

The Effects of Subclinical Bilharziasis on Mental Ability in Schoolchildren

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SUMMARY

Many people in the world are suffering from bilharziasis—a disease costly not only to the individual, but also at national level. The price paid by individuals with bilharziasis in terms of scholastic achievement is evaluated both cross-sectionally and longitudinally in White schoolchildren.

Although children with bilharziasis had on average a lower intelligence quotient (IQ) than those without, this was shown not to be a result of the disease process, but an associated finding caused by probably a difference in social background. Bilharziasis does not affect intelligence, but causes susceptibility to mental fatigue affecting the scores attained in tests where accuracy and speed in productivity are required.

S. Afr. Med. J., 48, 2035 (1974).

Keisser,^{1,2} working in South Africa, claimed that bilharziasis caused marked mental and physical effects in schoolchildren. He described the typical sufferer as having retarded growth and poor stamina physically, and as being tired and apathetic mentally, with an impaired memory and an inability to concentrate. Unfortunately, he reported no data in support of these opinions, and in general work aimed at studying the relationship between bilharzial infection and either physical or mental ability has given contradictory or uncertain results.

Jordan and Randall³ in Tanganyika, reported that scholars passing *Schistosoma haematobium* eggs have a better scholastic ability than those who were not passing eggs. Similarly, Loverage *et al.*⁴ commented that on balance Rhodesian Black children infected with bilharziasis had better school records than those free from the disease. However, Clarke and Blair⁵ in 1966 reported that among White schoolchildren in Rhodesia there was an association between schistosome infections and poor educational attainment, although they did not stipulate a cause-and-effect relationship.

In general, there has been considerable subjective observation by infected people, by employers of labour and by teachers, suggesting that infected people have lowered

physical or mental performance and well-being, and that treatment for their infections resulted in a noticeable improvement. However, such changes are difficult to measure objectively, and one is left with inadequate evidence as to the effect of bilharziasis. Consequently an extensive study was undertaken among schoolchildren in an attempt to gain useful data bearing on the subject, and in which an attempt was made to identify some of the educational associations with bilharziasis if, in fact, such associations exist.

The main objectives of this survey were firstly, by using mental and scholastic tests to determine if there was, in fact, a lowered average performance by schoolchildren showing subclinical bilharziasis infections when compared with children free of such infections, and secondly if there was such lowered performance, to attempt to determine whether this lowered performance was caused by the infections, or merely associated with other factors known to be related coincidentally with both the incidence of such infections and aptitude in school.

METHODS

White children attending school in the Marandellas district were used in the study. The children were relatively homogeneous with respect to social and cultural background. This group was chosen despite the fact that the infection rate was known to be low, thus rendering it less likely that differences could be detected. However, it has been said that Whites are more affected by the schistosome than Blacks. The study group included every child at school in Marandellas in 1968, but it was limited to those for whom parental consent for inclusion in the survey had been obtained. It must be emphasised that no attempt was made to select children known to be infected. In fact, any children ill at the time of the surveys, including children undergoing treatment for bilharziasis, were excluded from the trial because of their absence. Because of the small numbers showing infection, it was not possible to analyse the effects of the different species of *Schistosoma* separately, and therefore all infections were considered as one group.

Intradermal tests and repeated and detailed urine and stool examinations, incorporating both microscopic examination and hatching techniques, were undertaken to detect *Schistosoma* infection. Details were recorded of the father's occupation, family size, degree of risk of exposure to infection, and whether—so far as was known—these scholars had previously been treated for the disease. The children, unprompted, were also asked to write down

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Date received: 3 July 1974.

everything they knew about bilharziasis and were given tests to assess mental ability.⁶

The study concerned boys and girls between the ages of 11 and 18 years. The Thurstone PMA test was selected because it is a wide-ranging series which is applicable throughout the age group concerned. It consists of five subtests of different mental abilities thought to be related to school success in various ways.

They are:

- V — verbal meaning: to test the ability to understand ideas expressed in words.
- R — reasoning: to test the ability to solve logical problems.
- S — space: to test the ability to visualise and mentally manipulate objects in two or three dimensions.
- N — number: to test the ability to work with figures and to solve simple quantitative problems rapidly and accurately.
- W — word fluency: to test vocabulary.

Since each subtest is strictly timed and the scoring takes into account both productivity and accuracy, particularly as far as S and N tests are concerned, it was thought to be well suited to the purpose of this investigation. In addition, scores are convertible from a table of 'norms' into standard scores which take into account the subject's chronological age. Hence it is possible to make valid direct comparisons of these standardised scores for all children grouped together and for individuals, over a period of time. A further composite score can be extracted; it is a 'scholastic aptitude' score, which is made up of 2V + R, and which, when it is converted into a quotient, correlates highly with other orthodox measures of intelligence quotient. These Thurstone tests are internationally used and their reliability has been widely assessed.

