Physician-Diagnosed Abnormalities in Black and White Children in a Total Community

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THE PREVALENCE OF ABNORMALITIES in children has been the subject of numerous reports, but the populations studied usually were narrowly selected for age or socioeconomic status or to identify specific medical problems (*1–5*). Other studies, such as the Health Examination Survey (HES), have been part of national health surveys (*6*). In contrast, this report is concerned with the prevalence of physical abnormalities in noninstitutionalized black and white children who were examined by primary physicians during a survey of a total community.

The study was conducted in Bogalusa, La., a semirural, one-industry (paper and chemical) community that is typical of many small towns in the South. Based on the 1970 U.S. Census, the per capita income of Bogalusa blacks ($1,199) was 55 percent less than that of the whites ($2,673). Furthermore, almost half (45.3 percent) of all black families and 15.5 percent of all white families earned less than the U.S. Census poverty level. The median family income of $6,682 for Bogalusa was 31 percent less than the national median of $9,550.

A general-screening physical examination was incorporated into a large epidemiologic survey (the Bogalusa Heart Study) of the distribution, interrelationships, and time course of arteriosclerosis risk-factor variables in children (*7–11*). The physical examination was included in the survey primarily to provide medical service to the participating children and to obtain health data that might be correlated with the other findings of the research program.

The findings are of interest because abnormalities detected by physical examination of growing children may predict future clinical disease in adults that might be ameliorated or prevented by early therapeutic intervention. Determination of the prevalence of physical abnormalities should also be of value to planners of health delivery systems for estimating the health care needs of children.

Study Population

All school-aged children 5–14 years, living in the community, were eligible to participate in the Bogalusa Heart Study, which is the major research program of a Specialized Center of Research-Arteriosclerosis. During the school year 1973–74, 1,840 boys and 1,684 girls (93 percent participation) were examined. Of the 3,524 children, 37 percent were black and 63 percent were white.

For the preschool children (aged 2½–5 years), all born during 1969–71 and living in Bogalusa were eligible. We identified 898 eligible preschoolers, and 714 (80 percent) participated; 32 percent were black and 68 percent were white.

Before a child was entered in the study, the parents or guardian signed a consent form for all procedures and answered a brief history questionnaire (16 questions) on the health status of the child.

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Study Methods

Examination procedures. The following procedures were included in the study: venipuncture for serum lipids (*7, 10*), lipoproteins (*8, 10*), and hemoglobin (*12*); anthropometric measurements (*9*); physical examination; and blood pressure recordings (*10, 11*).

The physicians performed routine physical examinations. Although no attempt was made to standardize the specific examination techniques, a written protocol outlined the examination of each part of the body and included criteria for graded estimations of acne severity (*13*) and sexual maturity by the Tanner Scale (*14*). Visual acuity and audiometric and psychological examinations were not included. Severity of dental caries (none, minimal, moderate, or severe) was graded according to the physician's visual examination. The physician also classified nutritional status by visual appraisal—noting if the child was undernourished, normal, or obese by a subjective estimate of percentage of the norm. Specific criteria were based on distribution of an obesity index, $\text{weight/height}^{2.77}$ calculated by the Benn formula (*15*).

Based on the results of the screening procedures and the information on the health history form, the physician judged each system examined as normal, suspicious, abnormal, or unknown and decided whether to identify the chart for review by the program's chief pediatrician, who was responsible for notifying the parents of children with abnormal physical or laboratory findings. For followup, the children were referred to the private physician designated by the parents on the health history form or to the Washington-St. Tammany Charity Hospital.

For the purpose of this paper, a mean systolic blood pressure recording of at least 130 mm Hg or a mean diastolic reading of at least 85 mm Hg was considered abnormally high. This blood pressure level was arbitrarily chosen to reflect currently accepted medical practices, and it is not meant to be a recommendation for any age (*16*). Detailed analyses and recommendations for evaluation of blood pressure levels in children are presented elsewhere (*11, 17–19*).

Examiners and training. The examinations were performed by 11 physicians on a rotation basis; 2 physicians examined children each day. More than 80 percent of the children were examined by 3 of the 11 physicians. Although all of the physicians received orientation and followed a written protocol, no strict attempts were made to standardize the examinations, except as previously noted. The only diagnostic instruments used were a stethoscope and an otoscope.

The examiners measuring blood pressure (usually a registered nurse or a licensed practical nurse) were trained according to written protocols with specific criteria for definition of a "trained examiner." Throughout the entire data collection period there were frequent review sessions, as well as scheduled and unannounced observations and oral examinations.

