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A consideration of the economic impact of schistosomiasis*

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An attempt is made to estimate the economic effects of schistosomiasis, a disease known to be endemic in 71 countries or islands with a total population of about 1 362 million persons, of whom approximately 124 905 800 are infected. These data are based on prevalence rates representing, for the most part, single stool or urine examinations; the actual number of cases is undoubtedly much greater. This analysis refers only to resource loss attributable to reduced productivity. The annual loss from complete and partial disability is estimated to be US $445 866 945 in Africa, US $755 480 in Mauritius, US $16 527 275 in South-West Asia, US $118 143 675 in South-East Asia, and US $60 496 755 for the Americas. The total estimated annual world loss amounts to US $641 790 130 but this sum does not include the cost of public health programmes, medical care, or compensation for illness.

Few attempts have been made in recent years to analyse the economic impact of disease and to correlate public health expenditure with those conditions that are mainly responsible for disability and a loss of working capacity. When economists have dealt with the problem they have been mainly concerned with the cost of medical care. As an example, in one of the latest studies Klarman (1965) scarcely mentions the economic consequences of disease, and in the bibliography containing 230 titles there are only two references to this subject. This lack of interest may be due to difficulties arising from the paucity of basic data. However, Weisbrod (1961) believes that it is important to attempt some quantification, even if it is imperfect, to illustrate what could be done to provide a basis for the allocation of resources in the health sector.

The tropical diseases in particular have been greatly neglected; Wright et al. (1962) endeavoured to collect information of this kind but the data were few and mostly unauthoritative. Nevertheless, the infectious and parasitic diseases are mainly responsible for morbidity in the developing countries.

Schistosomiasis has been selected as a model for the economic impact of a tropical disease. A number of estimates have been made of the losses resulting from this disease in localized areas. Farooq (1964), a pioneer in collecting baseline data, has presented a comprehensive review of the subject.

In attempting to estimate the economic importance of schistosomiasis, one is immediately confronted with a varied array of factors for most of which there are no adequate measurements, Among these factors are geographical distribution, prevalence, intensity of infection, clinical gradients, morbidity and mortality, and transmission patterns, which are influenced by environmental conditions, the relative efficiency of the molluscan intermediate hosts, agricultural practices, and human behaviour. If facts were available, the economic impact of the disease could be estimated with some degree of accuracy in terms of the cost of medical care, public health programmes, the time lost from gainful occupation, and compensation for illness. At present, it is only possible to formulate reasonable projections on the basis of the conservative treatment of current data, such as they are.

GEOGRAPHICAL DISTRIBUTION

Schistosomiasis is known to be endemic in 71 countries or islands that have a total population of about 1 362 million people. The disease occurs in all countries of Africa with the exception of Lesotho

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(formerly Basutoland), in one of the Mascarene islands (Mauritius), in South-West Asia,[1] in South-East Asia, and in the Americas. Former foci in Cyprus and Portugal have now disappeared. India is not included in the present summary, since it is believed that transmission has ceased in the single focus in Maharashtra State.

PREVALENCE RATES AND TRANSMISSION PATTERNS

Prevalence rates are exceedingly variable. Even in the same locality the rate in one village may be very different from that in a neighbouring village. In Zanzibar, for instance, Forsyth & Macdonald (1966) found that *Schistosoma haematobium* infections were highly focal, even in an apparently homogeneous population living within a short radius of one school. In a locality comprising 36 villages, 98.2% of the children in 9 neighbouring hamlets were infected while in the remaining 27 hamlets only 19.9% of the children were infected. In the delta area of Egypt, Farooq et al. (1966) found significant differences in the rates of infection with *S. haematobium* in different parts of a single village, fishermen, boatmen, farmers, and labourers having the highest rates. Variations in the infection rate were related to differences in religion, educational attainment, and domestic habits.

In a 3-year study of 4 communities in the State of Pernambuco, Brazil, Barbosa (1965, 1966) found marked differences in the types of exposure, vector efficiency, prevalence rates, intensity of infection as measured by egg counts, and clinical involvement. The disease was most severe when transmission factors were at optimum levels.