RESULTS

Prevalence of Infection

The over-all prevalence of confirmed infections by stool and urine testing in the children was 4% (26/652). It was interesting to note that although the prevalence in this survey is small, 13% of those giving a history of previous treatment were again confirmed positive cases. This could possibly indicate high susceptibility, but this is unlikely; it is more logical to accept the attitudes of children exposing themselves to risk of infection. It is also interesting that the confirmed cases, as well as those with a history of previous infection, tended to come mostly from the lower socio-economic classes (rated solely on their fathers' occupations). Presumably such children make use of natural water for recreational swimming, since they are less likely to have access to well-maintained swimming pools.

Knowledge of the Disease and Degree of Risk

The children's knowledge of the causes, effects and prevention of bilharziasis was graded on a five-point scale

(Table I). In general, the children's factual knowledge was good, only 26% showed a level of knowledge inadequate to protect them from contracting the disease. It was disappointing to find no significant correlation between knowledge and the degree of risk to which the children admitted exposing themselves (Table II). It would appear that the children were honest about recording these risks. Their estimates correlated very significantly with history of having been treated ($P > 0.001$), and the skin test and follow-up results.

TABLE I. LEVEL OF KNOWLEDGE OF BILHARZIASIS, ITS CAUSES, EFFECTS AND PREVENTION IN 652 SCHOOL-CHILDREN AGED 11 - 18 YEARS

1. Very good factual knowledge of cause, effects and methods of prevention of disease	2%	} 74%
2. Adequate factual knowledge of above 3 aspects	11%	
3. Sufficient knowledge to avoid exposure	61%	
4. Inadequate knowledge	20%	} 26%
5. No knowledge	6%	

TABLE II. LEVEL OF RISK ADMITTED BEING TAKEN BY THE 652 SCHOOLCHILDREN

1. No risk	22,3%
2. Slight risk	43,4%
3. Definite/moderate risk	22,4%
4. Heavy risk	8,6%
5. Very heavy risk	3,3%

Despite the regular health education campaigns through mass media and in the schools, the degree of knowledge of this disease did not seem to be a real deterrent to activities in which there is a risk of infection. Of the 74% with adequate knowledge to prevent infection, 4,5% were in fact infected; whereas of those without the benefits of such knowledge only 3% were infected

The Thurstone Tests for Mental Ability

Initially, the children all underwent the five subtests of the Thurstone battery. Tables III and IV show the mean standardised results for two groups—the 26 confirmed cases and the 308 children who were skin-test positive but in whom follow-up urine and stool examinations failed to confirm the disease, were omitted from the analysis of scholastic aptitude.

Although the average scores for the confirmed cases were below those of uninfected children in all subtests, only two of the results were statistically significant. These were the verbal meaning score (V) and the abstract reasoning score (R); these two being the ingredients of the intelligence quotient. However, although it appears that there is a lower average performance by infected children than by comparable children free of infection, it was not warranted on that basis alone to conclude that infection resulted in

TABLE III. RESULTS IN THE THURSTONE MENTAL ABILITIES TESTS FOR THE CONFIRMED CASES AND FOR CHILDREN FREE OF INFECTION

Subtest	Average for -ve (308 cases)*	Average for confirmed (26 cases)	Conclusion
Verbal meaning (V)	47,0	34,8	$t = 2,12$ (0,05, $P = 0,01$)
Abstract reasoning (R)	64,5	52,4	$t = 2,28$ (0,05, $P = 0,01$)
Space relationships (S)	40,8	32,3	$t = 1,39$ NS
Number (N)	37,9	34,6	$t = 0,66$ NS
Verbal fluency (W)	64,8	61,3	$t = 0,59$ NS

* 318 skin test-positive unconfirmed cases were excluded from the analysis.

TABLE IV. RESULTS IN THURSTONE MENTAL ABILITIES TESTS FOR THE CONFIRMED CASES MATCHED BY AGE, SEX AND SOCIAL CLASS WITH A NEGATIVE CONTROL CASE

Subject	Mean difference (21 matched pairs)	Conclusion
V	+ 5,66	NS
R	+ 8,46	NS
S	+ 11,83	$t = 3,06$ (0,05, $P < 0,01$)
N	+ 10,26	$t = 2,02$ (0,05, $P < 0,01$)
W	+ 9,86	NS
2V + R	+ 4,66	NS

t -values (paired t -test) and the statistical significance levels of these differences.

