EDUCATION RESEARCH

Introducing physiology of diabetes to American Asian middle school and high school students

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Zuercher JL, Gopalan C. Introducing physiology of diabetes to American Asian middle school and high school students. Adv Physiol Educ 44: 587–591, 2020; doi:10.1152/advan.00088.2020.—Diabetes, a chronic condition that impacts millions, is a complex disease. Understanding the disease can contribute to increasing awareness about this debilitating condition and preventing occurrences. Furthermore, inoculation of physiology knowledge may lead to an increased likelihood of career goals that align with this area of study. In pursuit of these goals, we set out to educate middle and high school students about diabetes. Thirty (16 high school; 14 middle school) students from a Sunday school program at an urban religious center completed a 10-question pretest as a way to measure initial knowledge about diabetes. Following completion of the survey, a 1-h education session was presented by a local physician who also brought a glucometer and insulin syringes for students to have a hands-on experience with some disease-specific tools. A posttest was administered following the presentation. The posttest consisted of 11 questions, where all but 2 questions were the same as for the pretest, measuring improvement of prior knowledge and engagement in the presentation. The overall posttest average score increased by approximately two correct responses, which was a significant improvement ($P < 0.0001$), suggesting that the students were motivated to and did learn diabetes concepts. This study also suggests that exposing students to educational activities related to physiology is beneficial and may lead to an increase in interest in physiology, an awareness of diabetes, and perhaps the development of healthy habits.

INTRODUCTION

Diabetes mellitus, commonly referred to as diabetes, is a metabolic disorder that is characterized by high blood glucose levels over a prolonged period. There are two main forms of diabetes mellitus, type 1 and type 2. Diabetes is often associated with the dysfunction of insulin production and secretion, as well as the target cells’ responsiveness to insulin. The latest estimate of people with diabetes in the United States as per the Diabetes Statistics Report for 2020, is 34.2 million (10.5% of the U.S. population of all ages) (7). It is estimated that ~7.3 million people have the condition but have not been diagnosed (7). In addition, ~79 million people in the United States are estimated to have prediabetes, a condition in which blood glucose levels are abnormally high, but not high enough to be classified as diabetes.

Diabetes often progresses undiagnosed for years. Over time, persistently high levels of glucose in the blood injure tissues throughout the body, especially those of the blood vessels and nerves. Complications of this disease make diabetes the seventh leading cause of death in the United States (10). Early detection and subsequent treatment decrease the chance of developing the more serious complications of diabetes.

Learning about the disease can contribute to both increasing awareness about this debilitating condition and may lead to preventing occurrences. A key component to prevention is education about risk factors for developing the disease, including being overweight or obese, a family history of diabetes, high blood pressure, low high-density lipoprotein (HDL) cholesterol or high levels of triglycerides, lack of physical activity, and being of African American, Alaska Native, American Indian, Asian American, Hispanic/Latino, Pacific Island, or Native Hawaiian descent (18). Particularly, among non-Hispanic Asians, Asian Indians are at the highest prevalence of diabetes (7). Creating opportunities for primary prevention activities may prove to be particularly fruitful for long-term health among Asian Indian youth.

While educating adults is important, educating youth about the disease and its risk factors may lead to greater prevention through the possibility of longer term adherence to positive health behaviors. Many of these opportunities occur outside of the formal school setting, partially due to curricula changes in public and many private schools that have increased the emphasis on language arts and math, and limited time for science (15). Providing educational opportunities in extracurricular environments, such as youth organizations, typically require parental support for participation and the enthusiasm of the volunteer scientist (4). As recognized by Wang and Staver (24), parental support for learning science is strongly associated with career aspiration. In addition to learning more about the disease itself, providing youth with learning opportunities that allow them to explore topics related to the health sciences can increase the likelihood that these youth will become interested in and pursue careers in this area. Furthermore, a better understanding of one’s career aspiration may lead to better planning when it comes to determining coursework in high school and beyond (1). These factors combined may encourage students to follow careers in health and science.