THE DISTRIBUTION OF SCHISTOSOMIASIS AND POPULATIONS EXPOSED COMPARED WITH POPULATIONS INFECTED

Wright (1968) previously estimated the proportions of the population exposed and infected in most of the 71 countries where the disease occurs. Infection rates were based on data compiled from various urine and stool surveys carried out mainly during the period 1955–64.[2] In a few instances, the results of surveys made prior to 1955 were included. New material has been added, and the estimates have been reevaluated critically in the light of more recent information. In no instance have infection rates been based on the results of immunological tests. Population estimates are for mid-year 1965, and were compiled by the United Nations (1966).

The author is aware of the errors inherent in any attempt to derive an average rate of infection for any country. Available data for most countries comprise results of surveys conducted by many investigators employing different methods of examination at different times. In many countries, prevalence rates are virtually unknown and in other countries the data are extremely limited. Complete coverage exists in only a very few instances. In collating the data, a conservative approach has been adopted.

Some comment should be made about the estimates for certain countries. For Egypt as a whole no infection rates have been published since those of Scott (1937). The geographical areas used by Scott have been taken as a basis and more recent prevalence and population data have been applied to them.This procedure indicates a total of 13 852 916 infected persons in Egypt out of a population of 30 083 419 in 1967 (United Arab Republic, 1967). This number is close to the estimate of Farooq (1967) of 14 million cases. Here, as for other countries in Africa and parts of South-West Asia, the number of persons exposed and the number infected with *S. haematobium* and *S. mansoni* have been estimated separately but the numbers have been combined. *S. mattheei* has not been included in the compilation because it is usually concomitant with *S. haematobium*. Cases infected with *S. intercalatum* have been omitted because of the relative rarity of this schistosome.

In the almost complete absence of recent reports, it is impossible to arrive at any valid estimate of the number of cases of schistosomiasis in China. Wright (1950) estimated the total number of cases to be 32 777 630 on the basis of certain prevalence rates in the infected provinces and on census data for 1947. Maegraith (1958) stated that recent surveys had revealed over 11 million persons infected, with local infection rates ranging from 10% to 70%, and indicated that the working capacity of affected individuals was well below half the normal capacity. Hertwig & Oberdoerster (1960) stated that the official estimate indicated that 100 million persons were exposed and 10 million were infected.

Until recently, late population data for the infected provinces were not available. Their population

[1] As used in this article, the term "South-West Asia" refers to Democratic Yemen, Iran, Iraq, Israel, Lebanon, Saudi Arabia, Syria, Turkey, and Yemen.

[2] Wright, W. H. et al. (1966), unpublished WHO documents Bilh/WP/66.3A and Bilh/WP/66.3B.

in mid-year 1965 was estimated to be 335 252 000, as developed from 1957 census returns (US Congress Joint Economic Committee, 1967). Since 1947, there has been an increase of 35% in the population of the endemic areas. In estimating a total of 24 741 000 cases, a generous allowance has been made for the results of the control campaign. The current estimates are 24% below those made by the present author (Wright, 1950), and are considered to be conservative from the view of the population increase of 35% since 1947.

Schistosomiasis is no longer a public health problem in Japan. It was estimated by Komiya (personal communication, 1966) that in 1966 there were no more than 20 000 cases in that country. The extent of the disease in Laos, Cambodia, and Thailand is unknown. It appears to be more widespread than present evidence indicates but it is impossible at this time to estimate the number of infected persons in those countries.

Data relating to the total population of the 71 countries in which schistosomiasis is endemic, together with the population exposed or infected, are given in Table 1. The total population of those countries is over 1 362 million persons, of whom over 592 million are exposed to the disease and over 124 million infected. Considering that this estimate is based mainly on prevalence rates derived from single stool or urine examinations, the total number of cases is probably much greater.

The data are somewhat at variance with those previously presented by Wright (1968). The exposed population shows an increase of 238 000, and that infected an increase of 7 000. The differences are accounted for by the availability of new data for the populations of certain endemic areas, including the governates of Egypt, provinces of China, and states of Brazil and Venezuela.

