The Status of Cardiovascular Health Knowledge among Sixth, Seventh, and Eighth Grade Children

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SUMMARY The goals of this study were to develop and standardize a test of cardiovascular health knowledge to determine its status among primary school children, to ascertain the rate at which cardiovascular health knowledge increases as compared to other subject areas, and to demonstrate the feasibility of the use of standardized achievement tests for assessing the results of health education curricula.

The Iowa Cardiovascular Health Knowledge Test (ICVHT) was developed and administered in conjunction with a standardized educational testing program, the Iowa Test of Basic Skills (ITBS), to a stratified sample of 2,675 Iowa students from grades six, seven, and eight. The average student in the sixth, seventh, and eighth grades answered 37.9 ± 0.4, 41.2 ± 0.3, and 43.7 ± 0.4 (SEM) percent of the items correctly. ICVHT scores increased minimally (< 1 item/grade) as grade levels increased, but at a 75% slower rate than scores in other subjects tested. The results document a deficiency in cardiovascular health knowledge and provide a model for use in educational assessment programs in other health disciplines.

SUCCESSFUL EFFORTS to control the epidemic of cardiovascular disease will require the development of new and effective methods for primary prevention. To date, educational programs directed at risk factor modification in adults have been only modestly successful.1,2 Since health behaviors leading to the later development of heart disease are established in childhood, intensified efforts are now underway (personal communication) to improve the quality of health education for children.3 Accurate assessment of the success or failure of any educational program, however, requires a clear understanding of the initial level of knowledge. Unfortunately, such information among elementary school children is lacking. The following study demonstrates the feasibility of applying selected techniques used in standardized achievement tests to conduct a criterion-referenced assessment of health knowledge in primary school children. These techniques permit an assessment of the rate of accrual of health knowledge, and enable comparisons to be made with other subject areas.

Materials and Methods

The investigators posed to a panel of cardiovascular medical educators the question, "What constitutes the minimum amount of knowledge of the cardiovascular system a person should possess in order to make intelligent decisions regarding his or her health?" In response to this question, 44 specific concepts were identified, and written instructional objectives were composed for each conceptual area. Experts in the field of cardiovascular disease and continuing medical education were then asked to select from the list the 35 most relevant objectives. The objectives reflect the major cardiovascular content areas of anatomy, physiology, pathology, specific disease entities including atherosclerotic, hypertensive, rheumatic and congenital heart disease, commonly used diagnostic procedures, and concepts regarding disease prevention. Multiple choice questions based upon these objectives became the foundation for the Iowa Cardiovascular Health Knowledge Test (ICVHT).

With the cooperation of the Educational Measurement Section of the College of Education at the University of Iowa, the Iowa Cardiovascular Health Knowledge Test was administered in the fall of 1975 to a stratified sample of 2,675 Iowa students as an experimental unit in conjunction with the standardized Iowa Test of Basic Skills (ITBS). The ITBS is a nationwide standardized testing program sponsored by the College of Education of the University of Iowa. This test battery includes vocabulary, reading, language skills, work-study skills, and mathematics. A more detailed explanation of the methods used and an example of one of the test forms are given in the Appendix.

Results

The performance of sixth, seventh, and eighth grade students on the ICVHT is listed in table 1. A slight increase in raw scores can be seen as the grade level increases (< 1 item/grade). The mean test score across all grades was 14.35 ± .15% of the items.

Figure 1 shows the mean percentage of items answered correctly on the Iowa Cardiovascular Health Knowledge Test when compared to three subtests on the Iowa Test of Basic Skills. Although students in the sixth grade answered correctly approximately the same proportion of questions on the ITBS subtests as on the ICVHT, in the seventh and eighth grades performance on all ITBS subscales tested far surpassed performance on the ICVHT. It is clear from figure 1 that although cardiovascular health knowledge increases slightly as grade levels increase, the rate of increase is markedly slower than knowledge of vocabulary, reading or mathematics.