Specifically, this experience took place during Physiology Understanding (PhUn) Week. PhUn Week was an annual outreach program sponsored by the American Physiological Society (APS), partnering physiologists, and grades K–12.
students, introducing students to physiological concepts. Since
2005, physiology professionals, researchers, and teachers have
been providing focused efforts to educate youth in kindergarten
through 12th grade about a variety of topics related to physi-
ology during one specific week in November each year (23).
Through the introduction of concepts related to physiology and
health, youth become more aware of, and are potentially more
likely to learn about and pursue careers related to, physiology
and health.

In pursuit of these goals, we set out to educate a group of
Asian Indian middle school and high school students about
diabetes, the impact of this disease on health in the short and
long term, and the possibilities of pursuing a career in an area
of physiology, such as diabetes.

METHODS

This project was approved by the Institutional Review Board at
Southern Illinois University Edwardsville. Students attending a Sun-
day school program at an urban religious center were recruited to
participate in an educational session on diabetes. Before the session,
students completed a 10-question pretest (APPENDIX A). The first
question asked if students had heard of diabetes previously. The
remaining questions measured initial knowledge about the disease. A
physician expert provided a 1-h educational session, discussing dia-
betes mechanisms, causes, symptoms, and treatments. Students also
had the opportunity to learn about the purpose of a glucometer and its
use as well as to manipulate it. They were also introduced to insulin
syringes. A posttest was administered following the presentation,
measuring improvement of prior knowledge and engagement in the
presentation. The posttest consisted of 11 questions, 9 of which
matched the pretest (APPENDIX B). The first question was an opinion
question, asking students if they learned anything new about diabetes
during the presentation. The final question asked students to name
one thing new that they learned about diabetes during the session. A
paired Student’s \( t \) test was used to analyze the data from both the pretest
and the posttest using Graphpad Prism. Responses to the final question
were summarized for reporting.

RESULTS

A total of 30 students (16 high school; 14 middle school)
from the Sunday school program, and all of Asian Indian
descent, participated in the event (Fig. 1). The pretest began by
asking students if they had heard of diabetes before this event;
90% of students stated that they had heard of diabetes before.
The next nine questions were used to assess knowledge. The
overall posttest average score increased by approximately two
correct responses, which was a significant improvement \((P <
0.0001)\) (Fig. 2). Evaluated separately, posttest scores for
both middle school and high school students reflected a
significant improvement (Figs. 3 and 4). The topics men-
tioned most frequently as additional points that students
learned about diabetes were diet (“carbs have a large impact
on diabetes”), the organs involved or impacted (“the pan-
creas is the organ that creates the insulin”), and impacts of
the disease (“polyuria–excess urination”).

DISCUSSION

A special session was organized to provide an educational
opportunity to youth as a means of exposing them to physiol-
ogy, a science that receives little emphasis in the schools. This
one-time, short-duration session provided the opportunity for
youth to learn about a disease relevant to their ethnic group
(20). Furthermore, it allowed students to be exposed to con-
cepts that they may want to learn more about and use in a
future career.

As shown from the pre- and postsurveys, this one, short
presentation about diabetes, provided by a trusted source, led to
a significant improvement in knowledge on the topic. While
there is certainly more knowledge and depth for students to
learn on the topic, this does provide evidence that a one-time,
short educational session can prove impactful for such an
audience. Similarly, short-duration interventions with ado-
lescents on topics such as breastfeeding (19) and organ
donation (6) proved effective in increasing knowledge. The
addition of the hands-on aspect of this learning is supported

Fig. 1. Middle school and high school stu-
dents with the diabetes speaker. [Copyright:
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by literature in the area of experiential learning, wherein the addition of such opportunities yields significant gains in student understanding (13).

