

Service-Learning Project Improves Health Literacy via STEM Curriculum in Bronx NY Elementary Students



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Background

Bronx County, New York has a population of 1.46 million people, with an average per capita income of \$18,269 and 31.5% of residents living in poverty (years 2010-2014)¹. In an annual New York State review for health indices and community health environment, the Bronx has been ranked last out of 62 counties since 2010². Bronx county has been deemed a “food desert,” an urban area where it is difficult to buy affordable or good-quality fresh food³. The poverty and community environment in the Bronx likely contributes to physical inactivity and unhealthy eating habits of residents. Decreased physical activity and poor diet are implicated in higher rates of type 2 diabetes, hypertension, cardiovascular disease, obesity, and cancer^{4,5}. Furthermore, high school graduation rates in the Bronx in 2013 and 2014 were 53% and 55%, respectively, whereas the rest of New York State had 75% and 76%, respectively for those years⁶. Education level has been demonstrated to have causal effect on health outcomes and behaviors⁷. It is clear that health awareness and literacy are inadequate in Bronx County, however, it is possible that early age interventions could make substantial strides in increasing academic success and healthy habits. To this end, we created Hoops 4 Health (H4H), a community-based service learning organization of volunteer medical and graduate students at Albert Einstein College of Medicine (AECOM). H4H engaged youth at the after-school program of the South Bronx Police Athletic League (PAL) to 1) develop a survey to evaluate attitudes, competency, beliefs, skills, and cultural influences that impact scientific curiosity and health awareness; and 2) administer a STEM and nutrition-focused curriculum and identify significant factors resulting in health literacy and STEM-interest improvements.

Materials & Methods

❖ Hoops 4 Health at the Police Athletic League

We designed an innovative monthly STEM education and physical fitness curriculum for fourth and higher grade students at the PAL, which offers an after-school program Monday through Friday from 3pm-6pm. Over the past three academic years, we have held 1.5 hour sessions every month, where the students participated in a forty-five minute STEM module followed by forty-five minutes in the gymnasium for physical fitness and additional health-related counseling. To assess the impact of the intervention, we administered a 16-question survey at the initial visit in September, and then again at the final meeting in May. There was also a nine-question feedback survey to evaluate current interest in nutrition, science, health, as well as participants’ affinity for the program.

❖ Year 1 (Pilot; n=13)

One class of 4th and 5th graders. Only Feedback survey administered. Taught the following STEM modules:

- Blood Types
- Lava Lamp
- Autoimmunity
- DNA Extraction
- DNA Candy Caper
- Electrical Circuits
- Natural Selection

❖ Year 2 (n=40)

Taught 4th and 5th graders, one class of each. All three surveys administered. Taught the following STEM modules:

- Yeast+Sugar=CO₂ Balloon
- DNA Extraction
- Lava Lamp
- Slime
- Glucose Testing
- Electricity and Magnetism
- Smoker’s Lung
- Scared Pepper/Bubbles/Gliders

❖ Year 3 (Current; n=39)

Teaching 5th and 7th graders, one class of each. Pre-survey administered. Taught the following STEM modules:

- Balloon and Baking Soda
- Slime/Physics of Flight
- Brain Teasers and Acoustics
- Bendy Bones – Calcium/Vitamin D
- Enzymes, Osmosis, and Potatoes
- Blood Types
- Density Tower

