

# Evaluation of Hearing Testing Program in New York City Elementary Schools

MARVIN BELKIN, EDWARD A. SUCHMAN, Ph.D., MOE BERGMAN, Ed.D., DANIEL ROSENBLATT, Ph.D.,  
and HAROLD JACOBZINER, M.D.

A STUDY was undertaken in 1961 to evaluate the program for testing hearing in the New York City elementary schools. It sought to evaluate the effectiveness with which children with impaired hearing are being identified and the procedures by which these children are followed up for further diagnosis.

The goals of the school hearing test program are "to locate children with defective hearing early in order to refer them for comprehensive medical care; to prevent progress of loss of hearing, where possible; to help in the planning (educational, medical, vocational and social) for those whose hearing cannot be restored to normal" (1). Briefly, the current school procedure comprises the following:

*Test:* The hearing of each elementary school pupil enrolled in even-numbered grades is tested each year.

*Retest:* Those children found to have a hearing impairment on initial screening are retested shortly thereafter in the school.

---

*Mr. Belkin is a research associate, Dr. Suchman, the director, and Dr. Rosenblatt, the assistant director, of social science activities, New York City Department of Health; Dr. Jacobziner is assistant commissioner for maternal and child health. Dr. Bergman is professor and director of the speech and hearing center at Hunter College, City University of New York. The study, supported by a research grant from the Easter Seal Research Foundation of the National Society for Crippled Children and Adults, was jointly approved by the Coordinating Council on School Health and the Research Council of the New York City Department of Health.*

*Referral:* Children found to have impaired hearing on both the initial screening test and retest are referred for clinical examination at an approved agency. (The majority of examinations are conducted at junior high school 47, the school for the deaf.) The school health service makes the referral, but the parents are responsible for seeing that the child receives the clinical examination.

*Rehabilitation:* When the results of the clinical examination are reported to the school, the nurse confers with the teacher and principal to initiate a plan for the child's rehabilitation.

## Study Design

A sample of 53 elementary schools was selected for evaluation of the hearing test program. These schools represented a 10 percent proportional sample of the public elementary schools stratified by borough, size of enrollment, and socioeconomic status of the school population.

Socioeconomic stratification was based on median income of the health areas in which schools were located as reported in the 1950 census. However, the socioeconomic structure of the health areas of the city underwent considerable change between 1950 and 1961, when the study was begun. To provide more reliable estimates of socioeconomic status, principals of the sample schools were asked to rate the general socioeconomic status of their students on a four-point adjective scale: very high, high, low, and very low. The analysis of socioeconomic status in this report is based on the principals' ratings. For analytical purposes, "very

high" and "high" were combined and are referred to as "high" socioeconomic status in the text. A similar combination was made with "low" and "very low."

The school health records of all 51,415 pupils in the sample schools were examined. In addition, the principal of each school was interviewed to determine the test environment, test administrators, suggestions for program improvement, and other factors.

To compare the results of the school screening tests with those of independently administered tests, members of the study staff, trained in audiology and administration of audiometric tests, conducted tests in six classes in each of the sample schools. Two classes were selected at random from each of the available kindergarten, second, and fourth grades. A total of 7,129 children received these independent tests.

Fieldwork for the study began in March and ended in June 1961.

### Record Survey

For the school year 1960-61, 26,113 children, or 51 percent of the 51,415 enrolled in the schools under study, received a screening test. Of those tested, approximately 95 percent were considered to have normal hearing, and the remaining 5 percent, having been found on both initial test and retest to have impaired hearing, were referred for clinical examination. Among this 5 percent referred, 2 percent received a clinical examination and were found to have normal hearing, 1 percent received a clinical examination and were found to have an auditory impairment, and the remaining 2 percent never received a clinical examination (table 1).

