

Engaging Youth to Examine Lifestyle Behaviors through Authentic Research with University Partnerships

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Abstract

University researchers partnered with secondary students in West Virginia and Mali on an international science investigation to strengthen science education and public health practices. WV and Mali students made comparisons of diet, physical activity, BMI, and blood pressure gathered from study participants. Full IRB approval was provided by West Virginia University for this human subjects study. The mean systolic blood pressure for the Mali participants was significantly lower, especially when compared to African-American youth ($p=.0008$), as was the mean BMI scores of Mali participants ($F_{1,77}=11.43, p=0.0011$). Student investigators analyzed results with guidance by university faculty and showcased their results to peer-audiences at school, for local community events, and at annual Symposia. The University partnership provided opportunities for secondary students and their teachers to discover the role that environment plays in influencing health via authentic research and exposure to international public health strategies. Viable alternatives to unhealthy behavior were shared. Results point to the importance of a nutrition-dense diet (low in fats and sugar) combined with simple walking, as beneficial for all humans. Such comparisons can enhance science education, global health awareness, and empower young adults to alter their unhealthy behavior so as to avoid chronic disease in adulthood.

Key words: *Secondary School, Partnership, Dietary, Physical Activity, Life Style Behavior*

Introduction

It is a major challenge to alter the contemporary unhealthy eating habits and sedentary lifestyles of American youth, which lead to diabetes and cardiovascular disease in adulthood.¹ Public schools present an ideal context to assess promising public health strategies with students. Partnerships between university faculty, teachers, and students can facilitate the availability of resources and expertise that are crucial to increase the likelihood that students will integrate healthy behaviors into their lives.²⁻⁴ With such collaboration, teachers and students can become active participants in authentic research while they gain insight from investigations that extend beyond the classroom walls and across the globe.

Enhancing Secondary Student Research

An example of such a collaborative partnership is the Health Sciences and Technology Academy of West Virginia (HSTA, WV). HSTA is a 9th-12th grade math and science program that encourages aspirations, opens doors, and empowers minority and underrepresented students to pursue health science careers. HSTA provides the infrastructure and support for science experts from several higher education institutions to partner with teachers and students across the state to provide mentoring and share their expertise. This collaboration results in community-based health science projects that involve active-learning and authentic research, helping students stay motivated, gain self confidence, and acquire scientific knowledge.^{5,6} With over 700 students in the state-wide program, the success rate of HSTA programming is impressive. Over 95% of the graduating HSTA students go to college versus 56% of all WV students. Upon graduation from high school and successful completion of the HSTA program, these students will receive tuition waivers at state-funded colleges/universities in WV for undergraduate and graduate degrees in health sciences. Eighty percent of the HSTA students stay in college, while only one out of three non-HSTA students continues in their first college year.

Risk for Chronic Disease

HSTA students and West Virginia University (WVU) faculty initiated the Lifestyles Project, which focused on an examination of lifestyle behaviors to better understand the national trend of sedentary lifestyles, obesity, and chronic disease. In WV, 63.7% of their adults are classified as overweight or obese from calculations of body mass index (BMI) ($\text{weight [kg]/height}^2 \text{ [m]} \geq 25$ with high corresponding rates

of coronary heart disease as well as diabetes and over 50% of WV children are classified as overweight.⁷ By partnering with WVU faculty, HSTA students gained insight into their own diet and exercise levels by gathering data on a diet and exercise survey, body/mass index, and blood pressure. A WVU visiting scholar from Mali connected WV students with the school in Bamako and thus began the comparisons of daily diet and physical activity routines among student populations in both countries. The partnership expanded into a fully approved human subjects research study with students acting as co-investigators to help gather data from their peers on diet, body mass index, and blood pressure. Students were engaged as they compared basic health indicators of young people in West Virginia and Mali (see www.wv-hsta.org/lifestyles).

Mali and West Virginia share some similarities in that both confront economic disparities (over 24% of the WV children live in poverty;⁸ Mali has one of the highest poverty rates among developing countries globally.⁹) The extreme poverty in many parts of Mali consists of behaviors that would profoundly affect the results of this study. For our purposes, we were able to work with a middle-class, well established public high school in the capital city of Bamako, whose main struggles of upgrading curriculum are similar to public schools in West Virginia.

