

Lesson Seven Environmental and genetic risk factors

Overview

Students dive more deeply into environmental and genetic risk factors for type 2 diabetes and consider how these factors interact to reduce or increase risk. Students simulate genetic predisposition by drawing colored beans to represent alleles, and weigh environmental risk by assessing how access to resources and personal choice may increase or decrease risk factors over time.

Enduring understandings:

- The increase in type 2 diabetes nationally and globally appears to be associated with an increase in obesity, changes in diet to highly processed foods, a decrease in physical activity, as well as other factors.
- Type 2 diabetes can be prevented: factors contributing to a person's risk include good nutrition and exercise; personal choice; public health policies, access to resources, socio-economic status, and stress.

Essential question:

How do environmental and genetic risk factors influence a person's risk of developing type 2 diabetes?

Learning objectives

Students will be able to:

- Identify opportunities to increase or decrease risk for developing type 2 diabetes.
- Interpret genetic information associated with an increased risk for type 2 diabetes.
- Understand that genes do not influence the development of type 2 diabetes as much as behavior and lifestyle do, for the majority of people.

Prerequisite Knowledge

Students should have an understanding of the following terms: gene/genetic factor, environmental factor, inheritance, risk, protein, allele.

Time: Approximately 90 minutes

This lesson connects to the Next Generation Science Standards in the following ways:

Performance Expectation

HS LS3-3 Apply concepts of probability to explain the variation and distribution of expressed traits in a population.

HS LS3.B Disciplinary Core Idea

Variation of Traits: Variation and distribution of traits observed depend on both genetic and environmental factors.

Nature of Science: Science is influenced by society and society is influenced by science.

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Materials	Quantity
Computer and projector	1 per class
Access to the American Diabetes Association Risk Test found at http://www.diabetes.org/are-you-at-risk/diabetes-risk-test/ Or a paper version of the test, also available at the above address	1 per student
Class stock mixture of dry beans, in the following amounts and colors: 7-8 pounds of blue beans 2-3 pound of green beans 2-3 pound of orange beans Tan beans can be spray painted on one side, if similarly-sized blue, green and orange beans are not available. Pony beads of different colors can also be used.	Per class
Small opaque bag	1 per pair
From class stock mixture (above) make the following combinations: Standard Mix: Make most student groups a bag containing: 1 cup of blue beans, 1/3 cup green beans, and 1/3 cup orange beans. Risk Mix: Give one or two groups the standard mix, but add more orange beans and remove some green beans. Protective Mix: Give one or two groups the standard mix, but remove some orange beans and add some green beans.	1 per pair
Egg carton for 12 eggs	1 per pair
Student Sheet 7.1: <i>Genetic risk factors</i>	1 per student
Student Sheet 7.2: <i>Environmental influences and options</i>	1 per student
Teacher Resource: <i>Environmental and genetic risk cards</i>	1 set per class
<i>Contributions to Type 2 Diabetes</i> Poster, downloaded from https://gsoutreach.gs.washington.edu/ or copied from Teacher Resource	1 per class
<i>Optional:</i> Copy of the film <i>Unnatural Causes</i> from California Newsreel. It can be ordered from http://www.unnaturalcauses.org/	1 per class

Lesson Preparation

Prepare the bean bags for each student group, as described above. Make Copies of ADA risk assessment form, or provide student access to computers and the URL. Photocopy Student Sheets 7.1 and 7.2 one per student, and make a class set of the *Environmental and genetic risk cards*. Students will also need access to the *Contribution to Type 2 Diabetes* Poster found at the end of this lesson.

Teacher Note

The term “environment” is used quite broadly in this lesson, and encompasses factors such as access to resources, personal choice, and both the physical environment and the emotional/social environment. The film *Unnatural Causes*, available from California Newsreel, contains a 29-minute episode called *Bad Sugar* which addresses some of the

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social circumstances of health by making connections between diabetes, oppression, and empowerment in two Native American communities. This segment of the film would be ideal to show before this lesson, if possible.

Presenting the Unit

Part 1 (Engage/Explain): **ADA risk assessment** (15 minutes)

1. Remind students of the previous day’s discussion and refer to the Venn diagram (if available) showing the intersection of Environmental Factors and Genetic Factors that determine different traits.
2. Tell students that a **factor** (genetic *or* environmental) can be positive or negative. A positive factor is considered **protective**, and a negative factor is considered a **risk**. Ask students to think of an example of a protective factor and a risk factor for the environment. Answers could include:

Environmental Factors	
Protective	Risk
Walking to and from the school bus stop daily	Many hours of screen time daily
Low stress, or well-managed stress levels	High stress levels
Access to healthy, affordable food	Living in a “food desert” where access to healthy, affordable food is not available within a convenient travel distance

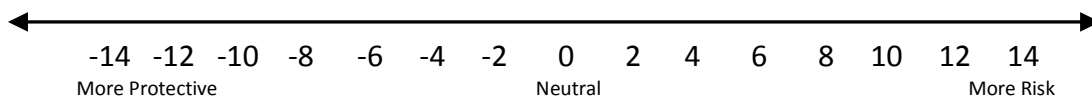
3. Tell students that genes can also be protective in nature, or add to a person’s risk of acquiring type 2 diabetes.
4. Review the American Diabetes Risk Assessment with students, either using the on line version or the paper version. Both are available at <http://www.diabetes.org/are-you-at-risk/diabetes-risk-test/>
5. Encourage students to play with the risk numbers in order to see which conditions lead to the highest risk for diabetes, and which conditions lead to the lowest. Allow students to take the test themselves if they choose to, but do not require students to share their results.
6. Discuss factors in the risk test over which people have control, or do not have control. Encourage discussion about how choices, access, genetic factors, and environmental factors affect the results of the risk assessment.

