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Research Article

Behaviors and Knowledge of HealthCorps New York City High School Students: Nutrition, Mental Health, and Physical Activity

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ABSTRACT

BACKGROUND: HealthCorps provides school wellness programming using curricula to promote changes in nutrition, mental health, and physical activity behaviors. The research objective was to evaluate effects of implementing its curricula on nutrition, mental health, and physical activity knowledge and behavior.

METHODS: Pre- and postsurvey data were collected (N = 2255) during the 2012-2013 academic year from 14 New York City public high schools. An 18-item knowledge questionnaire addressed 3 domains; 26 behavioral items were analyzed by factor analysis to identify 6 behavior domains, breakfast being a seventh 1-item domain. We examined the effects stratified by sex, applying mixed-effects models to take into account clustering effects of schools and participants adjusted for age.

RESULTS: The HealthCorps program significantly increased all 3 knowledge domains ($p < .05$), and significantly changed several key behavioral domains. Boys significantly increased fruits/vegetables intake ($p = .03$). Girls increased acceptance of new fruits/vegetables ($p = .03$) and breakfast consumption ($p = .04$), and decreased sugar-sweetened beverages and energy dense food intake ($p = .03$). The associations between knowledge and behavior were stronger in boys than girls.

CONCLUSION: The HealthCorps program significantly increased participants' knowledge on nutrition, mental health, and physical activity. It also improved several key behavioral domains, which are targets of the 2010 Dietary Guidelines to address obesity in youth.

Keywords: high school; HealthCorps; nutrition; physical activity; mental health.

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The goal of school-based health education is to improve students' knowledge, attitudes, and behavior in regard to the key dimensions of health—nutrition, physical activity, and mental health.[1] These 3 domains are closely related to prevention of obesity in children and adolescents.[2-6] Increasing health-related knowledge at an early age should lead to better health behaviors with better health outcomes during the course of one's life.[7,8] Given that child and adolescent obesity is a major public health concern in the United States and elsewhere,[9,10] education focusing on these domains should be emphasized in school curricula. In particular, physical education (PE) and health classes are crucial for promoting knowledge on nutrition, physical activity, and mental health.[11]

Underresourced schools can be at a disadvantage for increasing students' health-related knowledge and encouraging health behavior change.[12-14] For example, PE classes in urban high schools such as those in New York City (NYC) are often carried out in crowded gyms with inadequate equipment.[15] Furthermore, in urban settings, it is typically inconvenient to find a place for garden-based

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nutritional education.[16-18] Depressive mood among high school students in crowded urban settings is also more prevalent.[19,20] Therefore, it is a daunting challenge for such underresourced schools to develop and bolster educational programs targeting an increase in knowledge concerning the three domains that can help promote health behaviors.

HealthCorps® (www.healthcorps.org), a nonprofit extramural organization, was founded in 2003 in NYC, and has been steadily expanding nationwide. Currently, 62 high schools in 13 states and the District of Columbia are participating in the HealthCorps program. It aims to enhance students' wellness by offering and implementing in such underresourced high school settings programs that are developed to promote students' knowledge on those 3 domains so that students will adopt a healthy lifestyle. Programs are introduced and implemented into schools through trained coordinators often in conjunction with school wellness council members.

To evaluate the effectiveness of the HealthCorps program in increasing knowledge and promoting health behaviors, HealthCorps began surveying NYC students participating in its programs in 2011. The objective of this study was to evaluate whether participating NYC high school students showed: (1) increased knowledge on 3 health-related domains: nutrition, mental health, and physical activity; and (2) changes in health behavior. In addition, as a secondary aim, we also examined the relationship between increased knowledge and health behavior changes.

METHODS

The analysis was based on students' self-reported responses to the HealthCorps survey items administered both before and after implementation of the HealthCorps program in 14 NYC public high schools in the 2012-2013 academic year.

HealthCorps Program Overview

Designed to educate high school students on nutrition, physical activity, and mental health especially focusing on mental resilience,[21-23] HealthCorps uses intensively trained well-qualified program coordinators to deliver comprehensive curricula, and to engage both students and school staff in leading healthier lifestyles. All coordinators are rigorously screened for aptitude and depth of knowledge on a variety of health topics and are intensively trained for the 3 program components. HealthCorps curricula and programs were developed and reviewed by dietitians, nutritionists, integrative human physiologists, and a variety of the healthcare professionals. For example, HealthCorps employed a full-time registered dietitian to review and revise the original nutrition curriculum that was developed collaboratively by nutritionists and members of the HealthCorps Advisory. The HealthCorps program includes classroom teaching, mentoring, wellness councils, afterschool clubs, in-school health fairs, Café-O-Yeas, Teen Battle Chef, Youth Led Action Research, and Highway to Health Festivals.[24]

With respect to classroom teaching, which can be integrated in a variety of classes including PE, Health, Mathematics, Language Arts, and Political Science, coordinators are required to teach 10 HealthCorps lessons a week in their school. Lesson topics include mental resilience, developing healthy eating habits, and physical fitness. With regard to mentoring, the coordinators provide students and staff with various health-related resources and help design action plans that address meeting personal health goals. Coordinators also cofacilitate their school's wellness councils. Comprised of staff members and students, the Wellness Councils utilize the Alliance for a Healthier Generation platform (www.healthiergeneration.org) and/or the New York Department of Educations' School Wellness portal (https://www.nycenet.edu/wellness/wellnessportal/) to help identify and address gaps in the school's

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health policies and programming and to design action plans to improve nutrition, physical fitness, and mental resilience of their students.[25] Coordinators also run weekly afterschool clubs. Whether the club is focused on nutrition, physical fitness, and/or mental resilience and in what capacity is determined by the annual HealthCorps Community Needs Assessment instrument that systematically identifies areas of programming needed at the school.