Results

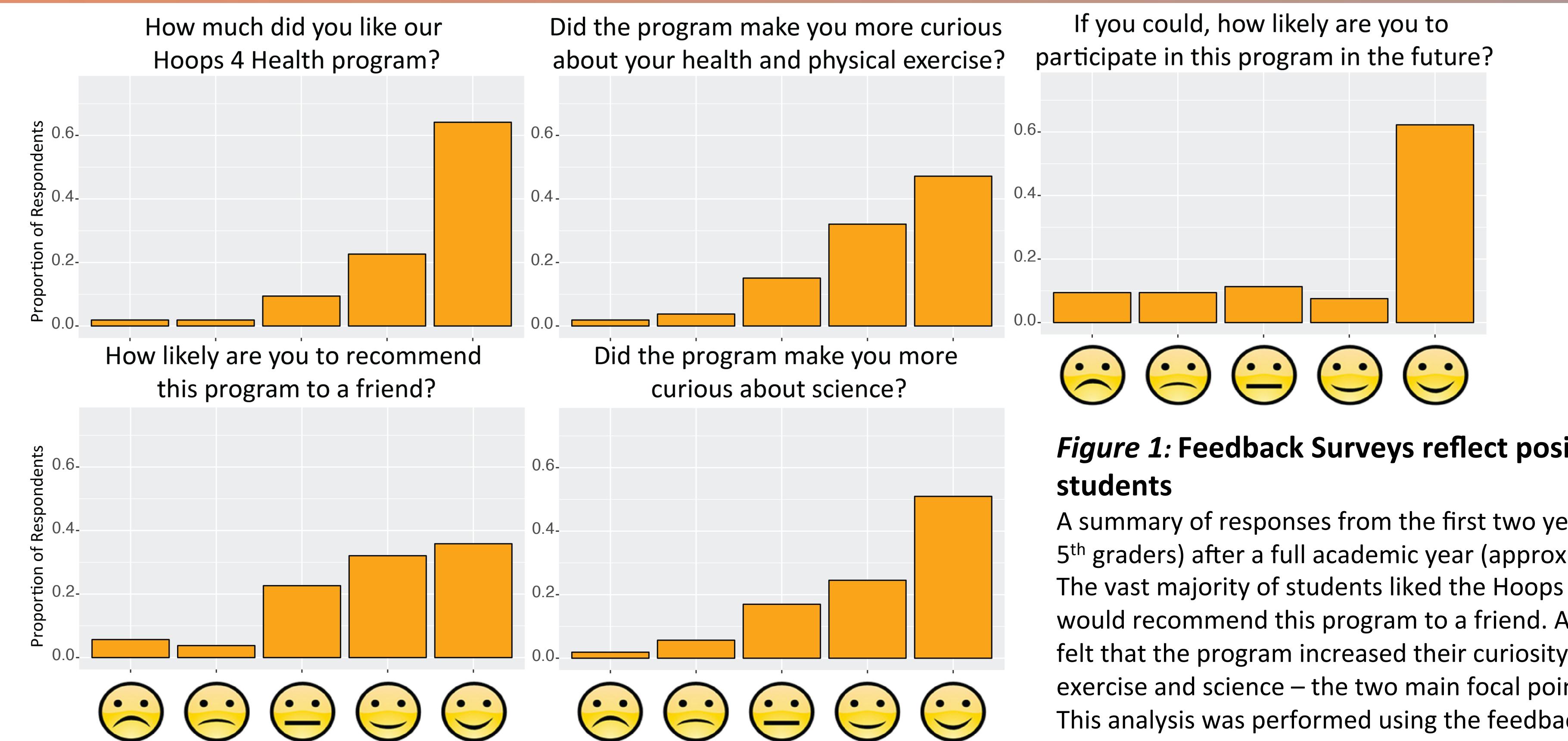


Figure 1: Feedback Surveys reflect positive impact on students

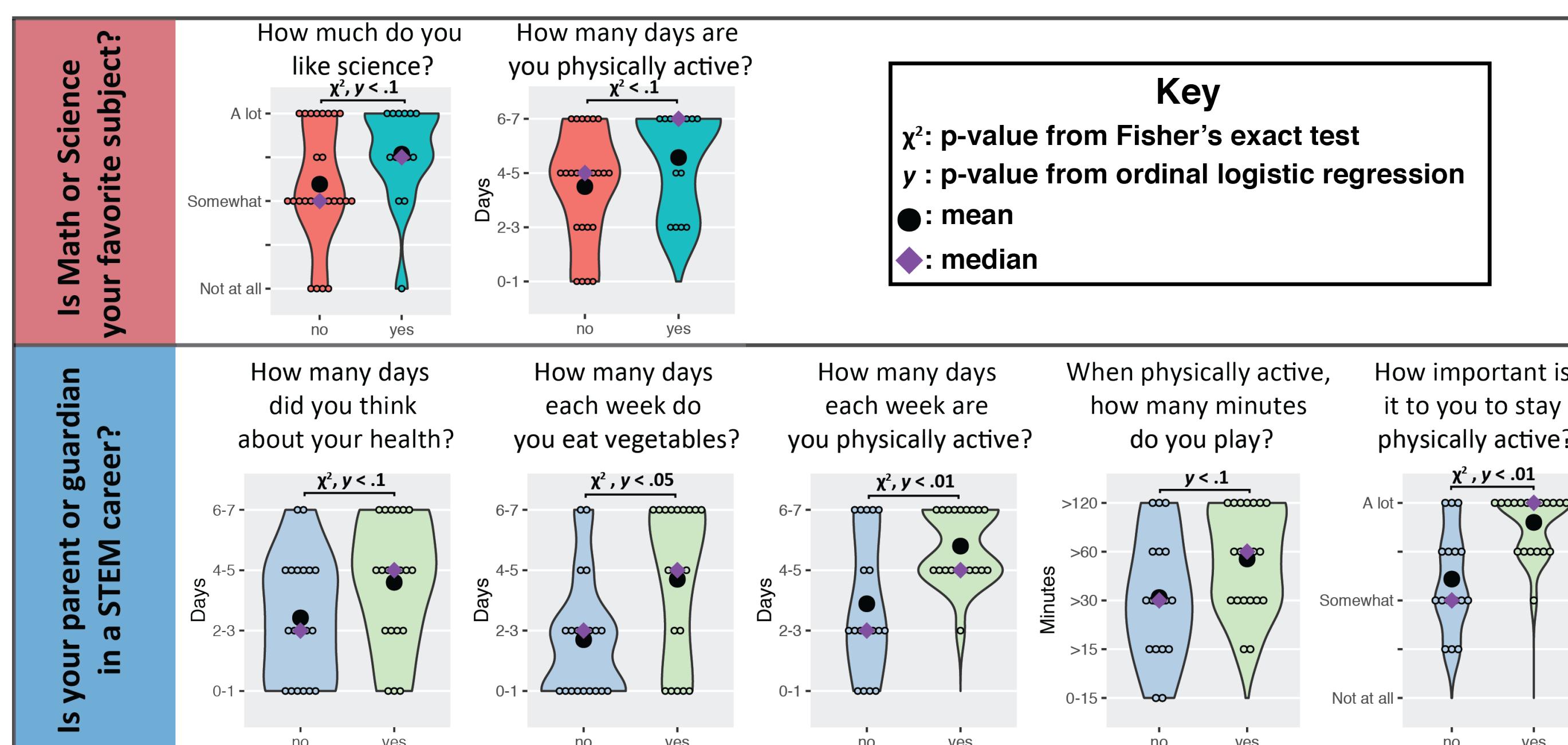
A summary of responses from the first two years (n=53; both 4th and 5th graders) after a full academic year (approximately eight sessions). The vast majority of students liked the Hoops 4 Health program and would recommend this program to a friend. Additionally, students felt that the program increased their curiosity in health/physical exercise and science – the two main focal points of the program. This analysis was performed using the feedback survey data from years 1 and 2.

Figure 2: Influence of Math/Science as a favorite subject and having a parent in a STEM career on survey results

[Red] PAL students listed whether math or science were their favorite subject. Those who answered “yes” were more likely to be interested in science and were physically active more frequently than those who answered “no.”

[Blue] PAL students who self-reported having a parent in a STEM career thought about their health more often, ate vegetables more frequently, were physically active more days and for longer, and valued physical activity more than those without parents in STEM careers.

This analysis was performed using the post-survey results of Year 2.



Key
 χ^2 : p-value from Fisher's exact test
 y : p-value from ordinal logistic regression
●: mean
◆: median

Figure 3: Comparison of pre-survey and post-survey results

Differences between the pre- and post-surveys answers’ means (non-numeric values were scaled to proportional levels) were tested for significance using Fisher’s T-test.

