Effects of a Web-Based Health Program on Fifth Grade Children's Physical Activity Knowledge, Attitudes and Behavior

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ABSTRACT

American children continue to be less physically active than they were a decade ago. Web-based programs (e-Learning), requiring minimal teacher training and expertise, could contribute to improvements in children's health-related knowledge, attitudes and behaviors. The purpose of this study was to evaluate the impact of the e-Learning module Healthy Hearts 4 Kids (HH) on the physical activity knowledge, attitudes and behaviors of 233 fifth grade children. A 2x3 repeated measures design was employed and significant changes in knowledge and attitude were found upon completion of the module and also six weeks after the post-test was completed. Results of this study suggest HH could be an effective component of a coordinated school health program (CSHP).

INTRODUCTION

Heart disease is the nation's leading killer, accounting for more than 30% of all deaths nationwide. The contribution of unhealthy behaviors such as physical inactivity, tobacco use and poor nutrition to the incidence of heart disease is well documented and evidence indicates that habits established during childhood continue into adulthood.[1] Recommendations for improving children's health behaviors include school health education.[2]

Evidence suggests that a majority of elementary school children do not receive health instruction during school. Teachers are less likely to include content in classroom curricula if states do not require testing in that particular subject, and data reveal that only 15.7% of states require students be tested on health education topics.[3] Many barriers exist for teachers inclusion of health instruction, such as time, a lack of resources and insufficient or no health training.[3,4]

Limited research exists regarding the specific implementation of health instruction in elementary school classrooms. What evidence is available suggests that health instruction is not included in classroom curricula.[5] Although eighty percent of states require health instruction in elementary schools, only 3.8% of health instruction at elementary schools nationwide is taught by health education specialists, while the largest proportion is taught by classroom teachers.[2] Furthermore, only thirteen states require health education training for multiple subject pre-service teachers.

There are many potential reasons for the failure of schools and classroom teachers to offer health instruction. In an effort to circumvent failure, it is possible to identify viable alternative methods for delivering health instruction. One option has been for school nurses and undergraduate nursing students to provide health instruction.[6] The CDC recommends that health instruction come from "teachers who have been trained to teach the subject."[2] Although school nurses are well trained in health content, they are not typically trained in pedagogy. The effectiveness of school nurses teaching health is one area in need of study.

Another evolving approach is to deliver health instruction using video, computer and Internet technologies. Health instructional videos that supplement existing health curricula with primary grade children have been significantly correlated with improved cognitive achievement and student interest towards health.[7] Videos are

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static in design and cannot evolve along with content and methods as a live teacher might. Internet and computer-delivered instructional programs have also been developed for use with children[8-10] and adults.[11] Internet-delivered programs have the advantage of evolving quickly and delivering up-to-date information.

Internet-delivered instruction, or eLearning, is a viable means of providing instruction to children in schools.[10] The eLearning module Healthy Hearts 4 Kids (HH) is one such program designed for children to use during school. HH presents units on cardiovascular function, physical activity, nutrition and tobacco. Fifth and sixth grade classroom teachers implement HH by taking their students to a computer lab for up to 50 minutes twice a week. While online, students are presented information, take quizzes, complete writing activities reinforcing the content, and report their physical activity and nutrition habits. After an initial introductory week working with HH, students complete activities on each of the content topics. Information presented includes benefits, recommended amounts and suggestions for how to participate in physical activity. Students are also offered feedback based on how much physical activity they engage in, and alternative physical activities are suggested. Information is presented through graphics and animations, and the children's responses on the Web site often determine which information and experiences are provided.

To determine the feasibility of implementing HH, Elliott[10] piloted and conducted a formative evaluation in two Virginia fifth grade classrooms and found that HH was technically functional, and that teachers and students could use it in elementary schools. Although a significant amount of funding has been directed towards placing computers and the Internet in schools, this is the first study designed to assess a Web-based instructional unit's impact on fifth grade students' health-related knowledge, attitudes and behaviors. The purpose of this study was to determine 1) Healthy Hearts effects on the physical activity knowledge, attitudes and self-reported behavior of fifth grade children, and 2) whether any changes in knowledge, attitudes or behavior were retained six weeks after the completion of HH.