**Table 1. Results of school hearing tests, 1960-61**

Results	Number	Percent
Total tested.....	26, 113	100. 0
Passed school test.....	24, 852	95. 2
Referred for clinical examination.....	1, 261	4. 8
Did not receive clinical examination.....	560	2. 1
Passed clinical examination.....	476	1. 8
Failed clinical examination.....	225	. 9

Of the 1,261 children referred for a clinical examination, only 701, or 56 percent, had actually gone for this examination at the time of the survey. Since parents are responsible for seeing that the child is examined, this figure is not necessarily a reflection on the school program, but it does indicate the need for better followup.

Among the 701 children whose records indicated that they had received a clinical examination, only 32 percent were positively identified as having a hearing loss on this examination. This figure provides a very crude measure of the efficiency of the school screening program. In interpreting the figure, one must remember first that the clinical examination is a pure tone threshold test administered by trained personnel in quiet surroundings, and second that failure of the school screening test and retest may have been due to a temporary condition such as a cold or ear infection.

Schools with a population of high socioeconomic background detected a significantly smaller proportion of children with hearing defects than did schools with a low socioeconomic population, 3.7 percent compared with 5.3 percent. The smaller proportion in the schools with pupils of high socioeconomic status may be a reflection of the better health care received by this group.

### *Completeness of Testing*

Since the current school procedure calls for testing every child in the even-numbered grades and assuming that there are as many children in the even-numbered grades as in the odd, the 51 percent screened is about what would be expected. The survey showed, however, that even-numbered grades were not completely tested and that there was some testing in the odd-numbered grades (table 2). In the second, fourth, sixth, and eighth grades, 82 to 85 percent of the pupils received tests, and in kindergarten, only 75 percent.

Although no even-numbered grade was completely tested, there is a trend toward more complete testing as the grade level increases. The relatively low proportion tested in the kindergarten is of special interest. Kindergarten children are probably the most difficult group to test but perhaps the most important. Testing

young children is difficult since audiometric screening requires meaningful responses. Several studies on auditory screening have shown a direct relationship between successful screening and a higher age level (2). Yet failure to detect and correct a hearing disability may needlessly retard a child's education. As previous studies have shown (3), hearing loss may become evident at an early age.

Both the size of school enrollment and socioeconomic level of the school population are related to the proportion of kindergarten children receiving tests (table 3). Schools with both high socioeconomic status and low enrollment test the largest proportion, 87 percent, while those with low socioeconomic status and high enrollment test the smallest, only 67 percent. (In the upper grades, size of enrollment and

socioeconomic status appear to make little difference in the proportion receiving tests.)

These findings point up the need among kindergarten children, especially in schools with low socioeconomic populations and high enrollment, for easier testing techniques and more time allocated to testing. Children of low socioeconomic status are generally less sophisticated than those of high socioeconomic status and therefore more difficult to test, and schools with large enrollments need more time, or more testers, to complete the testing of their children. An increase in the number of testers is probably not practical because the number of persons adequately trained to conduct hearing tests is generally limited.

#### *Time Lapse in Referral Process*

The original plan had been to determine the time lapse from original screening test to clinic referral examination to report to the school for the 225 children found on clinical examination to have a hearing impairment, by examining the dates entered in the school and nurse health records. The records of only a few children, however, were dated.

The time interval between the school screening test and the referral examination could be obtained for only 26, or 12 percent, of the 225 children. This interval ranged from 2 weeks to 4 months, with a median of 6 weeks, and accounted for the longest delay in rehabilitation. The reasons for this delay were not apparent from this study. The possibilities include hesitancy on the part of the parents, delay in school action, and lack of clinical facilities to handle testing. The time lapse between clinical examination and the report to the school, which could be determined for only 22 children (9 percent of the 225), ranged from 1 day to 2 months, with a median of 3 weeks.