MORBIDITY AND MORTALITY

Reliable data on morbidity and mortality are almost completely lacking and those that are available are therefore of no value in an analysis of the costs of disease. In 1963, schistosomiasis was notifiable in 39 countries, in 11 of which the disease is not endemic (World Health Organization, 1963a). Even in those countries that require reports, the data, when available, are far from complete and do not indicate the true morbidity and mortality rates. Table 2 shows regional morbidity and mortality data for 1957, as taken from the US National Academy of Sciences survey of tropical health

Table 2. Schistosomiasis morbidity and mortality rates in certain regions in 1957 [a]

Region	Morbidity rate per 100 000 persons	Mortality rate per 100 000 persons
Africa	64.1	00.44
South-West Asia	75.96	
South Central and South-East Asia	0.71	
the Americas	0.78	

[a] Adapted from Wright et al (1962) and based on country public health reports and limited data from WHO.

Table 1. World distribution of schistosomiasis: total regional population, population exposed, and population infected

Region	Total population	Population exposed	Population infected
Africa	308 021 000	226 102 740	91 200 310
Mascarene Islands (Mauritius)	741 000	370 500	66 690
South-West Asia	87 003 000	10 745 050	2 271 020
South-East Asia	868 531 000	337 051 500	25 223 650
the Americas	98 339 000	18 199 750	6 144 130
totals	1 362 635 000	592 469 540	124 905 800

(Wright et al., 1962). The figures are based on the limited WHO data available at that time, supplemented by information from the annual public health reports from many countries. The inadequacy of these figures is shown by the fact that if they were applied to the total population of the 71 countries, there would be less than 600 deaths from schistosomiasis in the whole world in any one year.

Further evidence of the inadequacy of reporting is provided by the fact that in 1966 only 3 127 cases of schistosomiasis were notified to the Pan American Health Organization (unpublished data). More cases were reported from New York City than from the whole of Brazil.

ECONOMIC CONSEQUENCES

Mushkin & Collings (1959) have divided the economic consequences of disease into 3 categories—viz., resource use, resource transfer, and resource loss. Resource use represents costs that are a share of the nation's resources of manpower and materials for providing health services and the materials used by the services. Resource transfer includes costs represented by the transfer of income from the healthy to the sick in public and private efforts to mitigate the burdens of illness. Resource loss represents costs reflected in reduced national production of all goods and services.

It is not possible at this time to estimate the cost of total resource use attributable to schistosomiasis. Few countries have control programmes whose direct cost might be determined, but even with this information, the portion of the health services cost attributable to schistosomiasis could probably not be estimated.

It is equally difficult to obtain data on the costs involved in resource transfer. While the costs of medical care in certain countries could no doubt be obtained, it would not be possible to separate the portion of such costs attributable to schistosomiasis cases alone.

In 16 countries in Africa for various years from 1955 to 1960 there was a total of 1 593 940 hospitalizations for all causes (World Health Organization, 1963b). Reports were made mainly by government hospitals and in many instances are obviously incomplete. Only 11 159 (0.7%) of the hospitalizations were for schistosomiasis but the 16 countries are estimated to have had a total of 43.6 million infected individuals. These data are probably representative of the paucity of medical care data for schistosomiasis.

Estimates of resource transfer costs could be calculated with some degree of validity if social security coverage with compensation for illness applied to countries in which schistosomiasis is endemic. In fact, some such coverage is available in 52 of the 71 countries in which the disease occurs (US Social Security Administration, 1967). However, adequate protection is provided only in South Africa and Japan and there is partial coverage in the Philippines. In most African countries, agricultural workers, i.e., those most frequently exposed to the disease, are excluded.

Since it is impossible at present to estimate the costs of public health services and medical care in relation to schistosomiasis, only resource loss is left to be evaluated for the economic consequences of schistosomiasis. Even here, however, the data are tenuous and subject to misinterpretation and miscalculation.

Estimation of degree of disability

For estimates of total and partial disability incurred as a result of schistosome infection, authoritative calculations have been accepted when they are available. Elsewhere, a careful study has been made of current data concerning clinical gradients, and estimates have been derived from such material. For Egypt and certain other countries in Africa, the data of Farooq et al. (1966) have been used; i.e., severe clinical involvement in 2.1% of cases and moderate involvement in 30.5% for both *S. haematobium* and *S. mansoni*. For *S. haematobium* alone the rates were 2.5% and 35.3%, and for *S. mansoni* 1.4% and 13.5%, respectively. For other countries in Africa, where the intensity of infection appears to be lower than in the Nile Delta area, a compensatory arbitrary reduction has been made in the above-mentioned rates.

