Exercise, nutrition and you: an off-campus course for grades 2–12

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Snyder, Ann C., and Debra K. Mauzy-Melitz. Exercise, nutrition and you: an off-campus course for grades 2–12. Adv Physiol Educ 29: 103–106, 2005; doi:10.1152/advan.00020.2003.—Since interest in science classes has declined recently and obesity, especially in youth, continues to increase, an exercise physiology-based course was taught in public parks to promote active-learning science and healthy living. The course emphasized and integrated exercise, nutrition, and health during a 3-h session. Following an introduction, five hands-on laboratory-based student modules were performed. Students performed respiratory, cardiovascular, temperature regulation, energy expenditure, oxygen uptake, and exercise modules. During most modules, the students made measurements at rest and during the performance of exercise at different intensities. The students were very involved and engaged in problem solving throughout the session. The program was given for 10 days to more than 500 students representing 18 classes from 10 different schools. Evaluations indicated that the program was a real-life science experience that gave the students a new understanding of how their bodies worked and the purpose of exercise. The students and teachers also experienced “school learning” put into action as the program fit well with their science curriculum.

applied science; field trips

Most current studies show that student interest in science is declining (1, 5–7, 12). Although much new and exciting work is being performed in biomedical areas, little interest is shown in grades 4–12 where basic science is taught. The “high school and beyond” surveys have shown a steady decline in the scientific literacy of students and in the number of students interested in natural science or engineering careers (8). Likewise, the survey reported that only a small fraction (0.2%) of high school sophomores were projected to receive a PhD in science areas (8). The 1996 and 1998 National Center for Educational Statistics report (8) showed a continual decline in science and math achievement of eighth and twelfth grade students. Concerns have been raised recently that science learned only from textbooks does not encourage interest in science. That is, memorizing information has not succeeded in learning science knowledge and interest; rather a more student-interactive approach is needed. Even so, a textbook-driven curriculum with emphasis on memorization remains the norm. Thus we need to examine how we teach science in grades 4–12.

The recently developed “Healthy People 2010”, a PHS-led national activity for setting priority areas for health promotion and disease prevention, has two main goals: 1) increasing the quality and years of healthy life and 2) eliminating health disparities (10). Although life expectancy has increased greatly over the last decade, males in 25 non-US countries currently have life expectancies greater than those in the United States (73 yr for those born in 1990s) and 17 countries have longer life expectancies for females than do those in the United States (79 yr for those born in 1990s) (10). Life expectancy and quality of life are both hypothesized to be enhanced by helping people gain knowledge, motivation, and opportunity to live healthier lives (10). A healthy life disparity occurs due to gender, ethnicity or race, education and/or income, disability, and location. Thus greater knowledge and exposure to healthy aspects of life should enhance these two goals.

The 28 focus areas of Healthy People 2010 include 12 areas directly affected by exercise and/or nutrition: diabetes, arthritis, osteoporosis and chronic back pain, nutrition and overweight, chronic kidney disease, physical activity and fitness disabilities, respiratory diseases, education and community-based programs, cancer, health communications, heart disease and stroke, and injury and violence prevention. According to 1997 information, the four leading causes of death (heart disease, cancer, stroke, and chronic obstructive pulmonary disease) along with diabetes (the seventh leading cause of death) could all be reduced with proper exercise and nutritional practices (10). We know that performance of regular exercise decreases the incidence of heart disease, colon cancer, high blood pressure, and diabetes, while increasing muscle and bone strength and lean tissue mass (2). Regular exercise also aids in weight control and is a key part of weight loss through the decrease of fat mass (11). Performance of regular exercise also enhances psychological well-being (2). Similarly, proper nutrition can affect these leading causes of death (3).

The 1996 National Science Education Standards set forth by the National Research Council and followed by individuals states and schools sought to address the science deficiencies and enhance the science curriculum (9). The standards include sections where science, health, exercise, and nutrition content can be merged and applied activities developed. In so doing, the study of the sciences and health can be an integrative and active process, not one where memorization predominates. Rather, an experience of exploring, observing, problem solving, and discussing in an engaging classroom atmosphere takes place. The overall goal of this program was to develop an integrated scientific program for students in grades 2–12 that would enhance and enrich the scientific, mathematical, and health knowledge of the students and their classroom teachers through an interactive and engaging atmosphere.