Based on the medians of these intervals, our estimate of the usual length of time required for a child to pass through the entire referral process is about 2½ months. Such a timelag is rather long. The child's education is continuing while he is unable to function at full capacity, and medical treatment might be most effective during this period. Additional study of both the timelag and the reasons for delay is indicated. Whatever the quality of school

**Table 2. Proportion of children receiving school hearing tests, by grade, 1960-61**

Grade	Number enrolled	Percent tested	Percent not tested
Kindergarten	6, 527	75	25
1	7, 206	29	71
2	6, 789	82	18
3	6, 706	11	89
4	6, 785	83	17
5	6, 591	9	91
6	6, 090	86	14
7	1, 187	6	94
8	1, 615	86	14
9	311	11	89
Special <sup>1</sup>	1, 518	51	49

<sup>1</sup> Special classes for mentally retarded children, health conservation classes, and others.

**Table 3. Proportion of kindergarten children receiving school hearing tests, by socioeconomic status of school population and size of enrollment, 1960-61**

Classification of school	Number enrolled	Percent tested	Percent not tested
High socioeconomic status:			
Low enrollment	1, 237	87	13
High enrollment	1, 367	77	23
Low socioeconomic status:			
Low enrollment	1, 409	76	24
High enrollment	2, 514	67	33

screening tests may be, the quickest possible referral and, if necessary, rehabilitation of all children with hearing defects should be a goal of the hearing program.

#### *Test Administration*

Two-thirds of the schools reported that a majority of their hearing tests are administered by teachers. Nearly 30 percent used primarily parent volunteers, and the remainder, mainly district health education counselors.

Schools with a high socioeconomic student body tend to make greater use of parent volunteers and district health education counselors in administering their hearing tests. Schools with a student body of lower socioeconomic status tend to make greater use of teachers as testing personnel.

Principals in the sample schools were asked to indicate in which type of room the majority of hearing tests were conducted. The largest proportion (43 percent) named the classroom as the testing site. The next most frequent site was the nurse's office (15 percent). Eleven percent of the principals cited a conference room, 9 percent an unspecified office room, and the remainder (22 percent) a library, a conference room, or other unspecified school room.

The setting in which the hearing test is administered is related to the socioeconomic status of the school population. While the classroom is the most frequent testing site regardless of socioeconomic background of the population, there is a definite trend for schools with pupils of high socioeconomic status to conduct tests less often in a classroom (33 percent use a classroom) and to use more often a nurse's office (28 percent) or a conference room (17 percent). Schools comprised of pupils of low socioeconomic status make more use of classrooms (49 percent), unspecified office rooms (14 percent), and auditorium space (11 percent) as test sites.

#### *Results of Testing, 1956-61*

For an analysis of the results of school testing over a 5-year period, we selected a systematic sample of 671 children who were in the fourth grade during the study year and investigated the results of their screening tests over their entire school career. Complete information about hearing tests for the 5 years was available

for 521 of these children who had been enrolled since kindergarten. This subgroup is referred to as the time study group.

In the time study group, the average number of screening tests each child received in the 5-year period was 2.4, somewhat lower than the theoretical three tests each pupil should have received. As shown in the following tabulation, more than 80 percent of the group had received either two or three screening tests, but 3 percent had never been tested:

<i>Number of tests received</i>	<i>Percent receiving tests</i>
0.....	3
1.....	12
2.....	34
3.....	47
4.....	4
Total.....	100

Over the 5-year period, 58 of the 521 children, or 11.2 percent, were found to have an auditory impairment on at least one screening test. This percentage is somewhat higher than that reported by Wishik (6.7 percent) from a study of pupils over an 8-year period (3). The majority (76 percent) of those who failed a screening test were found to have a hearing disability on only one test, but 22 percent failed two tests, and 2 percent, three tests (table 4). While a failure of one hearing test may be due to a temporary hearing impairment, it seems unlikely that failure on two or three hearing tests could be a chance event.