Health disparities between black and white Americans have been well-documented, with blacks having higher rates of hypertension, stroke and death from cardiovascular disease compared to whites.¹⁰ Ethnic differences in blood pressure become apparent in adolescence and tend to increase over time.¹¹ The mechanisms for these differences are not defined and studies that compare different ethnic groups in the US with those from other nations can provide some insight into differences in lifestyle that affect risk for chronic disease. One objective for this project was for the student investigators to examine specific behaviors related to healthy lifestyles in their peers and to associate those behaviors with health outcomes.

Methods

Student Investigator Training and Subject Recruitment

Medical professionals and science teachers trained HSTA students from 10 rural and urban high schools across WV and 1 urban high school in Mali to collaborate on a research project, known as The

Lifestyles Project. All student and teacher investigators in both countries received training in the ethical standards set forth by the National Institutes of Health and the Health Insurance Portability and Accountability Act (HIPAA). The Institutional Review Board for the Protection of Human Subjects at West Virginia University approved this study. Investigators (HSTA faculty, teacher and students) recruited non-HSTA students from their high schools to be participants for this project. In Mali only teachers were the investigators and subjects were recruited from the student population at their high school. The investigators in both countries handed each potential participant a package that included a consent and assent form for parents to review, sign, and return to the teacher investigators. In addition to handing out the package, teacher and students investigators were available to answer any questions that interested people might have about the study. Each participant in WV and Mali 18 years or older signed a consent form and those younger than 18 years signed an assent form and their parents signed a consent form. Participation on this study was voluntary.

Survey Instrument Data Collection

Data were collected during the 2002-2004 school years using a survey instrument that had been validated previously in five high schools in West Virginia. Validation of the instrument for the Mali students was established early on through a site visit. Initially, teachers in Mali were not uniform in how to count a serving of fruits/vegetables or daily exercise. By verbal communication on location, one author (J Bardwell) was able to clarify this cultural misunderstanding, and teachers were then confident that their students answered in a consistent manner. The instrument included questions on diet, exercise, and tobacco use with examples provided. Participants were asked how many servings of fruits and vegetables they consumed each day, whether their diet was low in fat, low in sugar and whether they exercised for at least 20 minutes per day 3 or more days per week. Examples of a serving size were stated on the survey as an apple, an orange, a small bowl of salad, beans, etc. Examples of a low fat diet were stated on the survey as 2% or less milk, low fat cheese, lean meat, avoiding chips, etc. In the city of Bamako, low fat dairy products are available, so it was assumed that the Mali students understood this concept. Examples of a low sugar diet were stated on the survey as avoiding pop, baked goods, candy, etc.

Health Data Monitoring

A local medical expert who was either a physician or a nurse professional in each country volunteered to oversee blood pressure monitoring and collection of other health indicators. This medical expert helped to ensure that the student and teacher investigators collected the health measurements accurately. Student investigators measured the height and weight of each participant and calculated body mass index (BMI) at the initial and follow-up visits. Either the medical expert or a student (who had been certified through the American Heart Association) measured resting blood pressure of the participants at each visit. In Mali, blood pressure was measured with an electronic device (LifeSource digital monitor) and in WV, with a similar electronic device or a manual sphygmomanometer.

Statistical Analysis by Students

Students in both countries were trained in computer software applications (Microsoft Word, Power Point, and simple analyses with Excel). All data were entered into a mega-database and WV student investigators were trained on how to compare data using Excel (t-tests and correlation coefficients). The WV students chose different dependent variables and analyzed the data accordingly. For example, one student group compared the amount of physical exercise between countries, another compared the low sugar diets, and another compared blood pressure differences. The WV students showcased their results in over fifty presentations using Microsoft PowerPoint to audiences of their peers at school, for local community events, and at the Annual HSTA Symposia during the years between 2002 and 2005. The students in Mali were excited to try out the exercise bike, the electronic blood pressure device, and the computers donated to the school. One of the Mali students was awarded a trip to St. Petersburg, USSR to present Lifestyles Project. Both the Mali students and teachers benefited from the applied knowledge base in computer sciences, math application, and biological sciences. The Lifestyles Project enabled students in both WV and Mali to experience an authentic science investigation and this helped them connect science theory with practice.