Scores on the ICVHT were correlated with students' scores on ITBS subscales (composite, vocabulary, reading, and math) using a stepwise multiple regression analysis (table 2). Scores on the ICVHT were most closely associated with scores on the vocabulary section of the ITBS (r = .538). Although scores on the ICVHT were positively correlated with each ITBS subscale, the low proportion of the cumulative ICVHT variance explainable by all ITBS performance subscores indicates that health knowledge test performance does not merely reflect performance in other academic areas.
TABLE 1. Performance of Children on the ICVHT

<table>
<thead>
<tr>
<th>N</th>
<th>Grade</th>
<th>Raw score (mean ± SEM)</th>
<th>% Correct</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>861</td>
<td>6</td>
<td>13.27 ± 0.12</td>
<td>37.91 ± 0.35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>920</td>
<td>7</td>
<td>14.43 ± 0.12</td>
<td>41.23 ± 0.33</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>893</td>
<td>8</td>
<td>15.31 ± 0.13</td>
<td>43.74 ± 0.37</td>
<td></td>
</tr>
</tbody>
</table>

Students taking the ICVHT were asked to indicate whether they had taken a health education unit on the heart or circulation as a required portion of their school's curriculum. Students of all grades taking the ICVHT who received some formal cardiovascular health education scored higher than those who had not by approximately 2% (P < 0.01). An interesting finding was that students who had received formal health education consistently showed superior performance on all non-health related ITBS sub-scores.

Discussion

In 1918 the Commission for Health Education placed health at the top of seven major objectives for education. This public emphasis on health education has continued with each White House Conference on Child Health since 1932 questioning improved health education. Despite this public concern, health education receives little attention in the current medical and scientific literature. Opinions regarding the present status of health knowledge and its implications are likely to be dogmatic and convincingly stated, but in all likelihood based on little scientific data. Health education efforts, in contrast to other educational disciplines, have not relied on standardized test instruments to provide scientific data and have generally been less than rigorous in evaluating their effectiveness. The aim of this study is to show that health knowledge can be assessed using standardized testing methods and to provide a model for further evaluative attempts in this area.

Standardized achievement test represent a potentially useful method for assessing the results of a variety of health education interventions. This method of testing permits a measure of yearly educational growth or lack of growth, allows a valid comparison to be made between performance in different subject areas and enables educational achievement to be compared among diverse groups. Strictly considered, standardized tests are norm-referenced. Test items for norm-referenced examinations are typically selected on the basis of gradations of increasing difficulty. This permits maximum discrimination among the test performances of the examinees. Although this format is appropriate for testing many intellectual skills and abilities, it was felt that an assessment of health knowledge in the general population could be more meaningfully achieved using a criterion-referenced format. Such an approach compares the student's performance to a predesignated standard. The ICVHT was designed as a criterion-referenced examination which would use a standardized format and method of delivery.

For valid comparison and interpretation of the results of standardized tests, however, there must be widespread agreement as to the appropriateness of the objectives to be tested. Lack of clearly specified objectives has been a major factor limiting the use of standardized testing methods as a means of measuring health educational achievement. The objectives for this test were based upon recommendations of a panel of cardiovascular medical educators and were chosen to reflect major cardiovascular content areas. Although designed to reflect more than a superficial understanding of normal and pathologic cardiovascular function, we tried to develop basic and global objectives.

It might be assumed that health education need not be formally taught for improvements in knowledge to ensue. Perhaps the total milieu present today (both educational and social) might act to increase health knowledge in children without the need for formal instructional programs. This study was designed to test this hypothesis and to examine the efficiency with which health knowledge is learned as compared to other subjects using a standardized achievement test.

The ICVHT was designed as a mastery test with the intent that a perfect score (all 35 items answered correctly) would reflect the minimum acceptable cardiovascular health knowledge. Since scores on any examination exhibit moderate variability due to errors of measurement and changing intrinsic factors affecting performance, a 90%

TABLE 2. Relationship Between ICVHT and ITBS Subscores (Stepwise Multiple Regression Analysis)

<table>
<thead>
<tr>
<th>Source</th>
<th>F(dfreg, df*)</th>
<th>Cumulative variance (%)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITBS - Vocabulary</td>
<td>1062.83 (1, 2608)</td>
<td>28.95</td>
</tr>
<tr>
<td>ITBS - Math</td>
<td>569.66 (2, 2607)</td>
<td>30.41</td>
</tr>
<tr>
<td>ITBS - Reading</td>
<td>390.80 (3, 2606)</td>
<td>21.03</td>
</tr>
<tr>
<td>ITBS - Composite</td>
<td>295.57 (4, 2605)</td>
<td>31.24</td>
</tr>
</tbody>
</table>

*dfreg = degrees of freedom due to regression; *df* = degrees of freedom for error.

