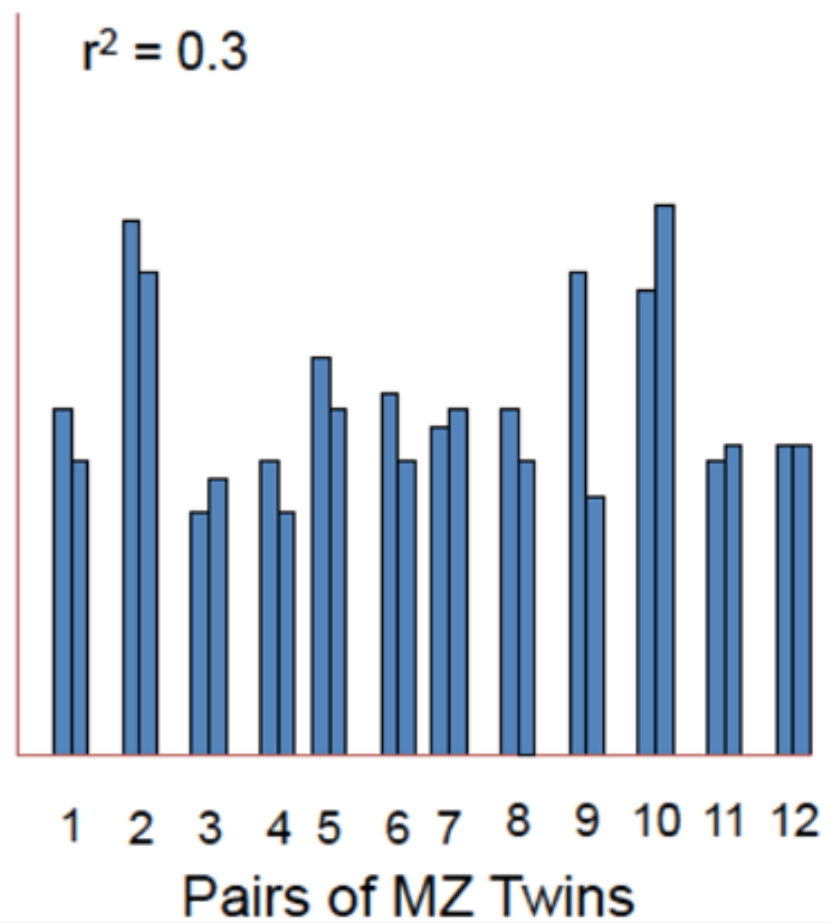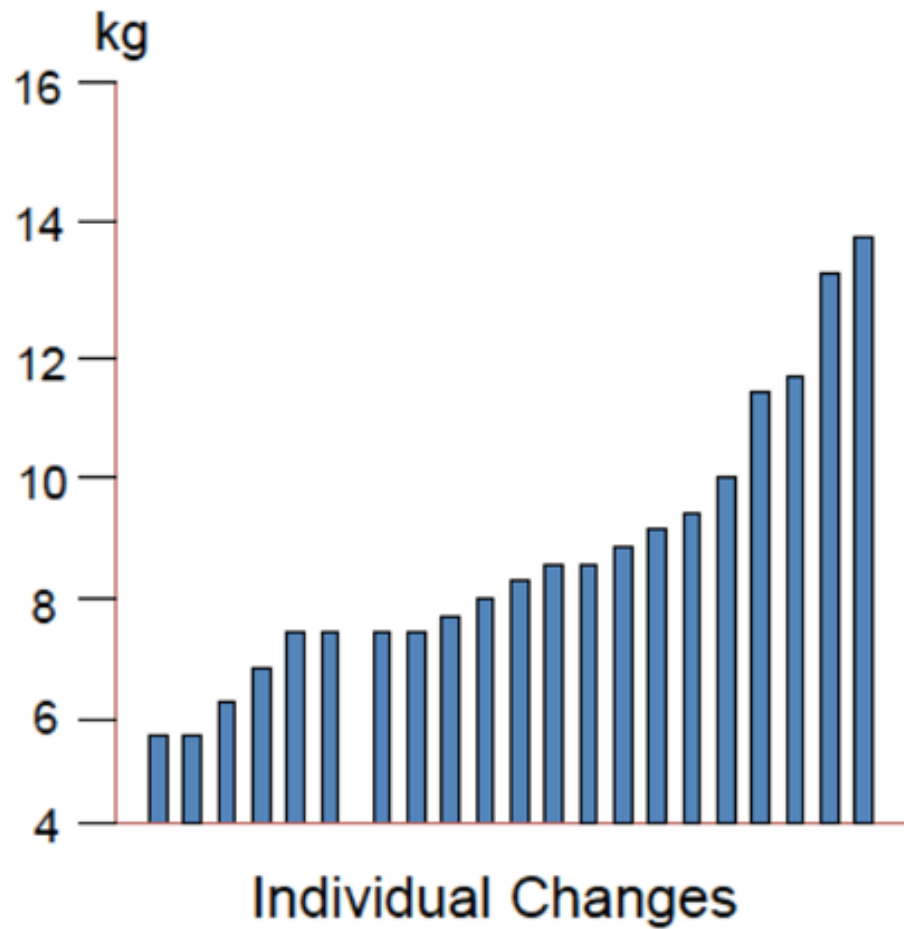
Bouchard et al. NEJM 1990:322;1477