HealthCorps extends its classroom teaching objectives outside the classroom through biweekly HealthCorps-trademarked demonstration events, including Café-O-Yeas, annual in-school health fairs, and annual Highway to Health Festivals during which booth activities are held focusing on a variety of mental resilience, nutrition, and physical fitness messages. The Teen Battle Chef program focuses on students' healthy-eating, cooking and mental resilience skills and behavior. Through culinary coaching and cooking ''battles,'' students learn how to cook healthy meals and build their public speaking, teamwork, and leadership skills. Finally, the Youth Led Action Research program is a class that develops students' research abilities so that they can use surveys, interviews, and ''photovoice'' (a participatory photography and digital storytelling method for advocacy and communication) to identify health needs in their school or community. Students then develop specific projects that meet those needs.[26]

With respect to potential total hours of exposure to HealthCorps activities, the class lesson ranges from half to one and half hours depending on class size. In addition, the biweekly Café-O-Yeas take approximately 35 minutes per event—a total of 10.5 hours of exposure for approximately 18 events per year. The annual events such as the Health Fair take about 45 minutes. One-hour opt-in afterschool programs such as Teen Battle Chef, Youth Led Action Research, and/or Wellness Councils can account for a total of 36 hours over 36 weeks during an academic year. Nonetheless, all HealthCorps activities are voluntary for students, and thus student participation varies among students who enroll in class learning and/or other HealthCorps activities.

NYC HealthCorps Schools

Overall, during the 2012-2013 academic year, a total of 16 NYC public high schools participated in the HealthCorps program. Each school has its own HealthCorps coordinator except that 2 small schools share 1 coordinator and thus together are considered as one ''HealthCorps programming school'' for programming and surveying purposes. These schools were selected based on the following 3 criteria required by the New York City Department of Health and Mental Hygiene, a major sponsor of HealthCorps: (1) Public high school in NYC; (2) 50% or more students receiving free or reduced lunch; and (3) Lack of existing programs aimed at improving nutrition, physical activity, and mental resilience behavior.

The racial and ethnic composition of the schools varied: 10 schools have a majority Hispanic population, 4 schools have a majority non-Hispanic Black population, and 2 schools have a majority Asian/Pacific Islander population. Of the 16 schools, 6 are located in Brooklyn, 5 schools in Manhattan, 4 in the Bronx, and 1 in Queens. In sum, non-Hispanic Whites are a minority population in the HealthCorps schools. Although all the 16 NYC schools were selected to participate in the surveying, survey data from 2 schools were not available due to failure to obtain the survey data in one school and surveys being lost in the mail for the other school.

HealthCorps Survey

The 2012-2013 HealthCorps Health Behavior Survey (Appendix S1, Supporting Information) was comprised of one item for age and another 48 questionnaire items. The first 26 items were based on the Network for a Healthy California's *School Physical Activity and Nutrition Project and the Fruits and Veggies More Matter*s *Consumption Survey* (http://www.cdph.ca.gov/programs/cpns/Documents/Compendium%20of%20Surveys.pdf) and the remaining 22 items were developed by HealthCorps. This development was necessary to address the classroom curriculum objectives, which are often adapted to meet the grade level or cultural needs of the school. Specifically, some of the 26 Network for a Healthy California items are derived from the *Youth Risk Behavioral Surveillance Questionnaire*[27] that evaluate dietary behavior, physical activity, and related factors whereas the other 22 HealthCorps survey items mainly measure student health-related knowledge (items 27-44) and mental well-being (items 45-49).

The survey was conducted as part of a HealthCorps evaluation and was administered by the HealthCorps coordinators before and after implementation of the HealthCorps program. The NYC high school HealthCorps coordinators were instructed to survey all of their regularly occurring classes, which can be semester-based or yearlong. Presurveys were conducted in late September or early October of 2012 for the yearlong or fall semester classes and in late February or early March of 2013 for spring semester classes. Postsurveys were conducted in January 2013 for fall semester classes and in May 2013 for the yearlong or spring semester classes.

Participants

A total of 2255 students aged 13-20 years old (1251 [55.5%] boys and 1004 [45.5%] girls) participated

in the surveys from 14 NYC high schools. Among the 1251 boys, 703 participated in both pre- and postprogram surveys and 403 participated only in the preprogram survey and 145 did only in the postprogram survey. Among the 1004 girls, 703 participated in both the pre- and postsurvey and 403 participated only in the presurvey and 145 did only in the postsurvey. We defined ''completers'' as the 1273 (56.5%) boys and girls who participated in both surveys, although the completers did not necessarily respond to all items without any missing responses.