[A-C] Students showed unexpected decreases in interest in Science, importance of physical activity, and knowledge of healthy eating.

[D] Of note, the favorite subject of the students drastically changed to non-Math/Science subjects, suggesting a different subset of students were surveyed.

[E] Interestingly, the minutes spent playing, when physically active, increased.

This analysis was performed using Year 2 pre- and post-survey results.

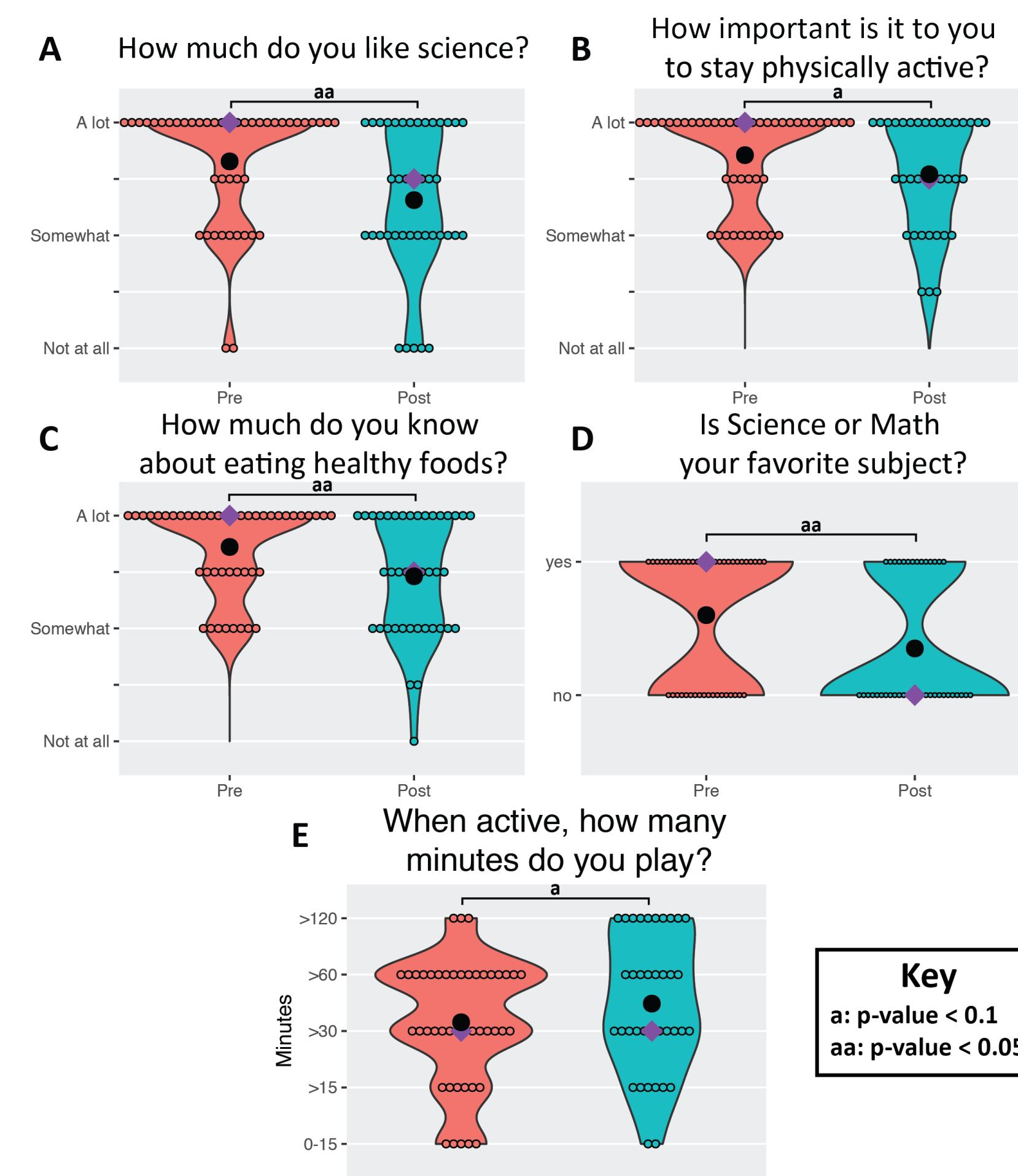
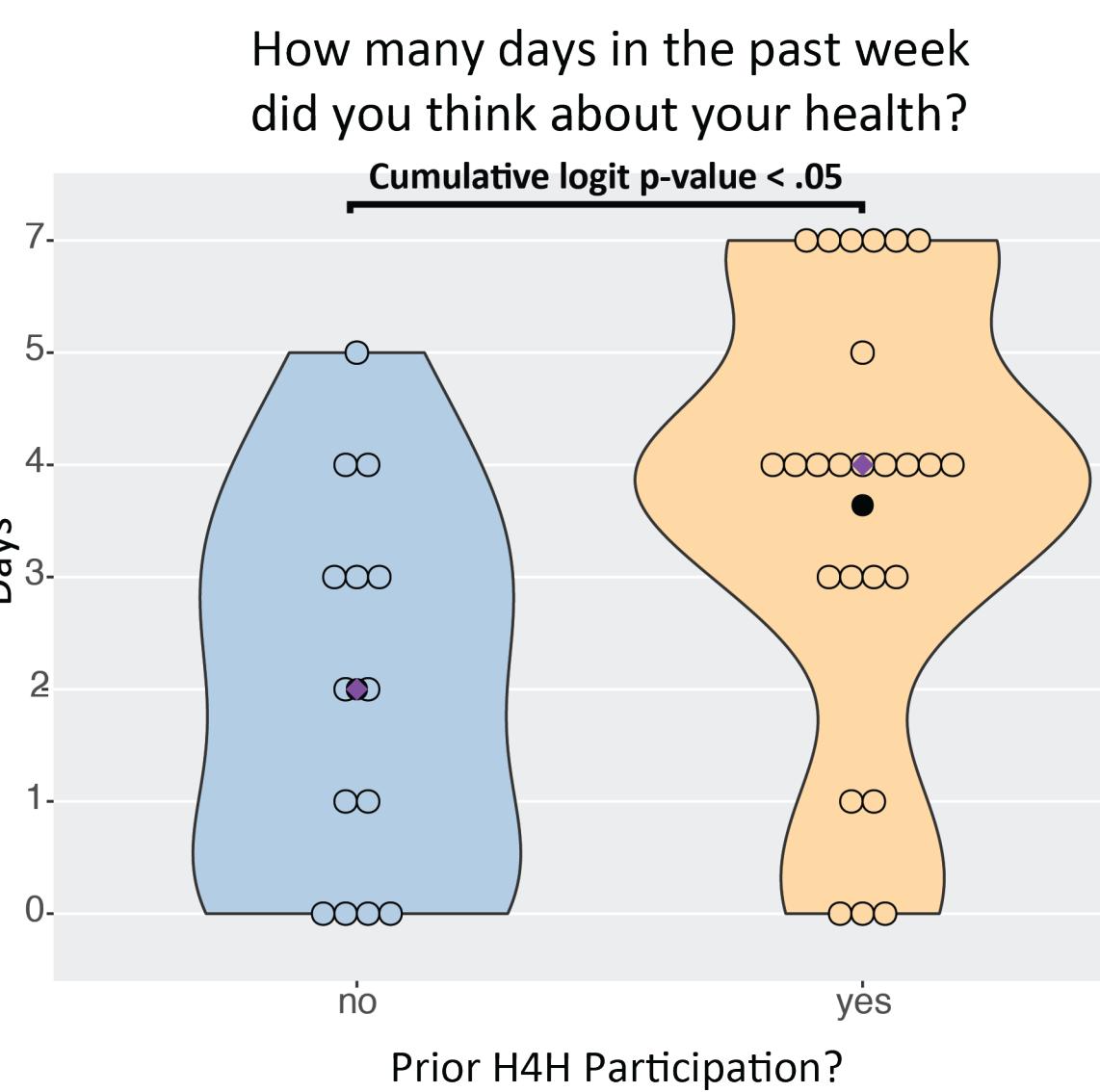


Figure 4: Interest in Health maintained in prior participants

Students who had previously participated in Hoops 4 Health were 4.9 times more likely to spend more days in the past week thinking about their health. The significance and odds ratio at every day level were determined using cumulative logit regression.