METHODS

The overall course involved the off-campus/park program, a pre-river packet that teachers received before coming, and a web page. The off-campus programs were taught at public parks along the Milwaukee River and the instructors of the program traveled from park to park via canoe, thus the term “pre-river.” Principals of schools near the Milwaukee River were contacted the summer before the off-campus/park program to generate interest in the program. The target age group was fourth through seventh grade because of the
increased emphasis in health and body systems in the curriculum of these grades. The course took into consideration the Wisconsin Model Academic Standards, particularly the theme of “Science as a system that should be seen as a single discipline rather than a set of separate disciplines.” Before the involvement of any students, use of human subjects was approved by the University of Wisconsin-Milwaukee Institutional Review Board. Parental consent was also obtained because all of the students were minors.

Pre-river packet. The pre-river packet was given to teachers ~2 wk before the off-campus/park program. The packet outlined the different modules and the information needed to be presented in class before the park program. The pre-river packet had introductory information covering the different topics to be discussed, so the teachers, if not the students, could be well-informed, depending on the amount of pre-program preparation. Instructors were available to meet with the teachers and students before the river trip. Three schools chose this option.

Park program. After the instructors met the students and introduced themselves, the students received a handout covering the different activities. A brief verbal introduction into the program and its purposes followed. Because the park program was part of a canoe trip for the instructors, the first topic was transportation and how we visit our friends (via canoe, or the most common answer was “Have mom drive me”). The conversation continued with other examples of energy-saving technology, i.e., dishwashers, lawn mowers, vacuum cleaners, and remote controls, which led into the discussion of exercise and the need for it. The different types of muscle contractions were described–isometric, isotonic (both eccentric and concentric), and isokinetic. The students felt the movement of their muscles while performing isometric, concentric, and eccentric contractions. Fast and slow muscle fibers were discussed, illustrated with the general percentage that different athletes tend to have. A discussion of the body’s energy sources followed, including the need for ATP for muscle contraction and when various stored energy sources (ATP, creatine phosphate, carbohydrates, fats, and proteins) are used (Table 1).

Table 1. Energy sources

<table>
<thead>
<tr>
<th>Energy Sources</th>
<th>When Used</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stored ATP</td>
<td>Very intense exercise, 1–2 s</td>
<td>Available. Requires no oxygen</td>
<td>Not abundant</td>
</tr>
<tr>
<td>Creatine phosphate</td>
<td>Very intense exercise, &lt;10 s</td>
<td>Can generate ATP quickly. Requires no oxygen.</td>
<td>Not abundant</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>High-to-moderate exercise, 10 s–2 h</td>
<td>Can be used for about 15 s before oxygen is required</td>
<td>Yield without oxygen: 2 ATP per glucose. Lactic acid formed without oxygen.</td>
</tr>
<tr>
<td>Fatty acids</td>
<td>Moderate-to-low exercise, long durations</td>
<td>Large amounts available. Yield: 130 ATP/fatty acid</td>
<td>Requires a lot of oxygen, so not used as much during exercise.</td>
</tr>
<tr>
<td>Proteins (as amino acids)</td>
<td>Moderate-to-low exercise, long durations</td>
<td>Always available. Yield: ~15 ATP per amino acid</td>
<td>Requires oxygen. If no amino acid stores available, muscle mass will be used.</td>
</tr>
</tbody>
</table>
students also determined whether carbohydrates or lipids was the major fuel being used through observation of the respiratory exchange ratio. The goal of the oxygen uptake module was to illustrate how scientists determine exercise-related body functions in a precise way and how these functions are interrelated.

Energy expenditure module. One of the student’s prepark assignments was to calculate the number of metabolic equivalents (METS) they had used outside of school on a typical day. Once their METS were determined, a daily expenditure was estimated (4, 13, 14). In the energy expenditure module, the students balanced their daily caloric expenditure with food intake using a double beam balance and weighted cards for both energy expenditure and food intake. The foods used to “balance” the caloric expenditure were compared with the food pyramid. This module was eliminated for students in the second grade. The goal of the energy expenditure module was to increase student awareness of the importance of exercise in increasing caloric expenditure and to learn the caloric value of some common foods.