As stated previously, individuals of Asian Indian descent are at increased risk for developing diabetes. At a minimum, the short-term gains in knowledge and understanding of the disease meet the goal of primary prevention programs (11). In the long term, this knowledge could serve a twofold purpose related to prevention: 1) to increase the knowledge base related to this disease among youth who may one day develop the disease; and 2) the opportunity for youth to bring such knowledge home to the adults in their family, thereby helping to lower risk among a larger portion of an ethnicity already at increased risk for disease development.

Students in both middle and high school participated in this event. While the middle schoolers still have plenty of time before making career and college major decisions, the earlier students are reached, and the larger the number of career exposures, the greater the likelihood that they will be able to make an informed decision about their major and future career (9). For older students, exposure can lead to career decisions, and repeated exposures can help to solidify previously made decisions (8). There are several strengths to this study. First, the youth who participated in this project meet together regularly, providing an audience for intervention. Because these youth regularly meet together, the level of comfort with the situation was quite likely high. Additionally, utilizing pre-/posttests that are essentially the same allowed us to effectively assess change in knowledge related to listening to the presentation.

Furthermore, opportunities such as this, even as a one-time short-duration session, may instill interest in students to pursue health careers due to the new knowledge they were able to receive from the PhUn activity. Providing learning opportunities in venues that are familiar and comfortable to attendees allows them to focus on the topic and presentation, rather than their potential discomfort in the situation itself. Even among students already on a career path, such as medicine, short-duration interventions providing exposure to a specific topic (such as surgery) were effective in generating interest toward career pursuits (22). As found by Blotnicky et al. (5), middle school students have little exposure and, therefore, little knowledge about what a career in STEM (Science, Technology, Engineering, Mathematics) involves, let alone about the STEM careers themselves. Exposing children to a variety of careers affords them more opportunities for self-evaluation of abilities and interests and, therefore, allows for greater fit of career expectations (21).

A limitation of this work is the small sample size. While it would have been desirable to reach more youth for this project, we were still able to observe a significant improvement in knowledge about diabetes among both middle and high school students. Furthermore, a point that we were not able to measure directly, or even measure at this point in time, is the residual influence of this event on students’ behavior, as well as their career trajectory. Learning about diabetes is important for everyone, but particularly for those who are at increased risk for development of the disease. Asian Indian Americans are at increased risk for developing diabetes compared with white Americans (16).

While any number of subtopics under the heading of physiology could have been selected to present to these students, diabetes was specifically chosen, given the increased risk among individuals of Asian Indian descent. As stated previously, in the United States, Asian Indians are among the highest risk populations for developing this disease (16). Asian Indians in the U.S. and other Western countries are at a particularly increased risk due to adoption of a Westernized diet, as well as increased risk for insulin resistance (12, 14). Even within India, due to this increased risk for insulin resistance compared with white people, risk for developing diabetes as well as other diseases, such as cardiovascular disease, are increased, even without the increase in weight seen in Western countries and other types of risk factors (2, 3, 17).

In conclusion, the positive impact shown through this study suggests that the students were motivated to and did learn diabetes concepts. This study also suggests that exposing students to educational activities related to physiology is beneficial and may lead to an increase in interest in the topic. Additional opportunities should be created to increase awareness of common chronic diseases early in life as a preventative measure, as well as a means of exposing youth to potential career paths and opportunities.

APPENDIX A: ALL ABOUT DIABETES PRETEST

Are you in: [ ] middle school [ ] high school

1. Have you heard about diabetes?
   a. Yes
   b. No

2. People can catch diabetes (like a cold or the flu).
   a. True
   b. False

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Fig. 3. Comparison of pre- and posttest scores of middle school students (n = 14). ***P < 0.001.