METHOD

Participants

Teachers from schools throughout West Virginia were contacted through mailings and phone calls to recruit study participants. Participants in this study included 233 fifth grade boys (n=103) and girls (n=130) from eight public schools in five West Virginia counties. Children were predominantly Caucasian from low– to moderate–income families. According to teachers, approximately 67% of children were eligible for free and/or reduced school lunch. Consent forms were sent to 260 children with a 90% return rate. Teachers were given two dates to choose from for starting HH, with those beginning in March assigned to Group 1 and those starting in April designated as Group 2. Teachers had the choice of dates to better allow them to fit HH into their yearly schedule. The Virginia Tech IRB approved study procedures.

Procedures

Paper-based questionnaires and a test script were mailed to teachers, who administered the Baseline and follow-up tests to their students while at school during class time. All children were provided by the teachers with Healthy Hearts IDs that were randomly created when teachers registered their students to use Healthy Hearts. Children wrote their HH ID number on the first page of the questionnaire. Children were provided up to fifty-five minutes of class time to complete each test. A crossover design was employed for this study. All participating children completed the Baseline questionnaire in March before Group 1 began using HH. At the end of March, teachers administered Test 2 followed by Group 2 using HH. Test 3 was administered during the first week of May after Group 2 had completed HH. Classroom teachers mailed the tests back to the researchers in addressed, postage-paid envelopes that were provided to them.

Instrument

Six physical activity items were developed from HH objectives to assess knowledge of the benefits of physical activity, recommended amounts of physical activity, and identifying light, moderate and vigorous activities.[12,13] Items were in a forced choice format with four answer options. A panel consisting of physical education, physical activity, health education and pediatric specialists reviewed the test items to determine content validity, and the test instrument was piloted with 21 children from a single 5th grade class in rural Virginia ($\propto = 0.40$). On the Baseline and Test 2 instrument, the six physical activity knowledge items were randomly assigned to one of two forms to keep the test instrument relatively short, and to reduce the chances of students learning from the test. Because each of the six physical activity knowledge items measured one of five HH knowledge objectives, scores are considered a general measure of knowledge of HH physical activity objectives. Children randomly completed one of the two forms at Baseline and were given a test with the second set of knowledge questions at Test 2. All six knowledge items were included at Test 3 so that all children would answer each knowledge item twice. The sum of correct answers represents general knowledge of the physical activity objectives addressed in HH.

The three attitude items used in this study were adapted from the Sport, Play and Active Recreation for Kids (SPARK) project.[14,15] Attitudes are often measured by likelihood of action, also known as behavioral intention, because attitudes cannot be directly measured.[16] Each question asked students to indicate their intention to be physically active from "definitely will" to "definitely will not" on a five point Likert-type scale. Interitem reliability (Cronbach's $\propto$) of the three attitude items when the instrument was piloted with 21 children from Virginia was 0.77.

Weekly energy expenditure from physical activity was measured using the weekly activity checklist (WAC).[17] The WAC is a twenty-item checklist used to identify activities engaged in for at least 15 minutes on each of the past 7 days. The WAC was validated with Caltrac accelerometers and is reliable for estimating changes in physical activity of children, although not as an absolute measure of energy expenditure.[17] Self-report of intensity was disregarded in this study based on the recommendations of the instrument developers.[17] The list of activities on the WAC was modified to include more likely "lifestyle" activities for children in West Virginia. For example, "boogie boarding" was replaced with "outdoor play: climbing trees, skiing and hiking." The activities listed were grouped according to metabolic value (MET), beginning with low (scored 3 METS), moderate (scored 5 METS) and vigorous (scored 9 METS) physical activity. Student WAC scores were calculated by multiplying the frequencies of each activity by the appropriate MET value. The estimate of weekly energy expenditure in METS was used to measure changes from Baseline to Test 2 and Test 3. Test-retest reliability was significant <0.001 (r = 0.414). The final instrument included an additional 24 knowledge, attitude and behavior items pertaining to nutrition and tobacco that were not analyzed in this study.