Three Knowledge Domain Variables

The HealthCorps survey has multiple questions asking for correct answers in 3 health-related knowledge domains: nutrition concepts, mental health concepts, and physical activity concepts (Table 1). We quantified the knowledge levels of these 3 domains by the sums of correct answers to corresponding questions/items for each domain. In addition, we also quantified an overall knowledge level by summing all the correct answers to the total 18 questions. If answers were missing, we counted them as incorrect answers; therefore, the knowledge scores might be underestimated. Thus, the ranges of the knowledge scores, that is, the number of correct answers, are as follows: 0 to 7 for the nutrition knowledge domain; 0 to 5 for the mental health knowledge domain; and 0 to 6 for the physical activity knowledge domain. The overall knowledge score ranges from 0 to 18. Higher scores indicated higher attained knowledge levels.

Behavior Domain Variables

We first considered breakfast consumption (item 18) with a yes/no binary response as its own behavior domain. To identify additional behavior domains, we then applied exploratory factor analysis to all the items other than the aforementioned knowledge domain items, breakfast consumption, sex, and age (item 1). In doing so, we excluded items 25 and 26 which have both nominal responses and multiple choices. Then, we scored all the other 26 remaining items (items 3-17, items 19-24, and items 45-49) with ordinal responses from 1 = (A) to n by increments of 1, where n is for the last letter such as (C), (D), (F), and (G) depending on items. However, an exception was applied to items 19 and 20. To make the ordinal scores consistent with the other items, we assigned scores as follows: (C) = 1, (B) = 2, and (A) = 3. For all items, we treated ''I don't know'' as a missing response.

For application of the factor analysis to all those 26 items, we used only preprogram survey data to avoid any potential effect of the program on the determination of factors. We used varimax rotation and eigenvalue > 1 criteria to determine the optimal number of factors. Although this method resulted in 7 factors (Table 2), we used the first 6 factors for behavior domain scores by taking averages of their corresponding nonmissing item scores. We note that, unlike the knowledge scores, the scores of the following factors represent abstract levels of the underlying constructs that may not translate into practically interpretable concrete units such as cups or serving sizes. The 6 behavior domains are status of well-being (''Well-Being'': items 45-49 with standardized Cronbach alpha [α] = .85), home environment for fruits and vegetables (''Home F&V'': items 21-24 with α = 0.70), intake of fruits and vegetables (''F&V Intake'': items 8-13 with α = .61), intake of sugar-sweetened beverages (SSB) and high energy density (HED) foods (''SSB & HED'': items 7 and 15-17 with α = .52), acceptance of new fruits and vegetables (''New F&V'': items 19-20 with α = .59), and consumption of milk and cereal (''Cereal & Milk'': items 4 and 6 with α = .53). These 6 factors explained 48% of the total variance of the 29 items (Table 2). The final factor 7 (items 3, 5, and 14 with α = .14) did not appear to have either reasonable construct validity or internal consistency. In sum, we considered seven behavior domains including breakfast consumption.

Statistical Analysis

We applied bivariate and multivariable multilevel mixed-effects linear or logistic models depending on the scale of the dependent/outcome variables to take into account clustering effects of schools and participants since the 2 pre- and postprogram observations are nested within participants who are in turn nested within schools. Specifically, both the school-level and student-level intercepts were considered normally distributed random variables, and all the other regression coefficients were assumed to be fixed. The mixed-effects linear model is also useful for analyzing incomplete data such that in this study there are students who responded to only one survey, pre- or postprogram survey. The variable representing HealthCorps curricula implementation was an indicator for the postprogram survey. We used age as a sole controlling variable for all of the multivariable models applications which were stratified by sex. Of note, the effects of schools encompass those of the coordinators since only one coordinator is assigned to each school. As a sensitivity analysis, we repeated our analyses using completers only. Any association with p-value less than .05 was declared significant. We used SAS v9.3 for all statistical analyses.

RESULTS

Descriptive Statistics and Bivariate Analysis Results

Table 3 summarizes results from bivariate comparisons of covariates and knowledge outcomes between

Table 1. **Survey Items for Assessments of Knowledge on 3 Domains: Nutrition, Mental Health, and Physical Activity**

Item#	Item Description
Knowledge questions on nutrition concepts	
27	What information can you NOT find on a nutrition label?
28	How do you determine the total amount of calories in a soda?
29	What determines how many servings you should have of a given food item?
30	What are the 3 macronutrients that your body needs to survive?
31	Which food items are NOT good sources of protein?
32	What are positive ways to reduce portion size?
33	Which of the following 20-ounce drinks are arranged from low to highest sugar content?
Knowledge questions on mental health concepts	
34	How does technology (cell phones, computers, TVs, etc.) affect our sleep?
35	Positive methods for stress reduction do NOT include:
36	Which of the following is an example of an optimistic thought?
37	What is NOT a positive way to deal with a situation that makes you angry?
38	The characteristic that does NOT describe a person with strong self-esteem is:
Knowledge questions on physical activity concepts	
39	What is the average recommended amount of time a teenager should workout each day?
40	Which of the following is NOT a leg muscle?
41	When you complete exercises like crunches or planks, what body region are you working?
42	Exercise can improve your life in all of the following areas EXCEPT:
43	Which exercise type is INCORRECTLY matched with a description?
44	What is the result if you eat more calories than your body burns through exercise?