Statistical Analysis by Faculty Investigators

What follows is an analysis of the data by WVU Investigators/Faculty using analysis of covariance (ANCOVA) models in SAS and performed using Proc GLM, Proc Mixed, Proc Univariate, and Proc Plot in SAS[®] Version 8.2 (SAS Institute, Inc., Cary, NC, USA). The statistical model included main effects and interactions. Because the age and gender distribution differed between locations, these

variables were used as continuous covariates in the ANCOVA model. Separate models were fitted using BMI and systolic blood pressure as dependent variables. Independent variables included location (Mali or West Virginia), ethnicity (all people from Mali were Africans; people from West Virginia were divided into 3 ethnic groups), gender, whether the participant reportedly ate a low-fat diet (defined as 2% or less milk, low fat cheese, lean meat, and avoiding chips), and whether the participant reportedly ate a low-sugar diet (defined as avoiding carbonated beverages, baked goods, and candy). Based on those factors we did a post hoc power analysis for this ANCOVA model. With $\alpha=0.05$ and $N=80$ participants, the power is 92%. Contrasts were used to compare means of participants from Mali to those of West Virginia European American, African-American, and multiracial ethnicity.

Contrasts were also used to perform orthogonal 1-degree-of-freedom tests on treatment factors such as fat and sugar intake. Multiple observations (averaging around 4 per individual over a year period) were taken on some of the participants to see if their choice of healthier foods (more low fat or low sugar food items) increased as a result of this intervention, so the model included the averages of the repeated measures for the analysis.

Results and Discussion

There were 58 participants (35 females and 23 males) from WV and 22 (8 females and 14 males) from Mali. The participants from West Virginia ranged in age from 11 to 17 years, with a median of 15 years. The participants from Mali ranged in age from 12 to 22 years, with a median of 19 years. The median age of study participants was figured at 16 years. Mean BMI and systolic blood pressure were significantly higher in the WV students than the Mali students (Table 1).

Diet and Physical Activity Levels

Students were asked early on in the study, to list their food choices for a week. This comparison of students' self-reported diet provides insight into what teenagers eat today (Table 2A).

Besides the French baguette, the Mali diet consists of unprocessed, unpackaged whole grains, fruits, and vegetables purchased at nearby markets. A typical Malian daily intake consists of yogurt, slices of baguette with mayonnaise, oranges, bananas, steamed millet and vegetable sauce (with an occasional serving of meat), green leaf salad, rice and beans.

Again, keep in mind that the sample population from Mali was from middle class families who do not struggle to get enough to eat, which is a reality in many parts of Mali. Meat, carbonated beverages, candy, and chips are consumed only upon special occasions or when presented as a gift.

A typical West Virginian daily intake consists of sugared cereal with milk, donut or granola bar, juice, fried meat dishes, french fries, green beans cooked with pork, desserts, carbonated beverages, assorted sugary snacks and chips.

The nutrient and energy intake of these two diets is worth comparing. An estimated analysis of the daily Mali teenage intake yields less than 2,000 calories, low in protein, and high in fruits and vegetables. The WV teenage diet tends to be over 3,000 calories and high in fats and carbohydrates.

The validated survey instruments were completed after the above mentioned self-reporting, and confirmed what students had self-reported. In Mali 77% of the respondents reported eating a low-fat diet compared to only 22% of respondents in West Virginia ($p<0.0001$). For low-sugar diets, the estimates were 50% for Mali and 9% for West Virginia ($p<0.0001$). (See Table 3)

Initially, students also self-reported details about the amount and types of exercise they completed in a week (Table 2B). The self-reporting indicates that the routine physical activity level of Mali participants is much higher than WV participants. The surveys confirmed the self reporting, providing evidence that all of the Mali subjects exercise at least 20 minutes for more than 3 times per week ($p<0.05$). Very few individuals in Mali own a car, so walking to markets, school, and elsewhere occur daily for no less than an hour. In addition, teenage Mali females perform manual household duties, such as washing clothes by hand, cooking over charcoal fires, and cleaning. Males tend to carry goods from markets and often play recreational sports.

The majority of the WV participants were enrolled in school athletics, yet only 79% of the participants reported exercising three times a week or more. Almost all WV families own at least 1 car, so walking to markets or schools is quite uncommon. Additionally, all public schools in West Virginia offer bus transportation to schools.