DISCUSSION

As previously reported, the results in this series showed that social class contributed appreciably to the difference in verbal meaning (V) and abstract reasoning (R), the ingredients of intelligence. If bilharziasis *per se* does affect mental aptitude, this is seen in the ability to cope with spatial relationships (S) and numbers (N)—the tests heavily loaded for speed and accuracy. In every subtest the infected children performed less adequately than those free of infection.

The infected children were then advised to seek treatment and those in the 11-14 years age group were at that time rematched with uninfected persons of the same sex, age and social status group, with the nearest aggregate score. Twelve such matched pairs were traced and, in 1971, after an interval of 3 years, they were retested for bilharziasis, and underwent the Thurstone mental ability battery of tests, in order to observe the effects of treatment for the disease.

Of the 12 bilharziasis cases, 2 previously infected again showed infection and one of the previously uninfected children had since contracted the disease, thus, 3 pairs had to be excluded. With the remaining 9 pairs, those

poorer performances. It is possible that both factors were merely associated through other factors such as social status, known to be related both to the prevalence of the disease and to the ability at school.

The space test (S) appears in other education studies to reflect specific aptitudes related to practical and mechanical ability and to require strong visual imagery rather than logical analysis. If one of the effects of bilharziasis is susceptibility to fatigue in mental activity, resulting in lowered accuracy and productivity, this subtest score and that for numbers (N) could be expected to be particularly affected by the disease process. This hypothesis was not confirmed by the over-all analysis, since neither of these tests revealed a significant difference. Nevertheless, the trends of differences in scores on the S and N tests favour the infection-free subjects. The two subtests, S and N, unlike V and R, are considered to be unrelated to social status.

The fifth subtest, W, which requires subjects to write as many words as possible beginning with a specific letter in a given time, also showed a non-significant trend. This test, of the whole battery, is the one which shows least reliability and it would be unwise to speculate on possible suggestions arising from such a trend.

Another analysis was done at this stage. In order to obtain an indication of the contribution of socio-economic factors, each of the confirmed cases was matched blindly, using tables of random numbers, with another uninfected scholar of the same age, sex and social status. Twenty-one such matchings were possible and Table IV shows the average differences in standardised scores, the

TABLE V. INTERIM PROGRESS BETWEEN TREATED CASES AND MATCHED CONTROLS

Subtest	Average difference in progress (treated controls) (9 matched pairs)*	Conclusion
Verbal meaning	- 6,5	Control gained more
Abstract reasoning	0	No difference
Spatial relationships	+ 16,5	(0,05 > P > 0,01)
Number	+ 15,3	NS
Verbal fluency	+ 2,9	NS

* The difference between the differences in scores from the 1971 and 1968 tests for the bilharziasis cases compared with their matched controls.

previously infected had been treated satisfactorily and the previously skin-test negative controls had remained negative. For each pair the interim progress (i.e. the 1971 standardised score less the 1968 standardised score) was compared using the paired-*t*-test (one tail), to see whether those previously suffering from the disease who had since been cured had gained significantly over their non-handicapped controls. Table V shows the average difference in progress between the pairs.

However, the cured children, even though few in number, had made statistically significant progress in one of the tests—space relations (S)—and had made much greater progress than their non-infected colleagues in the numbers subtest (N). Consequently, it appears that these two subtests are the ones influenced by the disease. Unlike the original significant differences in intelligence, differences which must be attributed to other factors, the facets of aptitude demonstrated by spatial relations (S), particularly, and by numbers (N) tests, held the children back while they had the disease, and improved on treatment. This is reassuring, since if a disease could affect the genetically endowed IQ then the measure of IQ must be suspect. Apathy is a more reasonable outcome of a disease process.

CONCLUSIONS

Despite the fact that the number of cases was small, and although the infections were subclinical, significant differ-

ences were found. These differences show that non-infected people perform better than infected people. The main educational implications of the findings were:

1. There is a demonstrated probability that active bilharziasis affects spatial relationships (S) and perhaps abilities with numbers (N), the two intellectual functions where fatigue is likely to lower accuracy and productivity.

2. The factors (V and R) which relate to basic intellectual ability were demonstrated as differing between infected and non-infected children, but these differences were probably derived from differences in socio-economic status.

3. The incidence of bilharziasis is closely related to factors such as affluence and social class, which are already known to influence scholastic success.

4. Existing health education measures, while leading to a relatively high degree of knowledge of bilharziasis appear to have little effect in lessening the risks of infection taken by schoolchildren.

We wish to thank Dr M. Webster, Secretary for Health, Rhodesia, for permission to publish.

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