**The cumulative variance represents the proportion of variance on the ICVHT which can be accounted for each of the predictors when sequentially added to the equation.
score was designated as the mastery level. The finding that the average sixth, seventh, and eighth grade students could answer correctly only 38, 41, and 44% of test items, respectively, provides evidence that the level of cardiovascular health knowledge of this segment of the population is inadequate. There is an increment in cardiovascular health knowledge as grade level increases. However, this increment is small and much less than the increase that is seen on standardized tests in other fields.

It should not be concluded that the performance of sixth grade students on the ICVHT was satisfactory because scores were similar to those achieved by these students on the ITBS subtests (fig. 1). The ITBS tests were designed to be norm-referenced, not mastery tests, and students would be expected to answer fewer items correctly. From these data it can be implied that the overall educational milieu of the primary school child today is not sufficient to provide for "adequate" cardiovascular health knowledge. However, we are unable to determine whether the inadequate performance results from substandard original educational programs or represents attrition due to lack of continued educational reinforcement.

One might contend that the poor examination performance by these students was merely a reflection of unrealistically high standards set by the cardiovascular medical educators. Such a possibility is disturbing and cannot be unequivocally refuted. The continuing high death rate from cardiovascular disease might be used, however, as strong support for the counterargument, that current educational standards are too low.

It is not surprising to see that students who had completed a cardiovascular health education course outscored those who had not. Differences in performance between these two groups, although statistically significant, were small. The performance of those students who had received formal health education was still far short of the desired mastery level goal. A recent review of the health curricula in the secondary schools in the metropolitan Washington, D.C. area revealed that only approximately 10–15% of the present course work was allocated to cardiovascular disease and cancer. In the primary schools as well, health curricula often reflect the major public health emphasis of the 1930s, infectious disease and hygiene. The results of this investigation suggest that in the future, greater emphasis should be placed on cardiovascular health education in the school health curriculum.

Underlying all health education efforts is the assumption that a successful educational program yielding higher levels of knowledge and improved understanding will translate into desired behavior changes. Does the acquisition of health knowledge assure healthier behavior? Certainly not. There is no guaranteed congruence between health knowledge and health behavior. There is little evidence, however, that greater levels of health knowledge are detrimental, leading to undesirable health behavior or health neurosis. Health education appears rather to be a necessary prerequisite for the success of other methods to improve health behavior. The results of this study quantitate the deficiency in cardiovascular health knowledge among primary school students. This deficiency becomes greater with age relative to knowledge of other subject areas. This study provides a model for the use of standardized achievement tests for cardiovascular educational assessment, a model which can be easily generalized to other health disciplines. The test distribution system effectively used in this study can be utilized for the assessment of health knowledge by all school systems performing either periodic testing or mandatory educational assessment.

Appendix

A panel of eight cardiologists at a major teaching hospital was asked to respond to the question, "What constitutes the minimum amount of knowledge of the cardiovascular system a person should possess in order to make intelligent decisions regarding his or her health?" In response to this query, 44 specific concepts were identified and written instructional objectives composed for each conceptual area. The eight cardiologists and two general physicians were then asked to rank each objective as to major or minor importance. Thirty-five major objectives were selected for use. Specialists in the area of nutrition, science education, health education, educational measurement, and medical education were asked to formulate five multiple choice test questions based upon each objective. The items were reviewed for psychometric quality by an educational measurement consultant, and for accuracy of content by a cardiologist.

An example of a conceptual statement, objective and question is shown below:

Concept: What is a heart attack?
Objective: Each person will be able to describe a heart attack as a condition which results when the blood supply to the coronary arteries is insufficient to meet the demands of the heart for oxygen, and an area of heart muscle dies.
Test Question: What occurs as the direct result of a heart attack?
1) An area of the heart dies.
2) A portion of the brain dies.
3) The blood pressure increases.
4) The blood begins to decompose.
1) An area of the heart dies. (Correct answer - #1)

Three hundred questions were prepared for preliminary evaluation. From this list, 175 met the strict psychometric guidelines set by the authors. Five test forms were created by randomly assigning the items associated with each objective to each of the forms. One question for each objective was used on each test form. An additional item was added asking if the student had taken a health education unit on the heart or circulation in the school curriculum. The five forms were pilot-tested on 30 sixth grade students to provide initial estimates of 1) time needed for completion, 2) item quality (as assessed by individual interviews), 3) appropriateness of the language level of the items for the age group and 4) test difficulty. Based upon the pilot test results the items were again revised to remove flaws. The maximum time necessary to complete the exam was 20 minutes.