pre- and postprogram. Although breakfast intake did not significantly change among boys (70.0% vs 70.8%, $p = .803$), it significantly increased among girls from pre- to postprogram (65.1% vs 70.1%, $p = .036$). With respect to the 6 factor scores, only intake of F&V significantly increased among boys (2.20 ± 0.74 [SD] vs 2.28 ± 0.79, $p = .011$) whereas among girls intake of SSB and HED foods significantly decreased (1.72 ± 0.55 vs 1.67 ± 0.55, $p = .007$) and acceptance of new F&V increased (1.96 ± 0.54 vs 1.90 ± 0.57, $p = .014$). Regardless of boys or girls, all 3 knowledge domain scores increased after the program as did the overall knowledge scores.

Effects on Enhanced Knowledge

Table 4 displays estimated means and their 95% confidence intervals (95% CI) of pre- and postprogram knowledge scores after adjusting for age. All the knowledge scores including the overall knowledge score significantly increased for both boys and girls. Increase in nutrition concept knowledge was greatest for both boys (0.33 ± 0.06 [SE], $p < .001$) and girls (0.52 ± 0.07, $p < .001$) followed by mental health concept knowledge (0.21 ± 0.05, $p < .001$ for boys and 0.24 ± 0.06, $p < .001$ for girls), and physical activity knowledge (0.18 ± 0.05, $p = .001$ for boys and 0.13 ± 0.06, $p = .035$ for girls). On average, the overall knowledge increased by about one score, or one more correct answer, for boys (0.70 ± 0.11, $p < .001$) and girls (0.92 ± 0.13, $p < .001$). Separate analysis of completers-only analysis yielded virtually no differences in terms of score changes and significance (data not shown).

Effects on Behavior Changes

Table 5 displays estimated means or odds ratios (ORs) and their 95% CIs of pre- and postprogram behavior domain scores adjusting for age. Among boys, intake of F&V significantly increased by 0.06 ± 0.03 ($p = .03$). Among girls, both breakfast consumption (OR = 1.27, 95% CI = 1.01, 1.58, $p = .04$) and acceptance of new fruits and vegetables (by 0.05 ± 0.02, $p = .03$) were increased, and intake of SSB and HED foods significantly decreased by 0.05 ± 0.02 ($p = .033$). Completers-only analysis revealed (data not shown) that all of the above significant changes became nonsignificant; however, in contrast nonsignificant decreases in both Home F&V and consumption of SSB and HED became significant among boys.

Associations Between Knowledge and Behavior Changes

Table 6 displays the estimated regression coefficients of behavior domains on knowledge domains. Most of the behavior domains are significantly associated with increased knowledge for boys, and for girls as well yet to a lesser extent. The directions of significant associations are reasonable. For example, intake of SSB and HED foods is significantly inversely associated with increased knowledge of all 3 domains and overall for both boys and girls; increased well-being is also associated with increased knowledge. Furthermore, increased breakfast consumption was significantly associated with increased knowledge of mental health for both boys (OR = 1.08, 95% CI = 1.00, 1.17, $p = .04$) and girls (OR = 1.12, 95% CI = 1.03, 1.21, $p = .008$). However, one exception was that intake of fruits and