Patient Example:

Gender: Women

Age: 45 years

Height: 5'6''

Weight: 200 lbs

BMI: 32.3

Waist Circumference: 40 inches

Fasting blood sugar: 115 mg/dL

Hemoglobin A1c: 6.2%

Would this patient benefit from decreasing body fat via TLC?

How much weight loss should we recommend?

Position of the Academy of Nutrition and Dietetics: Interventions for the Treatment of Overweight and Obesity in Adults

ABSTRACT

It is the position of the Academy of Nutrition and Dietetics that successful treatment of overweight and obesity in adults requires adoption and maintenance of lifestyle behaviors contributing to both dietary intake and physical activity. These behaviors are influenced by many factors; therefore, interventions incorporating more than one level of the socioecological model and addressing several key factors in each level may be more successful than interventions targeting any one level and factor alone. Registered dietitian nutritionists, as part of a multidisciplinary team, need to be current and skilled in weight management to effectively assist and lead efforts that can reduce the obesity epidemic. Using the Academy of Nutrition and Dietetics' Evidence Analysis Process and Evidence Analysis Library, this position paper presents the current data and recommendations for the treatment of overweight and obesity in adults. Evidence on intrapersonal influences, such as dietary approaches, lifestyle intervention, pharmacotherapy, and surgery, is provided. Factors related to treatment, such as intensity of treatment and technology, are reviewed. Community-level interventions that strengthen existing community assets and capacity and public policy to create environments that support healthy energy balance behaviors are also discussed.
J Acad Nutr Diet. 2016;116:129-147.

POSITION STATEMENT

It is the position of the Academy of Nutrition and Dietetics that successful treatment of overweight and obesity in adults requires adoption and maintenance of lifestyle behaviors contributing to both dietary intake and physical activity. These behaviors are influenced by many factors; therefore, interventions incorporating more than one level of the socioecological model and addressing several key factors in each level may be more successful than interventions targeting any one level and factor alone.

"Weight loss of only 3 to 5% that is maintained has the ability to produce clinically relevant health improvements (eg, reductions in triglycerides, blood glucose, and risk of developing type 2 diabetes)."

"Larger weight loss reduces additional risk factors of CVD (eg, low-density and high density lipoprotein cholesterol and blood pressure) and decreases the need for medication to control CVD and type 2 diabetes. Thus, a goal of weight loss of 5 to 10% within 6 months is recommended."

NIH National Institute of Diabetes and Digestive and Kidney Diseases

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Weight Management

Bariatric Surgery ✚

Binge Eating Disorder ✚

Body Weight Planner

Choosing a Safe and Successful Weight-loss Program

Dieting & Gallstones

Health Tips for Adults

Health Tips for African-Americans

Health Tips for Older Adults

Body Weight Planner

The Body Weight Planner allows users to make personalized calorie and physical activity plans to reach a goal weight within a specific time period and to maintain it afterwards.