These standards are not completely realistic since Farooq et al. (1966) have noted that the majority of cases with irreversible effects, and therefore those in the severest category, cannot usually be detected without recourse to detailed clinical, pathological, and radiological techniques. However, the lack of such data does not invalidate the standards employed but only emphasizes their conservative nature.

For South-West Asia, the above standards have been modified in some instances, particularly for Syria and Iran, where *S. haematobium* infections are less severe. In Iraq, where the severity of *S. haemato-*

bium infections is more marked than in other countries of the region, it is estimated that 5% of infected persons are totally disabled and 50% moderately disabled.

In *S. japonicum* infections in South-East Asia,[1] the standards employed for China were 3% totally disabled and 25% partially disabled and for Japan 0.5% totally disabled and 10% partially disabled; for the Philippines, 4% of symptomatic cases were classified as severe or very severe and 39% as moderate, in accordance with the findings of Persigan et al. (1958).

For *S. mansoni* infections in the Americas, clinical gradient data for Brazil have been derived from the findings of Kloetzel (1964), Cheever (1968), and Barbosa (personal communication, 1968), which indicate that 2% of cases are totally disabled and 25% partially disabled. The disease is less severe in other parts of the Americas, and the standards used for other countries are accordingly lower.

In all instances, severe cases are considered to be completely incapacitated or soon to become so. In any one year such patients are considered to have contributed nothing to the gross national product (GNP). The moderately severe cases are considered to have a reduced productive capacity of 10%.

The economic effect of deaths from schistosomiasis is not considered, since one cannot assign a monetary value to a human life. However, death during the active years deprives the economy of a productive asset. If a patient dies early in his productive career, the nation loses the net amount of material contribution for much of the patient's theoretical lifespan.

In certain countries, schistosomiasis occurs in such limited areas or in such a mild form that it is obvious that little or no disability results from the disease. Countries in this category include Antigua, Israel, Lebanon, St Lucia, and Turkey. Countries for which estimates of economic loss cannot be made because of insufficient data are Cambodia, Celebes, Laos, St Martin, and Thailand.

Estimation of economic loss from decreased productive capacity

In order to make a worldwide estimate of economic loss from the decreased capacity for production, some common denominator must be used. For this purpose, the *per caput* Gross National Product (GNP) in US dollars, as published in the *World Bank Atlas* (1967), has been employed. The GNP represents the sum of incomes accruing to factors of production after the deduction of direct taxation. National income represents the sum of incomes before the deduction of taxation. In an international study of health expenditure, Abel-Smith (1967) preferred to employ GNP; his procedure has been followed here.

Estimations of GNP entail certain margins of error. The income and output data in many countries leave much to be desired, and problems of interpretation arise. The conversion of sums in various national currencies into US dollars is also liable to distortion. This is particularly so for China, where the convertibility of the yuan into US dollar values has no fixed basis, and China's GNP has fluctuated widely within the past 15 years.

Estimates of the extent of disability caused by schistosomiasis in the various geographical areas are given in Table 3. The total number of persons considered to be totally incapacitated is 2 650 260, and the total number believed to be partially disabled is 24 782 805. Table 4 shows that the estimated annual loss from total disability amounts to US $270 794 100 and that the annual loss from partial disability is US $370 996 030. The total annual economic loss from reduced productivity throughout the world is estimated to be US $641 790 130. Since this sum is based on minimum prevalence rates, the real loss is undoubtedly much higher.

The estimates for Africa are some 75 million below the figure previously given by Wright (1968). In the former estimates the average GNP for Africa (except Egypt) was employed. The present

Table 3. The number of persons estimated to be totally disabled and partially disabled by schistosomiasis

Region	No. of persons totally disabled	No. of persons partially disabled
Africa	1 735 983	16 327 200
Mascarene Islands (Mauritius)	1 400	20 304
South-West Asia	43 622	639 406
South-East Asia	749 930	6 261 350
the Americas	119 325	1 534 545
totals	2 650 260	24 782 805

[1] As used in this article, the term "South-East Asia" refers to Cambodia, Celebes, China, Japan, Laos, the Philippines, and Thailand.