Note: The term **risk** is used here as it is in the field of public health. A person with an increased risk for t2d will not automatically develop t2d. Rather, risk is a measure that compares an individual to population data. In other words, a person’s risk of developing a disease given x, y, and z, is based on how many other people who have x, y, and z actually get the disease of concern.

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7. Tell students that they will now assess their *simulated* genetic predisposition for type 2 diabetes by doing an activity that will give them a hypothetical genetic risk score. During this exercise, we are assuming that some of the genes associated with type 2 diabetes increase susceptibility to the disease, some offer a protective effect, and some have no effect.
8. Show student the colored beans and egg cartons. Explain that each student will randomly draw two beans from the bag at a time to be placed in one of the egg spaces in the carton. When one person has drawn and recorded a total of 24 beans (2 beans x 12 egg spaces), the next person will draw 24 beans. Although students will be working independently, they will share supplies with a partner.
9. Tell students that students will be working with three different types of beans. Each pair of beans indicates a different pair of alleles.
10. Blue beans indicate alleles that have no effect on t2d. Orange beans increase risk for developing t2d, and green beans offer a protective effect, decreased the risk for developing t2d.
11. Pass out Student Sheet 7.1 *Genetic risk factors*, bean bags and egg cartons to each group. Give most student groups the **Standard Mix**, but give 1-2 groups the **Protective Mix**, and 1-2 groups the **Risk Mix**. Do not tell students which mix they have.
12. Let students complete the activity using Student Sheet 7.1: *Genetic risk factors*.
13. Have students tally their genetic risk score and record it on Student Sheet 7.1, as this number will be used at the beginning of the next section.
14. Ask the class to report back on their genetic risk scores, and record these numbers on a common scale, as shown below. Most of the scores should fall in a middle range, as most of the students received the Standard Mix of beans. The scores for the student groups who received either the Protective Mix or the Risk Mix, however, will be lower or higher than the norm.

Note: The commonly-used terms *dominant* and *recessive* are not generally used to describe genes related to type 2 diabetes. For many genes of interest, the exact mechanism is not well understood at this time.



15. Allow student to open their bags and look at the allele mix from their bags. How did the allele mix contribute to their (simulated) higher or lower risk scores? Will they take any actions based on this information?

Lesson Seven: Environmental and genetic risk factors**Part 3 (Explore): Assessing environmental access and choices (10 minutes)**

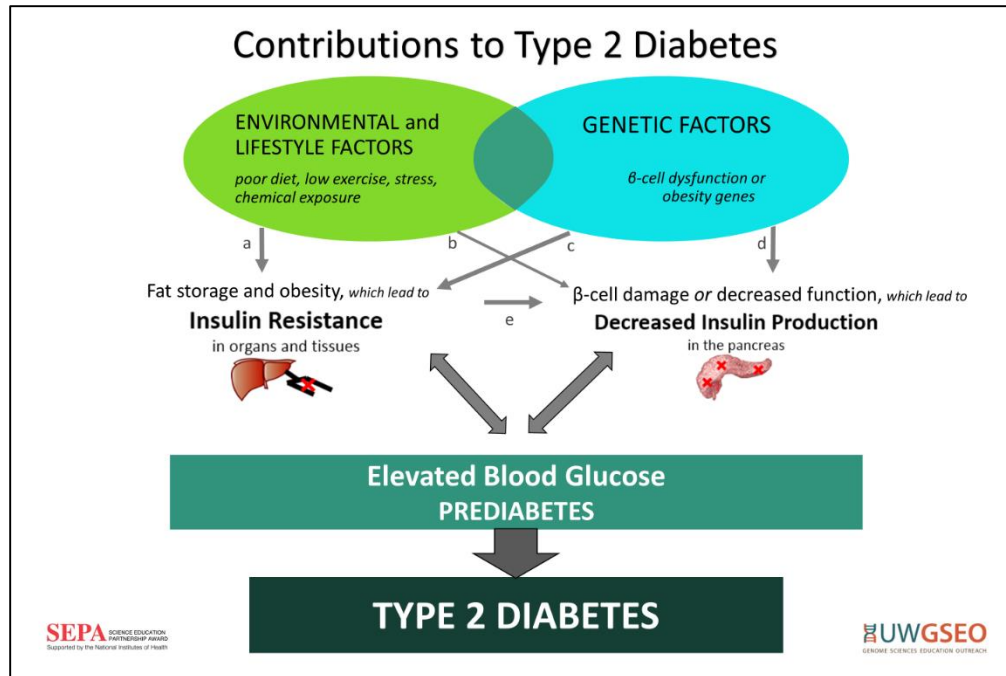
16. Tell students that they will be now be assessing their environmental risks for acquiring type 2 diabetes. If students don't feel comfortable assessing their own environmental risks, they may choose a fictional representative character to assess.
17. Pass out Student Sheet 7.2: *Environmental influences and options* for students to fill out. Allow students to tally their scores and answer the questions.
18. Help students determine which environmental factors are issues of *access*, and which are issues of *choice*. For example, students may live in neighborhoods with good parks (providing access to exercise) but choose not visit the park to walk, run, play Frisbee or otherwise exercise (an issue of choice). Conversely, students may not have access to a gym, but choose to run on a road.
19. Be aware that not all of the factors on the sheet are easily sorted into *access* or *choice* and be prepared to discuss areas of gray. If lack of time is a contributing factor to not exercising, is that an issue of choice or access? How does age factor into acquiring type 2 diabetes? Are high levels of stress a matter of access or choice?