Table 2. **Results of Factor Analysis on Responses From Preprogram Survey**

Item #	Item Description	Cronbach α*	Cum. %Var explained†
Factor 1: status of well-being (well-being)		.85	13.5%
45	I value and respect my mind and body		
46	I have at least one goal that I want to accomplish		
47	I know how to deal with anger and sadness		
48	Most nights, I go to sleep feeling happy about how and who I spent my day with		
49	I feel excited about my future after I graduate high school		
Factor 2: Home environment for fruits and vegetables (Home F&V)		.70	24.3%
21	At your home do you have fruits to eat?		
22	At your home do you have vegetables to eat?		
23	How often do your parents eat fruit?		
24	How often do your parents eat vegetables?		
Factor 3: Intake of fruits and vegetables (F&V Intake)		.61	32.1%
8	During the past 7 days, how many times did you drink 100% fruit juices such as orange juice, apple juice, or grape juice? (Do not count punch, Kool-Aid, sports drinks, or other fruit-flavored drinks.)		
9	During the past 7 days, how many times did you eat fruit? (Do not count fruit juice.)		
10	During the past 7 days, how many times did you eat green salad?		
11	During the past 7 days, how many times did you eat potatoes? (Do not count french fries, fried potatoes, or potato chips.)		
12	During the past 7 days, how many times did you eat carrots?		
13	During the past 7 days, how many times did you eat other vegetables? (Do not count green salad, potatoes, or carrots.)		
Factor 4: Intake of sugar-sweetened beverages and high energy density foods (SSB & HED)		.52	38.6%
7	Yesterday, did you eat French fries or chips? Chips are potato chips, tortilla chips, corn chips, or other snack chips		
15	Yesterday, did you drink any punch, sports drinks or other fruit-flavored drinks? Do not count 100% fruit juice or diet drinks		
16	Yesterday, did you drink any regular (not diet) sodas or soft drinks?		
17	Yesterday, did you eat sweet rolls, doughnuts, cookies, brownies, pies, or cake?		
Factor 5: Acceptance of new fruits and vegetables (New F&V)		.59	43.7%
19	I like to try new fruits		
20	I like to try new vegetables		
Factor 6: Consumption of cereal and milk (Cereal & Milk)		.53	48.0%
4	Yesterday, did you drink any kind of milk? Count chocolate or other flavored milk, milk on cereal, or drinks made with milk		
6	Yesterday, did you eat any hot or cold cereal?		
Factor 7:		014	52.1%
3	Yesterday, did you eat cheese by itself or on your food? Count cheese on pizza or in dishes such as tacos, enchiladas, sandwiches, cheeseburgers, or macaroni and cheese		
5	Yesterday, did you eat yogurt or cottage cheese or drink a yogurt drink? Do not count frozen yogurt		
14	Yesterday, did you drink any water, such as from a glass, a bottle, or a water fountain?		

*Standardized Cronbach α.
†Cumulative percent of total variance explained by factors.

vegetables was significantly and inversely associated with overall and all domains of knowledge among boys despite the fact that the HealthCorps program increased the fruits and vegetables intake among boys (Table 5). Completers-only analysis results (data not shown) in general agree with those presented in Table 6 in terms of direction and significance. Notably, however, the significant associations between mental health knowledge and breakfast consumption did not hold.

DISCUSSION

The primary finding from this study was that NYC high school students who participated in the HealthCorps program, regardless of sex, showed gains in their knowledge on nutrition, physical activity, and mental health; moreover, although there were improved behavior changes, the improvement differed by sex. Given that participating NYC high schools are underresourced and disadvantaged in terms of equipment and socioeconomic standards, the finding bears a significant implication concerning successful development and implementation of high school programs such as HealthCorps that aim to enhance knowledge and improve key health behavior components such as increased breakfast consumption,[28] increased consumption of fruit and vegetables,[29] decrease of intake of SSB[30,31] and HED foods,[32,33] and acceptance of new fruits and vegetables.[34,35]

The HealthCorps program indirectly improved many health behaviors as improved changes in behaviors were in general positively associated with increased knowledge with an exception. The exception, which is puzzling, was that intake of fruits and vegetables was significantly and inversely associated with all of increased knowledge domains among boys as mentioned earlier. This exception could be due to difference in referent constructs

Table 3. **Bivariate Comparison of Variables and Knowledge Domain Outcome Between Before and After HealthCorps Program, Stratified by Sex**

	Pre			Post			
	N	Mean	SD	N	Mean	SD	p
Variable				Boys (N = 1251)			
Age	1097	15.81	1.69	841	16.06	1.62	<.001*
Breakfast	1074	70.0%	—	837	70.8%	—	.803
Well-being	1036	3.57	1.09	801	3.51	1.09	.124
Home F&V	1101	2.75	0.54	842	2.73	0.56	.082
F&V intake	1106	2.20	0.74	846	2.28	0.79	.011*
SSB & HED	1106	1.77	0.58	845	1.78	0.61	.204
New F&V	1105	2.04	0.54	837	2.05	0.59	.997
Cereal & milk	1106	1.79	0.70	844	1.80	0.72	.447
				Girls (N = 1004)			
Age	901	15.73	1.65	662	15.96	1.56	<.001*
Breakfast	899	65.1%	—	656	70.1%	—	.036*
Well-being	866	3.63	0.93	635	3.60	1.01	.462
Home F&V	904	2.75	0.55	667	2.76	0.54	.957
F&V intake	909	2.10	0.71	669	2.15	0.71	.099
SSB & HED	909	1.72	0.55	669	1.67	0.55	.007*
New F&V	908	2.04	0.54	666	2.10	0.57	.014*
Cereal & milk	909	2.29	0.65	668	1.54	0.59	.262
Knowledge domain				Boys (N = 1251)			
Nutrition concept	1106	3.24	1.58	846	3.58	1.70	<.001*
Mental health	1106	2.39	1.42	846	2.60	1.53	<.001*
Physical activity	1106	2.34	1.30	846	2.54	1.37	<.001*
Overall	1106	7.96	3.29	846	8.72	3.53	<.001*
				Girls (N = 1004)			
Nutrition concept	909	3.18	1.53	669	3.66	1.66	<.001*
Mental health	909	2.67	1.39	669	2.86	1.49	<.001*
Physical activity	909	2.50	1.38	669	2.61	1.45	.049*
Overall	909	8.35	3.22	669	9.13	3.61	<.001*

*p < .05.