Table 4. Estimated annual costs of schistosomiasis resulting from lowered productivity in totally and partially disabled infected persons

Region	Estimated loss from total disability (US $)	Estimated loss from partial disability (US $)	Total estimated economic loss from lowered productivity (US $)
Africa	173 037 570	272 829 375	445 866 945
Mascarene Islands (Mauritius)	308 000	447 480	755 480
South-West Asia	6 711 930	9 815 345	16 527 275
South-East Asia	64 305 550	53 838 125	118 143 675
the Americas	26 431 050	34 065 705	60 496 755
totals	270 794 100	370 996 030	641 790 130

compilations are derived from the use of the GNP for each country and are therefore more accurate. An average GNP obviously introduces certain distortions in the net result.

It should be emphasized that the estimates quoted here are based on available data, and that these data are markedly inadequate; for this reason, the calculations are believed to be on the conservative side. It is hoped that this attempt to provide a partial quantification of the economic impact of a tropical disease will inspire investigators to obtain data that may eventually provide the basis for more accurate evaluations of economic losses caused by disease.

RÉSUMÉ

EXAMEN DES RÉPERCUSSIONS ÉCONOMIQUES DE LA SCHISTOSOMIASE

En dépit des pertes colossales occasionnées par les maladies, on s'est peu préoccupé dans les dernières années d'évaluer l'importance de ce fardeau économique. Le cas des maladies tropicales, notamment, n'a guère retenu l'attention et pourtant les maladies infectieuses et parasitaires sont la cause principale de morbidité dans les pays en voie de développement.

On a choisi la schistosomiase comme modèle pour l'étude des conséquences économiques d'une maladie tropicale. Endémique dans 71 pays ou territoires comptant une population totale d'environ 1 milliard 362 millions d'habitants, cette affection atteint approximativement 125 millions d'individus. Ce chiffre, obtenu après un examen approfondi de toutes les données disponibles, est basé sur les taux de prévalence établis le plus souvent à la suite d'un examen unique de selles ou d'urine. Le nombre réel des cas est sans nul doute beaucoup plus élevé.

Les conséquences économiques de la maladie peuvent être classées en trois catégories. On ne tient pas compte ici des frais de fonctionnement des services médicaux relatifs à la lutte contre la schistosomiase ni des sommes dépensées pour les traitements. Seules sont prises en considération les pertes économiques résultant d'une production diminuée de biens et de services.

Pour estimer l'invalidité totale ou partielle causée par la schistosomiase, on a utilisé, lorsqu'ils existaient, les taux provenant de sources dignes de foi. Ailleurs, on s'est fondé sur les données cliniques pour évaluer les pourcentages d'incapacité. Dans tous les cas, les infections graves sont considérées comme provoquant une inaptitude complète au travail, effective ou probable à brève échéance. Les personnes qui en sont atteintes n'apportent aucune contribution à l'économie de leur pays. Les sujets souffrant d'une infection plus légère sont considérés comme ayant une capacité de production réduite de 10%. On estime que, dans le monde, 2 650 260 personnes sont atteintes d'une incapacité totale et 24 782 805 d'une incapacité partielle. Dans certains pays, l'affection n'est pas d'une gravité telle qu'elle diminue l'aptitude du malade au travail.

Pour calculer les pertes économiques imputables à la schistosomiase, on a utilisé un commun dénominateur, c'est-à-dire le produit national brut par habitant (1967) exprimé en US dollars. Le montant annuel du manque à gagner résultant d'une productivité diminuée des per-

sonnes atteintes d'une incapacité totale ou partielle est estimé à $445 866 945 pour l'Afrique, $755 480 pour Maurice, $16 527 275 pour l'Asie du Sud-Ouest, 118 143 675 pour l'Asie du Sud-Est et $60 496 755 pour les Amériques. Le total mondial est de $641 790 130. Ces chiffres sont évidemment très au-dessous des pertes économiques réelles puisqu'ils n'incluent ni les sommes dépensées pour l'exécution des programmes de santé publique et les soins médicaux ni les indemnités pour maladie.

L'auteur souligne qu'il s'agit là d'une évaluation prudente basée sur des données qui sont loin d'être complètes.

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