Launch the Body Weight Planner ☐

Watch a video to see how to use the Body Weight Planner ☐

Starting Information

U.S. Units	Metric Units

Weight ____ lbs

Sex ____

Age ____ yrs

Height ____ ft ____ in.

Physical Activity Level ⓘ   1.6   Estimate Your Level

Use **SuperTracker** ☐ to get a personalized meal plan based on your calorie results from the Body Weight Planner. SuperTracker is a free food, physical activity, and weight tracking tool from ChooseMyPlate.gov.

Model of Human Metabolism

$$\rho_C \frac{dG}{dt} = CI - DNL + GNG_p + GNG_f - G3P - CarbOx$$

$$\rho_F \frac{dF}{dt} = 3M_{FFA}FI/M_{TG} + \varepsilon_d DNL - KU_{exc} - (1-\varepsilon_k)KTG - FatOx$$

$$\rho_P \frac{dP}{dt} = PI - GNG_p - ProtOx$$

$$FFM = BM + ECF + ECP + LCM$$
$$= BM + ECF + ECP + ICW + P + G + ICS$$
$$= BM + ECF + ECP + \hat{I}CW + P(1+h_p) + G(1+h_g) + ICS$$

$$\frac{dECF}{dt} = \frac{1}{[Na]}\left(\Delta Na_{diet} - \xi_{Na}(ECF - ECF_{init}) - \xi_{CI}(1 - CI/CI_b)\right) + \Delta ECF$$

$$\tau_{BW}\frac{d\Delta ECF}{dt} = \xi_{BW}(BW - BW_{init}) - \Delta ECF$$

$$TEE = TEF + PAE + RMR$$
$$RMR = E_t + \gamma_B M_B + \gamma_{FFM}\left[FFM - M_B - \Delta G(1+h_g) - (ECF - ECF_{init})\right] + \gamma_P F$$
$$+ (1-\varepsilon_d)DNL + (1-\varepsilon_f)(GNG_f + GNG_p) + (1-\varepsilon_k)KTG$$
$$+ \eta_H M_{exc} + (\eta_p + \varepsilon_p)D_p + \eta_P\frac{dP}{dt} + \eta_F D_F + \eta_F\frac{dF}{dt} + \eta_G D_G + \eta_G\frac{dG}{dt}$$

$$\tau_T\frac{dT}{dt} = \begin{cases} \lambda_1(\Delta EI/EI_b) - T, & \text{if } EI < EI_b \\ \lambda_2(\Delta EI/EI_b) - T, & \text{else} \end{cases}$$

$$\gamma_{FFM} = \sum_i \gamma_i \frac{dM_i}{dFFM}$$

$$\gamma_{FFM} = \hat{\gamma}_{FFM}\left[1 + (1-\sigma)T\right]$$

$$PAE = \delta(1+\sigma T)BW + \upsilon BW$$

$$TEF = \alpha_F FI + \alpha_P PI + \alpha_C CI$$

$$CarbOx = GNG_f + GNG_p - G3P + f_C \times T\hat{E}E$$
$$FatOx = KetOx + f_F \times T\hat{E}E$$
$$ProtOx = f_P \times T\hat{E}E$$

$$DNL = \frac{CI \times (G/G_{init})^d}{(G/G_{init})^d + K_{DNL}^d}$$

$$D_G = \hat{D}_G\left(\frac{G}{G_{init}}\right)$$

$$D_P = \hat{D}_P\left[\left(\frac{P}{P_{init}}\right) + \chi\left(\frac{\Delta PI}{PI_b}\right)\right]$$

$$D_F = \hat{D}_F\left(\frac{F}{F_{init}}\right)^{\frac{2}{3}}[L_{det} + L_{PA}]$$

$$\tau_L\frac{dL_{det}}{dt} = \frac{K_L^{\alpha_L}\left[1+(A_L - B_L)\times\exp(-k_L CI/CI_b) + B_L\right]}{K_L^{\alpha_L} + MAX\left[0,(F/F_{init} - 1)^{\alpha_L}\right]} - L_{det}$$

$$GNG_f = FI\left(\frac{\rho_C M_G}{\rho_P M_{TG}}\right) + D_F\rho_C\left(\frac{M_G}{M_{TG}}\right) \qquad L_{PA} = \psi\left(\frac{\delta+\upsilon}{\delta_{init}+\upsilon_{init}} - 1\right)$$