HED, high energy density; SSB, sugar-sweetened beverages. Although the means and SDs are based on available data, the p-values are based on the bivariate 3-level mixed-effects linear or logistic regression. Breakfast: breakfast intake; well-being: status of well-being; home F&V: home environment for fruits and vegetables; F&V intake: intake of fruits & vegetables; SSB & HED: intake of sugar-sweetened beverages and high energy density foods; new F&V: acceptance of new fruits and vegetables; cereal & milk: consumption of cereal and milk.

Table 4. **Comparison of Knowledge Domain Variables Between Before and After HealthCorps Program, Stratified by Sex After Adjusting for Age**

	Pre		Post		Difference (Post-Pre)		
	Est	95% CI	Est	95% CI	Est	95% CI	p
Knowledge domain	Boys						
Nutrition concept	3.13	2.76, 3.50	3.43	3.06, 3.80	0.30	0.18, 0.42	<.001*
Mental health	2.32	2.01, 2.63	2.53	2.22, 2.84	0.21	0.11, 0.32	<.001*
Physical activity	2.31	2.12, 2.51	2.50	2.30, 2.70	0.18	0.07, 0.29	.001*
Overall	7.75	7.63, 9.26	8.45	6.94, 8.56	0.70	0.47, 0.92	<.001*
	Girls						
Nutrition concept	3.11	2.77, 3.45	3.63	3.28, 3.97	0.52	0.38, 0.65	<.001*
Mental health	2.62	2.32, 2.92	2.86	2.56, 3.17	0.24	0.13, 0.36	<.001*
Physical activity	2.46	2.25, 2.67	2.59	2.37, 2.81	0.13	0.01, 0.26	.035*
Overall	8.17	7.37, 8.97	9.09	8.28, 9.90	0.92	0.66, 1.18	<.001*

*p < .05.

CI, confidence interval. Estimate represents estimated means were based on 3-level mixed-effects linear regressions with age as an adjusting covariate.

between knowledge domains and intake of fruits and vegetables. The overall findings, however, support the concept that increased knowledge indeed leads to improved behavior changes. When put together, the implementation of the HealthCorps program appears to improve key behaviors that are part of obesity-related behavioral recommendations by the 2010 Dietary Guidelines[36] such as breakfast consumption, decreasing SSB intake, increasing intake of fruits and vegetables, and becoming physically active. Although

Table 5. **Comparison of Knowledge Domain Variables Between Before and After HealthCorps Program, Stratified by Sex After Adjusting for Age**

	Pre		Post		Diff (Post-Pre)		
	Est	**95% CI**	**Est**	**95% CI**	**Est**	**95% CI**	**p**
Behavior domain	Boys						
Well-being	3.56	3.45, 3.62	3.50	3.38, 3.62	−0.06	−0.15, 0.03	.210
Home F&V	2.73	2.65, 2.81	2.70	2.63, 2.78	−0.03	−0.07, 0.01	.191
F&V intake	2.20	2.14, 2.27	2.27	2.20, 2.33	0.06	0.01, 0.12	.030*
SSB & HED	1.80	1.71, 1.89	1.84	1.75, 1.93	0.04	0.00, 0.08	.075
New F&V	2.04	2.00, 2.08	2.04	1.99, 2.08	0.00	−0.04, 0.04	.924
Cereal & milk	1.78	1.74, 1.82	1.81	1.76, 1.85	0.03	−0.03, 0.08	.346
					OR (Post/Pre)		
Breakfast					1.06	0.86, 1.31	0.587
	Girls						
Well-being	3.61	3.51, 3.70	3.58	3.48, 3.68	−0.03	−0.11, 0.06	.507
Home F&V	2.72	2.62, 2.82	2.72	2.62, 2.82	0.00	−0.04, 0.04	.976
F&V intake	2.09	2.00, 2.19	2.13	2.03, 2.23	0.04	−0.01, 0.10	.150
SSB & HED	1.74	1.64, 1.83	1.69	1.60, 1.78	−0.05	−0.09, 0.00	.033*
New F&V	2.02	1.95, 2.10	2.07	1.99, 2.15	0.05	0.00, 0.09	.030*
Cereal & milk	1.57	1.51, 1.62	1.54	1.48, 1.60	−0.03	−0.08, 0.02	.295
					OR (Post/Pre)		
Breakfast					1.27	1.01, 1.58	.040*

*$p < .05$.

CI, confidence interval; OR, odds-ratio; HED, high energy density; SSB, sugar-sweetened beverages. Estimate represents estimated means were based on 3-level mixed-effects linear or logistic regressions with age as an adjusting covariate. Breakfast: breakfast intake; well-being: status of well-being; home F&V: home environment for fruits and vegetables; F&V intake: intake of fruits & vegetables; SSB & HED: intake of sugar-sweetened beverages and high energy density foods; new F&V: acceptance of new fruits and vegetables; cereal & milk: consumption of cereal and milk.

completers-only analysis nullified a few significant results especially concerning breakfast consumptions, the completers-only analysis may be biased and may also limit generalizability, in addition to there being a loss of statistical power due to a reduced number of observations about half of all students. Nevertheless, those contradicting sensitivity analysis results may warrant further studies on breakfast consumption in particular.