Rescreening. On each screening day, four children of the same sex were randomly chosen to be screened a second time, including the physical examination but excluding venipuncture. A total of 535 children (12.6 percent of the total screening population) were reexamined the same day by a physician whom they had not previously seen.

Statistical analysis. A chi-square analysis was used to compare the number of children with abnormalities in the four race-sex groups, within race and within sex. These analyses were performed for all children and also for the preschool and school children separately. The Yates correction was applied when the frequency of abnormalities was compared within race and sex (*20*).

Table 1. Percentages[1] of 4,238 children with at least one abnormality requiring diagnosis or treatment, by age, race, and sex

Age (years)	White		Black		Total
	Male	Female	Male	Female	
Preschool-age children					
2	2.7	15.2	16.7	5.3	8.9
3	11.2	2.6	12.5	13.2	8.8
4	7.9	5.8	12.5	5.3	7.5
5	9.8	16.7	25.0	24.0	17.4
Total	8.5	7.9	15.7	11.7	9.9
School-age children					
5	8.7	6.1	20.0	23.7	11.7
6	8.6	9.2	16.7	15.5	11.6
7	15.0	4.2	8.9	13.1	10.2
8	12.5	5.8	18.5	16.1	12.2
9	15.9	8.6	7.3	15.2	11.6
10	14.7	7.2	6.7	12.9	10.6
11	10.1	11.3	16.0	12.8	12.1
12	21.6	10.2	12.6	17.3	11.0
13	14.1	13.3	14.7	16.2	14.4
14	12.9	7.8	17.6	17.5	13.4
Total	11.9	8.6	13.5	15.8	11.9
Grand total	11.3	8.4	13.8	15.1	11.6

[1] Of age-race-sex specific population.

Results

On examination, 9.9 percent of the preschool children and 11.9 percent of the school-age children were found to have some physical abnormality that, in the physician's clinical judgment, needed further medical attention either for diagnostic or treatment purposes (table 1). Although the percentage of school-age children having abnormalities was higher than that for the preschool-age children, abnormalities did not consistently increase with age for the entire population.

Black children were significantly more likely to have abnormalities than white children during both the preschool (13.6 versus 8.2 percent, $P<0.05$) and school-age years (14.6 versus 10.3 percent, $P<0.005$). Black girls were more likely to have abnormalities than white girls (15.1 versus 8.5 percent, $P<0.005$), but for boys the difference between the racial groups was not significant (13.8 versus 11.3 percent). Boys were more likely than girls to have abnormalities (12.2 versus 10.9 percent) but the differences were not statistically significant.

A total of 562 abnormalities were found in 490 children: 1 abnormality in 428 children, 2 in 55 children, and 3 or more in 7 children. Only 1.4 percent of the school-age and 1.3 percent of the

Table 2. Children aged 2½-14 years with at least 1 abnormality, by category of abnormality, race, and sex

Category	White boys (N=1,405)		White girls (N=1,301)		Black boys (N=790)		Black girls (N=742)		Total	
	Abnormal	Prevalence per 1,000	Abnormal	Prevalence per 1,000	Abnormal	Prevalence per 1,000	Abnormal	Prevalence per 1,000	Abnormal	Prevalence per 1,000
Skin	17	12.1	8	6.2	14	17.7	11	14.8	50	11.8
Eyes	8	5.7	5	3.8	5	6.3	2	2.7	20	4.7
Ear, nose, and throat	5	3.6	6	4.6	4	5.1	2	2.7	17	4.0
Dental	37	26.3	30	23.1	21	26.6	23	31.0	111	26.2
Neck	0	....	1	0.8	1	1.3	0	....	2	0.5
Pulmonary	2	1.4	2	1.5	4	5.1	1	1.3	9	2.1
Cardiovascular	19	13.5	13	10.0	17	21.5	15	20.2	64	15.1
Abdomen	0	....	0	....	8	10.1	4	5.4	12	2.8
Nodes	0	....	0	....	2	2.5	0	....	2	0.5
Extremities	0	....	1	0.8	1	1.3	3	4.0	5	1.2
Breast and genital	3	2.1	0	....	2	2.5	0	....	5	1.2
Obesity	49	34.9	35	26.9	14	17.7	25	33.7	123	29.0
Undernourished	27	19.2	14	10.8	32	40.5	29	39.1	102	24.1
Blood pressure[1]	5	3.6	5	3.9	10	12.7	6	8.1	26	6.5

[1] Blood pressure data were missing for 13 children.