Fig. 4. Comparison of pre- and posttest scores of high school students (n = 16). **P < 0.01.
3. What is diabetes?
   a. Too much sugar or glucose in your bloodstream
   b. Too much insulin in your bloodstream
   c. Weighing too much
   d. None of the above

4. What hormone is involved in diabetes?
   a. Thyroxine
   b. Epinephrine
   c. Cholecystokinin
   d. Insulin

5. If diabetes isn’t under control, it can harm which body part(s)?
   a. Liver
   b. Eyes and kidneys
   c. Heart
   d. a and c

6. The types of diabetes include:
   a. Type A and type B
   b. Type 1 and type 2
   c. Kids and adults
   d. There is only one type of diabetes

7. The nutrient that a person with diabetes needs to control really well is:
   a. Carbohydrates
   b. Vitamin C
   c. Protein
   d. Calcium

8. The type of diabetes that can be reversed is:
   a. Type 1
   b. Juvenile
   c. Type 2
   d. No type of diabetes can be reversed.

9. Eating too much sugar can cause diabetes.
   a. True
   b. False

10. Risk factors for developing type 2 diabetes include:
    a. Family history
    b. Diet
    c. Weight
    d. All of the above

APPENDIX B: ALL ABOUT DIABETES POSTTEST

1. Did you learn something new about diabetes today?
   a. Yes
   b. No

2. People can catch diabetes (like a cold or the flu).
   a. True
   b. False

3. What is diabetes?
   a. Too much sugar or glucose in your bloodstream
   b. Too much insulin in your bloodstream
   c. Weighing too much
   d. None of the above

4. What hormone is involved in diabetes?
   a. Thyroxine
   b. Epinephrine
   c. Cholecystokinin
   d. Insulin

5. If diabetes isn’t under control, it can harm which body part(s)?
   a. Liver
   b. Eyes and kidneys
   c. Heart
   d. b and c

6. The types of diabetes include:
   a. Type A and type B
   b. Type 1 and type 2
   c. Kids and adults
   d. There is only one type of diabetes

7. The nutrient that a person with diabetes needs to control really well is:
   a. Carbohydrates
   b. Vitamin C
   c. Protein
   d. Calcium

8. The type of diabetes that can be reversed is:
   a. Type 1
   b. Juvenile
   c. Type 2
   d. No type of diabetes can be reversed.

9. Eating too much sugar can cause diabetes.
   a. True
   b. False

10. Risk factors for developing type 2 diabetes include:
    a. Family history
    b. Diet
    c. Weight
    d. All of the above

11. Name one additional point about diabetes that you learned today:
    ____________________________________________________

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS
J.Z. and C.G. conceived and designed research; J.Z. and C.G. performed experiments; J.Z. and C.G. analyzed data; J.Z. and C.G. interpreted results of experiments; C.G. prepared figures; J.Z. and C.G. edited and revised manuscript; J.Z. and C.G. approved final version of manuscript.

REFERENCES
1. Arora V, Schneider B, Thal R, Meltzler D. Design of an intervention to promote entry of minority youth into clinical research careers by aligning ambition: the TEACH (Training Early Achievers for Careers in Health) research program. J Soc Sci 67: 580–598, 2011. doi:10.1111/j.1540-4560.2011.01715.x.

2. Bajaj M, Banerji MA. Type 2 diabetes in South Asians: a pathophysiology focus on the Asian-Indian epidemic. Curr Diab Rep 4: 213–218, 2004. doi:10.1007/s11892-004-0026-4.

3. Banerji MA, Faridi N, Atluri R, Chaiken RL, Lebovitz HE. Body composition, visceral fat, leptin, and insulin resistance in Asian Indian men. J Clin Endocrinol Metab 84: 137–144, 1999. doi:10.1210/jc.84.1.137.

4. Beck MR, Morgan EA, Strand SS, Woolsey TA. Mentoring. Volunteers bring passion to science outreach. Science 314: 1246–1247, 2006. doi:10.1126/science.1131917.

5. Blotnický KA, Franz-Odendaal T, French F, Joy P. A study of the correlation between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students. Int J STEM Educ 5: 22, 2018. doi:10.1186/s40594-018-0118-3.