In table 5 the proportion of the time study sample tested each year from kindergarten through their present grade may be compared with the proportion of pupils tested in each grade during the study year (1960-61). Five years before the study year, when the children

**Table 4. Frequency of failures of school hearing tests in time study group, 1956-61**

Number of tests failed	Percent of those failing (N=58)	Percent of total group (N=521)
1 or more.....	100	11.2
1.....	76	8.5
2.....	22	2.5
3.....	2	.2
0.....	.....	88.8

**Table 5. Comparison of proportions of time study group receiving school hearing tests, 1956-61, and of all pupils, 1960-61**

Grade	Percent tested in time study group (N=521)	Pupils tested in 1960-61		Absolute percentage difference
		Number	Percent	
Kindergarten...	<sup>1</sup> 55	6, 527	75	20
1-----	12	7, 206	29	17
2-----	76	6, 789	82	6
3-----	10	6, 706	11	1
4-----	86	6, 875	83	3

<sup>1</sup> Difference between two groups at kindergarten significant at 0.01 percent level.

in the time study sample were kindergarten pupils, 55 percent of them received a screening test. In comparison, 75 percent of the kindergarten children received a screening test during the study year, a difference of 20 percent. Similarly, 3 years before the study year, 76 percent of the time study group received a screening test, compared with 82 percent of the second graders during the study year, a difference of only 6 percent. These results indicate that while complete testing is at present an unattained goal, there has been an improvement in the completeness of testing over the past 5 years, especially at the kindergarten level.

The records of the time study group were also studied to determine the grade at which each child received his initial screening test. Although 45 percent of the 521 children missed the test in kindergarten, only 7 percent received an initial test in first grade (table 6). Twenty-

**Table 6. Grade at first hearing test for pupils in time study group, 1956-61**

Grade	Percent receiving first screening test (N=521)	Cumulative percent
Kindergarten-----	55	55
1-----	7	62
2-----	25	87
3-----	3	90
4-----	7	97
Not tested by 4th grade-----	3	-----
Total-----	100	-----

five percent were tested for the first time in second grade, and small percentages were initially tested in the third and fourth grades. At the time of this study, when all members of the group were fourth-graders, 3 percent had never been tested.

Two important points emerge from these data. First, it is possible for a small number of pupils to have gone through 5 years of elementary school without ever being examined for possible hearing loss. Second, the probability is low that a child who was not screened in kindergarten will be tested in first grade, a consequence of the school policy of testing only even-numbered grades. If a child misses his screening test in kindergarten, his initial test is generally delayed for 2 years, until second grade.

### Independent Research Tests

The objective of the independent research screening tests was to formulate a testing procedure which would take into account the following three possible sources of error in the school testing program: (a) testing environment, (b) testing personnel, and (c) maintenance of equipment. We wanted to see how a program which took care of these three possible sources of error and yet was practical for routine administration would compare with the standard program. We did not expect to be able to validate either the school tests or the research tests against some "true" measure. Therefore, this report deals only with the comparison of the two screening procedures.

The personnel conducting the independent tests had an extensive theoretical background in the field of audiology, plus a great deal of experience in audiometric testing. They took special care to secure the quietest possible sites in which to conduct the tests. The audiometers used were periodically checked and recalibrated.

All children found to have abnormal hearing on the initial research screening test were immediately retested by a different audiometrist.

Of the 7,129 children given research screening tests, nearly 95 percent were found to have normal hearing (table 7). This figure includes children who passed the initial test plus those who failed the initial test but passed the research retest. The remainder, approximately 5 per-

cent, were identified as having a hearing loss. These children, classified as "referred after retest," failed the retest as well as the initial test.

The results of the research tests indicate a smaller, although not significantly smaller, proportion of children with a hearing impairment among fourth-graders than among kindergarten pupils or second-graders. This finding probably reflects the relatively greater ease of testing older children.

The results of the research tests also show a relationship between detected hearing loss and socioeconomic status. Only 4.4 percent of the children in schools with a high socioeconomic population who were screened were found to have a hearing disability, in contrast to 5.7 percent of those in low socioeconomic schools.

#### Comparison of Research and School Tests

By comparing schools, grades, and names from school records, 5,711 of the 7,129 children receiving a research screening test were identified as also having received a school screening test during the study year. The difference between these two figures is made up largely of students who were not tested by the school, plus a few for whom school records could not be found. Before comparing the results of the research and school tests for these 5,711 children, it is important to note differences between the two procedures in audiometric standards and in timing.

