An investigation into the incidence and prevalence of peptic ulcer in children is reported. Based on an extensive case-finding effort, a clear picture emerges that a condition which had been thought to be relatively rare is now diagnosed with increasing frequency. Whether this is a real increase remains to be answered. Familial factors may be involved in pathogenesis of the condition.

THE EPIDEMIOLOGY OF PEPTIC ULCER IN CHILDHOOD

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ALTHOUGH there are few published reports on the incidence and prevalence of peptic ulcer in children, investigators have generally agreed that until recently peptic ulcer was an unusual childhood condition, an assumption which perhaps may account for its lack of epidemiologic interest. On the other hand, the few studies which have been conducted examined clinical populations, and they suggest that peptic ulcer is being diagnosed with increasing frequency among children, possibly because of greater awareness of it as a problem.[1,2]

The investigation into the incidence and prevalence of peptic ulcer in childhood was part of a broader survey initiated cooperatively in 1962 by the Erie County Health Department and the New York State Department of Health. The survey was made to determine the occurrence and distribution of about 70 long-term childhood illnesses, the demographic characteristics which may affect variations in their frequency, and the impact of disease on the child and his family. Data from this type of research may suggest etiologic hypotheses which could improve techniques of prevention and treatment, as well as offer a scientific basis for planning public health services and facilities.[3,4]

Erie County, N. Y., was selected for the survey because its population of over one million was of adequate size, so that even conditions which occur rarely would be present. More than 50 per cent of the people in Erie County reside in the metropolitan area of Buffalo. The combined medical services of the city and county were sufficiently comprehensive, so that little medical care was obtained outside of the county.

The study plan called for identification of every child in Erie County who was diagnosed as having one of the conditions under study before the age of 16 years. Pertinent epidemiological and other data regarding the patient and family were obtained from hospital records, from the office records of medical specialists, from birth and death certificates, and from selected school health records. The survey of medical records covered a 16-year period, so that a 15-year old child who received care only during infancy would be located. All 22 hospitals in or near Erie County serving the children of the county partici-

pated in a record survey for the study years 1946 through 1961.

In order to verify the incidence and prevalence estimates from the hospital records, a survey was conducted of the records of certain private physicians. These included pediatricians, allergists, and other appropriate specialists whose treatment or consultative services would probably be obtained for most of the children with conditions under study. Additional demographic and social data were obtained from almost 400 home interviews of a sample of the study population.

The location of the ulcer for 90 of the 106 cases was specified as duodenal and for three cases as gastric. The hospital discharge did not specify the location of the ulcer in 13 cases. In this study all of these cases are designated as peptic ulcer.

Incidence Rates

The development of the annual incidence rates and the cumulative prevalence rate of peptic ulcer in the study population under age 16 is illustrated in Table 1. Despite some variation, an increasing trend is apparent in the annual incidence rates for peptic ulcer. The three-year average annual incidence rates, derived to reduce fluctuations in incidence, increased from 0.5 per 100,000 children in 1947-1949 to 3.9 per 100,000 children in 1956-1958. A slight decline to 3.5 in the three-year average annual incidence rate occurred in the 1959-1961 period. The change in incidence over time is most evident in the comparison of the average annual incidence rate of 0.9 in the first half of the study with that of 3.6 in the latter half. Since only six cases were known to be nonwhite, there were too few to draw conclusions about the incidence rate, although it was comparable to that for white children. Because previously published reports involved hospital cases without clearly delineated populations at risk, they provide no comparable incidence rates which apply to a defined community.[5-7]

Table 2 presents the findings by age at diagnosis and sex. The incidence rate for infants was 1.2 per 100,000. Since peptic ulcer that occurs in infancy is

Table 1—Peptic ulcer cases and associated deaths among children under age 16, Erie County, N. Y., 1946-1961

	Estimated population under 16 yr	Cases from previous yr	New cases (incidence)	Average annual incidence rate*	Deaths	Cases reaching 16 yr	Cases under 16 yr at end of yr
1947–1949	210,400	—	3	0.5	1	—	2
1950–1952	240,500	2	7	1.0	–	3	6
1953–1955	272,800	6	25	3.1	–	6	25
1956–1958	305,000	25	36	3.9	1	14	46
1959–1961	337,300	46	35	3.5	3	25	53
1946–1953	229,800	—	16	0.9	1	4	11
1954–1961	315,800	11	90	3.6	4	44	53
1946–1961	272,800	—	106	2.4	5	48	53