Statistical Analysis

Data were analyzed in 2x3 repeated measures ANOVA to determine HH effects on physical activity knowledge, attitudes and behavior with Group (Group 1 and Group 2) and Time (Baseline, Test 2, Test 3) as fixed factors, and knowledge, attitude and behavior as dependent variables. Retention was determined using Group 1 scores for those variables that resulted in significant differences from Baseline to Test 2. All tests of significance were run at the .05 level using SPSS 8.0 for Windows.

Knowledge scores were calculated as a sum of the number of correct answers and indicate general knowledge of the HH physical activity objectives. Baseline and Test 2 scores ranged from 0 to 3 because knowledge items were divided between two forms. Because all six knowledge items were included on the final questionnaire, Test 2 knowledge scores were divided by two resulting in a range of 0-3. This allowed for comparison of Baseline and Test 2 scores. Higher scores indicated more questions answered correctly.

To measure attitude, a five point Likert-type scale was scored 1 to 5 points for each item with 1 point for "I definitely will not" and 5 points for "I definitely will" and a total attitude score was calculated by adding the scores for all three attitude items. Scores ranged from three to fifteen points with higher scores indicating greater intention to be physically active.

Weekly energy expenditure from physical activity was calculated by multiplying frequency of participation in a given activity by the appropriate MET value as reported on the WAC.[18] Scores ranged from 0 to 110 with higher scores indicating more weekly energy expenditure from physical activity. Results were calculated and are reported separately for knowledge, attitude and behavior.

PRINCIPAL FINDINGS

Knowledge

Test-retest reliability calculated from Group 2 Baseline and Test 2 scores ($r = 0.38$) was significant ($p<.001$). A t-test revealed no significant difference between Group 1 (mean = 0.91, sd = 0.811) and Group 2 (mean = 0.78, sd = 0.709) pretest performance (df = 231, p = 0.238), suggesting groups were similar. Table 1 displays mean scores and standard deviations for students by group. Repeated measures ANOVA between subjects' main effects (Group 1 and Group 2) revealed no statistical difference ($F(1, 197) = 2.785$, $p = .097$), suggesting both groups performed similarly when scores at Baseline, Test 2 and Test 3 are considered. Tests of within subjects' effects revealed significant effects on physical activity curriculum knowledge ($F(1, 197)=780.374$, $p<.001$). Significant interaction of group and test suggest groups performed differently at each test interval ($F(1.95, 26.523)=26.523$, $p<.001$).

Follow-up repeated measures ANOVA

Table 1. Knowledge, Attitude and Behavior Descriptive Statistics by Group and Test

		Baseline		Test 2		Test 3	
	N	Mean	SD	Mean	SD	Mean	SD
Knowledge							
Group 1	108	0.91	0.80	1.32	0.97	1.14	0.66
Group 2	91	0.78	0.73	0.68	0.79	1.53	0.69
Attitude							
Group 1	107	12.01	1.89	12.40	1.92	12.24	1.89
Group 2	88	12.01	1.99	12.19	1.87	12.51	1.73
Behavior							
Group 1	90	100.87	83.81	123.53	88.40	147.54	108.66
Group 2	82	112.21	94.78	142.71	122.25	124.40	98.92

Note. Only data collected from students who answered each question at Baseline, Test 2 and Test 3 are included.