NOTE: Data were missing for various stages of the examination for 3 or fewer children.

preschool-age children had more than one abnormality. Most of the children with more than one abnormality had either all abnormalities in the same organ system (for example, enlarged heart and heart murmur) or one that was nutritional or dental.

Table 2 shows the categories of abnormal conditions for each race-sex group, and table 3 details the specific abnormalities found within each of these categories. The most common abnormalities were obesity, undernutrition, and severe dental caries. The next most common abnormalities involved the cardiovascular system; primarily, these were grade 3 or greater systolic murmurs (scale 1–6) or diastolic murmurs. Functional or innocent murmurs, for which consultation was not suggested, were not included. Of 60 murmurs identified, the physicians classified (on physical examination alone) 26.7 percent as congenital and 8.3 percent as rheumatic lesions.

Table 3. Abnormalities diagnosed in 4,238 children aged 2½-14 years

Category of abnormality and diagnosis	Number of cases
Skin:	
Impetigo	19
Fungal infections	10
Eczema	2
Other rashes	9
Other lesions	10
Eye:	
Strabismus	12
Inflammation	4
Blindness	1
Other conditions	3
Ear:	
Otitis	9
Perforated or deformed tympanic membrane	6
Foreign body	1
Other ear, nose, and throat	4
Dental: severe decay	111
Neck:	
Enlarged thyroid	1
Webbing	1
Pulmonary:	
Asthma	2
Chest wall deformity	3
Other conditions	4
Cardiovascular:	
Suspicious murmur (tentative diagnosis)—	
Congenital lesions	16
Rheumatic lesions	5
Unknown origin	39
Enlarged heart	3
Abnormal heart sounds	3
Abnormal rhythm	2
Abdomen:	
Umbilical hernias	11
Inguinal hernia	1
Nodes: abnormally enlarged	2
Extremities:	
Osseous deformity	3
Muscular atrophy	1
Cerebral palsy	1
Breast and genital:	
Undescended testes	4
Paraphimosis	1
Nutritional:[1]	
Obesity	123
Undernourished	102
Blood pressure: systolic ≥ 130 mm Hg or diastolic ≥ 85 mm Hg, or both	33

[1] Physicians' subjective appraisal by observation only (more than 20 percent above or below ideal body weight).

The abnormalities detected varied among race and sex groups. Blacks were more likely than whites to be undernourished ($P<0.005$), and obesity was most common among black girls and white boys. Blacks also had significantly more cardiovascular ($P<0.05$) and abdominal abnormalities—hernias, either inguinal or umbilical—($P<0.005$) than whites. Blood pressure recordings in excess of 130/85 mm Hg were also more comon among black children ($P<0.025$). Although boys were slightly more likely than girls to have abnormalities of the heart, eye, skin, and genitalia or to be undernourished, the differences were not statistically significant.

The reliability of the examination in detecting abnormalities was assessed for both the preschool and school-age children by rescreening a selected sample of 535 children. A comparison of the two diagnostic impressions (excluding blood pressure examinations) showed that 82.8 percent were considered normal and 3.6 percent were considered abnormal on both examinations (table 4). An abnormality was found in 8.4 percent of the children only on the first examination and in 5.8 percent only during the second examination. The overall agreement between the two physicians was 85.8 per-

Table 4. Interphysician agreement on diagnosis in 535 children

Duplicate examination diagnosis[1]	Original examination diagnosis		
	Normal	Abnormal	Total
Normal	440	45	485
Abnormal	31	19	50
Total	471	64	535

[1] Excludes blood pressure.

NOTE: Overall agreement: $\frac{440+19}{535} = \frac{459}{535} = 85.8$ percent

Specific agreement: $\frac{19}{31+45+19} = \frac{19}{95} = 20.0$ percent

cent. However, if an abnormality was found by one of the physicians, only 20 percent of the time did both physicians agree that an abnormality was present.

Discussion

Individual medical judgment based on interpretation of health history and physical findings is the primary method by which physicians determine if an asymptomatic patient has a medical problem requiring further examinations or elaborate laboratory testing. As a result of this approach in our study, nearly one-tenth of all Bogalusa children aged 2½–14 years were judged to have an abnormality that required medical attention, referral for dental care being based on severe caries.

A comparison of our prevalence rates with those of other studies is difficult because of differences in population studied, study goals, methodology, and definitions of abnormalities. For example, our prevalence of total abnormalities in children aged 6 years was 11.6 percent, far less than the 21 percent found by Yankauer and Lawrence (*21*) in Rochester, N.Y. (even though that study excluded dental abnormalities), but it was close to the 11 percent found in the HES for this age (*6*).