Part 4 (Elaborate): Going Deeper (25 minutes)

20. Encourage students to ask questions about the specific factors listed and used for the tally. Tell students that each factor is supported by research in the scientific community.
21. Give each student an environmental or genetic risk card from the Teacher Resource: *Environmental and genetic risk cards*, or let students choose cards of interest to them.
22. Tell students that there are 25 environmental risk cards and only 6 genetic risk cards. Explain that the cards are weighted that way for a reason: Although genes may affect the development of type 2 diabetes, for most people they do not exert as much influence on health as behavior and lifestyle.
23. These cards can be used in a variety of ways depending on class time and teacher direction. Some examples include:
 - Each student could be asked to provide more research about his or her card, possibly as a homework assignment, using the source information on the card.
 - Students could share the information on the card in a round-robin exercise.
 - Students could meet in groups of four to share information the cards, and then regroup with new students until students have heard from a range of their peers.

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24. Show students the *Contributions to Type 2 Diabetes* poster found at <https://gsoutreach.gs.washington.edu/> as a PowerPoint slide, or as a Teacher Resource at the end of this lesson.



25. Spend some time unpacking the content of the slide with the class. For example, students saw the Venn diagram in the previous lesson, and learned about insulin resistance and β cell damage in the pancreas in Lesson Four. This slide puts those two concepts together. Ask students:

“What two mechanisms in the body lead to elevated blood glucose levels?”

Insulin resistance due to fat storage and obesity, and/or decreased insulin production, due to β -cell damage.

“Are these determined by environmental factors or genetic factors?”

Both. (Point out for students that arrows a, b, c, and d go from each side of the Venn diagram to each mechanism.)

26. Have students re-read their *Environment and genetic risk card*. Have them consider whether their particular card is more likely to be related to arrow *a* or *c* (*fat storage and obesity*) or arrow *b* or *d* (*β cell damage*). Ask students:

“Who has an Environmental Factor Card that follows arrow *a* (i.e. leads to insulin resistance through fat storage and obesity?)”

Almost all of the cards will fall into this category, even if it is a protective factor (i.e. getting lots of exercise). Even age as an environmental factor falls into this category.

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“Who has an Environmental Factor Card that follows arrow *b* (i.e. leads to decreased insulin production through β cell damage?)”

BPA exposure (Card 21) and Air pollution exposure (card 23) may both contribute directly to β cell damage.

“Why is arrow *b* thinner than the rest?”

*Arrow *b* shows that most environmental factors do not directly damage the pancreas, but rather contribute to diabetes risk through the fat storage and obesity route. Chemical exposure may be one way in which the pancreas is damaged directly through the environment.*

27. Likewise, ask about the Gene Cards. Which Gene Cards follow arrow *c* and which follow arrow *d*? See Table 1, below, for answers.

Table 1

	Insulin Resistance (through fat storage and obesity)	Decreased Insulin Production (through β cell damage)
Environmental Factor Cards	All cards <i>except</i> Cards 21 and 23	BPA exposure (Card 21) and air pollution exposure (Card 23) may both contribute directly to β cell damage
Gene Cards	Gene 1: Melanocortin-4 (MC4) Receptor Gene 2: Leptin (LEPR) Receptor Gene 3: PPAR Gene Family Gene 5: FTO	Gene 4: TC7L2 Gene 6: CDKAL1

28. Ask students to turn to a neighbor and explain their understanding of arrow *e*. What does it mean?

Prolonged insulin resistance itself can lead to β cell damage in the pancreas.

29. Tell students that this poster is a framework, or model, for thinking about factors that contribute to type 2 diabetes. What are some limitations of this model?

The mechanisms for developing type 2 diabetes are very complex and interconnected. This slide simplifies the process to the point that it likely introduces some inaccuracies. Also, there is much that is not known about how the mechanisms work, and how they affect each other.