Body Mass Index

It was not surprising that the mean BMI was significantly lower for the Mali participants

compared to the West Virginia participants (Table 1). Significant effects were identified among ethnicities (Table 1). When data was examined by ethnicity and corrected for gender, the BMI scores for Mali participants (all African) were over 28% less than those for African-Americans in West Virginia.

No significant main effect due to low-sugar diets was noted, nor were any interactions with other factors ($p > 0.05$). The same is true for fruit and vegetable consumption, measured in servings per day.

Blood Pressure

In the analysis of systolic blood pressure (SBP), only the ethnicity was a contributing factor ($p < 0.001$). Participants from Mali (n, mean \pm standard error: 88, 99.3 ± 4.71) had lower SBP ($p = 0.0011$) than those from West Virginia (74, 116.6 ± 4.37) when both were evaluated at the overall median age of 16 years (Table 1). The mean SBP for Mali was also significantly lower than that for the African-Americans in West Virginia (17, 123.6 ± 4.8775 ; $p < 0.001$).

Data from the National Health and Nutrition Examination Survey 1999-2000 indicate that the mean SBP for a nationally representative group of children and adolescents, 8 to 17 years of age, is 106.0 ± 0.3 mm Hg.¹² The mean SBP for the WV adolescents in this study was 11 mm Hg higher at 117.6. For those who were African American/Multiracial, mean SBP, adjusted for age and gender, was even higher at 123.6 mm Hg (Table 1). Blood pressure equal to or greater than 120/80 is considered "pre-hypertensive" for adolescents and adults.¹³ The African American youth in WV appear to be at greater risk for developing hypertension than are the white youth in West Virginia or the youth in Mali. The lifestyle factors for Malians consisting of lower BMI, increased activity, and a diet that includes more fruits and vegetables, may act together or independently to favor lower blood pressure levels.¹⁴⁻¹⁵

Limitations

Measuring blood pressure with a manual sphygmomanometer requires appropriate training and an appropriately sized cuff. In this study, only health professionals or students who were certified to measure blood pressure did so in order to minimize variability. The use of an electronic device to measure blood pressure in Mali and in some of the West Virginia sites could contribute to some variability. However, an electronic device tends to record higher systolic blood pressure when compared to manual readings.¹⁶ Therefore the true difference in

blood pressure between West Virginia and Mali may be even greater than reported.

Another limitation is that there are age differences between the comparison groups of Mali and West Virginia that may affect the interpretation of the results.

The participants were asked to report whether their diet was low in sugar or low in fat, as well as the number of servings of fruits and vegetables that they eat on a daily basis. Since there tends to be a great deal of intraindividual variation in a usual diet, what they reported may not reflect their daily intake.

Even though our sample size was small, the perceptions still showed clear differences between how the West Virginia youth perceived their diets compared to the Mali youth.

Conclusions

The Lifestyles Project helped visualize for WV and Mali students an awareness of global health in the context of a science investigation. In terms of public health programming, the partnership enabled students and educators to become enlightened about required guidelines to ensure the protection and privacy of health information, the value of maintaining high scientific rigor, and a better understanding of how simple lifestyle behaviors such as eating habits and exercise can impact public health.

Initially, West Virginia and Mali students communicated via letters, which helped considerably to peak students' curiosity and make the data more meaningful. Through their analyses, the WV student investigators were surprised that the participants' diet of high sugars and fats correlated with a higher blood pressure than is expected at their young age. The juxtaposition of the Mali diet (low in sugars and fats) and corresponding low BMI and blood pressure made an impression. Viable alternatives to unhealthy behavior were shared, such as eating less, choosing more nutrient dense foods, and increasing walking, all of which can help reduce related chronic disease in adulthood.

At the Lycee Kankou Moussa in Bamako, the student enrollment numbers increased in the science majors in consecutive years. Through Lifestyles Project, a student in Mali was awarded a trip to a science education conference in St. Petersburg, Russia (2003) where she presented results and conclusions. The school in Mali received several computers through outside funding sources, which enabled Malian

students and educators to gain familiarity with computer skills, and keep motivation at a high level. In addition, a national contest in Mali resulted in the Ministry of Education awarding the Lycee Kankou Moussa with ten additional computers at their school.