The reduced intake of SSB, for instance, was also supported by an earlier study of the HealthCorps program conducted by Cawley et al.[37] Our study replicates their finding, and thus, demonstrates the sustainability of the HealthCorps programs' effects that link an increase in knowledge to behavior changes. This is further supported by unpublished outcome data of an ongoing study of HealthCorps schools outside of NYC. Therefore, we believe that the findings are practical, significant, and warrant a continuation of the HealthCorps program. The HealthCorps program is continually improving by regularly evaluating both outcome and process measures. For example, because areas lacking positive impacts could be due to inconsistent dose and quality of delivery rather than to design of program components per se, fidelity assessments help identify futile components. It is unknown, however, if the increased knowledge and behavior improvement would eventually lead to a change in weight status. To this end, a randomized study utilizing the HealthCorps program is underway to rigorously test these relationships with measured weight and height.

Given all of the aforementioned positive impacts of the HealthCorps program, the following questions may arise from an implementation science perspective[38] to adopt school-based programs to enhance students' wellness: ''What would be a best strategy to maximize students' health behavior, knowledge, and potentially weight outcome?'' and ''How does implementing extramural programs such as HealthCorps into unique school settings in a tailored fashion engage various stakeholders?'' The stakeholders might include students themselves, parents, teachers, school administrators, community leaders, and extramural program providers. First, the approach should be evidence-based.[39] Research support that the 3 domains—nutrition, physical activity, and mental health—are key components for those outcomes. Therefore, development and implementation of programs should focus on those domains that at the same time conform to the 2010 Dietary Guideline recommendations. The evidence-based findings should be an important part of curricular education of the programs. Second, efforts should be put in place for identifying common interests of the involved stakeholders, and facilitators and barriers to implementing programs.[40] Finally, home and school environmental modification should also be put into place to sustain the program's outcomes.[41-46] For example, providing grab-and-go breakfast bags

Table 6. **Association Between Increased Knowledge Domains and Behavior Changes by Sex After Adjusting for Age**

		Boys			Girls		
Behavior Domain	**Knowledge Domain**	**Est**	**95% CI**	**p**	**Est**	**95% CI**	**p**
Well-being	Nutrition concept	0.089	0.06, 0.12	<.0001*	0.033	0.00, 0.06	.039*
Home F&V		0.035	0.02, 0.05	<.0001*	0.015	0.00, 0.03	.074
F&V intake		−0.029	−0.05, −0.01	0.008*	0.000	−0.02, 0.02	.972
SSB & HED		−0.046	−0.06, −0.03	<.0001*	−0.027	−0.04, −0.01	.002*
New F&V		0.017	0.00, 0.03	0.029*	0.041	0.02, 0.06	< .001*
Cereal & milk		0.005	−0.01, 0.03	0.585	−0.002	−0.02, 0.02	.815
Well-being	Mental health (MH)	0.140	0.10, 0.18	<.0001*	0.056	0.02, 0.09	.002*
Home F&V		0.030	0.01, 0.05	0.001*	0.019	0.00, 0.04	.045*
F&V intake		−0.043	−0.07, −0.02	0.001*	−0.016	−0.04, 0.01	.193
SSB & HED		−0.044	−0.06, −0.03	<.0001*	−0.042	−0.06, −0.02	< .001*
New F&V		0.031	0.01, 0.05	0.001*	0.024	0.01, 0.04	.012*
Cereal & milk		0.005	−0.02, 0.03	0.654	−0.010	−0.03, 0.01	.357
Well-being	Physical activity (PA)	0.052	0.01, 0.09	0.009*	0.021	−0.02, 0.06	.256
Home F&V		0.016	0.00, 0.03	0.070	0.003	−0.01, 0.02	.724
F&V intake		−0.019	−0.04, 0.01	0.146	−0.014	−0.04, 0.01	.266
SSB & HED		−0.027	−0.05, −0.01	0.006*	−0.024	−0.04, −0.01	.010*
New F&V		0.029	0.01, 0.05	0.002*	0.044	0.03, 0.06	< .001*
Cereal & milk		−0.003	−0.03, 0.02	0.787	−0.002	−0.02, 0.02	.862
Well-being	Overall	0.059	0.04, 0.07	<.0001*	0.023	0.01, 0.04	.004*
Home F&V		0.017	0.01, 0.02	<.0001*	0.008	0.00, 0.02	.056
F&V intake		−0.019	−0.03, −0.01	0.001*	−0.006	−0.02, 0.01	.302
SSB & HED		−0.025	−0.03, −0.02	<.0001*	−0.019	−0.03, −0.01	< .001*
New F&V		0.015	0.01, 0.02	<.0001*	0.023	0.01, 0.03	< .001*
Cereal & milk		0.002	−0.01, 0.01	0.725	−0.003	−0.01, 0.01	.563
		Or					
		OR	95% CI	p	OR	95% CI	p
Breakfast	Nutrition	1.03	0.96, 1.10	0.402	1.05	0.97, 1.13	.211
	MH	1.08	1.00, 1.17	0.040*	1.12	1.03, 1.21	.008*
	PA	1.06	0.98, 1.15	0.161	0.98	0.91, 1.07	.672
	Overall	1.03	1.00, 1.07	0.063	1.03	0.99, 1.06	.124

*$p < .05$.