Figure 1. Mean Knowledge Scores by Group at Baseline, Test 2, and Test 3

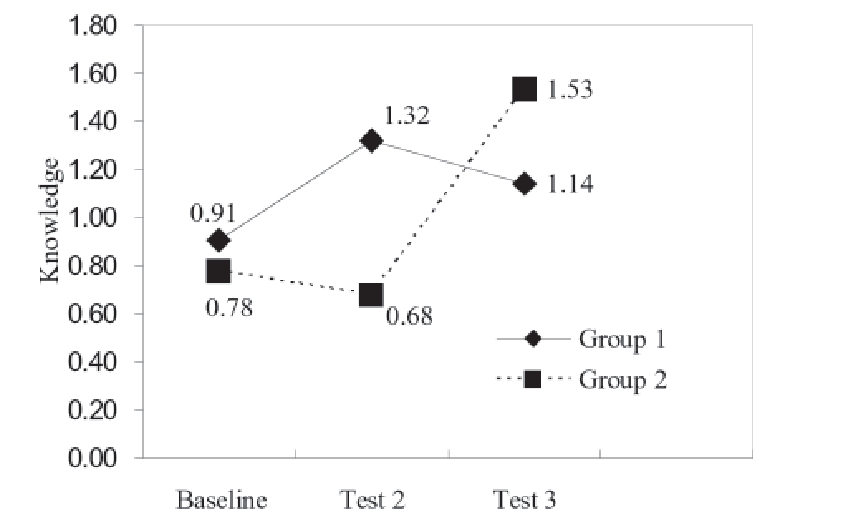
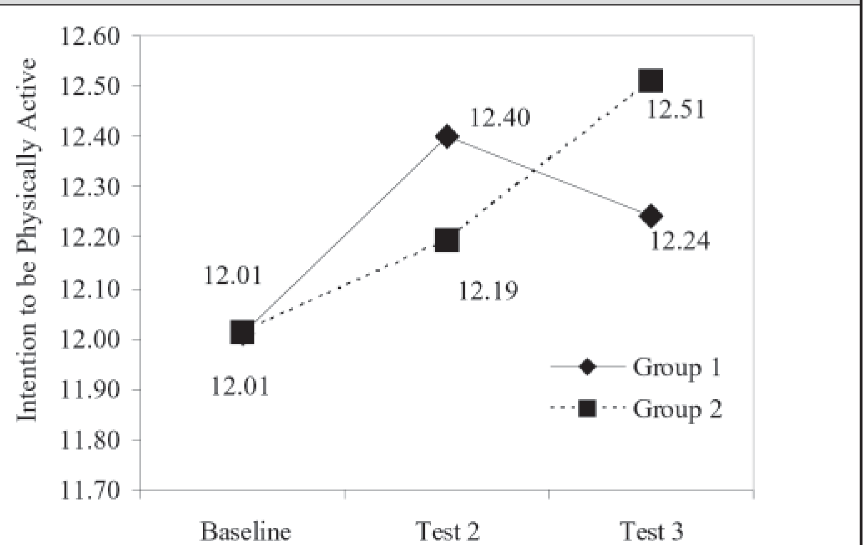


Figure 2. Mean Attitude Scores by Group at Baseline, Test 2, Test 3



for Group 1 and Group 2 confirmed HH effects on students' knowledge. Children who received the program between Baseline and Test 2 (Group 1) had significant improvements in knowledge ($p < .001$) during this interval. Group 2 students' knowledge at Test 2 was statistically similar to Baseline measures, and can be considered a control group from Baseline to Test 2. No significant changes for Group 2 or significant changes for Group 1 between Baseline and Test 2 indicate HH contributed to improvements in knowledge. Group 1 was the only group tested for knowledge retention in this study. Significant differences between Test 2 and Test 3 ($p < .05$) indicate some loss of knowledge, but Test 3 scores remained significantly higher than Baseline for Group 1 ($p = .008$), revealing retention of physical activity knowledge for children in Group 1. Follow-up repeated measures ANOVA for Group 2 revealed significant differences between Baseline and Test 3 ($p < .001$), and Test 2 and Test 3 ($p < .001$); however, no significant differences were found between Baseline and Test 2 knowledge. Significant changes in knowledge for both groups immediately following the program indicate positive effects of HH on knowledge.