Not only did student investigators find significant differences in the measurements between the populations in the two countries, but also the study offered the student investigators a chance to discover for themselves the role that environment plays in influencing health beyond their communities. The results point to the importance of a nutrition-dense diet (lower in fats and sugar) combined with simple walking, as beneficial for all humans.

Faculties from both countries were able to travel abroad through university and government-based travel exchange programs. This aspect enriched the science investigation for their students through enhanced intercultural awareness and personal accounts. The Lifestyles project is continuing with WVU faculty and HSTA students, whereby interventions will be designed to inform high school students about the efficacy of healthy diet and physical activity. We feel that an approach utilizing WVU partnerships with student-designed interventions will continue to yield increased student empowerment and suggest effective public health strategies to combat obesity and sedentary lifestyles.

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Table 1. Characteristics of High School Students in West Virginia Compared to those in Mali, the Lifestyles Project: 2002-2004.

Variable Measured	West Virginia, n=58 Mean ± SEM*	Mali, n=22 Mean ± SEM*	P value
BMI	All WV	22.2 ± 1.25	<0.0001
	African American/Multiracial (N=16)	24.6 ± 1.13	<0.001
Systolic BP	All WV	117.6 ± 4.37	<0.01
	African American/Multiracial(N=16)	123.6 ± 4.88	<0.001
Diastolic BP	All WV	68.5 ± 3.73	0.381

*Note: Means are averages of repeated measures (averaging 4 per individual over a year period) and adjusted for age and gender differences, between locations.

Table 2A. Food Consumed by Secondary Students in West Virginia Compared to those in Mali.

Time of day	West Virginia	Mali
Morning	Biscuit w/ gravy, bagel and cream cheese, hash browns, pastry, donuts, cookies, coco puffs, frosted flakes, lucky charms, sausage, ham, cheese, milk, bacon, eggs, gummi bears, toast, dr. pepper, orange juice, grape juice	Millet, corn, rice, sorghum porridge with milk, sugar, coffee w/ milk, bread or millet flat cakes, couscous, to, beans, and on weekends: eggs, meat steaks
Mid-day	Macaroni and cheese, pepperoni roll, corn dog, hotdog w/ chili, ham, turkey, steak, roast beef, turkey hoagie, chitlins, roman noodles, french fries, mashed potatoes w/ gravy, green beans, greens, cauliflower, black eyed peas, corn, candied yams, stuffing w/ gravy, roll, pickles, celery stix, chocolate milk, fruit, spice cake, coke	Rice, couscous, to, baobab leaves, peanut sauce, okra sauce, bean leaves sauce, cassava leaves sauce, yassa sauce, fakoye or zofon leaves sauce, meat or fish
Evening	Pizza, crackers and cheese, breadstix, potatoe salad, wild rice, cabbage, spinach, meat, turkey hoagie, hamburger, ham sandwich, peanut butter sandwich, beef raviolies, chicken wrap, soup, banana pudding, chips, coke, rootbeer, ice tea, orange juice, cider, candy	Salad (tomato and cucumber), potato, bread, couscous, beans, spaghetti, milk, stew with meat

Table 2B. Physical Activity conducted by Secondary Students in West Virginia Compared to those in Mali.

	West Virginia	Mali
Females	About an hour of physical education every other day at school, daily walks, working at varied jobs outside of the home, and about 10-15 minutes of daily exercise	An hour walk daily, lots of housework such as laundry and pounding millet, a few students play sports or martial arts for 1 ½ hours weekly
Males	About an hour of physical education every other day at school, playing 1-2 hours a day on sports teams, and daily walks	A 2 hour daily walk, and most students play sports for 2 hours 3-4 days a week

Table 3. Diet and Exercise Characteristics of High School Students in West Virginia Compared to those in Mali, the Lifestyles Project: 2002-2004.

Variable Measured	West Virginia, n=58 Mean ± SEM	Mali, n=22 Mean ± SEM	P value
Number Reporting a Low Fat Diet	22%	77%	<0.0001
Number Reporting a Low Sugar Diet	9%	50%	<0.0001
Number Exercising 3 Days per Week	79%	100%	0.0207