6. Cárdenas V, Thornton JD, Wong KA, Spigner C, Allen MD. Effects of classroom education on knowledge and attitudes regarding organ donation in ethnically diverse urban high schools. Clin Transplant 24: 784–793, 2010. doi:10.1111/j.1399-0012.2009.01200.x.

7. Centers for Disease Control and Prevention. National Diabetes Statistics Report 2020. Estimates of Diabetes and Its Burden in the United States (Online). https://www.diabetesresearch.org/life/national-diabetes-statistics-report-2020 [2 April 2020].

8. Ciarcio NJ. Traditional and new approaches to career preparation through coursework. Teach Psychol 45: 32–40, 2018. doi:10.1177/00962831744963.

9. Gore J, Holmes K, Smith M, Southgate E, Albright J. Socioeconomic status and the career aspirations of Australian school students: testing enduring assumptions. Aust Educ Res 42: 155–177, 2015. doi:10.1007/s13384-015-0172-5.

10. Heron M. Deaths: Leading causes for 2017. Natl Vital Stat Rep 68: 1–76, 2019.
11. Institute for Work & Health. What Researchers Mean by Primary, Secondary and Tertiary Prevention (Online). https://www.iwh.on.ca/what-researchers-mean-by/primary-secondary-and-tertiary-prevention [15 July 2020].

12. Kaushal N. Adversities of acculturation? Prevalence of obesity among immigrants. Health Econ 18: 291–303, 2009. doi:10.1002/hec.1368.

13. Kolb D. Experiential Learning: Experience as the Source of Learning and Development. Englewood Cliffs, NJ: Prentice Hall, 1984.

14. Lee JWR, Brancati FL, Yeh H-C. Trends in the prevalence of type 2 diabetes in Asians versus whites: results from the United States National Health Interview Survey, 1997-2008. Diabetes Care 34: 353–357, 2011. doi:10.2337/dc10-0746.

15. Marx RW, Harris CJ. No child left behind and science education: opportunities, challenges, and risks. Elem Sch J 106: 467–478, 2006. doi:10.1086/505441.

16. Misra R. Immigrant Asian Indians in the U.S.: a population at risk for diabetes and cardiovascular disease. Health Educ 41: 19–48, 2009.

17. Misra A, Khurana L. Obesity-related non-communicable diseases: South Asians vs. White Caucasians. Int J Obes 35: 167–187, 2011. doi:10.1038/ijo.2010.135.

18. National Institute for Diabetes and Digestive and Kidney Diseases. Risk Factors for Type 2 Diabetes (Online). https://www.niddk.nih.gov/health-information/diabetes/overview/risk-factors-type-2-diabetes [2 April 2020].

19. Reyes C, Barakat-Haddad C, Barber W, Abbass-Dick J. Investigating the effectiveness of school-based breastfeeding education on breastfeeding knowledge, attitudes and intentions of adolescent females. Midwifery 70: 64–70, 2019. doi:10.1016/j.midw.2018.12.010.

20. Rhee EJ. Diabetes in Asians. Endocrinol Metab (Seoul) 30: 263–269, 2015. doi:10.3803/EmM.2015.30.3.263.

21. Schaefer MB, Rivera LM, Ophals E. Creating a collaborative career development program for middle grades students. Middle Sch J 42: 30–38, 2010. doi:10.1080/00940771.2010.11461754.

22. Seo HS, Eom YH, Kim MK, Kim YM, Song BJ, Song KY. A one-day surgical-skill training course for medical students’ improved surgical skills and increased interest in surgery as a career. BMC Med Educ 17: 265, 2017. doi:10.1186/s12909-017-1106-x.

23. Stieben M, Halpin PA, Matyas ML. Developing a nationwide K–12 outreach model: Physiology Understanding (PhUn) Week 10 years later. Adv Physiol Educ 41: 357–362, 2017. doi:10.1152/advan.00005.2017.

24. Wang J, Staver JR. Examining relationships between factors of science education and student career aspiration. J Educ Res 94: 312–319, 2001. doi:10.1080/00220670109598767.