Attitude

Interitem reliability of the three attitude items calculated using Cronbach's alpha (n=199) was 0.72. Mean attitude scores by group are displayed in Figure 2. Between groups, main effects were not statistically significant ($F(1, 193) = .009$, $p = .923$). Within subjects' repeated measures ANOVA for both groups at all three tests revealed significant changes by test ($F(2, 386) = 3.524$, $p = .030$). Both groups' intentions to be physically active increased from Baseline to Test 3. Since there was no significant interaction ($F(2,386) = 1.35$, $p = .260$), the increase in attitude may not be directly attributed to HH because both groups' attitudes improved regardless of when they used HH. Pairwise comparisons in follow-up repeated measures analyses for Group 1 and Group 2 revealed significant changes in attitude for Group 1 from Baseline to Test 2 ($p = .042$) and no significant changes in Group 2 during this interval ($p = .405$). These results suggest HH had significant effects on Group 1 attitude when considering Group 2 as a control. Group 2 attitude scores at Test 3 were significantly higher than Baseline ($p = 0.028$), although not significantly higher than Test 2 ($p = 0.229$). Attributing attitude changes to HH, therefore, must made with caution. Group 1 scores decreased slightly from Test 2 to Test 3, but were not significantly different ($p = 0.413$), suggesting attitude gains were retained; however, no significant differences in attitude from Baseline to Test 3 ($p = 0.204$) indicate no retention of effects.

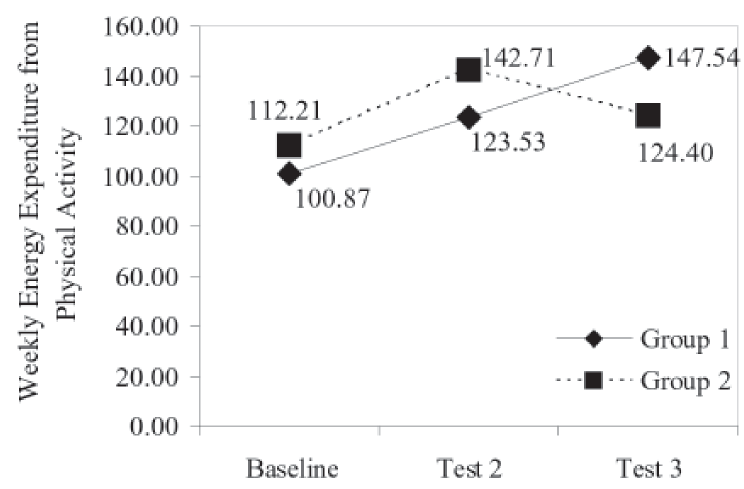
Behavior

Mean self-reported behavior scores are displayed in Table 1 and plotted by group in Figure 3. Tests of between subjects' effects revealed no significant difference between groups for main effects ($F(1, 170) = .043$, $p = .836$). Within subjects' analysis revealed significant main effects for test

(F(2, 340) = 7.524, p = .001), as well as significant interaction (F(2, 340) = 3.617, p = .028). Results suggest significant changes in self-reported behavior for both groups from Baseline to Test 3. The significant interaction indicated that group behavior changed at different test intervals. Follow-up to repeated measures ANOVA was conducted to determine at what test interval significant changes resulted.

Group 1 self-reported behavior showed significant changes from Baseline to Test 2 (p = .024) and again from Test 2 to Test 3 (p = .011) in a paired comparison. Children in Group 1 were more active at Test 2 than Baseline and again at Test 3. Group 2 physical activity also improved significantly from Baseline to Test 2 (p=.025), suggesting improvements in behavior cannot be attributed to HH. Paired behavior analysis for Group 2 revealed significant changes from Baseline to Test 2 (p = .025). There were no significant changes in self-reported behavior for Group 2 from Baseline to Test 3 (p = .332), or from Test 2 to Test 3 (p = .214), although behavior scores were lower. An increase in both groups' physical activity from Baseline to Test 2 suggests HH may not have impacted physical activity behavior. Overall, results imply HH led to significant improvements in fifth grade children's physical activity knowledge, potential effects on attitude, and no impact on behavior. Although there was a drop in scores from Group 1 at Test 3, significant knowledge and attitude gains were retained.