This analysis was performed using Year 3 pre-survey results.



Discussion

Our mission is to increase aptitude and awareness regarding healthy habits while stimulating interest in STEM education with a long-term goal of increasing the health status and graduation rates in Bronx youth. Over the course of three years conducting a monthly STEM and physical activity curriculum at the South Bronx Police Athletic League (PAL), we found that students gave positive reviews of the program (Figure 1) using feedback surveys; however, we wanted to assess our impact on specific health habits with an IRB-approved pre- and post-survey. Before quantifying our impact, we examined potentially confounding covariates influencing our results. Specifically, we found underlying relationships between interest in Science/Math and physical activity, as well as familial STEM involvement and health habits (Figure 2):

❖ Students who reported math or science to be their favorite subject were physically active on more days than their peers ($p<.1$)

❖ Students who reported having parents in a STEM career were 2.81x more likely to think about their health ($p<.1$), 4.58x more likely to eat vegetables in a given day ($p<.05$), 6.27x more likely to be physically active in a day ($p<.01$), and 12.29x more likely to feel that physical activity was more important ($p<.01$) than their peers.

Although our sample size was too small to include the covariates in our assessment of the program’s impact, we were able to compare the 46 pre-survey results with the 40 post-survey results, 36 of which attended at least half of the voluntary H4H sessions (Figure 3).

❖ Students showed unexpected decreases in interest in Science, importance of physical activity, and knowledge of healthy eating, while showing an increase in the number of minutes spent when physically active.

Possible explanations for these contradictory results include: the Fisher’s T-test being the best but not ideal model for our mostly ordinal data; the dropping out of one 5th grade class and changing student population; and survey fatigue (Figure 3).

❖ More students in the initial survey reported math or science as their favorite subjects than in the final survey ($p<.1$). We interpret this to show that the subjects surveyed may be different between the two surveys.

Despite these discouraging results, we were able to examine the effect of prior participation on student responses in the pre-survey given at the beginning of year 3 (Figure 4).

❖ Students were 4.9 times more likely to have spent more days thinking about their health ($p<.05$).

This speaks to the enduring message and impact of Hoops 4 Health.

Future Aims

❖ Adjusting the survey used to attain better results in the following ways:

- Reduce survey fatigue: more space and colorful, helpful pictures
- Self-generated anonymous unique identifiers to track individual changes.

❖ Continue partnering with PAL, increasing sample size

❖ Develop a robust method to follow-up with prior participants and assess long-term impacts of H4H

References

1. US Census Bureau. <http://www.census.gov/quickfacts/table/>. Revised: October 15, 2015. Accessed October 8, 2016
2. University of Wisconsin Population Health Institute. 2016 Bronx County Health Ranking. <http://www.countyhealthrankings.org/>. Accessed July 13, 2016
3. Bronx County Indicators For Tracking Public Health Priority Areas. New York State Department of Health. <https://www.health.ny.gov/prevention/agenda/indicators/county/bx.htm>. Revised: October 2012. Accessed July 1, 2016
4. Freudenberg N, Franzosa E, Sohler N, Li R, Devilin H, Albu J. The State of Evaluation Research on Food Policies to Reduce Obesity and Diabetes Among Adults in the United States, 2000-2013: Preventing chronic disease. [Research Support, U.S. Gov’t, P.H.S. Review]. 2015;12:e182.
5. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. [Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov’t]. 2012 Jul 21;380(9838):219-29.
6. National Center for Education Statistics; <http://nces.ed.gov/datatools/>. Accessed October 10, 2016
7. Conti G, Heckman J, Urzua S. The Education-Health Gradient. The American economic review. 2010 May;100(2):234-8.

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