* Age-adjusted incidence rates differed from the unadjusted rates by less than one-tenth of a case per 100,000 population.

considered by many to be a different entity from ulcers that occur at later ages, it is interesting to observe the clear demarcation in incidence by age, illustrated in Figure 1. The lowest rate was found among children from one to four years of age. This finding is in accord with other reports.[6-8] The incidence rate increases geometrically in subsequent age groups. Of importance is the sharp increase in incidence found among 15-year-olds. The over-all ratio of males to females is 1.6 to 1. It should be noted, however, that the greater incidence among males is not found until age 10. Over half of the females were diagnosed before age 10 as compared to only 28 per cent of the males. In fact, the sharp increase in incidence among 15-year-olds is due almost exclusively to peptic ulcer diagnosed among boys.

Although not presented in a table, the increase in the incidence of peptic ulcer in male children during the study period occurred mostly among the older groups. For females, however, the major increase over time occurred among girls

Figure 1—Average annual incidence rate of peptic ulcer among children by age at diagnosis, 1946-1961 (rate per 100,000 population at risk)

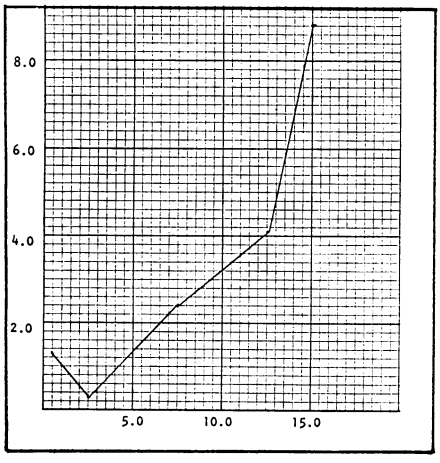

Table 2—Age and sex specific average annual incidence rates for peptic ulcer cases, Erie County, N. Y., 1946-1961

Years	Males				Females				Total			
	1954 Population	Cases	Average no. of cases	Incidence average annual	1954 Population	Cases	Average no. of cases	Incidence average annual	1954 Population	Cases	Average no. of cases	Incidence average annual
<1	10,200	2	0.12	1.2	9,900	2	0.12	1.2	20,000	4	0.25	1.2
1-4	41,600	3	0.19	0.5	40,100	1	0.06	0.1	81,600	4	0.25	0.3
5-9	44,100	13	0.81	1.8	42,700	20	1.25	2.9	86,800	33	2.06	2.4
10-14	36,400	33	2.06	5.7	35,100	14	0.88	2.5	71,500	47	2.94	4.1
15	6,400	14	0.88	13.7	6,300	4	0.25	3.9	12,800	18	1.13	8.8
All ages	138,700	65	4.06	2.9	134,100	41	2.56	1.9	272,800	106	6.25	2.4

from five to nine years of age. Boys from the highest socioeconomic class appear to be at greater risk to peptic ulcer than males from the middle and lower classes. Table 3 shows the number of cases expected and observed by social class. The relationship of peptic ulcer to socioeconomic status was assessed by classifying individuals according to census tracts of residence, the smallest units for which data were available. While this method has obvious limitations, it has been used with reasonable success in other studies and appears to be the most practical of the possible alternatives.[9,10]

The socioeconomic status of each census tract was classified on the basis of family income, rate of unemployment, and years of education completed.[9] Since the first and second characteristics are related to each other, years of education completed were given double weight. The 170 census tracts in Erie County, for which the data were available, were ranked in ascending order on the basis of income, employment, and education. The tracts were classified into three groups, the lowest and the highest containing 25 per cent of the children under 16 years of age and the middle group containing 50 per cent. A statistically significant difference was observed for the highest social class among the boys. Girls, however, did not evidence any variation in incidence by social class.

If the five male and three female cases diagnosed at less than five years of age are excluded from this analysis, on the basis of a differing etiologic hypothesis, the differences observed by class among boys result in greater statistical significance ($P<0.01$ as compared to $P<0.05$). The finding for girls remains essentially unchanged.