The ICVHT was administered as an experimental unit of the Iowa Test of Basic Skills (ITBS) in the fall of 1975. The ITBS is a nationwide testing program which was last standardized in 1970 using a base sample of over 20,000 students per grade. Stratification of the ITBS sampling units was based primarily upon community size and socio-economic characteristics with care being taken to achieve regional representation and public-parochial school balance. Subtests of the ITBS include vocabulary, reading, language skills, work-study skills and mathematics. The ITBS is administered by the classroom teacher under strictly controlled conditions.

A stratified sample of 2,675 Iowa students from 20 schools was selected to be representative of the state of Iowa with respect to geographic location, school size, and general intellectual performance. Stratification as to intellectual performance was accomplished by selecting schools ranking in each of ten percentile groups (10% to 100%) using the school's mean composite score on the 1974 ITBS.

All of the schools asked to participate in the study administered and returned the exams. Scoring of the answer sheets was performed by computer and item difficulty and discrimination values were calculated for each question. The mean discrimination index of all questions used was 0.30, thus implying good functional discrimination. Scores on each test form were calculated separately and compared. Since differences between individual test forms failed to achieve statistical significance all descriptive statistics are based on combined forms.

Test scores on the ICVHT at each grade level were compared to scores obtained by the same students on the ITBS subscales. Although the ICVHT was constructed as a mastery test, it did not exhibit the ceiling effect characteristic of mastery exams. The low mean item difficulty allowed the scores to exhibit a large amount of variability which, at each grade level, closely approximated a normal distribution. The lack of a ceiling effect and the normality of the distribution led the authors to conclude that valid comparisons could be made between the ICVHT and the standardized ITBS subscales.

A
step-wise multiple regression analysis using the ITBS subscales was performed to determine the percentage variability of the ICVHT which could be explained solely on the basis of student performance in other subject areas (see table 2).

**Test A: Health Test**

This is a test of how well you know basic health facts. Read each exercise first and then mark the answer to the question.

Here is a sample question with the correct answer.

1. Red blood cells carry
   (1) Helium
   (2) Oxygen
   (3) Carbon dioxide
   (4) Carbon monoxide
   Ans. (4)

2. The major cause of death in the United States is
   (1) Cancer
   (2) Heart disease
   (3) Infectious diseases
   (4) Automobile accidents

3. The heart functions as a
   (1) Pump
   (2) Filter
   (3) Vacuum
   (4) Centrifuge

4. During exercise the heart needs
   (1) More oxygen than at rest
   (2) Less oxygen than at rest
   (3) More carbon dioxide than at rest
   (4) The same amount of oxygen and carbon dioxide

5. The brain works through the ——— system to control the heart.
   (1) Venous
   (2) Nervous
   (3) Skeletal
   (4) Respiratory

6. Smoking may lead to the development of
   (1) Cancer
   (2) Lung disease
   (3) Heart disease
   (4) All of the above

7. Normal arteries can be described as
   (1) Rigid
   (2) Elastic
   (3) Oxygen carriers
   (4) Both (1) and (3)

8. Often people with coronary artery disease are told to eat less
   (1) High fat meat products
   (2) Beans, dried peas and nuts
   (3) Vegetable oils and margarine
   (4) Whole wheat and bran products

9. A stethoscope is an instrument which magnifies
   (1) Sounds
   (2) Objects
   (3) Electrical impulses
   (4) Very slight motions

10. Where are the heart and lungs located in the body?
    (1) The chest
    (2) Separated from the liver by the diaphragm
    (3) Separated from the stomach by the diaphragm
    (4) All of the above