Figure 3. Weekly Energy Expenditure by Group at Baseline, Test 2, and Test 3



DISCUSSION

The purpose of this study was to measure the Web-delivered program Healthy Hearts's (HH) effects on fifth grade children's physical activity knowledge, attitudes and self-reported behavior. This study was a summative program evaluation implemented as a follow-up to the formative evaluation and subsequent redesign of HH.[10] The most important findings of this study were that the program led to improved physical activity knowledge and attitudes toward physical activity participation in study participants. Results of this study suggest that Internet-delivered eLearning programs could be a viable alternative to traditional classroom instruction.

Results revealed that HH led to significant improvements in physical activity knowledge for children in Group 1 and Group 2 immediately following completion of HH. When considering the overall improvements in physical activity knowledge, evidence revealed that HH effectively improved participating children's knowledge of the benefits, barriers and recommended amounts of physical activity. Limited research shows that knowledge of the benefits and recommended amounts of physical activity contributes to improved behaviors.[19-21] It is generally recognized, however, that improved knowledge is not sufficient for improving health behaviors.[22]

In a review of correlates and determinants of physical activity, Sallis, Prochaska and Taylor reported that physical activity intention consistently predicted behavior.[22] In this study, baseline attitude scores were similar when comparing Group 1 and Group 2, suggesting that Group 2 was an appropriate control and that HH contributed to improved physical activity intention in Group 1. Results between groups during the second half of this study suggest caution in attributing changes in attitude to HH is warranted.

Results of repeated measures ANOVA also revealed there were no significant differences in attitude between groups regardless of when the program was administered, but follow-up analyses revealed significant changes for Group 1 from Baseline to Test 2. In a review of correlates of physical activity, Sallis et. al. reported that attitude towards physical activity consistently correlated with behavior.[23]

An encouraging result of this study was a significant correlation between attitude and behavior. Evidence suggests a consistent positive relationship between physical activity attitude and behavior.[22,24] HH did lead to potential improvements in physical activity attitude—an encouraging result considering the relatively small amount of time children spent with health instruction and the fact that self-reported behavior changes could not be attributed to HH. Improved intention to be physically active does suggest potential for behavior change.

Although children significantly increased self-reported behavior during this study, the changes could not be attributed to HH. These results are consistent with other research, demonstrating the many variables related to physical activity behavior.[14,25] Research on correlates and determinants of physical activity in children suggest that gender, parental influence, age, perceived barriers, opportunities and perceived skill are all related to children's participation in outside of school physical activity.[12,26] Other correlates include access to physical activity facilities, television viewing and computer gaming.[27,28] One potential for the increase in activity seen in both groups in this study could be that weather may have permitted greater opportunity for activity later in the year than when Baseline tests were conducted.

Successful school-based behavior change programs have taken multi-pronged approaches by addressing multiple correlates of behavior. The Child and Adolescent Trial for Cardiovascular Health (CATCH) resulted in significant improvements in fitness and physical activity during physical education through teacher training, curriculum and support to improve physical education and physical activity.[29] Planet Health and Pathways, two other programs that led to improved health behaviors, incorporated classroom and physical education teacher training and materials and targeted changes to the school and home environment.[30,31]

The multitude of variables contributing to the health decisions of children led to the development of coordinated school health programs (CSHP), a multi-level approach targeting children's health behaviors. A CSHP coordinates efforts of classroom teachers, physical educators and after-school activity programs along with the school and community variables to improve children's health. Such programs are complicated to implement, in large part due to difficulties coordinating efforts of all parties involved. Such programs require financial resources to train personnel, coordinate committees and implement the program. It is difficult enough training and encouraging elementary school teachers to teach health, let alone coordinating their efforts along with others in a CSHP.