Overall rates for abnormalities in the Bogalusa and HES children aged 6–11 years were also similar —Bogalusa, 11.8 percent for boys and 10.3 percent for girls; HES, 12.2 percent for boys and 10.2 percent for girls. As in the HES, the rate of total abnormalities was higher in the older age groups, but neither study revealed a consistent increase of abnormalities with age.

For children aged 12–14 years, the abnormality rate in Bogalusa was 12.8 percent, whereas in the HES it was 19–25 percent. This difference may be due to the different examination data gathered from the older (12–17 years) than from the younger (6–11 years) children in the HES. For example, in the HES severe ear abnormalities were included in the overall diagnostic impression of the older but not the younger children. Also, most of the increase in abnormalities in the older group was due to conditions associated with the onset of puberty. In contrast, in Bogalusa the same examination data were gathered for all age groups, and few cases of severe acne or other conditions related to maturation were noted.

In a 1967–70 study of school children in El Paso (*22*), 13.4 percent were found to have significant abnormalities previously undetected or inadequately followed. The examination included a tuberculin test, urinalysis, and hearing and vision screening (producing the most common abnormality), but it excluded dermatologic conditions and dental problems. In the Head Start Project in California (*23*), 51.3 percent of the preschool-age children examined were found to have abnormalities that, in the judgment of the examining physician, needed referral; one-third of these were classified as "major" abnormalities. As in Bogalusa, dental findings (severe caries) were the most common abnormalities, contributing 39 percent of the total abnormalities (compared to 25 percent for Bogalusa preschool children).

A comparison of the prevalence of cardiovascular abnormalities reveals a rate of 0.9 percent in Rochester first-grade children, 0.6 percent for all ages in the El Paso study, and 1.5 percent for all ages in our study.

Although none of the studies clearly define obesity, the stated prevalence of obesity among the various studies was similar: 1.1 percent of the boys and 1.6 percent of the girls in El Paso compared to 1.3 percent for each sex in Bogalusa school children and approximately 1.2 percent of the study children in Rochester. An equal number (1.2 percent) were classified "below-par" in the Rochester study compared to 1.8 percent in Bogalusa who were considered to be undernourished.

Abnormal ear, nose, and throat findings (0.5 percent) among Bogalusa children may appear unusually low for a pediatric group when compared to the Health Examination Survey where 1.6 percent of the children had otitis media alone. This low percentage may have been related to the lack of audiometry screening or to the possibility that an acute illness (tonsillitis, earache, or other) might have been a reason for a Bogalusa parent to postpone a child's screening.

Blood pressures above 130/85 mm Hg were recorded for 0.6 percent of the older and 0.9 percent of the preschool children in Bogalusa. These percentages are comparable to the 0.3 percent of the children in the El Paso study ("established norms for the child's age" as the criteria) and to the 0.6 percent who had "persistent hypertension" in the Muscatine, Iowa study (pressure $\geq$ 140/90 or the 95th percentile) (*24*). The overall rates in Bogalusa are somewhat misleading, especially the comparisons of blacks and whites in the older and younger groups. Elevated blood pressure was detected in 0.3 percent of the white school-age children of both sexes compared to 0.8 percent of the black girls and 1.3 percent of the black boys of school age. For the preschool group,

the rates for all race-sex groups were between 0.8 and 0.9 percent. This finding may reflect the gradual emergence with increasing age of differences in hypertension rates between blacks and whites similar to those commonly seen in studies of adults.

Since the criteria for defining abnormal conditions were not rigidly standardized (a situation similar to clinical practice), reliability of the clinical diagnosis was ascertained by random selection of nearly 13 percent of the children for a second examination by another physician. Although the overall agreement was relatively high (85.8 percent) due to the large number of normal children, when an abnormality was discovered the physicians agreed only 20 percent of the time. This small percentage of agreement reflects both variation in the examinations performed by the different physicians and the subjectivity of the physicians' judgment in their definition of abnormality, particularly when the abnormalities were relatively minor. Low interobserver agreement appears to be a common occurrence, as summarized by Koran for other studies with physician examiners (*25*).

It is interesting that the three most prevalent abnormalities seen in the Bogalusa study—obesity, undernutrition, and dental caries—could to some extent be preventable by such traditional public health measures as health education, dietary counseling and intervention, and fluoridation of water supplies. Diet intervention by controlling weight and salt intake may be an important modification measure among children already exhibiting abnormally high blood pressures.

For other communities similar to Bogalusa in which medical needs are at least partially defined by physicians, the findings of this study should also be of general interest to persons who plan the allocation of medical care resources or personnel.