Lesson Seven: Environmental and genetic risk factors**Closure (Evaluate)***(15 minutes)*

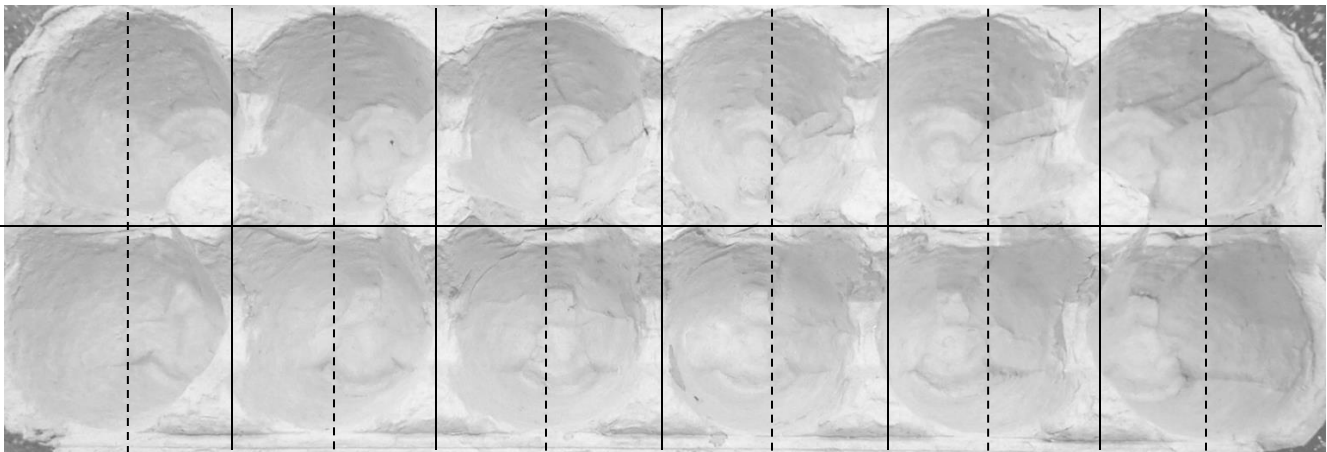
30. Ask students to write down five factors that appear to be associated with an *increase* in type 2 diabetes. Have them then turn to a neighbor and compare lists. If time allows, create a class list on the board.
31. Ask students to write down five factors that contribute to the *prevention* of type 2 diabetes. Again, have students turn to a neighbor and compare lists, and then create a class list if time allows.
32. Review with students that both genetic and environmental exposures may increase an individual's risk of acquiring type 2 diabetes. Likewise, there are genetic and environmental protective factors that influence likelihood of acquiring type 2 diabetes.
33. Ask students how this lesson contributes to their understanding of the Driving Question: ***How can the growth of type 2 diabetes in the Yakima Valley be slowed?***
34. Ask students if this lesson has raised any additional questions they would like to put on the Question Wall.

Name: _____ Date: _____ Period: _____

This activity simulates a genetic predisposition for getting type 2 diabetes. A high number indicates an increased risk, a neutral number indicates no change, and a low or negative number indicates the possibility of a protective effect.

Directions:

1. One person selects two beans from the bag and places them in the first egg carton slot.
2. Continue drawing two beans until each egg carton slot has two beans, for a total of 24 beans.
3. Record your bean combinations in the space below using the following symbols:
 - An orange bean is represented by a **+**. This indicates a risk factor.
 - A green bean is represented by a **-**. This indicates a protective factor.
 - A blue bean is represented by a **0**. This indicates a neutral factor.
4. Put the beans back into the bag and let your partner draw beans and record his or her combinations.



5. Tally your genetic risk score by adding 1 for each **+** and subtracting 1 for each **-**. Make no adjustments for each **0**.
6. Record your simulated genetic risk score: _____
7. No model is 100% accurate.
 - a. What are some strengths of this model?

 - b. What are some limitations?

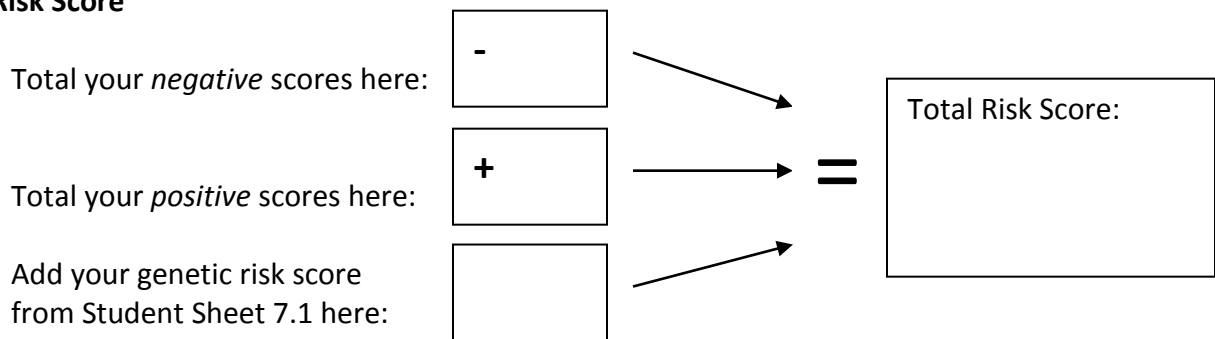
Name: _____ Date: _____ Period: _____

Directions: Fill in the following table to the best of your ability. You will not be required to share your score unless you choose to. “In your community” means the distance you can walk in 15-20 minutes, or the area you drive through frequently.