$$GNG_p = G\hat{N}G_p\left[\left(\frac{P}{P_{init}}\right) - \Gamma_C\left(\frac{\Delta CI}{CI_b}\right) + (\Gamma_p + \chi)\left(\frac{\Delta PI}{PI_b}\right)\right]$$

$$KTG = \rho_K D_F\left[A_K\left(\frac{D_F/\hat{D}_F}{K_K + D_F/\hat{D}_F}\right)\exp\left(-k_F\frac{PI}{PI_b}\right)\exp\left(-k_G\frac{G}{G_{init}}\right)\right]$$

$$KU_{exc} = \begin{cases} 0, & \text{if } KTG/\rho_K < KTG_{thresh} \\ \dfrac{\rho_K KU_{max}(KTG/\rho_K - KTG_{thresh})}{(KTG_{max} - KTG_{thresh})}, & \text{else} \end{cases}$$

$$f_C = \frac{w_G(D_G/\hat{D}_G) + w_C MAX\left[0,(1+S_C\Delta CI/CI_b)\right]G/(G_{init} + G)}{Z}$$

$$f_P = \frac{w_P\left(D_P/\hat{D}_P\right)}{Z}$$

$$f_F = \frac{w_F MAX\left[0,(1+P_{sig})\right] + (D_F/\hat{D}_F)S_A\exp\left(-k_A(\delta+\upsilon)/(\delta_b+\upsilon_b)\right)}{Z}$$

$$\tau_M\frac{dP_{sig}}{dt} = S_I \Delta PI/PI_b - P_{sig}$$

Body Weight Planner | *Balancing Your Food and Activity*

Switch to Expert Mode

Starting Information

U.S. Units	Metric Units

Weight	200	lbs

Sex	Female ▼

Age	45	yrs

Height	5	ft.	6	in.

Physical Activity Level ⓘ	1.6
	Estimate Your Level

Starting Information

Enter your starting information, including your weight, sex, age, height, and physical activity level.

Physical Activity Level

Click the "Estimate Your Level" button to find your physical activity level.

Typical physical activity level numbers range from 1.4 (sedentary) to 2.5 (very active).

The default value of 1.6 describes someone who does very light activity at school or work (mostly sitting) and moderate physical activity (such as walking or cycling) at least once a week.

Next Step ➡

Body Weight Planner | *Balancing Your Food and Activity*

Step 1 of 4 - Enter your starting information

Starting Information

U.S. Units	Metric Units

Weight	200	lbs
Sex	Female ▾	
Age	45	yrs
Height	5	ft.	6	in.

Physical Activity Level ⓘ	1.6
	Estimate Your Level

Next Step ➡

Starting Information

Enter your starting information, in[...] physical activity level.

Physical Activity Level

Click the "Estimate Your Level" bu[...]

Typical physical activity level num[...] active).

The default value of 1.6 describes someone who does very light activity at school or work (mostly sitting) and moderate physical activity (such as walking or cycling) at least once a week.

Estimate Your Physical Activity Level

Describe your physical activity at work or school:

Very Light ▾

Sitting at the computer most of the day, or sitting at a desk.

Describe your physical activity at leisure time:

Moderate ▾

Regular activity at least once a week, e.g., walking, bicycling (including to work) or gardening.

Cancel   Save

Body Weight Planner | *Balancing Your Food and Activity*

Switch to Expert Mode

Weight Goal

Goal Weight	180	lbs

I want to reach my goal in	140	days

OR select a date

I want to reach my goal by	9/24/2018	📅

Goal Weight

Enter your goal weight and when you would like to reach it.

You can enter a number of days OR choose a specific date using the calendar.

← Previous Step   **Next Step →**

National Institute of
Diabetes and Digestive
and Kidney Diseases

Body Weight Planner | *Balancing Your Food and A...*

Step 3 of 4 - Enter your physical activity change (optional)

Physical Activity Change

To reach my goal, I will change my physical activity by **9** %

[Calculate]

Physical Activity C...

Click the "Calculate"...

Changing your phys...