References

1. Sundelin C., and Vuille, J.-C.: Health screening of four-year-olds in a Swedish county. Part 1. Organization, methods and participation. Acta Paediatr Scand 64: 795–800 (1975).
2. Kirk, T. R., Rice, R. G., and Allen, P. M.: EPSDT—One quarter million screenings in Michigan. Am J Public Health 66: 482–484 (1976).
3. Brooks, D. N.: School screening for middle ear effusions. Ann Otol Rhinol Laryngol 85 (No. 2, suppl. 25, pt. 2): 223–228 (1976).
4. Dodge, W. F., West, E. F., Smith, E. H., and Bunce, H.: Proteinuria and hematuria in school children: epidemiology and early natural history J Pediatr 88: 327–347 (1976).
5. Richardson, B. D., and Walker, A.R.P.: Prevalences of leg and chest abnormalities in four South African schoolchild populations with special reference to vitamin D status. Postgrad Med J 51: 22–29 (1975).
6. National Center for Health Statistics: Examinations and health history findings among children and youths, 6–17 years. Vital and Health Statistics, Series 11, No. 129. U.S. Government Printing Office, Washington, D.C., 1973.
7. Frerichs, R. R., Srinivasan, S. R., Webber, L. S., and Berenson, G. S:: Serum cholesterol and triglyceride levels in 3,446 children from a biracial community: the Bogalusa Heart Study. Circulation 54: 302–309 (1976).
8. Srinivasan, S. R., Frerichs, R. R., Webber, L. S., and Berenson, G. S.: Serum lipoprotein profile in children from a biracial community: the Bogalusa Heart Study. Circulation 54: 309–318 (1976).
9. Foster, T. A., et al.: Anthropometric and maturation measurements of children, ages 5 to 14 years, in a biracial community: the Bogalusa Heart Study. Am J Clin Nutr 30: 582–591 (1977).
10. Berenson, G. S., et al.: Cardiovascular disease risk factor variables at the preschool age—the Bogalusa Heart Study. Circulation 57: 603–612 (1978).
11. Voors, A. W. et al.: Studies of blood pressure in children, ages 5–14 years, in a total biracial community: the Bogalusa Heart Study. Circulation 54: 319–327 (1976).
12. Frerichs, R. R., Webber, L. S., Srinivasan, S. R., and Berenson, G. S.: Hemoglobin levels in children from a biracial southern community. Am J Public Health 67: 841–845 (1977).
13. Pillsbury, D. M., Shelley, W. B., and Kligman, A. M.: Dermatology. W. B Saunders Co., Philadelphia, 1956, pp. 807–810.
14. Tanner, J. M.: Growth at adolescence. Blackwell Scientific Publications, Oxford, England, 1962.
15. Benn, R. T.: Some mathematical properties of weight-for-height indices used as measures of adiposity. Br J Prev Soc Med 25: 42–50 (1971).
16. Loggie, J. M. H.: Systemic hypertension in children and adolescents. Pediatr Clin North Am 18: 1273–1311 (1971).
17. Voors, A. W., Webber, L. S., and Berenson, G. S.: A consideration of essential hypertension in children. Practical Cardiol 3: 29–40 (1977).
18. Voors, A. W., Webber, L. S., Frerichs, R. R., and Berenson, G. S.: Body height and body mass as determinants of basal blood pressure in children. The Bogalusa Heart Study. Am J Epidemiol 106: 101–108 (1977).
19. Berenson, G. S., Voors, A. W., Webber L. S., and Frerichs, R. R.: Letter to the editor. Blood pressure in children and its interpretation. Pediatrics 61: 333–336 (1978).
20. Maxwell, A. E.: Analysing qualitative data. Methuen & Co., London, 1961.
21. Yankauer, A., and Lawrence, R. A.: A study of periodic school medical examinations. 1. Methodology and initial findings. Am J Public Health 45: 71–78 (1955).
22. Grant, W. W., Fearnow, R. G., Hebertson, L. M., and Henderson, A. L.: Health screening in school age children. Am J Dis Child 125: 520–522 (1973).
23. Gilbert, A., Lewis, A., and Day, R. W.: Project Head Start: an evaluation of the medical components in California. California Med 106: 382–387 (1967).
24. von Behren, P. A., and Lauer, R. M.: Blood pressure measurements in children. Pediatr Ann 6: 384–389, June 1977.
25. Koran, L. M.: The reliability of clinical methods, data and judgments. N Engl J Med 293: 642–646, 695–701 (1975).