Environmental Factor	Range	Score	
1. Number of fast food establishments (such as McDonald’s or Burger King) or convenience stores that are in your community.	0–3 4+	0 +1	
2. Number of times you eat a meal at a fast food restaurant over the course of the week.	0–1 2–4 5+	0 +2 +4	
3. Number of servings of fruit juice you drink per day.	0–1 2–4	0 +2	
4. Number of 12-ounce sugar-sweetened sodas you drink on an average day (one 36 ounce drink = 3 x 12-ounce drinks).	Add 2 points per 12 oz.		
5. Number of grocery stores in your community.	0 1 2+	+1 0 -1	
6. Number of Farmer’s Markets, community gardens, or neighbors who share fresh produce in your community.	0 1 2+	+1 0 -1	
7. Number of servings of fruits and vegetables you have on an average day	Subtract 1 pt per serving		
8. Number of times per week you eat red meat (beef, pork, lamb)	0–1 2–4 5+	0 +2 +4	
9. Number of times per week you eat whole grains	0–1 2–4 5+	+4 0 -4	
10. Number of times per week you eat dessert, cookies and other sweets	0–1 2–4 5+	0 +2 +4	
11. Number of local gyms or sports clubs such as the Boys & Girls Club or YMCA in your neighborhood.	0 1 2+	+1 0 -1	
12. Number of times you exercise for 30 minutes or more over the course of the week.	0-1 2-4 5+	+4 0 -4	
13. Number of safe, free places to be physically active, such as parks, trails, skate parks, etc., within walking distance of where you live.	0 1-2 3+	+1 0 -1	
14. Number of days a week you spend more than 2 hours watching TV.	0-1 2-4 5-7	-2 0 +2	
15. Number of days per week you spend more than 4 hours playing video games or being on a computer or on your smart phone.	0-1 2-4 5-7	-2 0 +2	
16. Are the sidewalks in your neighborhood in good repair and/or do you see other people walking?	Yes No	-1 +1	
17. Are there bike lanes, paved shoulders of roads, or other safe places to ride a bike, near where you live?	Yes No	-1 +1	
18. Number of times you bike or walk to a destination over the course of a week, 1/2 a mile or more.	Subtract 1 point per time		

19. Do you have bus access in your neighborhood or within walking distance of where you live?	Yes No	-2 +1	
20. Number of times you drive to a destination less than 2 miles away from your home over the course of a week.	0-5 6+	0 +1	
21. Number of times per day you drink out of an older, hard plastic water bottle that is not BPA-free.	Add 1 point per time		
22. How many hours of sleep do you usually get every night?	Less than 5 5-9 >9	+1 -1 +1	
23. Do you live along a busy road?	Yes No	+1 -1	
24. What is your age?	Up to 45 46-64 65+	0 +2 +4	
25. How are your stress levels, on an average day? (Circle a number)	1 2 3 4 5 Not much Moderate Very stressed	Add the number you circled	

Total Risk Score



Assessment of Risk Score:

1. Do you consider your risk to be high, low, or average? Why?
2. What total risk score would you list as “high risk?” What about “low risk?” Explain your answer.
3. Given your risk score, how would you alter or improve environment risk factors contributing to your risk score?

Access and Choice:

Look back at the environmental factors table. Some of the factors are issues of **access** (do you have access to many fast food restaurants in your neighborhood?) and some are issues of **choice** (how often do you eat at fast food restaurants?). Put a STAR next to the factors that represent a **choice**.

Photocopy the following cards back to back, one set per class. Cards can be cut out along the lines.

<p>Environmental Factor 1</p> <p>Number of fast food establishments (such as McDonald’s or Burger King) or convenience stores that are in your community.</p> <p>Abby G. Ershow, Sc.D. 2009. Environmental Influences on Development of Type 2 Diabetes and Obesity: Challenges in Personalizing Prevention and Management in Journal of Diabetes Science and Technology, Diabetes Technology Society, 3, 727-734.</p>	<p>Environmental Factor 2</p> <p>Number of times you eat a meal at a fast food restaurant over the course of the week.</p> <p>Farah Naja, Hwalla N, Itani L, Salem N, Azar ST, Zeidan MN, 2012. Dietary patterns and odds of Type 2 diabetes in Beirut, Lebanon: a case control study. Nutrition and Metabolism 9: 111-122</p>
<p>Environmental Factor 3</p> <p>Number of servings of fruit juice you drink per day.</p> <p>Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/</p>	<p>Environmental Factor 4</p> <p>Number of 12-ounce sugar-sweetened sodas you drink on an average day (one 36 ounce drink = 3 x 12-ounce drinks).</p> <p>Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/</p>
<p>Environmental Factor 5</p> <p>Number of grocery stores in your community.</p> <p>Curry, Andrew. “Bringing Healthy Fare to Big-City ‘Food Deserts.’” Diabetes Forecast. December 2009. http://forecast.diabetes.org/magazine/your-ada/bringing-healthy-fare-big-city-food-deserts</p>	<p>Environmental Factor 6</p> <p>Number of Farmer’s Markets, community gardens, or neighbors who share fresh produce in your community.</p> <p>Curry, Andrew. “Bringing Healthy Fare to Big-City ‘Food Deserts.’” Diabetes Forecast. December 2009. http://forecast.diabetes.org/magazine/your-ada/bringing-healthy-fare-big-city-food-deserts</p>
<p>Environmental Factor 7</p> <p>Number of servings of fruits and vegetables you have on an average day</p> <p>Harding, AH, Wareham, NJ, Bingham SA et al (2008) Plasma vitamin C level, fruit and vegetable consumption, and the risk of new-onset type 2 diabetes mellitus: the European prospective investigation of cancer—Norfolk prospective study. Arch Intern Med 168:1493-1499.</p>	<p>Environmental Factor 8</p> <p>Number of times per week you eat red meat (beef, pork, lamb)</p> <p>Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/</p>