11. Blood moves from the right ventricle to the
    (1) Body
    (2) Lungs
    (3) Left atrium
    (4) Right atrium

12. The "pulse" can be felt in what part of the body?
    (1) Arms
    (2) Legs
    (3) Neck
    (4) All of the above

13. Coronary arteries take blood
    (1) To the heart
    (2) To the lungs
    (3) From the heart
    (4) From the lungs

14. A stroke most commonly causes
    (1) Shock
    (2) Nausea
    (3) Paralysis
    (4) Hypertension

15. Which set of risk factors might lead to coronary artery disease?
    (1) High blood pressure, leukemia, obesity, smoking
    (2) High blood pressure, rheumatism, obesity, diabetes
    (3) Increased cholesterol, diabetes, obesity, a family history of coronary artery disease
    (4) Increased cholesterol, obesity, a family history of coronary artery disease, emphysema

16. The disease rheumatic fever usually follows a sore throat and may
    (1) Impair hearing
    (2) Damage heart valves
    (3) Result in a heart attack
    (4) Cause coronary artery disease

17. Which statement about the heart murmur?
    (1) It causes sudden death
    (2) It can be seen with a chest x-ray
    (3) It can be heard with a stethoscope
    (4) It results from a diet high in fats

18. The doctor may x-ray you to learn if you have
    (1) Diabetes
    (2) An enlarged heart
    (3) High blood pressure
    (4) Elevated cholesterol

19. When the heart is unable to pump blood efficiently around the body, we say the patient has
    (1) Had a stroke
    (2) Hypertension
    (3) Heart failure
    (4) Atrial fibrillation

20. The heart valves function by
    (1) Filtering the blood
    (2) Causing the heart beats
    (3) Controlling direction of blood flow
    (4) Analyzing the blood's oxygen content

21. The normal sounds made by the heart are produced by
    (1) Relaxation of the atria
    (2) Opening and closing of the heart valves
    (3) Flow of blood through the coronary arteries
    (4) Contraction and expansion of the veins

22. Systole refers to
    (1) The hissing sound heard in the heart
    (2) The time during which the heart relaxes
    (3) The time during which the heart contracts
    (4) The time during which the brain relays messages to the heart

23. A temporary lack of oxygen to the brain causes
    (1) Syncope
    (2) Fibrillation
    (3) Palpitations
    (4) Atherosclerosis

24. People with high blood pressure have an increased chance of developing
    (1) Those with normal blood pressure
    (2) Rheumatic fever
    (3) Coronary artery disease
    (4) Congenital heart disease

25. The heart's pacemaker triggers the
    (1) Heart's relaxation
    (2) Heart's contraction
    (3) Closing of the heart valves
    (4) Opening of the coronary arteries

26. Coronary heart disease is caused by
    (1) Excess Vitamin C
    (2) Running too fast
    (3) Low blood pressure
    (4) Arteries being plugged up

27. A heart attack results when
    (1) The arterial blood is anemic
    (2) Too much arterial blood reaches the heart
    (3) The heart suffers from electrical build-up
    (4) Not enough arterial blood reaches the heart
28. Ischemia refers to a situation in which tissue is
   (1) Without enough blood
   (2) Reproducing uncontrollably
   (3) Permanently damaged due to excess oxygen
   (4) Temporarily damaged due to excess carbon dioxide

29. Sudden unexplained death in a previously healthy person usually results from
   (1) Edema
   (2) Syncope
   (3) Systole
   (4) Fibrillation

30. The term edema refers to
   (1) A warning sign of a stroke
   (2) A sign of high blood pressure
   (3) Accumulation of fluid in the tissues
   (4) Accumulation of blood in the lower extremities

31. An electrocardiogram is a record of
   (1) Heart sounds
   (2) Heart beat strength
   (3) Changes in blood pressure
   (4) The heart's electrical activity

32. During ventricular fibrillation the heart's electrical activity
   (1) Ceases
   (2) Decreases
   (3) Becomes regular
   (4) Becomes irregular

33. The urine examination may provide clues to the presence of
   (1) Diabetes
   (2) Neurological disease
   (3) Heart and kidney disease
   (4) Both (1) and (3)

34. Long-term heavy intake of alcohol may cause
   (1) Brain disease
   (2) Heart disease
   (3) Liver disease
   (4) All of the above

35. Congenital heart disease refers to a condition which
   (1) Is infectious
   (2) Is present from birth
   (3) Always results in death
   (4) Causes rapid deterioration

36. Do you frequently watch medical shows on TV?
   (1) Yes
   (2) No

37. Do you frequently watch other health education programs on TV?
   (1) Yes
   (2) No

38. Have you ever had a health education unit on the heart or circulation in school?
   (1) Yes
   (2) No

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