The physical activity...
reach your goal and...

If you don't want to change your physical activity, click the "Next Step" button to skip this step.

[⬅ Previous Step]   [Next Step ➡]

Estimate Percent Change in Physical Activity Level

I will make the following changes to my physical activity:

I plan to [Add ▼] [Medium Walking ▼] for [30 ▼] minutes, [3 ▼] times per [week ▼] [Delete] ✔

This represents a change of **9%** to your starting activity level

[Specify Another Change]

[Cancel] [Save]

Recommendations for
1 lb of fat loss per week

Recommendations for
2 lbs of fat loss per week

Body Weight Planner | *Balancing*

Step 4 of 4 - Results

➡ Results

Calories	Kilojoules

In order to *maintain* your current weight, you should eat: **2,515 Calories/day**

To *reach* your goal of **180 lbs** in **70 days**, you should eat: **1,420 Calories/day**
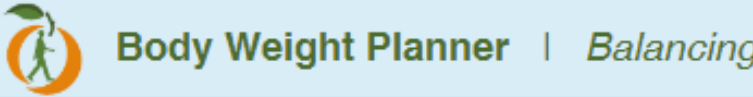
To *maintain* your goal of **180 lbs**, you should eat: **2,423 Calories/day**

⬅ Previous Step   Expert Mode ➡

Body Weight Planner | *Balancing Your Food and Activity*

Starting Information

Advanced Controls: OFF

Weight	200	lbs ▼

Sex	Female ▼

Age	45	yrs

Height	5 ft.	6 in.	feet ▼

Physical Activity Level ⓘ	1.6
	Estimate Your Level

Goal Weight | Lifestyle Change

Weight Goal

Goal Weight	180	lbs

I want to reach my goal in	140	days

OR select a date

I want to reach my goal by	9/24/2018	📅

Physical Activity Change (Optional)

Weight Change Phase

To reach my goal, I will change my physical activity by | 9 | %
Calculate

Goal Maintenance Phase

To maintain my goal, I will change my physical activity by | 9 | %
Calculate

Results

Calories	**Kilojoules**

In order to *maintain* your current weight, you should eat: → **2,515** Calories/day

To *reach* your goal of **180 lbs** in **140 days**, you should eat: → **1,899** Calories/day

To *maintain* your goal of **180 lbs**, you should eat: → **2,416** Calories/day

Body Weight Planner | *Balancing Your Food and Activity*

Starting Information

Advanced Controls: OFF

Weight	200	lbs ▼

Sex	Female ▼

Age	45	yrs

Height	5 ft. 6 in.	feet ▼

Physical Activity Level ℹ	1.6
	Estimate Your Level

Goal Weight | Lifestyle Change

Weight Goal

Goal Weight	180	lbs

I want to reach my goal in	45	days

OR select a date

I want to reach my goal by	6/21/2018	📅

Physical Activity Change (Optional)

Weight Change Phase

To reach my goal, I will change my physical activity by | 9 | %
Calculate

Goal Maintenance Phase

To maintain my goal, I will change my physical activity by | 9 | %
Calculate

➡ Results

Calories	Kilojoules

In order to *maintain* your current weight, you should eat: | **2,515** Calories/day

To *reach* your goal of **180 lbs** in **45 days**, you should eat: | **991** Calories/day

To *maintain* your goal of **180 lbs**, you should eat: | **2,429** Calories/day

Simulation Displayed

❗ The information you entered results in a calorie level that is too low.
Calorie goals must be at least 1000 calories/day. Food group targets and nutrient recommendations will not be met below 1000 calories/day.
The last change you made has been reset so that you can enter a different value. Try giving yourself more time to achieve your goal, changing your activity level, or setting a different goal.