The five deaths which occurred among 106 children with peptic ulcer resulted in a case fatality rate of 4.7 per cent. None of the six nonwhite cases died during the study period. Female case fatality was more than twice that of males. Three of the five deaths occurred among the lowest socioeconomic class patients, yielding a much higher case fatality rate than cases from other classes. Three of

Table 3—Distribution of male and female children with peptic ulcer by socioeconomic status

Socioeconomic status	fo	fe*	$\frac{(fo-fe)^2}{fe}$	
		Males		
Total	65	65.0	7.30	
Group 1 (low)	15	16.5	0.14	
Group 2	28	35.2	1.47	$0.02<P<0.05$
Group 3 (high)	22	13.3	5.69	
		Females		
Total	41	41.0	0.94	
Group 1 (low)	13	10.4	0.65	
Group 2	21	22.2	0.06	$0.50<P<0.75$
Group 3 (high)	7	8.4	0.23	

* Expected frequencies were based on the sex-specific distribution of the population at risk by social class.

the four cases diagnosed under one year of age did not survive the study period. The remaining two deaths occurred among those diagnosed after ten years of age. All deaths occurred within one year after diagnosis.

The length of hospitalization for children with peptic ulcer varied from year to year, but remained essentially unchanged during the study period. The fairly close argeement between mean and median measures of hospitalization occurred because the total inpatient stay of 87 per cent of the cases was less than 18 days.

Table 4 presents the data on hospital

Table 4—Hospital utilization of peptic ulcer cases by patient characteristics

	Number		Mean no. of days per		Median no. of days per	
	Adm.	Cases	Adm.	Case	Adm.	Case
Sex						
Male	69	61	10.4	11.8	6.0	7.0
Female	44	39	9.7	10.9	6.0	7.0
Race						
White	100	90	9.3	10.3	6.0	6.0
Nonwhite	8	6	21.4	28.5	12.0	14.0
Race and sex						
White male	63	55	9.1	10.5	6.0	6.0
White female	37	35	9.6	10.1	6.0	6.0
Nonwhite male	3	3	36.0	36.0	—	—
Nonwhite female	5	3	12.6	21.0	—	—
Social class and race						
White low	24	21	10.0	11.4	7.5	10.0
White medium	49	43	9.9	11.3	6.0	6.0
White high	27	26	7.6	7.9	5.0	5.0
Nonwhite low	8	6	21.4	28.5	12.0	14.0
Nonwhite medium	—	—	—	—	—	—
Nonwhite high	—	—	—	—	—	—
Residence						
Urban	58	50	12.0	13.9	7.5	10.0
Suburban	45	43	6.8	7.1	6.0	6.0
Rural	10	7	14.4	20.6	3.0	3.0
Age at diagnosis						
Under 1 yr	4	4	12.3	12.3	—	—
1–4 yr	6	4	14.3	21.5	4.0	—
5–9 yr	30	29	7.3	7.6	4.0	5.0
11–14 yr	53	46	9.4	10.9	6.5	7.8
15 yr	20	17	14.5	17.0	9.5	12.0
Mortality status						
Living	108	95	9.9	11.3	6.0	7.0
Deceased	5	5	14.2	14.2	11.0	11.0
Total	113	100	10.1	11.4	6.0	7.0

utilization by demographic variables. Male and female children did not differ in amount of hospitalization. Nonwhites, however, accounted for considerably more hospital time than whites. The few nonwhite males in the study population had extended hospitalizations. The median hospital stay of low socioeconomic class whites was somewhat longer than that for middle and upper-class whites, although still much less than that for nonwhites of the same socioeconomic class. Average hospitalization per admission and per case of rural children was greater than that of urban or suburban children. The lower median figures resulted from a few unusually long hospitalizations among the children from the rural areas. Children diagnosed over 14 years of age were hospitalized longer than children diagnosed at younger ages. The five children with peptic ulcer who died experienced five more hospital days per admission than those who survived.

Environmental and Genetic Factors

The home interview provided an opportunity to test the frequently stated hypothesis that stress is a factor in the etiology of peptic ulcer. Of the 400 interviews in the broader study, 28 were conducted with the mothers of children with peptic ulcer. Only three of the 28 were diagnosed under five years of age. As has been already noted, there is an apparent differential risk by age, sex, and social class for males. The home interview findings suggest additional characteristics which may have acted in concert to increase the risk to peptic ulcer. For example, among these randomly selected cases, 11, or almost 40 per cent, were children of parents of different religious backgrounds. This contrasts sharply with the 12 per cent of mixed marriages of parents of children with other chronic conditions.