Back of cards

<p>A study from Beirut, Lebanon showed that people with type 2 diabetes are 2.80 times more likely to eat a high fast food diet than people without type 2 diabetes.</p>	<p>A study in Portland, OR showed that an increase in fast food outlets is associated with a 7% increase in being overweight and obese.</p> <p>Li F, Harmer PA, Cardinal BJ, Bosworth M, Acock A, Johnson-Shelton D, Moore JM. Built environment, adiposity, and physical activity in adults aged 50–75. <i>Am J Prev Med.</i> 2008; 35 (1):38–46.</p>
<p>Based on data from several studies, for every 12 oz. serving of a sugary drink per day, diabetes risk increases by 25%.</p> <p>Research on the effects of artificially-sweetened beverages is still unclear about association with t2d, but one large study of men showed that drinking one 12 oz can of diet soda per day does not affect t2d risk.</p>	<p>Drinking 2 or more servings per day of fruit juice is associated with a 31% increase in t2d risk compared to drinking less than 1 serving per month. There is growing evidence that daily drinking of sugary drinks also results in chronic inflammation, high triglycerides, decreased HDL (“good” cholesterol) and increased insulin resistance.</p>
<p>There is a strong correlations between increased rates of type 2 diabetes and people who live in areas without access to affordable, healthy food options within a convenient travelling distance.</p>	<p>A study of Chicago neighborhoods found that people who did not have access to affordable, healthy food options within a convenient travelling distance died from diabetes at twice the rate as people from areas offering access to grocery stores.</p>
<p>Eating red meat (beef, pork, or lamb) or processed red meat daily, even a small serving about the size of a deck of cards, increases diabetes risk by 20%.</p> <p>Replacing red meat with a daily serving of fish, poultry, nuts, or whole grains results in a 35% reduction in diabetes risk.</p>	<p>A 12-year study showed that people with higher levels of vitamin C were less likely to develop diabetes. Vitamin C is a good indicator of fruit and vegetable consumption because fruits and vegetables are the main source of vitamin C in the western diet. Even small amounts of them may be beneficial, and protection against diabetes increases with the amount of fruits and vegetables consumed.</p>

Front of cards

<p>Environmental Factor 9 Number of times per week you eat whole grains.</p> <p>Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/</p>	<p>Environmental Factor 10 Number of times per week you eat dessert, cookies and other sweets</p> <p>Farah Naja, Hwalla N, Itani L, Salem N, Azar ST, Zeidan MN, 2012. Dietary patterns and odds of Type 2 diabetes in Beirut, Lebanon: a case control study. Nutrition and Metabolism 9: 111-122</p>
<p>Environmental Factor 11 Number of local gyms or sports clubs such as the Boys & Girls Club or YMCA in your neighborhood.</p> <p>Auchincloss AH, Roux, A, Mujahid MS, et al. (2009) Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. Arch Intern Med. 12(18):1698-1704.</p>	<p>Environmental Factor 12 Number of times you exercise for 30 minutes or more over the course of the week.</p> <p>Gill JM and Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. Sports Med. 2008; 38(10):807-24.</p> <p>Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/</p>
<p>Environmental Factor 13 Number of safe, free places to be physically active, such as parks, trails, skate parks, etc., within walking distance of where you live.</p> <p>Li F, Harmer PA, Cardinal BJ, Bosworth M, Acock A, Johnson-Shelton D, Moore JM. Built environment, adiposity, and physical activity in adults aged 50–75. Am J Prev Med. 2008; 35 (1):38–46.</p>	<p>Environmental Factor 14 Number of days a week you spend more than 2 hours watching TV.</p> <p>Harvard School of Public Health. The Nutrition Source: Simple Steps to Preventing Diabetes: http://www.hsph.harvard.edu/nutritionsource/preventing-diabetes-full-story/</p>
<p>Environmental Factor 15 Number of days per week you spend more than 4 hours playing video games, being on a computer or on a phone.</p> <p>Owen N, Healy GN, Matthews CE, Dunstan DW. Too Much Sitting: The population-Health Science of Sedentary Behavior. Exerc Sport Scien Rev. July 2010; 38(3): 105-113.</p>	<p>Environmental Factor 16 Are the sidewalks in your neighborhood in good repair and/or do you see other people walking?</p> <p>Auchincloss AH, Roux, A, Mujahid MS, et al. (2009) Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. Arch Intern Med. 12(18):1698-1704.</p>