The screening level used in the school testing program is 15 db in a quiet environment. Where a "noisy" environment exists, compensation is made by relaxing the screening level to 20 db. It is a matter of discretion on the part of the

**Table 7. Results of research hearing tests, by grade**

Results	Kindergarten (N=1,888)	2d grade (N=2,568)	4th grade (N=2,673)	Total (N=7,129)
Percent passed.....	94.5	94.1	95.7	94.8
Initial test.....	85.4	87.0	89.2	87.4
Retest.....	9.1	7.1	6.5	7.4
Percent referred after retest.....	5.5	5.9	4.3	5.2
Total.....	100.0	100.0	100.0	100.0

**Table 8. Comparison of standard school hearing tests with research screening tests**

School tests	Research tests	Number	Percent
Passed.....	Passed.....	5,237	91.8
Passed.....	Referred.....	225	3.9
Referred.....	Passed.....	201	3.5
Referred.....	Referred.....	48	.8
Total.....	.....	5,711	100.0

screening test administrator to assess intelligently the noise level of the environment. Research tests were conducted generally at a 15-db level. When a child was unable to hear the 15-db signal at 500 c.p.s., this standard was relaxed to 20 db. At 4,000 c.p.s. a unilateral loss at 30 db was not considered to constitute a hearing loss; however, a bilateral loss at 30 db, at this frequency, was considered a hearing loss.

The time difference between the school tests and the research tests creates a difficult analytical problem. For example, a child with a head cold may have a true hearing loss which will no longer be present when his cold disappears. If this child's hearing is tested during the acute phase, his hearing would be accurately assessed as subnormal. However, a subsequent test would substantiate that the child's hearing had been restored to normal. The results of these tests would each accurately reflect the child's hearing ability on those two different occasions. Therefore, the effect of transitory hearing loss on the results of the research and school testing affects, to an unknown degree, the reliability of the comparisons.

The results of the research tests and the school tests were in agreement for 92.6 percent of the 5,711 children receiving both tests (table 8); 91.8 percent passed both tests and 0.8 percent failed both. There was, however, disagreement for 7.4 percent of these children; 3.9 percent were passed on the school screening test but were failed by the research audiometrists, and 3.5 percent had the reverse results.

The agreement found in approximately 93 percent of the screening tests indicates a fairly high degree of accuracy in the school screening program. From an administrative point of view, it is as important that a screening program successfully identify children with normal

hearing as those with abnormal hearing and thereby eliminate needless reexamination. Thus, the consensus between the research and school tests in classifying 92 percent of the total tested as having normal hearing illustrates the quality of the school screening program in the identification of children with normal hearing, who, after all, comprise the vast majority of the population.

Using the results of research testing as criteria, the 3.9 percent of the children found to have normal hearing on the school tests but abnormal hearing by the research audiometrists should have failed their school screening tests and been referred for clinical examinations; they represent children that school tests missed. The consequences of this disparity are more serious than those of the reverse situation. The 3.5 percent who were considered to have abnormal hearing by school tests but found to have normal hearing on research tests represent a group for which referral for clinical followup was unnecessary, an unfortunate but far less serious situation.

Of the 273 children found by the research tests to have a hearing loss, only 12 percent had been identified as having impaired hearing by the school test; the remaining 225 (88 percent) had been passed as having normal hearing.

The possibility that the results reflect transient hearing loss precludes any definite conclusions about the quality of the school testing. Nevertheless, because of the precautions taken by the research group in selection of test personnel, choice of environment, and equipment maintenance, we feel that the research tests present an accurate picture of the hearing situation at the time of administration and can serve as estimates of the quality of the school screening tests.

### **Suggestions for Program Improvement**

On the basis of the study results, a number of suggestions for program improvement may be made.