Body temperature regulation. The last module was body temperature regulation where students measured skin temperature of sites forehead, neck, and wrist through the use of a Dermatemp device (Exergen, Watertown, MA) which measures heat emitted from the body surface by infrared thermometry. The measurements at the three sites were compared with other data collected on other days of the program at different air temperatures. Daily temperatures ranged from 45–80°F during the 2-wk program. Students were asked to compare their normal body temperature to their skin temperature and to the environmental temperature. Older students were asked to explain the difference between the temperatures. The goal of the body temperature regulation module was to demonstrate how the body cools itself.

After all students had performed all modules, a short wrap-up occurred. During this time, the need for different types of exercise was stressed, what happens to the body during exercise was discussed, and the students were quizzed on how the effect of exercise was healthful to our bodies.

Web site. A world wide web site that had a physiological, nutrient, and weather emphasis was updated and available to students each day following the activities of the 2-wk canoe trip of the instructors. The physiological topics were: preparing the body for adventure, muscles and movement, heart and blood vessels, respiration, blood, temperature regulation, skin, regulation by the nervous and endocrine systems, injuries and illnesses, energy expenditure and body composition, and digestion and excretion. The nutrient topics of the day were: basic nutritional requirements of the body, proteins, lipids and cholesterol, oxygen, vitamins, water, fats, minerals, carbohydrates, and fiber. The weather topics of the day were: lightning, dew point and humidity, temperature aspects, and weather emphasis was updated and available to students each day for the program. Students were asked to compare their normal body temperature to their skin temperature and to the environmental temperature. Older students were asked to explain the difference between the temperatures. The goal of the body temperature regulation module was to demonstrate how the body cools itself.

In the section assessing the off-campus park program day itself, the teachers were pleased with the organization overall, but would have liked more time for the actual program. When teachers reflected on the program, they were in agreement that the topic of nutrition and exercise was appropriate for their students and that ties to the science curriculum made the program worth using school time. Examples of teachers’ responses to the question “In your perception, what was the educational benefit for your students and yourself?” indicated that the “real world” application of the science was an important aspect of the program. Students were able to see school learning tied into other learning activities. In addition, the teachers received very positive feedback from the parents who had volunteered, possibly encouraging further participation in programs similar to this one.

From the instructors’ perspective, the park program went well. Having five different modules at one time with only two instructors could have been a real problem, but the teachers and parents were oriented by one instructor while the other instructor provided the introduction to the students. For five of the days, a high school student volunteered to help, improving the overall delivery of instruction. The high school student circulated among the groups, making sure that the teachers and parents were comfortable with their roles, and answered questions.

The age range of students did not present a problem for the instructors, because each program was tailored to the abilities of each group of students. Most of the students were in grades five through seven; however, one second grade and one high school class took part in the program. For the younger grades, the handouts and explanations were simplified. The hands-on activities were successfully completed at all age levels, and only the discussion had to be made age-appropriate. The activities were designed with fifth graders in mind, but were found to be effective for grades fourth through high school without major changes. Except for the cardiovascular module, students had not done any of the activities before the program. The subject matter of exercise and nutrition and its effect on their bodies was personal and interesting to most of the students. Every age group from second graders to high school seniors was interested in their own lung capacity, heart rate, skin temperature, and energy expenditure. The oxygen uptake module, which was interesting for all students, was very useful for the high school students. This module examined
energy usage during different intensities of exercise and also allowed for discussion of questions dealing with research, such as those dealing with experimental design, which could be answered through individual demonstrations.

The web site, while mostly written before the start of the park program, still needed updating each day, which became too time intensive for the instructors. The web site was initially meant to be used as an extension of the off-campus/park program, allowing students to participate in the 10-day event. When asked about the use of the web page, teachers either had not accessed the site or had problems accessing the site. A simpler site, with pretraining of the teachers on its use, may have made the site more useful and more worth the time that was spent on it.

Student evaluations of the program were not obtained; therefore, the program may have been improved with the use of pre- and postcompetency tests. We would also have a better measurement of the effectiveness of the program if students and volunteers had performed written evaluations and if we had a better return rate on evaluations from teachers.

In conclusion, from the conversations that occurred during and after the programs with teachers, students, and parent volunteers and from the teachers’ written evaluations, it was apparent that the students gained new insights into how their bodies function and why physical activity is needed to remain healthy. The program complemented and integrated both science and health curricula and was probably most effective at this in the fourth through seventh grades, the level for which the program was initially developed. The park program was a positive program as far as student learning and exposure to life science experiences.

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REFERENCES