Application:

1. Patients can track food & calorie intake with an App on their phone, like My Fitness Pal, using goals & calorie recommendations from the NIH body weight planner
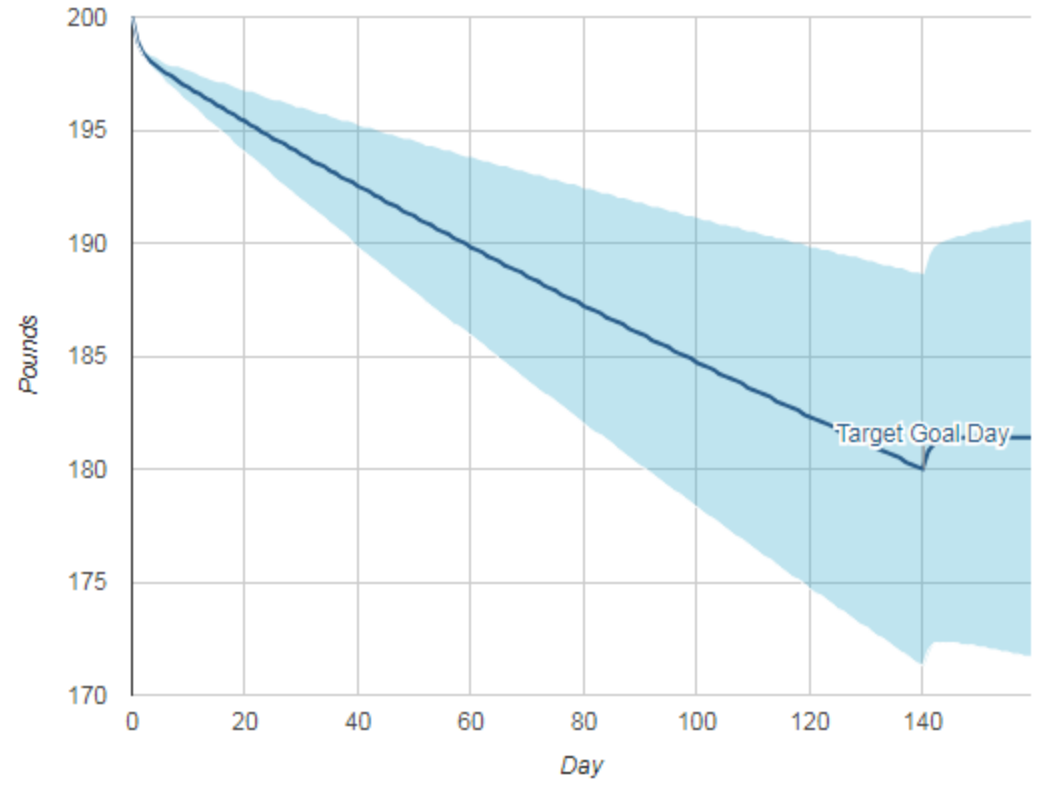
Length of Simulation	365	days

Initial Weight (lbs):	200	Initial % Fat:	43.1	Initial BMI:	32.3
Final Weight (lbs):	181.2	Final % Fat:	39.7	Final BMI:	29.2