Back of cards

<p>A study from Beirut, Lebanon showed that people with diabetes are 3.85 times more likely to eat a diet high in refined grains and dessert, than people without type 2 diabetes.</p>	<p>In one study of women followed over 18 years, women who ate 3 or more servings of whole grains per day had a 30% lower risk of t2d than those who ate little or no whole grains. Based on several large studies, eating an extra 2 servings of whole grains per day reduces risk by 21%.</p>
<p>Vigorous physical activity is associated with a 20-30% reduction in diabetes risk, and brisk walking for 3.5-5 hours/week can improve risk of not developing type 2 diabetes by 30%.</p> <p>Active muscles involved in physical activity are able to take up increased amounts of glucose. This is balanced by the liver producing more glucose.</p>	<p>A study following people over 5 years found that better neighborhood resources, such as those that offered opportunities to be physically active and access to healthy food, were associated with a 38% lower incidence of type 2 diabetes.</p>
<p>One study found that for every two hours a day spent watching television instead of doing something more active resulted in a 20% increase in diabetes risk.</p>	<p>A Portland, OR study found that a mix of more street intersections interspersed with green spaces and parks was associated with more neighborhood walking. A 10% increase in land-use mix resulted in a 25% reduction in the prevalence of people being overweight and obese, which affects type 2 diabetes.</p>
<p>A study following people over 5 years found that better neighborhood resources, such as those that offered opportunities to be physically active and access to healthy food, were associated with a 38% lower incidence of type 2 diabetes.</p>	<p>One study found that the more time a person sits per day correlates to higher levels of blood glucose and fasting glucose, even in active adults.</p> <p>This study coined the term “Active Couch Potato” to describe adults who got enough physical activity to meet healthy guidelines, but still sat for long periods of time each day</p>

Front of cards

<p>Environmental Factor 17</p> <p>Are there bike lanes, paved shoulders of roads, or other safe places to ride a bike, near where you live?</p> <p>Auchincloss AH, Roux, A, Mujahid MS, et al. (2009) Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the multi-ethnic study of atherosclerosis. <i>Arch Intern Med.</i> 12(18):1698-1704.</p>	<p>Environmental Factor 18</p> <p>Number of times you bike or walk to a destination over the course of a week, 1/2 a mile or more.</p> <p>Gill JM and Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. <i>Sports Med.</i> 2008; 38(10):807-24.</p>
<p>Environmental Factor 19</p> <p>Do you have bus access in your neighborhood or within walking distance of where you live?</p> <p>Li F, Harmer PA, Cardinal BJ, Bosworth M, Acock A, Johnson-Shelton D, Moore JM. Built environment, adiposity, and physical activity in adults aged 50–75. <i>Am J Prev Med.</i> 2008; 35 (1):38–46.</p>	<p>Environmental Factor 20</p> <p>Number of times you drive to a destination less than 2 miles away from your home over the course of a week.</p> <p>Gill JM and Cooper AR. Physical activity and prevention of type 2 diabetes mellitus. <i>Sports Med.</i> 2008; 38(10):807-24.</p>
<p>Environmental Factor 21</p> <p>Number of times per day you drink out of an older, hard plastic water bottle that is <i>not</i> BPA-free.</p> <p>Alonso-Magdalena P, Morimoto S, Ripoll C, Fuentes E, Nadal A. Effect of Bisphenol A Disrupts Pancreatic B-Cell Function <i>In Vivo</i> and Induces Insulin Resistance. <i>Environmental Health Perspectives.</i> 2006; 114(1):106-112.</p>	<p>Environmental Factor 22</p> <p>How many hours of sleep do you usually get every night?</p> <p>Gangwisch JE, Heymsfield SB, Boden-Albala B, Buijs RM, Kreier F, Pickering TG, Rundle AG, Zammit GK, Malaspina D. Sleep duration as a risk factor for diabetes incidence in a large US sample. <i>Sleep.</i> 2007; 30(12):1667–1673.</p>
<p>Environmental Factor 23</p> <p>Do you live along a busy road?</p> <p>Ursula Krämer, Christian Herder, Dorothea Sugiri, Klaus Strassburger, Tamara Schikowski, Ulrich Ranft, Wolfgang Rathmann, 2010. Traffic-Related Air Pollution and Incident Type 2 Diabetes: Results from the SALIA Cohort Study. <i>Environ Health Perspect</i> 118:1273-1279 (2010).</p>	<p>Environmental Factor 24</p> <p>What is your age?</p> <p>http://www.diabetes.org/diabetes-basics/statistics/</p>

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<p>Vigorous physical activity is associated with a 20-30% reduction in diabetes risk, and brisk walking for 3.5-5 hours/week can improve risk of not developing type 2 diabetes by 30%.</p> <p>Active muscles involved in physical activity are able to take up increased amounts of glucose. This is balanced by the liver producing more glucose.</p>	<p>A study following people over 5 years found that better neighborhood resources, such as those that offered opportunities to be physically active and access to healthy food, were associated with a 38% lower incidence of type 2 diabetes.</p>
<p>Vigorous physical activity is associated with a 20-30% reduction in diabetes risk, and brisk walking for 3.5-5 hours/week can improve risk of not developing type 2 diabetes by 30%.</p> <p>Active muscles involved in physical activity are able to take up increased amounts of glucose. This is balanced by the liver producing more glucose.</p>	<p>A study in Portland, OR found that more public transit stations in an area were associated with people walking more for transportation.</p>
<p>Routinely getting 5 hours or less sleep per night as an adult is associated with developing type 2 diabetes. This effect is attributed to weight gain and chronic stress due to low sleep.</p> <p>There is also an association between getting more than 9 hours sleep per night as an adult and type 2 diabetes. This association may be due to increased release of small proteins which cause sleepiness, and disrupt glucose balance and β cell function.</p>	<p>Bisphenol A (BPA) is used in making polycarbonate plastics and leaches from plastics. BPA is found in the urine of most Americans, and higher levels of BPA in the urine are associated with type 2 diabetes.</p> <p>In studies of mice with higher levels of BPA, beta cells produced and released more insulin, which increased insulin resistance.</p>
<p>As people get older, their risk for type 2 diabetes goes up. About 11% of the people between the ages of 20 and 64 have diabetes. After the age of 65, almost 27% of people in this age group have diabetes. As in other age groups, type 2 diabetes is associated with obesity.</p>	<p>In a longitudinal study of women in an industrialized section of Germany, risk of type 2 diabetes was increased by 15% for each doubling in exposure to particulate matter such as that found in air pollution near busy roads.</p>