CI, confidence interval; HED, high energy density; SSB, sugar-sweetened beverages; OR, odds-ratio. Estimate represents estimated beta coefficients were based on multiple variable 3-level mixed-effects linear or logistic regression with age as an adjusting covariate; the estimated beta coefficients represent the increase in behavior scores per unit score increase in knowledge. Breakfast: breakfast intake; well-being: status of well-being; home F&V: home environment for fruits and vegetables; F&V intake: intake of fruits & vegetables; SSB & HED: intake of sugar-sweetened beverages and high energy density foods; new F&V: acceptance of new fruits and vegetables; cereal & milk: consumption of cereal and milk.

in the school cafeteria would facilitate breakfast consumption;[47] replacing competitive vending machines with easily accessible water jets may discourage consumption of energy-dense snacks or SSB.[48–52] Evaluation of this implementation strategy may then be conducted following the RE-AIM principle: Reach, Efficacy/Effectiveness, Adoption, Implementation, and Maintenance.[53]

The study setting targeted underresourced NYC urban high schools that are encountering many challenges in implementing effective programs that can improve students' health behaviors and wellness including obesity problem. Despite these challenges, the finding that the implementation of HealthCorps programs was successful in the urban settings could mitigate concerns about the generalizability of findings into other settings such as suburban and rural areas. Although it is unknown whether the findings can be replicated in these nonurban schools, suburban and rural schools may be more likely to be equipped with greater resources, and serve less densely populated communities.

Limitations

This study findings should be interpreted with the following limitations. First, although the pre-HealthCorps status is used as a within-group control status, there is no between-group control status to compare the pre-post effects with. Second, weight status outcomes such as weight and height, self-reported or measured, were not available for this study. Therefore, it was not possible to assess associations among improvement of health behaviors, increased knowledge and weight status. Third, even if they were excerpted from well-established surveys, the survey items have not been assessed for validation or reliability for the student population under study. For example, the internal consistency values of the Cronbach alpha among items within factors are not high except for the first factor. This might have resulted in

counterintuitive findings such as the aforementioned inverse association between knowledge and consumption of fruit and vegetables among boys. Finally, the participating students are not a random sample from the student body and may be a more motivated sample.

Conclusions

The HealthCorps program significantly increased participants' knowledge on nutrition, mental health, and physical activity and also significantly improved a few key health behaviors. The findings support expansion and implementation of health-behavior-promoting programs in underresourced school settings and beyond in an effort to curb the obesity epidemic in youth since additional attained knowledge and accompanying behavior changes should be the first step toward that end.

IMPLCATION FOR SCHOOL HEALTH

The Federal Child Nutrition and Women, Infants and Children Reauthorization Act of 2004 require by law that all local education agencies participating in the National School Lunch Program create local school wellness policies. In 2010, Congress added new provisions for local school wellness policies related to implementation, evaluation, and publicly reporting on progress of local school wellness policies (http://www.fns.usda.gov/tn/local-school-wellness-policy). Local education agencies are now being held accountable for local school wellness policy implementation, assessment, and public updates.

Although the HealthCorps program addressed 3 areas of behavior (healthy eating, physical activity, and mental health), behavior improvements were found exclusively in the area of healthy eating. Thus, schools with limited resources could target access to healthy breakfast (such as grab-and-go mentioned earlier) and promotion of the benefits of breakfast. That along with enhancing the availability of fruits and vegetables in school breakfast could create a focused strategy to gain biggest potential for improved healthy eating behaviors within the policy and educational resources generally available for most schools.

The HealthCorps University program uses a train-the-trainer approach to help local education agencies and schools assess interests and needs with regard to training and program services within the school wellness budget. The HealthCorps University trainees learn how to facilitate implementations of wellness program components that were associated with improved student knowledge and skills reported in this article. Underresourced or socioeconomically disadvantaged high schools can use the RE-AIM evaluation framework in combination with HealthCorps University activities to develop and evaluate their wellness programs.

Human Subjects Approval Statement

The New York City Department of Education Institutional Review Board (IRB) approved collecting data from the student participants. Students provided oral assent, and passive consent was obtained from parents of students via an IRB-approved informed consent letter that asks to allow their children to complete the study survey. Both groups received instructions for opting out of the survey. The Albert Einstein College of Medicine IRB approved analyzing the collected 2012-2013 HealthCorps survey data.

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SUPPORTING INFORMATION

The following Supporting Information is available for this article:
Appendix S1. Network/HealthCorps program survey for NYC school.

Additional Supporting Information may be found in the online version of this article.