In response to a direct question concerning the effect of the child's illness on the husband-wife relationship, 25 per cent of the mothers of peptic ulcer patients, compared to only 7 per cent of the mothers of children with other conditions, indicated that their marital relationship had deteriorated. This suggests an instability that existed prior to the child's illness.

In 18 of the 28 children there was a history of peptic ulcer in the family, nine on the father's side, five on the mother's side, and four on both sides. In 10 of these 18 families, either the mother or father or both had ulcers, and in eight of the 10 cases, the father had peptic ulcer. Although the familial pattern of peptic ulcer has been well documented among cases over 18 years of age, our findings indicate that the same patterns exist throughout childhood.[11,12] These figures on familial history, although of interest, shed no light on the relative importance of environmental and genetic factors.

Summary

The incidence of peptic ulcer has been determined by an extensive case-finding effort primarily conducted among hospitals and specialist-physician records. Most of the cases were obtained from the records of the 22 hospitals serving the children of Erie County. Six of the cases had never been hospitalized. The incidence rates presented are, if anything, an under enumeration of the cases ever brought to medical attention, since the study did not permit a survey of the private office records of general practitioners. Nevertheless, a clear picture emerges of a condition which, in the past, had been thought to be relatively rare and is now diagnosed with increasing frequency. Whether this increase reflects greater awareness of the entity as a childhood condition, or a real increase in its occurrence or a combination of both, remains unanswered.

There has been some speculation that

the increased stress on children in modern urban society may be a factor in the increasing occurrence of peptic ulcer. Certain of our findings seem to support that hypothesis. The sharp increase among teenagers, particularly boys, the apparent higher risk of the highest socioeconomic strata, the greater number of mixed marriages among the parents of peptic ulcer cases, the remarkably high proportion of parents of peptic ulcer cases who, themselves, had the same condition, and the evidence of marital discord distinguish childhood peptic ulcer from the many other long-term childhood conditions.

REFERENCES

1. Fällström, S. P., and Reinand, T. Peptic Ulcer in Children. Acta. paediat. 50:431-436 (July), 1961.
2. Milliken, J. C. Duodenal Ulceration in Children. Gut (London) 6,25:25-27, 1965.
3. Sultz, H. A.; Schlesinger, E. R.; and Mosher, W. E. The Erie County Survey of Long-Term Childhood Illness: I. Methodology. A.J.P.H. 56:1461-1469 (Sept.), 1966.
4. ————. The Erie County Survey of Long-Term Childhood Illness: II. Incidence and Prevalence. Ibid. 58,3:491-498 (Mar.), 1968.
5. Singleton, E. B. The Radiologic Incidence of Peptic Ulcer in Infants and Children. Radiology 84:956-957, 1965.
6. Alvi, A. W., and Rogers, A. G. Primary Peptic Ulcer in Children—Report of Fourteen Cases and Review of Literature. Canad. M. A. J. 80:352-358 (Mar.), 1959.
7. Ramos, A. R.; Kusner, J. B.; and Palmer, W. L. Peptic Ulcer in Children—Review of Literature and Report of 32 Cases. Am. J. Dis. Child 99:135-148 (Feb.), 1960.
8. Gillespie, J. B., and Bliss, H. E. Peptic Ulcer in Childhood—Report of Six Cases. Arch. Pediat. 68:361-372, 1951.
9. Wallace, H. M.; Eisner, V.; and Dooley, S. Availability and Usefulness of Selected Health and Socioeconomic Data for Community Planning. A.J.P.H. 57:762-771 (May), 1967.
10. Hollingshead, A. B., and Redlich, F. C. Social Class and Mental Illness. New York: Wiley, 1958, pp. 398-407.
11. Mirsky, I. Arthur. Physiologic, Psychologic, and Social Determinants in the Etiology of Duodenal Ulcer. Am. J. Digest Dis. 3,4:285-314 (Apr.), 1958.
12. Lukash, William M.; Sifre, Francisco R.; and Moore, Paul T. Peptic Ulcer Disease in Young Males Under Twenty-One. Illinois M. J. 121:142-144 (Feb.), 1962.

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