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<p>Environmental Factor 25</p> <p>How are your stress levels, on an average day?</p> <p>Diabetes.co.uk (2013). Diabetes warning for stressed men. http://www.diabetes.co.uk/news/2013/Feb/type-2-diabetes-warning-for-stressed-men-96045737.html</p>	
<p>Gene 1</p> <p>Melanocortin-4 (MC4) Receptor</p> <p>http://www.diabetes.org/news-research/research/research-database/molecular-genetics-of-human-obesity.html</p>	<p>Gene 2</p> <p>Leptin (LEPR) Receptor</p> <p>http://ghr.nlm.nih.gov/condition=leptin-receptor-deficiency</p>
<p>Gene 3</p> <p>PPAR Gene Family</p> <p>http://www.diabetesselfmanagement.com/Articles/Diabetes-Definitions/ppar_agonists/</p> <p>Marie-France Hivert et al., Updated Genetic Score Based on 34 Confirmed Type 2 Diabetes Loci is Associated with Diabetes Incidence and Regression to Normoglycemia in the Diabetes Prevention Program. 2011. Diabetes, 6, 1340-1348.</p>	<p>Gene 4</p> <p><i>TC7L2</i></p> <p>Marie-France Hivert et al., Updated Genetic Score Based on 34 Confirmed Type 2 Diabetes Loci is Associated with Diabetes Incidence and Regression to Normoglycemia in the Diabetes Prevention Program. 2011. Diabetes, 6, 1340-1348.</p> <p>http://www.ncbi.nlm.nih.gov/omim http://www.ncbi.nlm.nih.gov/SNP/</p>
<p>Gene 5</p> <p><i>FTO</i></p> <p>Frayling, T. M., Timpson, N. J., Weedon, M. N., Zeggini, E., Freathy, R. M., Lindgren, C. M., Perry, J. R. B., Elliott, K. S., Lango, H., Rayner, N. W., Shields, B., Harries, L. W., and 30 others. A common variant in the FTO gene is associated with body mass index and predisposes to childhood and adult obesity. Science 316: 889-894, 2007.</p> <p>http://www.ncbi.nlm.nih.gov/omim http://www.ncbi.nlm.nih.gov/SNP/</p>	<p>Gene 6</p> <p><i>CDKAL1</i></p> <p>Marie-France Hivert et al., Updated Genetic Score Based on 34 Confirmed Type 2 Diabetes Loci is Associated with Diabetes Incidence and Regression to Normoglycemia in the Diabetes Prevention Program. 2011. Diabetes, 6, 1340-1348.</p> <p>http://www.ncbi.nlm.nih.gov/omim http://www.ncbi.nlm.nih.gov/SNP/</p>

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	<p>From a 35 year longitudinal study of 7000 Swedish men, it was found that chronically stressed men had a 45% higher risk of developing type 2 diabetes.</p> <p>Stress results in the release of the hormone cortisol, which raises blood pressure, and raises blood glucose by causing insulin resistance.</p>
<p>Leptin is a hormone produced by fat cells that manages appetite and metabolism. Binding of leptin to leptin receptors reduces the amount of glucose released into to the blood by the liver and increases glucose uptake from the blood into the muscle.</p> <p>A mutation to the LEPR (leptin receptor) is a rare cause of obesity.</p>	<p>The MC4 receptor is expressed in the brain and helps match food intake to energy expenditure.</p> <p>Mutations in the MC4 receptor can predispose an individual to severe obesity. Mutations in the MC4 receptor gene account for 1 to 6% of cases of severe obesity cases</p>
<p>The protein coded for by the gene TC7L2 is involved in maintaining glucose homeostasis. Risk alleles in this gene have been shown to be associated with impaired β cell function and type 2 diabetes in European populations</p>	<p>This gene family regulates the body's breakdown of fatty acids, the generation of fat cells and affects blood glucose control.</p> <p>A variation in the PPAR-gamma gene is associated with a <i>reduction</i> in the risk for type 2 diabetes as it predisposes people to having less fat.</p> <p>A group of anti-diabetic drugs targets the PPAR-gamma gene</p>
<p>The gene CDKAL1 is expressed the most in skeletal muscle and the brain. The protein from this gene may be involved with insulin release, and certain allele combinations decrease insulin levels by 20%.It is thought to be associated with decreased β cell function.</p>	<p>The gene FTO is involved in hunger control, and people with the risk alleles are associated with increased body mass indexes and rates of obesity, both of which are linked to type 2 diabetes.</p>

Contributions to Type 2 Diabetes