Evidence suggesting that children do not receive health instruction during school supports the search for alternative means of providing health instruction to children. Health instruction, such as HH, delivered via the Internet rather than through traditional teacher-directed methodologies circumvent the difficulties of providing materials and resources and training educators to provide health instruction. Internet delivery allows for interactive and interdisciplinary instruction regardless of teacher content knowledge and pedagogy. In traditional curricula, teachers are able to individualize instruction when teaching familiar content; however, the extent of multiple subject teachers' health content knowledge is questionable. Well-designed Internet-delivered programs can individualize instruction regardless of teacher content knowledge.

The availability of computers and the extent of teacher technology training has historically been a liability to using eLearning programs. Recent evidence suggests that teachers are trained to use computers to teach. A third of teachers reported feeling well or very well prepared to use computers in the classroom, and a majority (53%) of teachers reported feeling at least somewhat prepared to teach with technology.[32] Furthermore, 56% of teachers reported using a computer for classroom instruction.[32] Such data suggest it might be more realistic for teachers to use technology to deliver health instruction than to teach health by traditional textbook and classroom activities and methods.

Recent data also reveal that the availability of computers connected to the Internet in schools is not as great a concern today as it was just 10 years ago. As of 2002, 92% of public schools had instructional rooms with Internet access, and 94% of these schools with Internet access had broadband connections.[33] The ratio of computers connected to the Internet to students has also improved from 12:1 in 2000 to 4.8:1 in 2002.[33] Student access to the Internet at schools is quickly becoming a reality rather than liability, supporting Elliott's findings that the Internet can be used to deliver health instruction.[10]

Results of this study suggest that health instruction, one component of a CSHP, may be delivered via the Internet regardless of teacher training; however, certain limitations must be considered. First of all, there may be some concern with the physical activity behavior self-reported by children. The test-retest correlation of 0.42, although low, is consistent with published research using self-report measures of physical activity.[18,34] Accurately measuring physical activity has been the subject of many reviews, and self-report, although not perfect, is an acceptable means of estimating activity.[18,34]

A second limitation is that children participating in this study were all in classes whose teachers had volunteered to implement HH. This suggests that the results of this study might not be representative of 5th grade children throughout West Virginia. Similarly, access to adequate computer and Internet technology was necessary to participate in this study. Some teachers at schools that were contacted could not participate because they did not have computers or an Internet connection capable of using HH. This further suggests the participants in this study might not accurately represent all West Virginia fifth grade children. National efforts to "bridge the digital divide," or to make sure children in schools have access to computers and the Internet regardless of ethnic and socioeconomic background, have improved the disparity between computer technology in schools.[35] Such efforts could provide more children with access to the Internet and lead to a more representative sample in future studies.

A final limitation is that classroom curricula other than HH could not be controlled. In a survey completed by teachers, HH was the only health instruction implemented in some classrooms while HH was supplemented by other health programs in other classes. It is important to further explore the amount of time allocated to health instruction other than HH, as well as any overlap of instructional objectives. Regardless of these limitations, this study revealed encouraging results for HH and delivering health instruction using the Internet.

CONCLUSIONS

Classroom teachers are expected to teach health, but all too often do not have the training, resources, time or incentives to teach health in their curriculum. Although teacher training and support might arguably be the best approach to improving health education in schools, the high costs typically required to implement in-service training reveals a need to identify viable alternative or supplementary methods of offering health instruction to children.[36] The results of this study reveal that the Internet may be one alternative to providing more, and perhaps even better, health instruction to children in elementary schools. Children who completed Healthy Hearts 4 Kids had improved knowledge and attitudes towards physical activity. Many would argue, however, that eLearning can never replace active class participation and interaction with a knowledgeable and enthusiastic teacher. Healthy Hearts is not being suggested as a replacement or alternative to this type of teaching. If, however, children are receiving no health instruction or instruction that is passive and devoid of both teacher enthusiasm and interaction with students, then one can argue that a module like Healthy Hearts is a superior way to deliver this vitally important instruction to children. This study suggests that the development, review and study of health eLearning programs is warranted as a viable alternative for those elementary school classroom teachers who are either unprepared or have no time to teach important health concepts to their children.

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