1. Perhaps annual tests of all children would be desirable. Until this can be achieved, however, the following testing schedule might be considered: (a) all children annually in kindergarten, first, second, fourth, sixth, and eighth

grades; (b) all newly admitted children; (c) all children for whom no previous tests have been made; (d) all children referred by teachers as suspected of having a hearing problem.

2. The high proportion of overreferrals might be reduced by improved testing techniques and test environment. The testing program should be carried out by a sufficient staff well trained in the techniques of testing. The screening procedure should take place at an approved site. A qualified person should select the place for such tests on the basis of desirability, not availability.

3. The followup system should be strengthened in view of the fact that only 56 percent of the children in this study identified on the screening test as having a hearing loss received further examinations.

From a long-range point of view, the following more basic recommendations might be considered.

1. A well-organized, coordinated program should be established under the administration of a certified audiologist. He should have the responsibility for coordination and implementation of the program.

2. A staff of technicians should work under the immediate direction of the audiologist.

### **Summary**

A study of the hearing testing program in New York City elementary schools reviewed the health records of 51,415 pupils of 53 representative schools for the results of each child's hearing test. In the same schools, independent screening tests for hearing acuity were administered by the research staff to a subsample of 7,129 pupils. The objective of the research tests was to formulate a procedure which would take into account three possible sources of error: (a) test environment, (b) test personnel, and (c) equipment maintenance.

Of 26,113 children who received school hearing tests in 1960-61, 5 percent were found to have a hearing impairment and were referred for clinical examination. About 3 out of 10 children referred were identified as having a hearing loss on clinical examination.

Over a 5-year period, slightly more than 1 out of 10 pupils were found to have a hearing im-

pairment by at least one screening test. Of that number, 76 percent failed only one test, 22 percent failed two tests, and 2 percent failed three tests. Nearly one-half of the children received three screening tests from kindergarten through fourth grade, about one-third were tested twice, more than one-tenth were tested only once, and 3 percent did not receive a test. A lower proportion of kindergarten children were tested than of children in the higher grades. As grade level increases, testing becomes more complete.

Slightly more than one-half of those pupils referred on the basis of a school screening test actually received a followup clinical examination. The usual length of time required for a child with impaired hearing to pass through the complete referral system (of identification, clinical retest, and report to the school) was about 2½ months.

Five percent of the pupils screened by members of the research staff were identified as having a hearing impairment. Research tests de-

tected a smaller proportion of children with hearing impairments in schools with high socioeconomic populations than in schools with low socioeconomic populations.

Comparison of the results of the school tests and the research tests on children receiving both showed agreement for 93 percent of the children. Of the 7 percent about whom there was disagreement, 4 percent were passed by school tests and failed by research tests, and 3 percent had the reverse results.

#### REFERENCES

- (1) New York City Department of Health, Bureau of School Health: *Manual of procedures—health services for school children in New York City*. Ed. 3. 1958.
- (2) Mosher, W. E., and Maines, A. E.: A screening program for the detection of hearing loss in pre-school children. *Amer J Public Health* 45: 1101-1108, September 1955.
- (3) Wishik, S. M., Kramm, E. R., and Koch, E. M.: Audiometric testing of school children. *Public Health Rep* 73: 265-278, March 1958.

## Trivalent Oral Polio Vaccine

A three-in-one Sabin live, oral, poliovirus vaccine, recently licensed in the United States, is designed to confer simultaneous immunity against all three types of poliomyelitis. The new product, to be given in two doses 8 weeks apart, is a balanced combination of the three monovalent vaccines. The amount of each strain included is based on the characteristics of the virus strains and on their combined action. Considerably more of the types 1 and 3 vaccines are included than of the type 2.

A trivalent vaccine eliminates the need for health authorities and vaccinees to keep track of the separate types of vaccines administered. Also, in a community where the population already possesses some immunity, even a single dose of the trivalent vaccine would confer some immunity to all types of poliomyelitis.

The vaccine, extensively tested in accordance with Federal regulations, was found to induce antibodies in at least 90 percent of those who completed the two-dose schedule. It will be produced and marketed by Lederle Laboratories, Pearl River, N. Y.