Weight   Body Fat %   Intake & Expenditure   Tabular

Click and drag to zoom   Reset View   Download Chart as Image   ⓘ

Target Goal Day

Pounds

Day
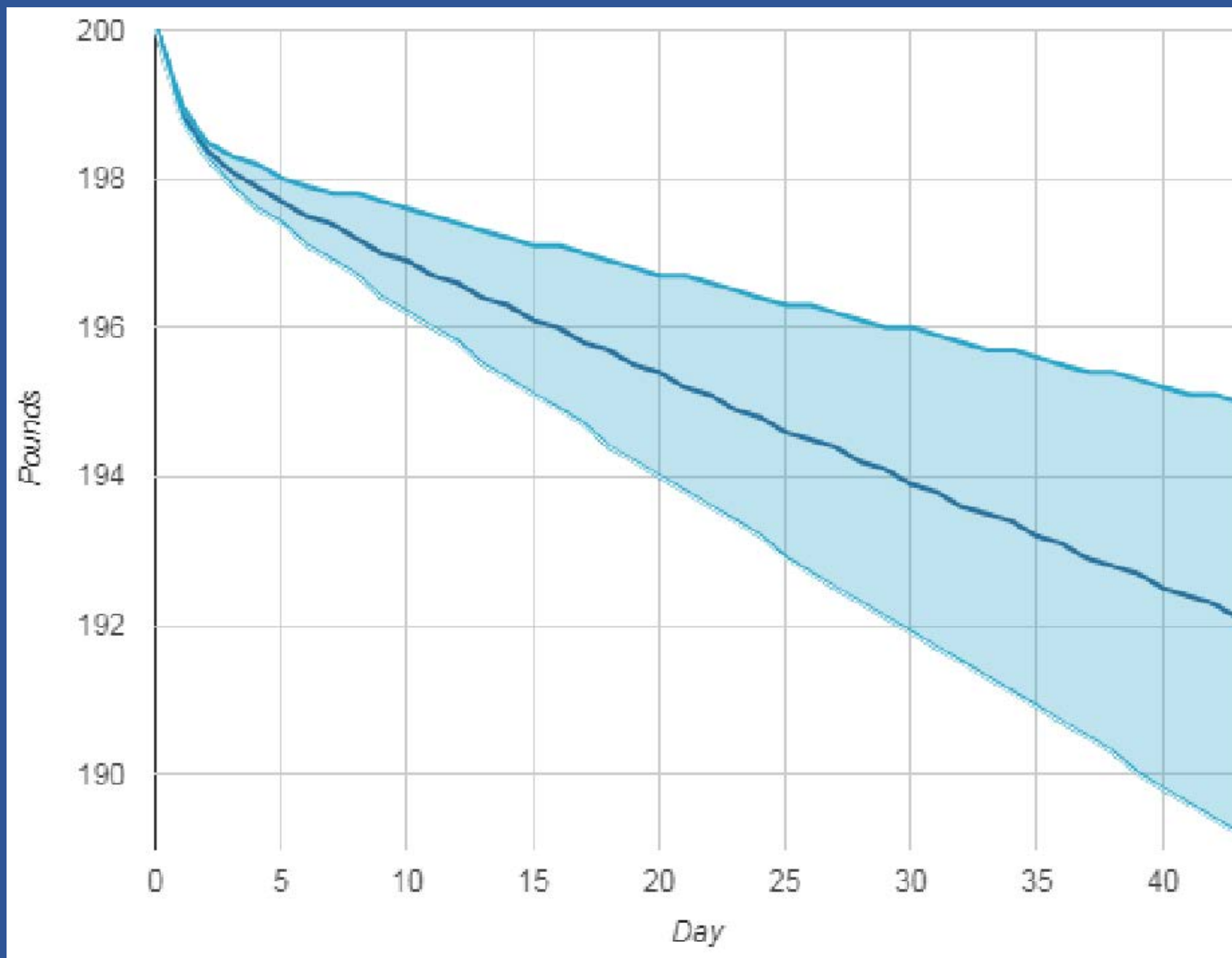
Application:

2. Tracking body weight over time provides insight into calorie intake & expenditure

Calorie Deficit = Decreasing Weight

Calorie Balance = Weight Maintenance

Calorie Surplus = Increasing Weight

How else is this information useful?

new ⓢ dollar menu & more

$1.00

Buffalo Ranch McChicken
350 Cal.

BBQ Ranch Burger
350 Cal.

Grilled Onion Cheddar Burger
310 Cal.

McChicken
360 Cal.

Side Salad
1.29
20 Cal.

Sweet Tea lg.
220 Cal.

Fruit 'N Yogurt Parfait
150 Cal.

Cookies
150-160 Cal. ea.

Cone
170 Cal.

Double Cheeseburger
$1.49
440 Cal.

McDouble
$1.19
390 Cal.

$2.00 & more

Bacon Cheddar McChicken
480 Cal.

Bacon Buffalo Ranch McChicken
420 Cal.

Bacon McDouble
460 Cal.

20 pc. Chicken McNuggets Serves 2
$5.00
470 Cal. ea.
McNuggets Sauces 30-110 Cal. ea.

*Pasteurized process

Application:

3. Provide calorie guidelines for meals & snacks that patients can use when eating out:

Daily goal: 1,900 calories/day

If a patient ate 3 meals and 2 snacks per day, they could aim for 500 calorie for meals and 200 calories for snacks

QUARTER POUND 100% BEEF PATTY* **SESAME SEED BUN** **PASTEURIZED PROCESS AMERICAN CHEESE** **KETCHUP** **PICKLE SLICES** **ONIONS**

VIEW NUTRITION SUMMARY ⌄

VIEW INGREDIENTS & ALLERGENS ❯

770 Calories	**45g** Total Fat (69% DV)	**42g** Total Carbs (14% DV)	**51g** Protein

Calories From Fat: 400
Saturated Fat: 21g (104% DV)
Trans Fat: 2.5g
Cholesterol: 175mg (58% DV)

Sodium: 1290mg (54% DV)
Dietary Fiber: 3g (12% DV)
Sugars: 10g

Vitamin A: 1090IU (20% DV)
Vitamin C: 4mg (6% DV)
Calcium: 180mg (20% DV)
Iron: 6.5mg (35% DV)

GARLIC AIOLI

SHARP WHITE CHEDDAR CHEESE

TOMATO

SHREDDED LETTUCE

ARTISAN ROLL

ARTISAN GRILLED CHICKEN FILLET

VIEW NUTRITION SUMMARY ⌄

VIEW INGREDIENTS & ALLERGENS ❯

530 Calories	**20**g Total Fat (30% DV)	**48**g Total Carbs (16% DV)	**42**g Protein
Calories From Fat: 180	Sodium: 1150mg (48% DV)	Vitamin A: 460IU (10% DV)	
Saturated Fat: 7g (33% DV)	Dietary Fiber: 3g (13% DV)	Vitamin C: 12mg (20% DV)	
Trans Fat: 0g	Sugars: 11g	Calcium: 330mg (35% DV)	
Cholesterol: 125mg (41% DV)		Iron: 2.5mg (15% DV)	

Nutrition Facts

Serving Size 2/3 cup (55g)
Servings Per Container About 8

Amount Per Serving

Calories 230   Calories from Fat 72

% Daily Value*

Total Fat 8g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**12%**
Dietary Fiber 4g	**16%**
Sugars 1g	
Protein 3g	

Vitamin A	10%
Vitamin C	8%
Calcium	20%
Iron	45%

* Percent Daily Values are based on a 2,000 calorie diet.
Your daily value may be higher or lower depending on
your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Nutrition Facts

8 servings per container
Serving size   **2/3 cup (55g)**

Amount per serving
Calories   230

% Daily Value*

Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	

|	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 235mg	6%

* The % Daily Value (DV) tells you how much a nutrient in
a serving of food contributes to a daily diet. 2,000 calories
a day is used for general nutrition advice.

Application:

4. Understanding the daily calorie deficit necessary to reduce body fat allows a provider to predict the impact of individual dietary change

2,515 - 1,899 = **616 calorie deficit**
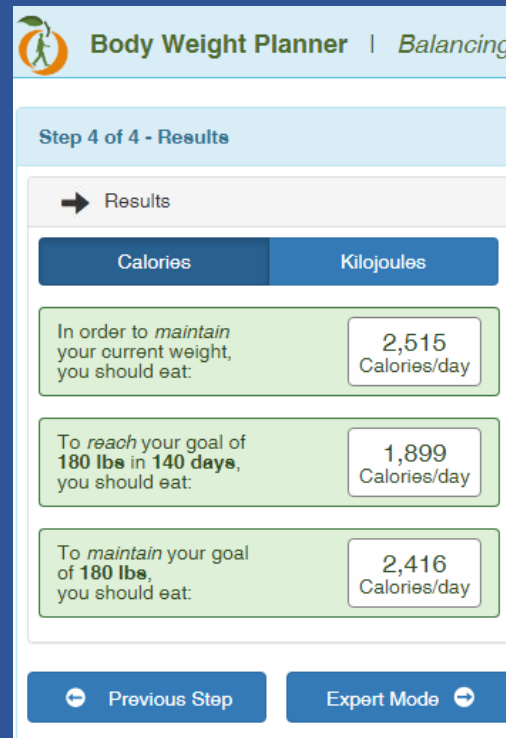
24 ounces of Pepsi (300 calories)

Conclusion:

1. The NIH Body Weight Planner is a free, easy to use & evidence based tool to estimate calorie requirements

2. This information can be used to educate patients during visits & make practical recommendations that don't necessarily require counting calories

Thank you!
Any Questions?

Gavin Moloney, MS, RD